Department of Agriculture, Food
and Rural Development

Investigations of Animal Health Problems at Askeaton, County Limerick

HUMAN HEALTH

BÓRD SLÁINTE
AN MHEAN-IARTHAIR

Teagasc
Agriculture and Food Development Authority

Environmental Protection Agency

Establishment
The Environmental Protection Agency Act, 1992, was enacted on 23 April, 1992, and under this legislation the Agency was formally established on 26 July, 1993.

Responsibilities
The Agency has a wide range of statutory duties and powers under the Act. The main responsibilities of the Agency include the following:

- the licensing and regulation of large/complex industrial and other processes with significant polluting potential, on the basis of integrated pollution control (IPC) and the application of best available technologies for this purpose;

- the monitoring of environmental quality, including the establishment of databases to which the public will have access, and the publication of periodic reports on the state of the environment;

- advising public authorities in respect of environmental functions and assisting local authorities in the performance of their environmental protection functions,

- the promotion of environmentally sound practices through, for example, the encouragement of the use of environmental audits, the setting of environmental quality objectives and the issuing of codes of practice on matters affecting the environment;

- the promotion and co-ordination of environmental research;

- the licensing and regulation of all significant waste disposal and recovery activities, including landfills and the preparation and periodic updating of a national hazardous waste management plan for implementation by other bodies;

- implementing a system of permitting for the control of VOC emissions resulting from the storage of significant quantities of petrol at terminals;

- implementing and enforcing the GMO Regulations for the contained use and deliberate release of GMOs into the environment;

- preparation and implementation of a national hydrometric programme for the collection, analysis and publication of information on the levels, volumes and flows of water in rivers, lakes and groundwaters; and

- generally overseeing the performance by local authorities of their statutory environmental protection functions

Status
The Agency is an independent public body Its sponsor in Government is the Department of the Environment and Local Government. Independence is assured through the selection procedures for the Director General and Directors and the freedom, as provided in the legislation, to act on its own initiative. The assignment, under the legislation, of direct responsibility for a wide range of functions underpins this independence Under the legislation, it is a specific offence to attempt to influence the Agency, or anyone acting on its behalf, in an improper manner.

Organisation
The Agency's headquarters is located in Wexford and it operates five regional inspectorates, located in Dublin, Cork, Kilkenny, Castlebar and Monaghan

Management
The Agency is managed by a full-time Executive Board consisting of a Director General and four Directors. The Executive Board is appointed by the Government following detailed procedures laid down in the Act

Advisory Committee
The Agency is assisted by an Advisory Committee of twelve members. The members are appointed by the Minister for the Environment and Local Government and are selected mainly from those nominated by organisations with an interest in environmental and developmental matters. The Committee has been given a wide range of advisory functions under the Act, both in relation to the Agency and to the Minister.

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HUMAN HEALTH

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NOTE

This document is one of a five-volume report on the investigations of animal health problems in the Askeaton area of Co. Limerick, carried out in the period 1995 – 1998. The five volumes are as follows:

- Main Report
- Animal Health
- Soil, Herbage, Feed and Water
- Human Health
- Environmental Quality

The investigations were prompted by reports of severe animal health problems on two farms in the Askeaton area, which first came to notice in the early 1990s. In February 1995, following preliminary investigations by Limerick County Council, the Environmental Protection Agency was requested by the Minister of State at the Department of Agriculture, Food and Rural Development to co-ordinate a wider study of the situation. This was considered necessary, as there were local concerns that human health was also being affected in the area and that environmental pollution was involved.

Arrangements for the undertaking of the investigative work were put in place in late February 1995, this being assigned to the Veterinary Research Laboratory of the Department of Agriculture, Food and Rural Development (animal health), Teagasc (soils, herbage and related aspects), the Mid Western Health Board (human health) and the Environmental Protection Agency (environmental quality aspects). Subsidiary studies were carried out by Coillte and the Mid Western Health Board, respectively, on tree health and the levels of metals and other substances in vegetable produce.

Field measurements and observations took place between March 1995 and December 1998. Interim reports were published in December 1995, June 1996 and August 1998.

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BACKGROUND

Sporadic concerns about the occurrence of animal health problems in the Askeaton area of County Limerick have been voiced since the late 1980's and were often perceived locally to be related to the concentration of heavy industry in the Shannon Estuary. These issues came to the fore in late 1994 and early 1995. On 6th January 1995 Mr Donagh O'Grady, a farmer in the Askeaton area, wrote to Mr Martin Duffy, Programme Manager, Mid-Western Health Board. He argued that as the animal problems being experienced in the area were the result of environmental pollution, then the health of people living in the area must also be at risk. At a public meeting on the 10th January 1995, which was attended by Dr Mary O'Mahony, MWHB, widespread concern was raised concerning adverse human health in the local area. The local community expressed concern about the numbers of miscarriages and foetal abnormalities ("Every woman who has one miscarriage has a second"), and the rate of cancer in the local area ("Young people, less than five, dying of cancer"). There were widespread reports of episodes of upper respiratory tract and eye irritation, with some burning of exposed skin. Until the letter mentioned above and this first public meeting on the issue, the MWHB had not been aware of any adverse episodes of human ill health in the area. However local people related that these concerns had existed for the last seven to eight years.

Following this public meeting Dr O'Mahony responded swiftly by contacting six general practitioners (GPs) in the Askeaton/ Ballysteen area requesting a review of the patterns of illness in their practices. The type of adverse health effects which may result from exposure to an environmental hazard could include skin rashes, mucosal irritation, i.e. eye, nose and throat irritation, respiratory problems, abnormal outcome of pregnancy, change in the pattern or incidence of cancer and neurological problems. No cluster of adverse health effects that might be attributable to an environmental hazard was reported by any general practitioner, although isolated reports of health problems of the type described had been received. Later one GP wrote concerning cancer, while others contacted the board when the health status survey was being conducted to offer support. At this point Dr O'Mahony also conducted a literature review of the possible health effects of the known pollutants, as well as holding discussions with local industry and the Senior Environmental Engineer in Limerick County Council.

Following the Ministerial request to the EPA to co-ordinate investigations into the animal health problems in the area, the MWHB was charged with investigating human health and illness patterns and this work commenced in 1995.

A further public meeting on the issue was held on 11th April 1995, following which Dr O'Mahony met Mr Liam Somers and Mr Justin Ryan on 2nd May 1995. At this meeting both Mr Ryan and Mr Somers reported how concerned they were regarding adverse upper respiratory symptoms they and others in the area had experienced. The MWHB continued to meet both a local action group (the Askeaton/Ballysteen Animal Health Committee) and individuals on a regular basis over the period of the investigation. These meetings proved to be essential as they facilitated communication between the local population and the MWHB. At such meetings local people were encouraged to put their questions, concerns, criticisms and comments to the investigating team. The health board was able to feedback results and keep local people updated on the progress of the investigation and the problems encountered. Communication is an essential element in an investigation into suspected environmental pollution and both the MWHB and the local community made good use of such meetings. The MWHB also offered individuals further investigation of health issues by expert clinicians. Some of these offers were accepted, while others were declined.

The Board asked the Department of Epidemiology and Public Health Medicine at UCD to work with it on the project. The two organisations set up a joint Steering Group to oversee the project.

Over the summer months and early autumn of 1995 the two organisations developed the scope of the study and detailed protocols for each element of the proposed investigation.
In November 1995 the MWHB wrote to the Department of Health detailing the protocols for the proposed investigation and seeking funding. The Department of Health responded by approving funding for 1996. At this point in time the Department of Public Health was created in the MWHB and assumed responsibility for the MWHB's investigation. The newly appointed Director of Public Health, Dr Kevin Kelleher, hired a team of personnel specifically to examine human health in the Askeaton area.

Given the relative scarcity of experience of prior pollution investigations in the Republic of Ireland, as the investigation progressed there was extensive consultation nationally and internationally with environmental pollution experts and epidemiologists. A number of individuals experienced in pollution investigations were invited to the Mid-West and their comments and advice sought. These experts included Prof. Tim Aldrich, Environmental Epidemiologist in South Carolina Department of Health & Environmental Control, Dr Nichol Black, Consultant in Communicable Disease Control in Newcastle, England, and Dr Patrick Wall of the Public Health Laboratory Service in Colindale in the UK. Two of these external consultants also attended meetings between the Department of Public Health and members of the local community action group. Such meetings provided a valuable opportunity for local people to ask their own questions, and maintain confidence in the investigation process.

Following the initial contact with GPs in the area, the attention of the investigating team of the MWHB turned to examining in more detail both the health concerns reported by the local population and the relevant health information systems which might be of use in investigating these concerns. Four clear features of this investigation emerged very quickly, which largely defined the nature of the ensuing investigation:

- The first feature was the absence of reports of one specific adverse health effect. Concern among the local population was not limited to just evidence of upper-respiratory tract, eye and skin problems. Other issues such as cancer and congenital abnormalities were repeatedly mentioned. This meant that there was no one clear line of inquiry to investigate. The investigation process was therefore largely a trawl of health data.
- The second feature of the investigation that emerged was that no one pollutant was specifically mentioned. Concern ranged over a number of possible pollutants including aluminium, fluoride, SO_2, NO_2, and particulate matter (PM_{10}). The absence of an explicit pollutant with a known adverse health effect hindered the choice of clear routes of investigation.
- The third defining feature was the almost complete absence of adequate health information systems, particularly computerised health information systems. This deficiency in particular proved to be an enormous impediment to the swift execution of the investigation. The investigators found that where computerised health information systems existed, they were not geographically coded below County level, and therefore expensive and time-consuming effort had to be expended to extract relevant information. Similarly where only paper based health information systems existed, a mammoth task was undertaken by the investigators to access the information. The investigators also found that no useful health information system detailing either miscarriage rates or low-level morbidity existed in the region. This meant that investigators had no alternative but to embark on an expensive and time-consuming effort to assess health in the region through the use of a survey of human health.
- Fourthly, the investigation was hampered by the absence of established Irish, and more particularly rural, norms for many of the health measures. This meant that as well as undertaking an examination of health in the suspected high and medium risk areas of Askeaton and the surrounding area, it was necessary to undertake the same investigation in a number of control areas throughout the MWHB region to facilitate a comparison. This once again slowed the pace

of the investigation and involved an extensive investment of time and resources. The absence of reliable health information systems was particularly noticeable in relation to child health, where other proxy health measures had to be sought and used.

The poor state of the health information systems in existence meant that with the exception of some of the small preliminary studies, there was a significant delay in the ability of the MWHB to respond to the concerns of the local community. This delay left a void in which community concern over possible environmental pollution effects grew unabated. Concerns over differing adverse health effects were given time to develop, which in turn necessitated an increasingly large scale and wide-ranging investigation to evaluate those concerns. By the time of its completion the investigating team had attempted a total of fourteen separate studies, twelve of which were deemed viable and were pursued until conclusion.

RESEARCH QUESTIONS

In the absence of more specific information, this investigation began with three basic questions:

1. What is the health experience of people living in the Askeaton area?

2. Is the health experience of people living in the Askeaton area significantly different from that of people living in similar areas in the MWHB region?

3. Can any observed differences in the health experience of people living in the Askeaton area reasonably be thought to be the result of environmental pollution?

THE STUDY AREAS

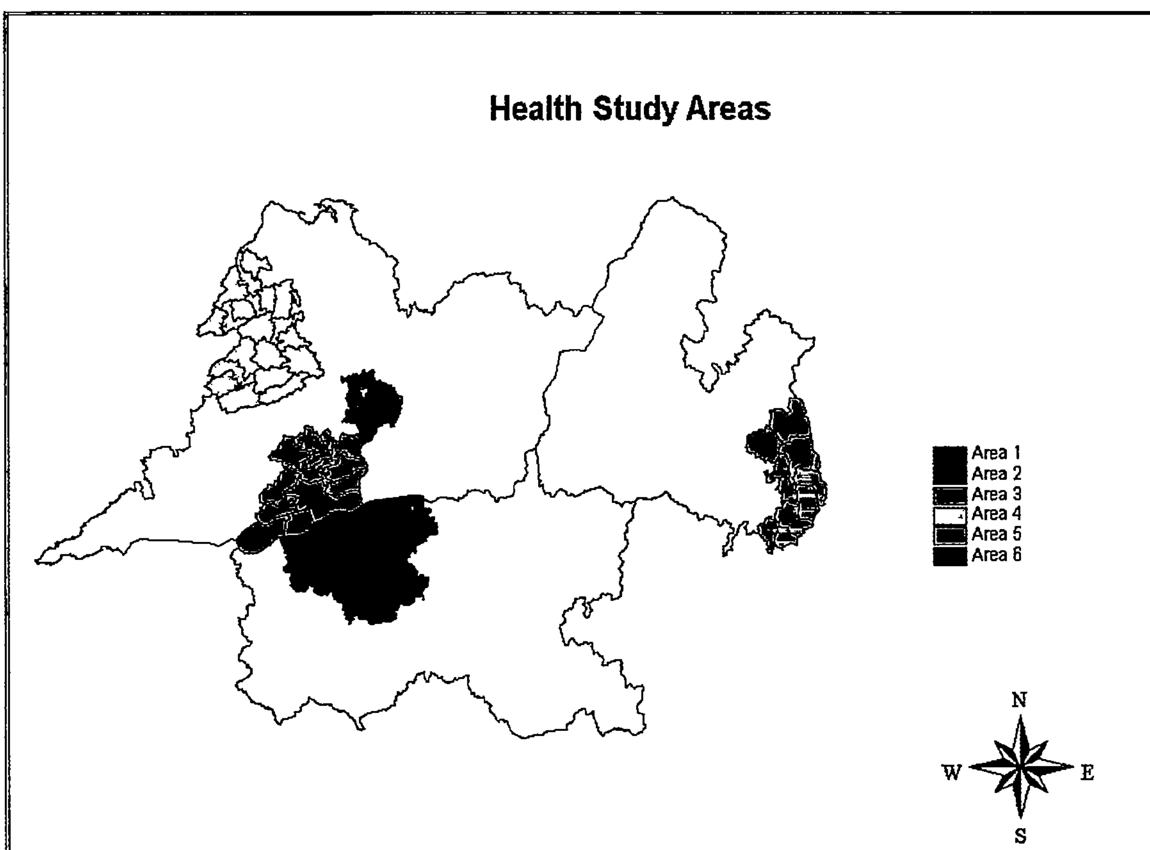
Although the Counties of Clare and Limerick are predominantly rural, a significant amount of industry has developed there in recent years, putting 'rural' Askeaton close to a relatively high concentration of industry by Irish standards. The majority of this industry is based around the edge of the Shannon estuary. The most visible industrial developments are probably Aughinish Alumina near Askeaton, the Roche-Syntex plant in Clarecastle across the estuary and the two ESA power stations of Moneypoint and Tarbert to the west of Askeaton. Although not having a reputation for heavy industry, the scale of the industries along the Shannon Estuary should not be underestimated. Industry along the Shannon Estuary now produces over 50 per cent of Ireland's sulphur dioxide emissions (*see* Chapter Five). In addition to the industries already mentioned above, the presence across the estuary of Shannon Airport and Shannon Aerospace should be noted, as should other industries in Shannon Industrial Estate such as De Beers Industrial Diamonds, SIFA Ltd., and PGP Industries (Ireland) Ltd. Askeaton, itself, has two small industrial premises making expanded polystyrene (Southern Chemicals) and baby food (Wyeth Nutritionals Ireland). The areas to be examined were chosen in the very early days of the investigation.

Previous studies of health effects associated with airborne pollution have identified the geographical area of concern on the basis of:

- available meteorological data on wind direction and strength;
- the local topography's influence on plume transport;
- the results of environmental tests for specific pollutants;
- the basis of nuisance complaints received;
- or a combination of the above.

The EPA and the Technical Group considered the possibility of using similar data to delineate the areas of concern in the Askeaton area. However given the presence of a number of emission sources interspersed through the greater area and the absence of an identifiable contaminant as sufficient cause for the observed animal health problems, the group assessment was that such an approach would be of questionable value. The technical feasibility of adopting such an approach was also questioned. Thus it was agreed that the presence of animal health problems was the best indicator of potential exposure to an environmental hazard for humans. The prime area of concern was the area (area 1, Fig. 4.1) in and around Askeaton where cases of severe animal ill health had been reported. This area encompasses a population of approximately 4000 people in eight DEDs (Askeaton East, Askeaton West, Iveruss, Craggs, Aughinish, Lisnakeery, Nantenan and Riddlestown).

In the majority of the studies in this investigation, the comparison areas were five other areas (Map) throughout the MWHB's area chosen for their similarity to the Askeaton area. However some studies make use of norms for Limerick County or the State as a whole for comparison purposes. The medium risk area (area 2) encompasses the rest of Rathkeale rural district and Rathkeale Urban district. This area effectively forms a rough concentric ring around the Askeaton area. Two further comparison areas were chosen in County Clare. One is situated across the estuary comprising Kill'adysert rural district (area 3), while another in the north of the County encompasses all of Ennistymon rural district (area 4). The final comparison area chosen is in Tipperary North Riding and encompasses Moyne & Litteleton dispensary districts (area 5). As a result of emerging environmental concerns in Clarecastle, County Clare, this area was included in the study as area 6. Area 6 consists of the DEDs of Clareabbey and Doora as well as the southern half of Ennis Rural DED (made up of the townlands of Coor, Cahircalla More, Cahircalla Beg, Shantulla, Ballymacaulla, Keelty, Kilnacally, Ballylinnidy, Shanvogh, Clonroad More, Bunnow, Gaurus, Drumbiggil).



Map.

OUTLINE OF THE STUDIES

The majority of studies that took place in the Askeaton investigation are examined in more depth in the Human Health Volume. This chapter is an overview of the main findings and characteristics of each study. However the chapter will also fully detail a small number of studies which were either very compact or unfeasible. The studies were all ecological in design, comparing the health experience of the Askeaton area with other similar areas within the MWHB region. What follows is a short description of each of the studies.

Literature Review Of The Effects Of Common Atmospheric Pollutants On Human Health*

Comment on the effects of pollution on mortality has been traced back to Graunt's Bills of Mortality in 1662. Since the industrial revolution the volume of pollutants has increased. The rapid industrialisation seen in Western Europe and North America in the last century led inevitably to air pollution disasters. These were characterised by short-term episodes of overload of the local atmospheric pollutants, notably in the Meuse Valley in Belgium in 1930, in Donora in Pennsylvania in 1948 and in London in 1952. Following the well known episode in London in 1952, which was associated with approximately 4,000 more deaths than would have been expected in a similar, normal time-period, the Clean Air Act, 1956 was passed in the United Kingdom and was followed in 1963 by its equivalent in the United States of America. The first pollutant to be identified as damaging was black smoke and following the 1952 smog episode in London black smoke and sulphur dioxide were the parameters adopted for monitoring. Since then several other pollutants have been identified and different categories of size of particulate matter have been established. Over the last twenty years the Environmental Protection Agency in the United States of America, the World Health Organisation and the European Union have all developed their own standards or guidelines as to the permissible level of these substances.

Research has shown that health effects due to air pollution tend to be acute. Less information is available on possible long-term effects upon health. Those with respiratory disease are most likely to demonstrate ill effects due to airborne pollution. Other research has indicated that the effects of air pollution may magnify or add to the effects of other risks to respiratory or cardiovascular health. Cigarette smoking is the cardinal cause of this condition but there is evidence that atmospheric pollution may also contribute. Environmental studies have shown that these diseases are more commonly found in urban areas particularly those with heavier atmospheric pollution. Evidence exists that chronic bronchitis and emphysema are aggravated by smoke, sulphur dioxide and other pollutants, and that patients with these conditions do less well during these episodes.

It should be noted that childhood asthma has increased by about 50 per cent in the last 30 years in the United Kingdom against a background of diminishing emissions of coal, smoke and sulphur dioxide but increasing levels of nitrogen dioxide and volatile organic compounds. Although atmospheric pollution may exacerbate asthma, there is no evidence to suggest that it causes the condition.

The evidence of the health effects of atmospheric pollutants appears stronger in relation to day to day variations rather than chronic exposure to long term average concentrations. Some studies have led to the assertion that there is no safe level of exposure to particles. This remains unproven. The effects on cardiovascular disease remain unquantified. It is possible that exposure to air pollutants may precipitate deaths which would have in any case occurred very soon. This would not affect the

* Details of the scientific literature consulted in writing this section are given in the Human Health volume.

number of deaths brought about by air pollution but would affect the public health importance of such pollutants. The time scale involved is unknown - were it only a few days, perhaps, it may not be so important but were lives to be considerably shortened then it would obviously become a more important public health issue.

Air pollutants and ill health are undoubtedly linked. The only dispute in the last 50 years has been about the relative contribution of constituent pollutants and the ambient levels at which such pollutants are likely to produce their effects. Many of the contradictory conclusions arising from the literature over the years have been resolved by the use of advanced statistical techniques to overcome the many sources of confounding factors in studies into the health effects of atmospheric pollutants. Atmospheric pollution has not been demonstrated *per se* to cause disease but it can exacerbate pre-existing conditions The effects of smoke and particulate matter on mortality and morbidity are well documented and while airborne particles appear to have the most profound influence, sulphur dioxide is increasingly recognised as being associated with increased mortality and morbidity, independent of the effect of particle. The adverse short-term effects of sulphur dioxide on the airways of asthmatics, mortality and the admission patterns of elderly subjects and children have been extensively documented. Long-term exposure has recently been recognised as having an adverse effect on survival in the general population.

The standards currently in place in the US and Europe are dramatically lower than was the case even 15 years ago, but health effects in response to atmospheric pollutants, are being demonstrated at levels at and below these standards. If this is the case, then are the statutory guidelines sufficiently stringent, particularly given the changing nature of the pollution to which we in the West are subjected, to protect the public from harm?

Recent data from the APHEA European Cities Pollution Study has suggested that smaller rises in ambient pollution levels in western Europe are required to produce the same mortality effects as seen in central European cities, suggesting a greater sensitivity to pollution effects amongst the population of western Europe. A subsequent study has shown that sulphur dioxide concentration and mortality for cardiovascular and respiratory conditions as more strongly associated in western Europe than in central Europe and that this effect is more pronounced for sulphur dioxide than for particulate matter. These results suggest that populations who enjoy the cleanest air may be more likely to react adversely to even modest levels of air pollutants and if this trend continues that health effects may continue to be seen at levels below what are considered "safe".

The Births and Congenital Abnormalities Study

Background

At the public meeting in early 1995, concern was expressed about the level of congenital abnormalities among new-born children and the number of miscarriages suffered by women in the area. One particular concern was the rate of multiple miscarriage in individual women. However in assessing the rate of congenital abnormalities it is important to note the 'normal' rate, which one would expect to find in any area. Internationally, the rate of congenital abnormality is approximately 2.2 per cent of all births. However it should be noted that minor physical abnormalities which have no surgical or cosmetic significance could occur in up to a further 4 per cent of births. It is thought that environmental causes are responsible for about 10 per cent of human birth defects, while genetic causes are estimated to account for 20-25 per cent of such defects. However, over 60 per cent of birth defects are of unknown aetiology.

Unusually in a case of suspected industrial pollution, the Department of Public Health was given no clear picture of specific abnormalities to investigate in the target area. No reports of clusters of specific abnormalities were reported. Alternatively, in the absence of such case reports, it is often normal for investigators to be made aware of a specific environmental pollutant, with a known effect. This in turn would allow investigators to focus their attention in a specific direction. However no clear contaminant was identified and concern ranged over a number of known pollutants.

Aim and Method

The aim of this study was to determine if the rates of congenital birth defects in Askeaton were normal, or indicative of possible environmental pollution. For the purpose of this study Askeaton was designated the "high risk area", the area around Askeaton was designated as the "medium risk area", while the remainder of Limerick Community Care Area was used as a control area. The study time frame covered the period from 1987 until 1994, as this was the period of concern.

Cases were defined as all malformed live and stillbirths to mothers resident in the defined geographical areas. These included structural malformations, chromosomal abnormalities, metabolic disorders and hereditary diseases. Malformations were classified into subgroups indicating their mutagenic (e.g. Downs syndrome) or teratogenic origin and known association with environmental exposures. The form in which the information was available did not allow for the identification of all abnormalities where more than one major congenital abnormality was present. This report as a consequence does not differentiate between individual types of abnormalities. A case is a baby or stillbirth not an abnormality. The EUROCAT system of coding includes metabolic and genetic diseases such as Phenylketonuria (PKU) and Cystic Fibrosis. Whilst these cases have been identified, they are kept apart from the rest of the study as their cause is known to be genetic and not environmental.

This study necessitated the perusal of over 14,000 manual records, due to the absence of any form of more advanced recording system. Supplementary sources of potential information on congenital abnormalities were also examined. These were Special Care Baby Unit records, Public Health Nurse records, Counselling Nurse records, Long Term Illness records, domiciliary care allowances and official birth notices. All still birth records were examined in the Limerick, Cork and Tralee hospitals in order to ascertain whether a congenital abnormality was present.

Results

Table 1

Prevalence Rate /10,000 births per year of cases of congenital anomalies in Limerick and other registries

Area	**Year**								
	1987	***1988***	***1989***	***1990***	***1991***	***1992***	***1993***	***1994***	***Mean***
Area 3	136	85	132	138	144	73	92	117	115
Area 2	64	0	73	125	280	300	170	86	129
Area 1	160	170	170	0	0	0	217	0	90
Area 1+2	92	46	103	92	188	222	185	57	118
Dublin*	283	274	209	227	227	227			
Galway*	229	171	144	223	295	295			
EUROCAT*	231	216	220	210	203	203			213

- * prevalence rates only available to 1992 EUROCAT

Of the total number of 14,906 births in Limerick Community Care Area during the study time frame, just 443 (2.97 per cent) were from area 1, while 1078 (7.23 per cent) were from area 2 and 13,385 (89.79 per cent) infants were born to women resident in area 3. There were 98 still births during the eight years giving a still birth rate of 6.6 per 1,000 live and still births. This rate is the same as the most recent national rates (1986-1992).

Between 1st January 1987 and 31st December 1994, 191 cases of congenital abnormality were identified in Limerick community care area. Of the total number 95 per cent (n =183) were liveborn and just 5 per cent (n =4) were stillborn. More males (52.3 per cent) than females (47.7 per cent) were born with a congenital abnormality. This includes 12 cases of Cystic Fibrosis and 7 cases of PKU. For the purposes of the analysis these cases have been excluded as they have a genetic basis and therefore are not considered to be congenital abnormalities. Thus, the total number of cases in the study was 172 of which four came from the high-risk area, 14 from the medium risk area and 154 from the control area (area 3). The total prevalence rate of congenital abnormalities in Area 3 during this period was 115/10,000 births. The annual prevalence rates in areas I and 2 fluctuated during this period, which probably reflects the uneven and incomplete nature of data, and the small numbers involved available in this study (Table 1) Overall rates in area 3 are relatively stable which reflects the larger sample size. The prevalence rate per 10,000 was highest in area 2 (129/10,000) and lowest in area 1 (90/10,000). When area 1 and 2 are combined the rate is 118/10,000. Comparing area 1+ 2 with area 3 there is no statistically significant difference between the two areas.

Discussion

Overall the rate of congenital abnormality is lower than in other European registries but within the norms accepted internationally (1-2 per cent births). The results show rates for the eight-year period, which are lower than the control area for the high-risk area and very slightly higher for the medium risk area. Neither of these rates is statistically significantly different from the rate for the control area.

The main problem affecting this study is the whole issue of small numbers. The number of cases and the number of births in both areas 1 and 2 were small, especially in area 1. This can lead to a number of difficulties in interpreting the data. There is likely to be much greater year on year fluctuation and one extra case could result in a 20 per cent or even 100 per cent increase. Unfortunately the study has been affected by the poor quality, accessibility and structure of the base data. An investigation, which involved the perusal of 14,000 manual records, was by necessity prolonged beyond its anticipated finish date. Data collection for this study was severely hampered by a number of factors. These included the absence of computerised records, limited information on still births, missing records, imprecise diagnosis and missing information on both medical records and birth notification forms. In addition information on births occurring outside the Mid-Western Health Board to unmarried mothers resident in Limerick who were not keeping their baby was missed.

Early warning systems of surveillance can be effective for the detection of large increases in rare and well-defined anomalies, which are easily diagnosed at birth. For the detection of smaller increases in prevalence in common anomalies a well validated data set is needed as well as longer duration of surveillance. It is desirable to conduct enhanced surveillance of public health in the Shannon Estuary Area so as to enable the timely detection of outbreaks or clusters of adverse health events and to determine trends in the overall number of cases. Baseline health status could be determined and in time the pattern of incidence rates according to gender, age, socio-economic status and other variables could be described. Such information would offer substance for testable hypotheses in the event of public health concerns arising in the future. This study was costly, time consuming, arduous and suffered from poor data quality. It is recommended that a structured and systematic surveillance system should be put in place to allow routine analysis of trends in congenital abnormalities in the region. This should be the EUROCAT system to allow comparison with other parts of Ireland and Europe.

The Sex Ratio Study

Background

Normally male births exceed female births. The sex ratio refers to the ratio of male births to female births. However alterations in the usual sex ratio pattern have been associated with airborne pollution from steel foundries and from incinerators. It has been suggested that as male infants and foetuses are weaker than females, unborn males may be more susceptible to the adverse effects of environmental pollution. Environmental and other occupational health research suggest that change in the sex ratio in births in favour of girls may be an early indicator of environmental hazards of importance to public health.

Aim and Method

The aim of this study was to examine if the sex ratio of births in Askeaton was normal, or indicative of possible environmental pollution. For the purpose of this study Askeaton was designated the "high risk area", the area around Askeaton was designated as the "medium risk area", while the remainder of Limerick Community Care Area was used as a control area. The study time frame covered the period from 1987 until 1994. To examine the sex ratio for births, gender details on births in the areas were obtained from the community care birth lists compiled from the midwife and official birth notifications. A check with the public health nurse birth registers in the areas 1 and 2 was also undertaken to confirm geographic coding. Data on birth notifications without information on gender were obtained by a further check with the public health nurse.

Results

The sex ratio overall was 1.08:1 males to females which is similar to national norms (Table 2) There was a slight increase of males in areas 1 and 2 compared with area 3, but no more than would be expected by chance (This is what is meant by the term non-significant). If an abnormal sex ratio was present, one would expect fewer males rather than more males, which was the case here.

Table 2

Birth Sex Ratios 1987-1994

	Area 1+2 Study area	*Area 3 control area*	*Total*
Males Births	800	6,919	*7,719*
Female Births	719	6,438	*7,157*
Totals[1]	1521	13365	*14,884*
Male sex ratio	1.11	1.07	1.08

[1] Sex was not given for some birth records

Discussion

Overall the ratio of male to female births is actually higher rather than lower than national norms, the opposite of what might be expected in an area of environmental pollution. However, as in all three of the birth studies that formed part of this investigation, one major difficulty is the small number of births involved. Of the total number of 14,906 births in Limerick Community Care Area during the study time frame, just 443 (2.9 per cent) were from area 1 while 1078 (7.2 per cent) were from area 2 and 13,385 (89.7 per cent) infants were born to women resident in area 3.

The Twin Rates Study

Background

Media reports alleged that an increase in twin births among farm animals, especially dairy cows, had been seen in the area around Askeaton. Some years ago a study carried out in Scotland looked at the geographical distribution of twinning during the period 1975 to 1983 in defined geographic areas which were considered by some health authorities to be most at risk from air pollution from incinerators. An increased frequency of human twinning was found in these and was accompanied by a dramatic increase in twinning among dairy cattle about the same time. While there was no concern expressed by the community of an increase in human twinning in the Askeaton area, an examination of twinning rates was carried out to see if a similar relationship existed.

Aim and Method

The aim of this study was to determine if the rates of twin births in Askeaton were normal, or indicative of possible environmental pollution. The definition of a twinning rate is the number of twin births per thousand births. For the purpose of this study Askeaton was designated the "high risk area", the area around Askeaton was designated as the "medium risk area", while the remainder of Limerick Community Care Area was used as a control area. The study time frame covered the period from 1987 until 1994. To examine the twinning rate details on births in the areas were obtained from the community care birth lists compiled from the midwife and official birth notifications. A check with the public health nurse area birth registers in the areas 1 and 2 was also undertaken to confirm geographic coding.

Results

The twinning rate overall was 12/1000 which is similar to national norms (Table 3) There is no increase in the twinning rate in area 1 which had a rate of 9.1/1000. Although area 2 has a higher rate (14.1/1000) compared with the remainder of Limerick community care area (12/1000), this difference is not greater than would be expected due to chance variation.

Table 3

Twin Birth Rate January 1 1987 – December 31 1994

	Area 1	*Area 2*	*Area 3*	*Total*
Births[1]	439	1,063	13,222	***14,724***
Twins	4	15	159	***178***
Total	**9.1/1000**	**14.1/1000**	**12/1000**	***12/1000***

[1]Twin birth counted as a single event here

Discussion

The twin rate observed in Askeaton is actually slightly lower, although not significantly, than the County and State norms. The reverse would have been predicted in an area of environmental pollution. However as in all three birth studies which formed part of this investigation one major difficulty is the small number of births involved. Of the total number of 14,906 births in Limerick Community Care Area during the study time frame, just 443 (2.9 per cent) were from area 1 while 1078 (7.2 per cent) were from area 2 and 13,385 (89.7 per cent) infants were born to women resident in area 3.

The Survey of General Practitioners' Perceptions of Health Problems in their Practices

Background

Preliminary investigations were carried out of six General Practitioners in the Askeaton area in 1995. GPs in this area were requested to review the pattern of illness encountered in their practice. The type of adverse health effects which may result from exposure to an environmental hazard could include skin rashes, mucosal irritation, i.e. eye, nose and throat irritation, respiratory problems, abnormal outcome of pregnancy, change in the pattern or incidence of cancer and neurological problems. No cluster of adverse health effects that might be attributable to an environmental hazard was reported by any general practitioner, although isolated reports of health problems of the type described had been received.

However despite this result it was felt that as GPs are the main health contact for most individuals, a more systematic analysis of GP experiences should be undertaken. General practice is relatively underdeveloped in Ireland compared to Britain. Approximately one third of the population are entitled to free medical care at the primary level (General Medical Service entitlement - the medical card). Entitlement is based on income assessment and is highest in deprived urban areas, rural areas and to those who are self-employed, have serious illness or are elderly. The remainder of the population, not covered by a GMS card, are private patients who may attend more than one GP. Most general practices therefore do not have defined private practice populations with age/sex registers of all their patients. Therefore for research purposes they are of reduced value. In addition few practices are computerised throughout the country. It should be noted that not all GPs record each patient contact either on paper or on computer. The Department of Public Health therefore decided to conduct a postal survey of GPs using questions with a similar format to that used in the main health status study.

Aim and Method

The main aim of the study was to describe the perceptions of GPs regarding patient morbidity and environmental hazards in six geographically defined areas in the MWHB region and to see if there were significant differences between them. The specific objectives were to assess whether GPs in Askeaton and Rathkeale compared with other areas had noted an increase in number of patient consultations for respiratory symptoms, sinus and skin irritations, cancers and serious illness over the past one year and, for fertility problems, cancer and serious conditions, over the past ten years.

A questionnaire was sent to all GPs registered with the MWHB as being in either private or public practice in one of the six defined areas during the month of November 1996 (Each area was based on the population sampled for the human health study and included Askeaton, Rathkeale, Killadysart, Clarecastle, Ennistymon and Littleton/Moyne.) GPs in towns adjacent to the six areas were also included for practical reasons. GPs were asked if they had concerns about respiratory, skin and sinus/throat diseases within the past year. Details of the age group of patients most affected were requested and other additional relevant information. GPs were also asked if they had concerns about fertility problems or unusual numbers of cases of miscarriages in their practice population within the past 10 years, or if they had specific concerns about health problems in the practice population. In addition they were asked about unusual numbers of patients with serious illnesses within the past one to ten years. Serious illness was not defined, but examples were given such as cancer, leukaemia and neurological problems. Finally GPs were asked to give their views on environmental hazards in their area. In light of the small numbers involved for the purpose of analysis, the Askeaton and Rathkeale areas were combined. All other areas were treated as controls. GP perceptions were examined by county of residence.

Results

A total of 50 general practitioners were contacted. A response rate of 68 percent was achieved.

- Fewer doctors in the exposed area had concerns about sinusitis/rhinitis than GPs in non-exposed areas. (15.3 per cent compared with 23.8 per cent).
- Four doctors indicated that they had noticed an unusual number of miscarriages in the past 10 years. Amongst comments received were that miscarriages were clustered in areas. The number of doctors concerned about miscarriages in the exposed area was three (23 per cent) compared with one (4.8per cent) in the non-exposed area (a ratio of 4.85 but the confidence level did not reach statistical significance).
- Seven GPs (20.5 per cent) said that they had experienced an unusual number of cases of serious illness in their practice in the past year. These included brain tumour, leukaemia, pancreatic and oesophageal cancers. Proportionally fewer doctors replied that they were concerned about serious illness in the exposed area than in the non-exposed area (ratio 0.69). Six doctors (17.6 per cent) were concerned about the rate of serious illness over the past ten years (examples given included childhood cancers, health problems in older people, depression, deaths in young men).
- In contrast proportionally more doctors in the exposed area were concerned about illness over the past ten years. However this was not statistically significant (ratio 1.76 CI .42-7.3).
- About one in three general practitioners said they had more than usual concerns about specific health problems in their practice, 38 per cent in Askeaton/Rathkeale compared with 25 per cent of the remainder.
- The health problems cited at least twice were asthma and chest diseases, smoking and cancer in young people. Other health problems mentioned once were obesity, hypothyroidism in women, childhood autism, air pollution, public worries about health and numbers of patients with skin rashes.

A recurring theme throughout several commentaries was the lack of information or accurate statistics to answer these queries: "patients express concerns about miscarriage but I don't have specific knowledge" and "this has been queried but there are no hard facts" were some of the replies.

The results indicate that general practitioners have a variety of concerns about their patients' health. GPs in Askeaton/Rathkeale were more likely to be concerned about rates of miscarriages, incidence of serious illness and specific health problems in their practice compare with those in "non exposed areas". However, doctors in the latter areas had proportionally more concerns about other illnesses including respiratory problems, sinusitis and incidence of serious illness within the past ten years. Over a third of doctors in Askeaton/Rathkeale compared to a quarter of GPs elsewhere were concerned about environmental hazards in their area.

Discussion

Overall the 34 general practitioners who responded to the questionnaire did not indicate undue concern over their patients health. There was a trend throughout all areas of a perception of an increase in respiratory problems especially asthma in younger patients. General practitioners in all areas were also concerned about specific health problems in their practice, which were mainly related to smoking, air pollution, chest diseases and patient perceived worry. Overall just under one third of doctors had concerns about the environment and these related mainly to air pollution, food and water pollution and road traffic accidents. There was no consistent variation in the perceptions of general practitioners regarding patient morbidity in their practice, although GPs from the exposed area did express proportionally more worries about rates of miscarriage and serious illness over five years and had more health concerns about their patients. This may reflect the level of anxiety conveyed to general practitioners by their patients and their own proximity to major industry.

Overall, there was no statistically significant difference in perception among general practitioners between exposed and non-exposed areas and between counties Clare, Limerick and Tipperary.

It must be stated that GPs in the Mid Western Health Board area do not have accessible information on patient morbidity in their practices and that the study was unable to answer questions about patient morbidity because of lack of routinely recorded or computerised records. The renewed introduction and support of a widespread system of GP sentinel practices and the whole-scale introduction of computerised GP patient information systems are highly recommended. Given the reality that only an estimated five per cent of GP consultations are referred on for further consultation, the potential of both quality sentinel systems and more accessible computerised GP information systems cannot be ignored.

The Health Status Survey

Background

In the light of the poor human health information systems that existed at the time of the Askeaton investigation, the decision was made to conduct a survey of human health in the risk and comparison areas. In order to respond to community concerns a number of different areas still required investigation. These included illnesses such as upper respiratory tract problems, eye and skin irritation. Another focus of this research was an examination of pregnancy outcomes, particularly given community concerns over miscarriage rates. In the light of the importance of this issue, the size of the target sample of women of child bearing age (15-44) was doubled compared to all other groups.

A key task of this study was to examine 'low level' morbidity. None of the data sets examined elsewhere, when this study was designed, could measure low levels of illness that might not even require presentation to a GP. Such an analysis was important given the likely low-level effect of environmental pollution. This study was felt to be vitally important because many of the other elements to the Askeaton investigation were retrospective analysis of existing routine data sets, not designed for such an environmental pollution investigation. This survey was however designed solely to answer these concerns. One obvious concern in undertaking an investigation into self-reported health of this type is the effect that community concerns can have on people's evaluation and memory of their health. People may focus very attentively on and remember every symptom and episode when alerted by concern over environmental health. In areas where there is no such concern however such instances may be ignored and quickly forgotten.

There was consultation between the Department of Public Health and the local community group on the study design. The local group reviewed the questionnaire and made recommendations on changing the order of some sections of the questionnaire. Such comments were welcomed and the suggested changes were implemented.

Aim and Method

The main objective of the human health study was to examine geographical patterns in human health to see if there was any association with the reported pattern of animal ill health. The study was an interviewer administered questionnaire on self-reported health and ill-health. There were six study areas, viz. Askeaton, from where animal health problems had been reported, Rathkeale, adjacent to Askeaton, and four comparison areas - Ennistymon, Killadysert, Moyne and Littleton and Clarecastle.

The questionnaire was comprised of nine separate sections:

Section 1 - The Short Form-36 The largest single piece of the questionnaire is the Short-Form 36 questionnaire (a very well validated questionnaire), usually just called the SF-36. This is a set of 36 questions, developed and evaluated by the Medical Outcomes Trust in the USA. Their purpose is to provide a general measure of health, the SF-36 score, and a set of more specific measures of health and well being. The SF-36 is not appropriate for children, and was asked only of those aged 15 and over.

Sections 2,3 and 4 - The Symptom questionnaires These three sections focus on specific symptoms. The first of these was a set of questions on chest symptoms, such as coughing, wheezing, treatment for asthma, and hay fever. The next was a set of questions about skin disease. These include questions on itching, flaking skin, dry skin and so on. Finally, there was a set of questions about general health, including questions on tiredness, on aches and pains, dizzy spells, ear problems, sickness, and allergies.

Section 5 - Pregnancy, fertility and childbirth This section inquires about pregnancies, babies, and difficulties in getting pregnant. Every pregnancy mentioned by the women interviewed is recorded, and basic details of the outcome are documented. Only women aged between 15 and 44 were asked these questions.

Section 6 – Lifestyle This section was a series of questions about diet, changes in diet, smoking and drinking, exercise and use of televisions, computers and video games. Only people aged 15 and over were asked these questions.

Section 7 - Social details This section asked about social and demographic factors such as housing, work, education, farm or land ownership, as well as asking for self-reported weight and height. Everyone was included.

Section 8 - Concerns about the environment This section examined how worried respondents were about the environment, and what action they had taken about this worry. It also investigated which aspects of the environment concerned participants most. Only people aged 15 and over were included.

Section 9 - Animal health This was a set of questions for people who lived on farms where cattle are kept. This section was included to facilitate the research being conducted by DAFRD and was not examined by the Department of Public Health.

Ireland has no population register and given the limitations of the electoral register the Economic and Social Research Institute (ESRI) was commissioned to identify participants for the survey. Given the strict stratified sampling frame used in this research project the ESRI worked from the electoral register to identify demographic (age and sex) details of household occupants prepared to take part in the sample. From respondents who agreed to take part in the research, a random sample of people, ranging in age from 1 year old to 69 years old was chosen. The target sample size for each area was 450 people. This was comprised of 50 people of each sex in each of four age groups (1-4, 5-14, 15-44, 45-69), with the exception that the female 15-44 year age group had a sample size of 100.

The questionnaire was interviewer administered, and in light of the sensitivity of the questions, all of the interviewers were nurses, the majority of whom worked as public health nurses. Ten per cent of respondents who completed interviews were contacted either by telephone or in person to verify that the interview had in fact taken place. The ESRI achieved a participant rate of 77 per cent in valid households. The nurse-interviewers completed 2480 interviews from 2697 people, giving an overall response rate of 71 per cent.

Results

Study areas were compared with and without statistical adjustment for other factors, such as age and socio-economic status. Results were similar irrespective of this adjustment. It is important to note that the overall finding of this study is the low level of reported illness and ill health in any of the study areas. The median score on many of the measures used was zero, indicating no health problems were reported. However examining the different areas in more detail, a clear pattern of similarities and differences emerges (Figs 1-3).

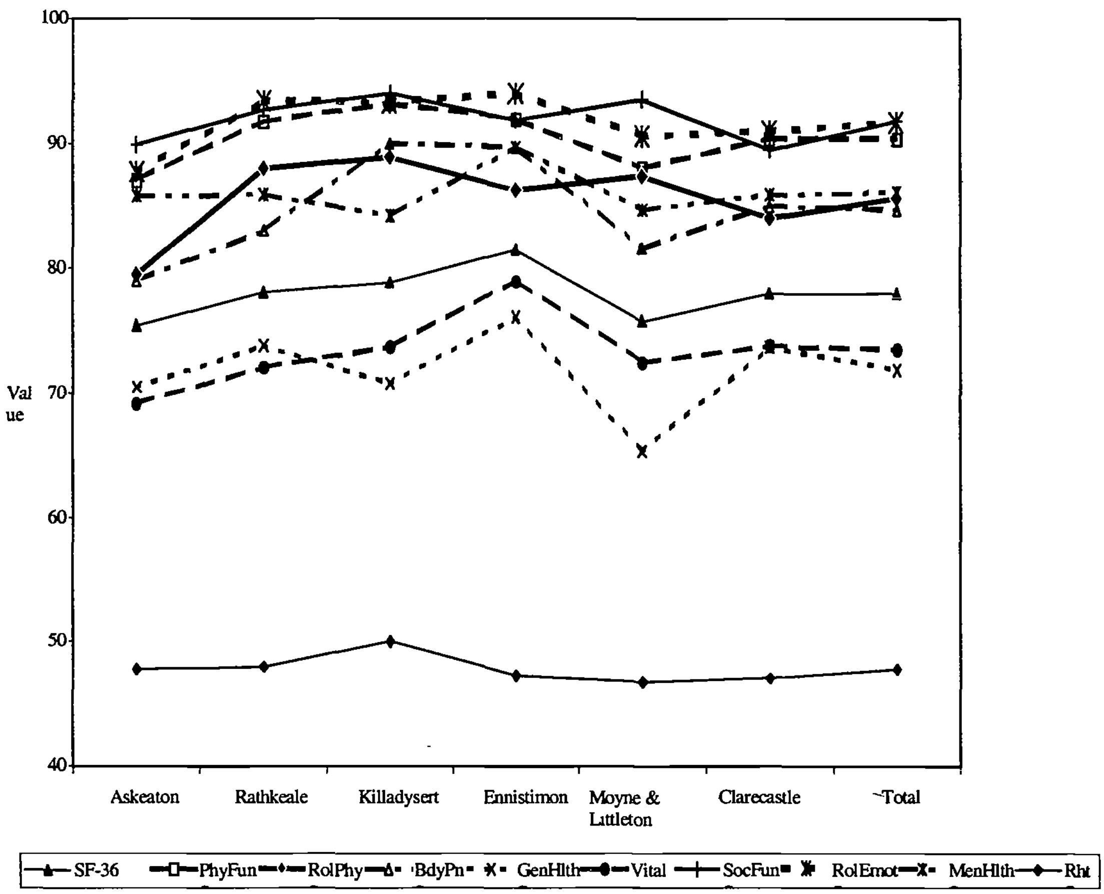


Fig. 1 Sf-36 scores by area (PhyFun: physical functioning; RolPhy: role limitations due to physical problems; BdyPn: bodily pain; GenHlth: general health; Vital: energy/vitality; SocFun: social functioning; RolEmot: role limitations due to emotional problems; MenHlth: mental health).

The SF-36 total and sub-scale scores indicate that Askeaton residents report worse health than the other areas. That worse health experience is equivalent to the difference between men and women or to the health experience of somebody who is five years older. However residents of the Moyne & Littleton region of Tipperary North Riding reported a similar health experience. On the asthma measure Askeaton and Clarecastle both had high scores, well in excess of those found in Killadysert and Ennistymon. The respiratory disease measure revealed that Askeaton, Clarecastle and Moyne and Littleton had the worst health experience in this domain. Similarly on the general health measure Askeaton, Moyne and Littleton and Clarecastle report the worst health. The skin disease measure again shows this pattern, with Moyne and Littleton reporting the worst health in this area, followed by Askeaton. The pregnancy and birth outcomes information section found no statistically significant differences between the six areas.

Discussion

Some statistically significant differences in self-reported health were detected among the six study areas. The actual impact of many of these differences is debatable, as many are of little or no clinical significance.

However a general pattern emerged in that Askeaton, Clarecastle and Moyne and Littleton tended to have a similar level of self-reported health, that was somewhat poorer than that observed in Rathkeale, Ennistymon and Killadysert. This pattern is not consistent with any known pollution source.

Fig. 2 Mean Health Scores by area

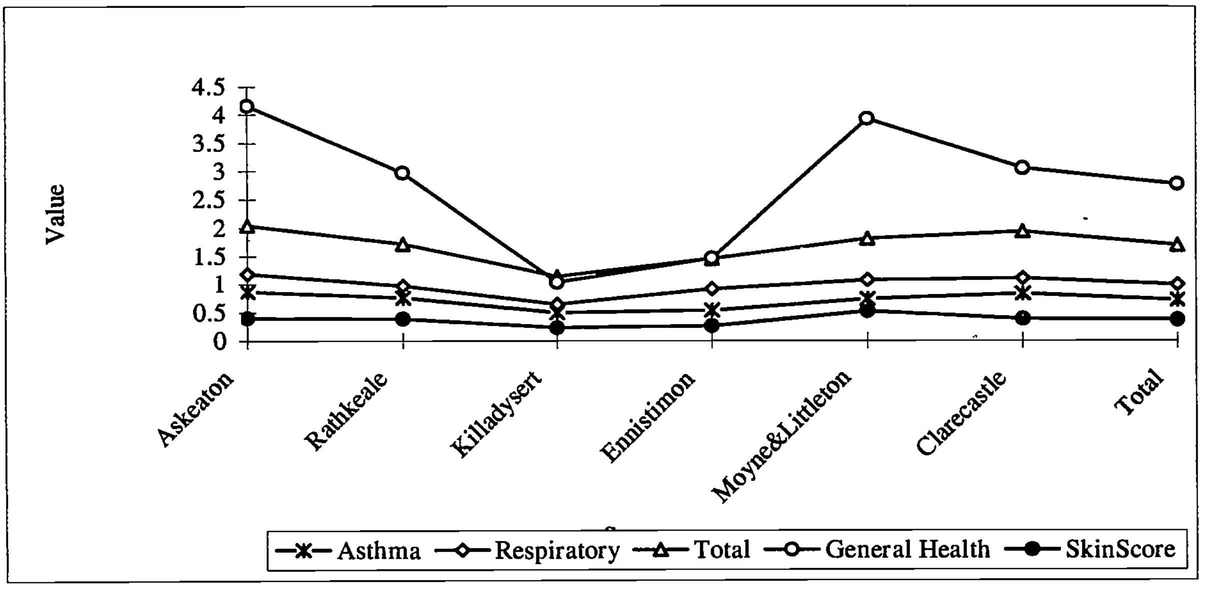
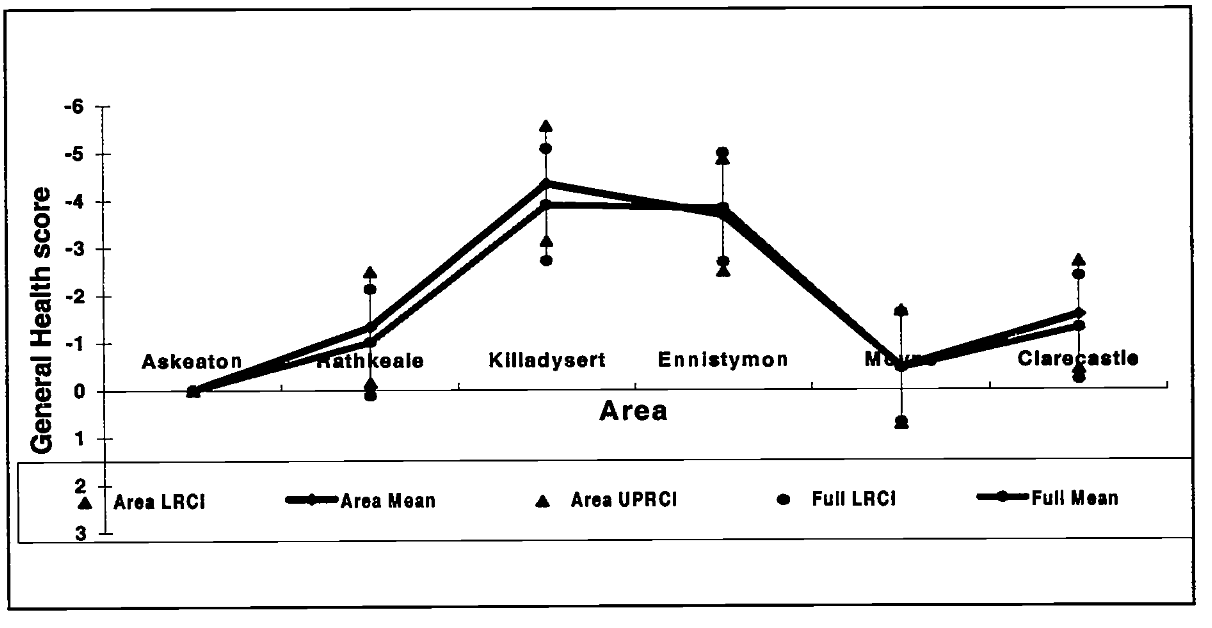


Fig 3 General Health Scores by area.



The Acute Health Effects/Diary Study

Background
Given the reports of extreme animal ill health on a number of farms in the Askeaton area, and reports of human ill health, it was decided to examine the health of individuals on farms in the affected area in more detail. Aim and Methodology

The study had five aims:
- To identify acute health problems recorded prospectively by family members in a one-year period.
- To determine the prevalence rates of symptoms of the upper respiratory tract, eye and skin irritation.
- To investigate if some family members experienced more health problems than others.
- To investigate seasonal differences in the health status of family members.
- To investigate possible causes of health problems.

All of the farms that participated in this study had experienced unexplained animal death or animal ill health. The method of inquiry was a diary study conducted over a 13-month period. A total of 26 families agreed to take part in the study, although by the end of the study only 19 were still involved. For the purpose of the analysis only 18 were included, due to incomplete data in one instance. Despite this drop in the numbers, the adherence rate was much higher than would have been anticipated from the literature, where it is noted most diary studies usually only last short periods, such as one or two weeks. Each family taking part in the study appointed a family co-ordinator for the project. Each day the family co-ordinator would record the presence of health problems on a dedicated form for all members of the family. Each month the survey co-ordinator visited the farms, collected the previous month's diary and gave participants a new set of forms. Demographic information on each individual was collected, as well as the number of family members reporting symptoms and the number of symptoms recorded by each family member. Information was collected on the number of recurring days each symptom persisted, the mean severity of each symptom, action taken to alleviate symptoms, as well as the perceived cause of the symptoms. Symptoms recorded by each family were re-coded into the following categories: Respiratory, Eye, Skin, ENT, Mental Health, Skeletal-muscular, Gastrointestinal, Fatigue and Other.

Results
The 76 individuals (18 families) recorded a total of 1353 symptoms. In total, 11,827 days were reported as ill days by respondents. Respiratory symptoms were the most commonly reported symptoms (19.5 per cent), followed by ENT symptoms (16.4 per cent), skin symptoms (13 per cent) and fatigue (12.6 per cent). Reported symptoms peaked in the winter months (Fig. 4.5) and the rate for children was in all months slightly lower than that for adults (Fig 4.6).

Five individuals reported high levels of morbidity throughout the study. These five individuals accounted for 550 symptom episodes and 6475 ill days. In addition they accounted for almost half of all fatigue symptom days. The results clearly show a pattern of two farm households with extremely poor health, three farm households with moderate health and the remainder with good health. In the absence of a control population, it is not known if this finding is of any significance.

Discussion
The problems inherent in this type of self-reporting study are significant. This type of study is obviously highly subjective. Given the long duration of the study (13 months) it is possible to

influence health behaviours as well as sensitising individuals to focus on their health status. Five individuals suffered an excess of low-level morbidity over a protracted period. However, most of this ill health did not require consultation with a GP or any other health professional.

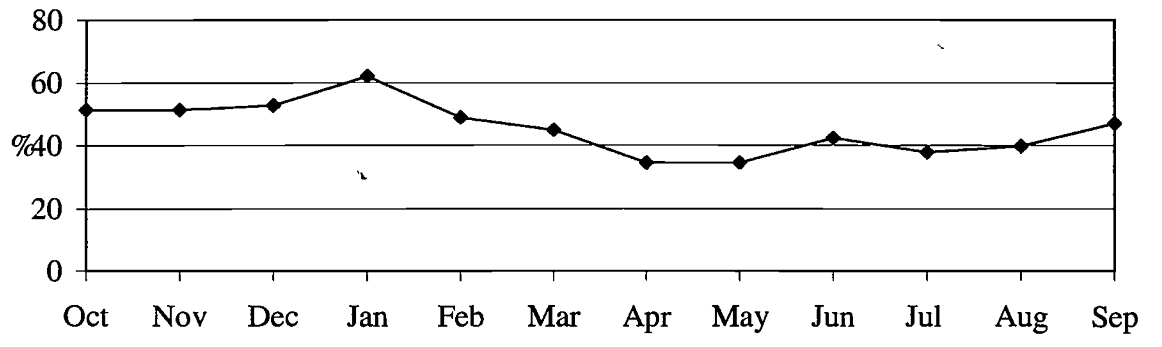


Fig. 4 Percentage of respondents who reported a health symptom throughout the year of investigation.

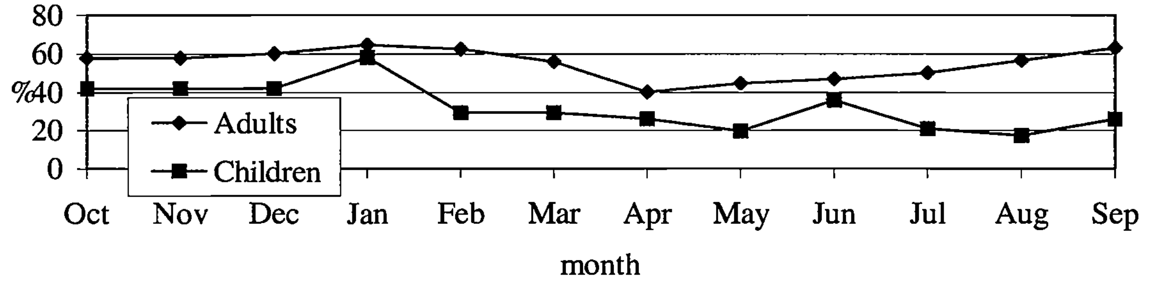


Fig. 5 Percentage of adults and children who reported a health symptom throughout the year of investigation

The Cancer Incidence Study

Background

The local population expressed concern about the incidence of cancer in the Askeaton area at a series of public meetings. In assessing cancer, it is important to note that in Ireland 1 in 10 hospital admissions and 1 in 4 deaths are due to cancer. Cancer death rates in men and women are relatively low during early life and rise rapidly beyond the age of 60. The overall death rate from cancer has remained unchanged since the early 1970s and Irish figures are comparable to those for other western European countries. Variations do occur however. Within Ireland death rates and incidence for cancer show geographical variation; for example, lung cancer is commoner in the more heavily industrialised parts of eastern Ireland, in keeping with the known epidemiology of lung cancer.

Much of the evidence linking human cancer and air borne noxious substances has come from studies of occupational cancer. From the 1930's onward a steady rise in lung cancer incidences was noted in the industrialised world and this was initially attributed to fumes, in particular from diesel engines. The definitive work of Doll and Hill in examining the lung cancer experience of British doctors demonstrated that cigarette smoking and lung cancer were closely linked. The confounding effects of cigarette smoking therefore have dogged studies into the possible carcinogenic effects of atmospheric pollution.

Epidemiological studies over the past 40 years have suggested rather consistently, that general ambient pollution, chiefly due to incomplete combustion of fossil fuels, may be responsible for increased rates of lung cancer. The highest number of potentially carcinogenic chemicals are emitted by combustion sources (i.e. tobacco smoke, car exhausts and coal combustion). Polycyclic organic materials that are produced by the incomplete combustion from the above sources make up the largest single contribution to human cancer risk. From these combustion sources motor vehicle emissions account for the greatest cancer risk in outdoor air. Environmental tobacco smoke and radon are the major sources of cancer risk from indoor exposures. While the evidence may not favour a link between point source emissions and cancers due to airborne pollution, urban/rural differences in cancer experience are well documented.

Aim and Methodology

The aim of the study was to determine if people living in the Askeaton area had a greater likelihood of developing cancer than those living outside the Askeaton area. To this end, the study used the same six areas as the other studies. The study time frame consisted of cancer incidence returns for 1994 and 1995, the first two years of operation of the National Cancer Registry. These data only became available in late 1997.

Cancer incidence data provided by the National Cancer Registry were geocoded manually from tables of addresses provided by Local Government Computer Services. Incident ratios were calculated for each of the study areas and compared with the regional Mid-West cancer incidence rates that were used as a reference. Rates of cancer incidence for those years were then determined for each sex and age group in each of the areas. Age specific rates per 100,000 population were calculated and compared with regional Mid-Western Health Board standards and with national standards to give standardised incidence ratios (SIRs). The results were further analysed in terms of total rates of cancer, including skin cancers and total rates of cancer excluding non-melanomatous skin cancers, in order to allow more detailed evaluation of data without the diluting effects that large numbers of cases of skin cancer produce.

Results

When cancer incidence in 1994 - 1995 is examined with the Mid-Western Health Board as a standard population (Tables 4 and 5) there is no increased risk of cancer in Askeaton regardless of whether skin cancers are included or not. Results from the analysis of cancer incidence (including skin cancer) indicate that males in Askeaton have an SIR of 86.02 meaning they have approximately 15 per cent less risk of developing cancer than the average population of the Mid-Western Health Board. The figure is roughly similar for Rathkeale (SIR of 86.48) and the control area interestingly reports an excess of cases (SIR of 140.98). In the case of females this pattern is even more pronounced. In Askeaton the SIR for females is 35.59 meaning that their risk of developing cancer is approximately one-third that of the standard Mid-Western Health Board population. Rathkeale rate was 64.06 but is still below what would be expected and again the control area demonstrates an excess of cases (SIR of 185.65).

Results from the analysis of cancer incidence (with data on skin cancer excluded) show that this pattern is maintained. In the case of men the reduction in risk in Askeaton was not as marked (SIR of 99.50). However in the case of women the reduction was even more marked down to one-quarter of what would be expected in the standard Mid-Western Health Board population (SIR of 25.27).

Table.4

Standardised Incidence Ratios for cancer in Males and Females in each of the 3 Study Areas compared to the Mid-Western Health Board Population including skin cancer data.

	Observed Cases	Expected Cases	SIR	95per cent CI
Males				
High Risk Area	16	18.6	**86.02**	72.69, 99.35
Medium Risk Area	43	49.72	**86.48**	78.31, 94.66
Control Area	166	117.75	**140.98**	134.20, 147.76
Females				
High Risk Area	6	16.86	**35.59**	26.58, 44.59
Medium Risk Area	29	45.27	**64.06**	56.68, 71.43
Control Area	156	84.03	**185.65**	176.44, 194.86

Table 5

Standardised Incidence Ratios for cancer in Males and Females in each of the 3 Study Areas compared to the Mid-Western Health Board Population excluding skin cancer data.

	Observed Cases	Expected Cases	SIR	95per cent CI
Males				
High Risk Area	12	12.06	**99.50**	81.70, 117.31
Medium Risk Area	23	32.24	**71.34**	62.12, 80.56
Control Area	92	76.36	**120.48**	112.70, 128.27
Females				
High Risk Area	3	11.87	**25.27**	16.23, 34,32
Medium Risk Area	20	31.86	**62.77**	54.07, 71.48
Control Area	86	59.15	**145.39**	135.68, 155.11

When compared against the standard Irish population the pattern seen in the three areas are maintained and if anything slightly accentuated (Tables 6 and 7). This is not unexpected given the favourable cancer mortality experience of the Mid-Western Health Board population as compared with the national population. An analysis of all cancer incidence, demonstrates that for males in Askeaton the SIR is 70.18 indicating a decreased risk of cancer in that area by about 30 per cent. The control area shows a slight excess, with an SIR of 104.55. In the statistical analysis of these figures, however, these merely indicate trends as the confidence intervals indicate that these results were not statistically significant. Looking at females the patterns of reduced incidence are maintained and enhanced. Females in Askeaton have an even lower SIR when compared with Ireland with a value of 27.13. This indicates that the risk was approximating close to one-quarter the risk of the Irish standard population. The control area showed a significant excess over what would be expected (SIR of 142.40). These results were statistically significant.

Table 6

Standardised Incidence Ratios for cancer in Males and Females in each of the 3 Study Areas compared to the National Population including skin cancer data.

	Observed Cases	**Expected Cases**	**SIR**	**95per cent CI**
Males				
High Risk Area	16	22.80	**70.18**	43.79, 112.57
Medium Risk Area	43	56.91	**75.56**	52.98, 98.14
Control Area	166	158.78	**104.55**	88.65, 120.45
Females				
High Risk Area	6	22.11	**27.13**	5.42, 48.84
Medium Risk Area	29	55.07	**52.66**	33.49, 71.83
Control Area	156	109.55	**142.40**	120.05, 164.75

Table 7

Standardised Incidence Ratios for Males and Females in each of the 3 Study Areas compared to the National Population excluding skin cancer data.

	Observed Cases	**Expected Cases**	**SIR**	**95per cent CI**
Males				
High Risk Area	12	14.21	**84.45**	36.67, 132.23
Medium Risk Area	23	35.56	**64.68**	38.25, 91.11
Control Area	92	98.83	**93.03**	74.07, 112.11
Females				
High Risk Area	3	14.19	**21.14**	-2.78, 45.06
Medium Risk Area	20	35.78	**55.90**	31.40, 80.40
Control Area	86	70.16	**122.58**	96.67, 148.49

The analysis of the study data compared to Irish norms with skin cancer data excluded, demonstrated that the pattern is maintained with diminished risk for males and females in Askeaton. This was particularly marked for females with an SIR of 21.14, while males have a SIR of 84.45.

Discussion

These figures indicate that there was no increased incidence of cancers in the high risk Askeaton area in 1994 and 1995. If anything, these figures indicate that there are fewer cancers in the Askeaton area in that period than would otherwise be expected. This pattern is maintained whether or not Askeaton is compared with the Mid-West in general, or with the Irish population as a whole. This pattern is also maintained whenever skin cancers are excluded from the picture as the large numbers of such cancers will tend to have a dilutional effect on the less common and more serious cancers.

The Askeaton Mortality Study

Background

An analysis of all cause mortality and respiratory mortality between 1991 and 1996 in the Mid-Western Health Board region was undertaken. Routinely produced mortality information in the Republic of Ireland is only detailed to County level. Even County Boroughs such as Limerick City are not separated out. However it was felt this level of analysis was insufficient to examine possible excess mortality in small areas, such as those currently under investigation. The decision was made therefore to invest a significant amount of time and resources to extract this information.

Aim and Methodology

This investigation set out to answer the following three questions:

- did people living in the Askeaton area have a higher mortality rate than people living in the lower risk or control areas?
- if they did suffer a higher incidence of mortality was this increase to be found in any particular sub-groups of the population?
- was there an association between mortality and distance from nearby pollution sources?

The areas chosen were the same six as for the other studies.

All deaths in the Mid-Western Health Board region between 1991 and 1996 were geocoded by hand and analysed. Deaths which could not be considered due to the effects of environmental pollution were excluded, namely those due to accidents and suicide. Death rates for each of the district electoral divisions (DEDs) in the Mid-West region were calculated as standardised mortality ratios using the Mid-Western region as a standard. A form of analysis known as Bayesian analysis was used to analyse the data, to ensure greater validity. In addition analysis were conducted both with and without an adjustment for deprivation levels in the areas being examined.

Results

The results (Tables 4.8 and 4.9) for each of the analysis are detailed below by cause, age, and gender:

All cause mortality, all ages (Males and Females)

When the SMRs for this category are considered without adjustment for deprivation the results show that there is no evidence of difference between any of the areas. There is a non-significant rise from a SMR in Askeaton of 83 to a SMR of 102 in Clarecastle indicating that Askeaton and Rathkeale have a more favourable mortality experience than the other areas. When adjustment is made for deprivation there is little change in the outcome.

All cause mortality, all ages (Females)

When the SMRs in the six areas are considered under this heading there is a rise from Askeaton with an SMR of 57 to an SMR of 99 in Clarecastle. These levels are at or below the expected levels of mortality for the region and again indicate a favourable mortality experience for those living in the Askeaton area. When adjustment is made for deprivation Askeaton has a more favourable mortality experience than the control areas.

All cause mortality, all ages (Males)

There was no evidence of statistical differences between the areas. This picture did not change after adjusting for deprivation.

All cause mortality, ages 1-64 (Male and Female)
Examining all cause mortality among people aged 1 to 64 revealed that Askeaton has an SMR of 101 indicating that the population in Askeaton in this category have a mortality experience which is approximately that of the rest of the Mid-West. However SMRs are lower for areas 2, 3, 4 and 6 and there is evidence of statistical difference between areas 1 and 3 and 4. This picture is maintained whenever deprivation is taken into account and the first time a relationship is seen with distance in that the risk of mortality increases the farther away the area from the point source.

All cause mortality, ages 0-14 (Male and Female)
Analysis of the SMRs between different areas show area 1 varying from other areas, although still close to the average, with the highest SMR being found in area 5. The differences between area 1 and areas 3, 4, 5 and 6 are statistically significant and indicate that those aged 0 to 14 in the Askeaton area and in one of the control areas have a higher mortality experience than would be expected for the rest of the region. This relationship remains but is weakened whenever deprivation is taken into account. The actual numbers of children involved however are very small. The total number of deaths of children in the Askeaton area, during the study period, was three. Although the difference between the number of deaths that would be expected and the number seen is statistically significant, the actual difference is very small.

All cause mortality, ages 15-64 (Male and Female)
The low SMR of 93 for Askeaton indicates it had a favourable mortality experience in relation the Mid-West. After adjustment for deprivation this pattern is maintained.

All cause mortality, ages 65-84 (Male and Female)
Askeaton had a favourable mortality experience (SMR of 77) compared to the control areas and the Mid-Western region and this relationship is maintained following adjustment for deprivation.

Respiratory mortality, all ages (Male and Female)
There is no statistically significant difference between the areas.

Respiratory Mortality, all ages (Female)
There is a gradual rise across the areas from an SMR of 58 in Askeaton to 109 in Clarecastle. The differences between are statistically significant and this relationship is maintained following adjustment for deprivation.

Table 8

All Cause Mortality (A without and B with adjustment for deprivation level)

Outcome	No. (per cent) DEDs with SMRs significantly a) > 100 b) > 150	Evidence of association with distance	Evidence of difference by Area	Area SMRs (median)
1A. All Cause all age (Male & Female)	75 (18) 58 (14)	No	No	1. 83 2. 91 3. 54 4. 85 5. 105 6. 102
1B. All Cause all age (Male & Female)	76 (18) 53 (14)	No	No	1. 84 2. 90 3. 54 4. 85 5. 106 6. 91
2A. All Cause all age (Female)	51 (12) 48 (11)	No	No	1. 57 2. 54 3. 61 4. 100 5. 89 6. 99
2B. All Cause all age (Female)	52 (12) 48 (11)	No	Yes 1 vs. 4,5 2 vs. 4,5	1. 56 2. 54 3. 61 4. 100 5. 87 6. 91
3A. All Cause all age (Male)	48 (11) 41 (10)	No	No	1. 87 2. 85 3. 64 4. 73 5. 99 6. 91
3B. All Cause all age (Male)	50 (12) 42 (10)	No	No	1. 88 2. 83 3. 64 4. 73 5. 104 6. 78
4A. All Cause age 1-64 (Male & Female)	8 (2) 6 (1)	No	Yes 1 vs. 3,4 2 vs. 3,4,5	1. 101 2. 89 3. 58 4. 79 5. 110 6. 85

Contd.

Table 8 contd.

Outcome	No. (per cent) DEDs with SMRs significantly a) > 100 b) > 150	Evidence of association with distance	Evidence of difference by Area	Area SMRs (median)
4B. All Cause age 1-64 (Male & Female)	18 (4) 14 (3)	Yes RR increases with distance.	Yes 1 vs. 3,4,6 2 vs. 3,4,6	1. 97 2. 91 3. 65 4. 81 5. 108 6. 74
5A. All Cause age 0-14 (Male & Female)	None	No	Yes 1 vs. 3,4,5,6 2 vs. 3,4,5,6	1. 125 2. 112 3. 55 4. 80 5. 172 6. 85
5B. All Cause age 0-14 (Male & Female)	1 (< 1) 1 (<1)	Not determined	Yes 1 vs. 3,4,5,6 2 vs. 3,4,5,6	1. 109 2. 100 3. 44 4. 66 5. 135 6. 73
6A. All Cause age 15-64 (Male & Female)	28 (7) 27 (6)	Yes RR increases with distance.	Yes 1 vs. 3,4 2 vs. 3	1. 93 2. 71 3. 50 4. 78 5. 104 6. 75
6B. All Cause age 15-64 (Male & Female)	32 (8) 31 (7)	Yes RR increases with distance.	Yes 1 vs. 3,4 2 vs. 3,4,5	1. 88 2. 72 3. 53 4. 72 5. 104 6. 72
7A. All Cause age 65-84 (Male & Female)	55 (13) 46 (11)	No	No	1. 77 2. 90 3. 60 4. 93 5. 103 6. 108.
7B. All Cause age 65-84 (Male & Female)	55 (13) 46 (11)	No	No	1. 77 2. 90 3. 61 4. 93 5. 103 6. 108

Table 9

Respiratory Mortality (A without and B with adjustment for deprivation level)

Outcome	No. (per cent) DEDs with SMRs significantly a) > 100 b) > 150	Evidence of association with distance	Evidence of difference by Area	Area SMRs (median)
8A. Respiratory all age (Male & Female)	26 (6) 26 (6)	No	No	1. 98 2. 108 3. 73 4. 88 5. 71 6. 77
8B. Respiratory all age (Male & Female)	29 (7) 29 (7)	No	Yes 2 vs. 5	1. 94 2. 106 3. 76 4. 88 5. 68 6. 62
9A. Respiratory all age (Female)	13 (3) 13 (3)	No	Yes 1 vs. 3,4,6 2 vs. 3,4,6	1. 58 2. 58 3. 78 4. 100 5. 55 6. 109
9B. Respiratory all age (Female)	13 (3) 13 (3)	No	Yes 1 vs. 3,4,6 2 vs. 3,4,6	1. 58 2. 57 3. 85 4. 100 5. 57 6. 95
10A. Respiratory all age (Male)	7 (1) 7 (1)	No	Yes 1 vs. 3,4,5,6 2 vs. 3,4,5,6	1. 129 2. 111 3. 78 4. 82 5. 74 6. 67
10B. Respiratory all age (Male)	11 (2) 11 (2)	No - marginally	Yes 1 vs. 3,4,5,6 2 vs. 3,4,5,6	1. 128 2. 104 3. 83 4. 81 5. 78 6. 52
11A. Respiratory age 1-64 (Male & Female)	none	No	Yes 1 vs. 3,4,6 2 vs. 3,4,6	1. 96 2. 92 3. 86 4. 101 5. 94 6. 71

Contd.

Table 9 contd.

Outcome	No. (per cent) DEDs with SMRs significantly a) > 100 b) > 150	Evidence of association with distance	Evidence of difference by Area	Area SMRs (median)
11B. Respiratory age 1-64 (Male & Female)	12 (3) 12 (3)	No - marginally	Yes 1 vs. 6 2 vs. 6	1. 83 2. 79 3. 79 4. 93 5. 86 6. 56
12A. Respiratory age 0-14 (Male & Female)	Nos. too small	-	-	-
12B. Respiratory age 0-14 (Male & Female)	Nos. too small	-	-	-
13A. Respiratory age 15-64 (Male & Female)	2 (< 1)) 2 (< 1)	-	Yes 1 vs. 4,5 2 vs. 4,5,6	1. 81 2. 78 3. 81 4. 105 5. 94 6. 68
13B. Respiratory age 15-64 (Male & Female)	18 (4) 18 (4)	Yes RR increases with distance.	Yes 1 vs. 4 2 vs. 4	1. 74 2. 67 3. 77 4. 95 5. 83 6. 55
14A. Respiratory age 65-84 (Male & Female)	14 (3) 14 (3)	No - marginally	Yes 2 vs. 5	1. 103 2. 105 3. 75 4. 87 5. 74 6. 102
14B. Respiratory age 65-84 (Male & Female)	12 (3) 12 (3)	No - marginally	Yes 1 vs. 6 2 vs. 6	1. 83 2. 79 3. 79 4. 93 5. 86 6. 56

Respiratory mortality, all ages (Male)
This group shows a statistically significant drop in SMRs from the Askeaton area (SMR of 129) to the control areas (e.g. Clarecastle has an SMR of 67) and this relationship is maintained following correction for deprivation.

Respiratory mortality, ages 1-64, (Male and Female)
Results indicated statistically significant differences between Askeaton and other areas. There is an overall downward trend in SMRs from Askeaton (96) to other areas indicating that Askeaton has a slightly worse mortality experience in this age group than in the control areas. This pattern is maintained following correction for deprivation. However, it must be noted that the Askeaton experience is no worse than the region as a whole.

Respiratory mortality, ages 0-14 (Male and Female)
The numbers here were too small to analyse.

Respiratory mortality, ages 15-64 (Male and Female)
Results here indicated a picture of better mortality experience than the Mid West for all areas.

Respiratory mortality, ages 65-84 (Male and Female)
The SMR for Askeaton was 103, slightly worse mortality experience than three of the four control areas. This relationship is largely maintained following correction for deprivation.

Conclusions
Generally, the mortality picture for Askeaton was better than the overall regional position. However some exceptions are apparent in relation to the Area controls. All cause mortality among young people (aged 0-14) of both sexes showed a significantly higher rate in Askeaton. In addition the rate of respiratory mortality among men of all ages was significantly higher in Askeaton. On the basis of this analysis of deaths from all cause and respiratory mortality, there is no consistent pattern of elevated risk associated with Askeaton compared to the control areas or the Mid West as a whole. Based on a distance from site model, is there no consistent evidence for an increased risk closer to the alumina plant – if anything, the risk increases as distance increases away the plant.

The investment of resources in this study was significant and intensely time-consuming. The current level of geocoding mortality data to County level in the Republic of Ireland is no longer acceptable. More precise information, to DED, townland, enumerator district, or ideally to individual household level is an essential and overdue development.

The Adolescent Health Study

Background
The Askeaton investigation quickly identified the limits of existing health information systems. These deficiencies were particularly apparent in relation to child health. It was felt that a specific child health status measure should be used. Up to the 1990's, health-related outcomes in children and adolescents were still being defined in predominantly clinical terms of morbidity and mortality. The field lacked a well-validated and comprehensive self-report tool measuring perceived health and well being of children. After considerable research, a newly developed questionnaire from the USA was adopted. The Child Health Questionnaire (CHQ) was constructed to measure the physical and psychosocial well being of children five years of age and older. Concepts measured in the CHQ-CF87 (Child Form, 87 items) include physical functioning, role/social limitations - physical, role/social limitations - emotional and behavioural, general health perceptions, bodily pain, self-esteem, mental health, general behaviour, family activities, family cohesion, and change in health.

Aim and Methodology
The aim of this study was to determine if the physical health experience of teenagers living in the Askeaton/Rathkeale area of County Limerick was worse than that of teenagers in three comparison areas in County Clare (Killadysert, Ennistymon and Clarecastle). Secondary schools were located within the study areas with the assistance of the local School Inspectorate and were invited to participate. Nine of the ten schools identified agreed to take part, the tenth stating that at the time they were too busy. The study consisted of a respondent completed survey comprised of the CHQ-CF87 plus a short section recording demographic details being administered to an opportunistic sample of second year and pre-Leaving Certificate year pupils at schools in the risk and control areas. (It should be noted that the Moyne & Littleton comparison area in Tipperary North Riding is excluded from this study as there is no secondary school within the area.) Due to the small number of participating schools in Askeaton and Rathkeale (one secondary school in each), results from these areas are combined for the purpose of the analysis. The seven schools in the comparison areas of Killadysert, Ennistymon and Clarecastle were combined and used as controls. A total of 750 pupils took part in this study, approximately one-third from Askeaton and Rathkeale and the remainder from Killadysert, Ennistymon and Clarecastle.

Results
From the present study (Table 4.10), it was evident that the physical health experience (as measured by physical and general health subscales of the CHQ-CF87) of teenagers living in the Askeaton/Rathkeale area is not significantly different to that of teenagers living in comparison areas in Co. Clare. Askeaton/Rathkeale students did not:

- experience more problems doing physical activities due to health problems,
- experience more bodily pain or discomfort,
- have role or social limitations due to physical health problems

and they perceived their general health in the same way as control area students.

The "change in health" item which asked respondents to rate their health now compared to one year ago did produce a significant difference between areas. Respondents in the risk area scored significantly higher on this item than respondents in the comparison area. On average, however, both risk and comparison area students rated their health as between "about the same now as one year ago" and "somewhat better than one year ago". Care must be taken when evaluating data from single global items, especially in the absence of other significant effects. Students from the risk area had significantly higher mental health, self-esteem and behaviour scores than students in the control area.

Table 10

Results of Adolescent Health Study

Subscales	**Area**	
	Risk	**Comparison**
Bodily Pain**	69.32 (103)	70.65 (479)
Role/Social Limitations - Physical**	91.27 (98)	91.89 (471)
Physical Functioning**	92.94 (96)	93.51 (442)
Global Health**	69.71 (103)	71.56 (473)
General Health Perceptions**	62.08 (89)	62.98 (412)
Change in Health*	3.46 (101)	3.28 (475)
Mental Health**	70.02 (86)	69.25 (427)
Self-Esteem**	69.66 (85)	69.10 (445)
Role/Social Limitations - Emotional**	83.88 (102)	82.05 (476)
Global Behaviour**	68.89 (104)	67.48 (475)
Behaviour**	72.14 (95)	71.11 (431)
Role/Social Limitations - Behavioural**	90.12 (99)	86.46 (476)
Family Cohesion**	69.31 (101)	66.18 (467)
Family Activities**	72.96 (98)	75.46 (456)

*p<0.05; **NS

Discussion

Retrospective health assessment can be problematic. In view of this fact, health status measures generally adopt recent time frames within which respondents report their health experience. For example, in the CHQ-CF87 used in the present study, the physical health questions refer to the "past four weeks". Self-reports of physical health would be unreliable beyond this time frame. While anecdotal concerns in the risk area about young people's health may have spanned a number of years, it is not possible using a self-report measure to examine physical health for that time period. However, at the time of this study (mid-1997) the physical health of teenagers living in the risk area of Askeaton/Rathkeale was not significantly different to the physical health of teenagers living in three comparison areas in Co. Clare.

The Child Absenteeism Study

Background

This study following consultation with and recommendations from the local residents group (Askeaton/Ballysteen Animal Health Committee) and Dr Pat Wall, Consultant Environmental Epidemiologist. The study was a response to the absence of child health information systems and the problems encountered in examining child health through questionnaire-based methodologies.

The use of routinely collected data to try and assess the impact on health of pollution is not a new phenomenon. Fairbairn and Reid (1959) used routinely available archival data on sickness absence among civil servants and postmen to try and evaluate the negative health effects of fog pollution. Their pioneering study found a significant link between pollution and sickness absence in different parts of Great Britain. A significant volume of research has linked pollution with negative health effects among both children and adults. Many of these effects would logically seem to be of a nature whereby they could impact adversely on school attendance among children. Landgraf *et al.* (1996) note that 'historically, restricted school attendance (i.e., disability days) has been the most frequently used proxy item for assessing role limitations in children'. However, only a small number of studies have specifically examined the relationship between pollution and school absenteeism.

Aim and Methodology

The aim of this study was to determine if school absenteeism in the risk areas was different from that in the comparison areas. As with previous studies the same six areas were used.

There were no centralised records of pupil absenteeism in a format amenable to this type of investigation. Fifty-two National Schools were identified in the six study areas. All 52 schools agreed to take part and data were collected from 50 of these. The study time frame for this ecological study was the ten years covering the school year 1985-1986 to the school year 1994-1995. The data were generally collected from the "clárleabhar", which provides a summary of total days attended for pupils over their stay in each school year. As well as attendance data, date of birth and gender were collected. However, the "clárleabhar" register was incomplete in approximately one-half of schools and data were collected in part or entirely from the day to day roll-book. Information on the number of days each school was open for each of the ten years included of the study was also collected and an attendance rate for each pupil was calculated. In the light of age differences reported in the research literature on school absenteeism and pollution, results were also analysed by age group. Analysis of attendance by area and age was undertaken. Data were collected on 10,723 pupils in total; of these, 4,531 came from Askeaton/Rathkeale, while 6,192 came from the comparison areas.

Results

Attendance in Askeaton/Rathkeale and the comparison areas over the ten years studied showed a very similar pattern of peaks and troughs (Fig. 4.7). The Askeaton area had lower attendance in each of the ten years examined and in nine of the ten years examined this difference was statistically significant. The year in which no statistical difference was found was 1988.

Discussion

Children from the Askeaton area had significantly higher rates of absenteeism in nine of the ten years examined (1986-1995) than children from the comparison areas. The difference in rates was not statistically significant for 1988. It is however important to put the present study's findings in context. The statistically

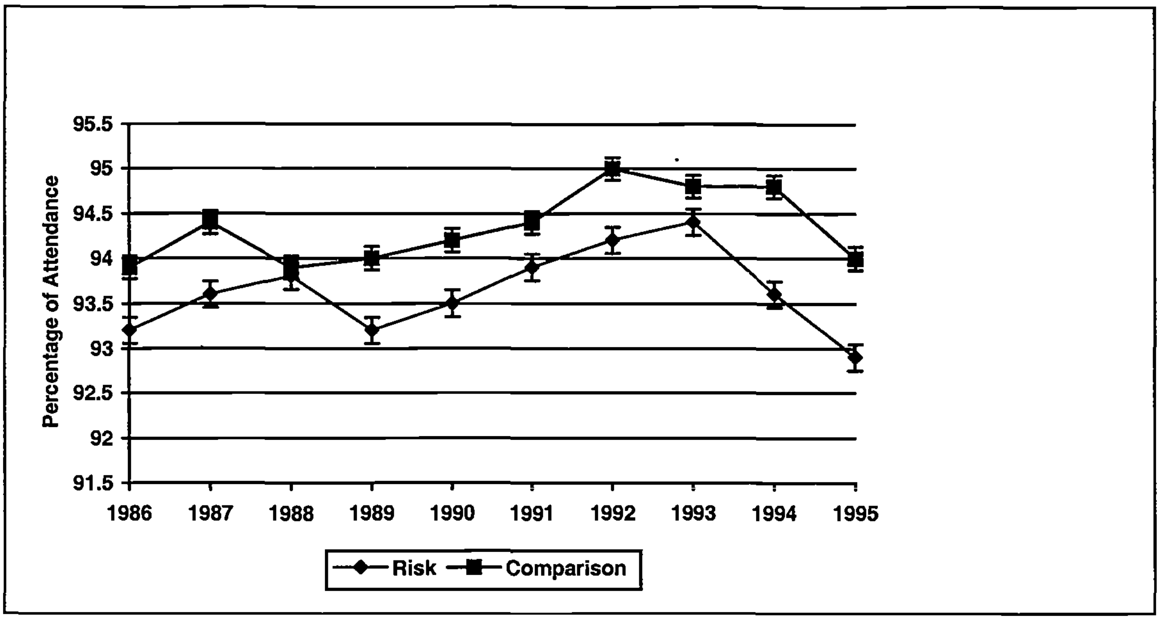


Fig. 6 Percentage of attendance at school in the risk and comparison areas (2-6) 1986-1995

significant differences in school absenteeism reported above equate to a difference, on average, of between 0.5 days and 1.25 days a year. To help put this difference in perspective, asthma sufferers have on average three more days absent from school per year than non-sufferers. It is important to differentiate between statistical and clinical significance. The very large sample sizes involved mean that even very small differences may be statistically significant. It should be noted that this retrospective study has limitations and care should be taken when evaluating the results. School absenteeism is only a proxy measure of ill health. Other studies examining school absenteeism have tended to include only sickness-related absenteeism or were only focused on respiratory-related absenteeism. This study had no such detailed information, only a crude absenteeism score. Additionally, the study does not include information on the social class of the children involved. This factor has been shown to influence school attendance.

In conclusion, statistically significant differences in absenteeism were found between Askeaton and the other areas. These differences may not be clinically significant. The absenteeism rates cited are only a proxy measure of ill health and it is not possible to state that they are ill health absences let alone respiratory ill health absences. It is not possible to link the absenteeism to pollution as no measure is available. This study was exploratory in nature and no causal links can be drawn from the results.

Report On The Sampling Of Horticultural Produce

Background

The Environmental Health Department of the Mid-Western Health Board at the request of the EPA undertook a sampling programme for horticultural products from the Ballysteen area. The programme was instigated on foot of fears expressed by some market gardeners in the area. They feared that their livelihoods would be adversely affected by a public perception of an environmental problem in the area (Ballysteen) in which their vegetables were sourced.

Method and Objectives

The objective of the survey was to establish whether vegetables grown in the Ballysteen area showed evidence of being contaminated or unfit for human consumption and to this end establish:

- Whether certain elements were present in the vegetables.
- Whether these elements, if present, were present in levels that might be considered above normal.

Following consultation with the Public Analysts Laboratory, University College Hospital, Galway, it was decided that samples would be analysed for aluminium, fluoride, lead, cadmium, arsenic, chromium and vanadium. A total of 40 samples was submitted. This figure included samples of vegetables produced in the Ballysteen area as well as control samples from outside the area. The vegetables sampled were predominantly loose-leaf vegetables such as cabbage and spring greens with a very limited number of cauliflower, turnips, leak and potatoes also included. The sampling programme extended from March to December 1996, with the majority of the samples being submitted on a fortnightly basis between March and May of that year. Samples were transported to the Public Analysts Laboratory on the day on which they were procured. Samples were identified by reference number only.

Results

The results are listed below for each of the elements investigated and the comparison with control areas.

Lead

A total of 18 samples was analysed for lead content. Statutory admissible levels for lead in food are set out in the Health (Arsenic and Lead in Food) Regulations 1972 (S.I. No. 44 of 1972). These Regulations prohibit the sale of food which contains lead in a proportion exceeding two parts per million. All samples submitted were found to be well within the acceptable range.

Cadmium

Of the 18 samples analysed for cadmium, twelve contained levels below that which can be detected in the laboratory (<0.05mg/kg). The highest reading for vegetables sourced in the Ballysteen area was 0.08mg/kg. There is no national legislation in respect of admissible levels of cadmium in food in this country. Daily intakes of cadmium in food in Europe, New Zealand and the USA are usually about 10-25 μg. Estimating average green vegetable consumption to be 0.043 kg/person per day (MAFF Report on Aluminium in Food, 1993) intake of cadmium from this source based on highest level detected would amount to 3 μg/day.

Aluminium

Since aluminium is the third most abundant element in the earth's crust, as expected aluminium levels in samples submitted were higher than other monitored elements. A total of 22 samples was analysed for aluminium. In analysing four samples submitted on 04.12.96 particular care was taken to exclude soil particles. Quantifiable levels of aluminium were not found in any of these samples. In the case of the remaining 18 samples aluminium levels of less than 10 mg/kg were detected in16 (89per cent). The remaining two samples had levels of 11.6 mg/kg and 14.7 mg/kg respectively.

The average aluminium content of vegetables sourced in the Ballysteen area from which soil had not been excluded was 6.20 mg/kg, while the average content of control samples was 5.97 mg/kg. Allowing an average aluminium dietary intake of 3.9 mg/day (MAFF Report on Aluminium in Food, 1993) consumption of vegetables from the Ballysteen area would represent 6.8 per cent of the daily dietary intake of the element in the UK. The median of aluminium values for Ballysteen grown vegetables was 5.0 mg/kg. This figure would represent 5.5 per cent of the average daily intake.

Chromium

Thirteen samples were analysed for chromium, and all were shown on analysis to contain less than the detection limit of 0.25 mg/kg.

Vanadium

Five of the samples submitted were analysed for vanadium. All samples analysed were found to contain less than the detectable level of 1 mg/kg..

Arsenic

All five of the samples analysed for arsenic were found to have levels of less than 1mg/kg. The Health (Arsenic and Lead in Food) Regulations, 1972 (S.I. No. 44 of 1972) prohibits the sale of any food which contains arsenic in a proportion exceeding one part per million.

Fluoride

Five samples were analysed for fluoride, and all were found to contain levels less than the detection limit of 1mg/kg.

Control Samples

Out of a total of 40 samples submitted, 17 were control samples. In the case of lead, chromium, vanadium, arsenic and fluoride no difference was detected in levels between control samples and samples from the Ballysteen area. A very slight difference in aluminium and cadmium levels was noted between the vegetables from the two locations. The mean level of aluminium detected was 6.2 mg/kg in Ballysteen, while in the control samples it was slightly lower at 5.9 mg/kg. The mean level of cadmium detected was 0.056 mg/kg in Ballysteen, while in the control samples it was higher at 0.090 mg/kg.

Conclusion

The survey gave no indication that any of the elements measured in the Ballysteen sourced vegetables were present at levels which might be considered above normal when compared with levels measured in the control samples.

The Chloracne Study

At the beginning of the Askeaton investigation there were speculative press reports of cases of chloracne in the Askeaton area. Chloracne is a 'particularly refractory form of acne caused by halogenated aromatic chemicals, which may also cause systemic toxicity' (Oxford Textbook of Medicine. 3rd Edition. Eds: Weatherall, Ledingham & Warrell. OUP. 1996: 1165). Chloracne is perhaps best known as a result of contamination following the leakage of 2,3,7,8-tetrachlorodibenzodioxin around Seveso in Italy.

In response to the local concerns, the Department of Public Health, MWHB, wrote to every known Consultant Dermatologist in the State asking them about their pattern of referrals suffering from chloracne. Responses from the Consultant Dermatologists indicated that none had ever encountered a case of chloracne in Ireland. In those instances where Consultants had encountered chloracne, it was while previously working in the UK and elsewhere and related to cases of occupational exposure. It was therefore possible to indicate that no such hazard existed in the Askeaton area.

The General Medical Script (Abnormal Prescribing Patterns) Study

Given the absence of health information systems that could facilitate an in-depth analysis of morbidity and mortality in the study areas, attention focused on other information systems that might be of some use to the investigation. The computerised General Medical Services (GMS) prescription record system was examined as a potential proxy measure of human health in the study areas. It was initially felt that it might prove feasible to detect abnormal patterns of morbidity in the Askeaton area through abnormal prescribing patterns. However following exploratory talks with the agency responsible for maintaining the database, and careful local review, the GMS system was rejected as a potential tool in this investigation. A number of key factors influenced this decision:

- the GMS scheme covers less than half of the population (approximately 35 percent) and therefore such a measure can at best yield an incomplete picture.
- the data held in the system are coded by General Practitioner. Therefore it cannot clearly be stated where an individual GMS patient resides. Only the location of their GP could be coded.
- the amount of information involved made the task a practical impossibility, particularly given the absence of any clear health effect or environmental contaminant.
- it is well known that at the level of individual GPs their own prescribing preferences are the main determinant of prescribing not local morbidity
- the measure was only a proxy method of examining health.

The HIPE Study

A number of studies have been done internationally linking environmental pollution with increased hospital admissions for certain diseases. The feasibility of using the equivalent in Ireland, the Hospital In-Patient Enquiry (HIPE) system, was examined. This system records information on each in-patient discharged from hospital including sex, age, date of admission and discharge, as well diagnosis and procedures undergone. Diagnosis is assessed using the standard International Classification of Diseases system (ICD-9). When HIPE records are matched with records from the Patient Administration System (PAS) which records a patient's home address it is theoretically possible to geographically code patterns of illness that resulted in hospital admission. However further investigation revealed that the patient address recorded in the PAS system is input simply as a string of characters. The only geographical level at which the HIPE/PAS systems define patient residence is a separate question in which residence at County and County Borough level is coded. Therefore, although it was simple to differentiate between HIPE/PAS records for Limerick County, as opposed to Limerick County Borough, more refined spatial analysis proved impossible.

The Eastern Health Board had developed address matching software which can geo-code the vast majority of addresses in its area to ward/ district electoral division (DED) level. Outside of this, the only commercially available software was designed to geo-code addresses to the nearest town. For the purpose of this investigation neither methodology was felt to be adequate or precise. Quality address matching software capable of working at DED level, or preferably sub-DED level (townland, enumerator district, or household level), would have been essential to investigate morbidity using the HIPE/PAS system. The tens of thousands of records involved made the possibility of geo-coding records by hand unfeasible, particularly in the absence of a clearly identifiable health effect or environmental contaminant in Askeaton.

CONCLUSIONS

An assessment of the findings of the investigation suggests the following conclusions:

- The review of the literature on the effects of atmospheric pollutants states that recent evidence is emerging of adverse reactions to environmental pollution at levels well below present national and international standards.

- The Chloracne study as discussed above can be discounted as little more than a media red herring.

- It is equally reassuring that the three birthing studies did not find any evidence of abnormal ill health in the area. The rate of congenital anomalies was as expected, as was the twinning rate. The possible change in the sex ratio among births in favour of females, as might have been expected in an area of pollution, was absent.

- The GP study, an admittedly imprecise instrument, but a key one given GPs importance in being solely responsible for dealing with 95 per cent of patient health queries, found proportionally more worries about rates of miscarriage, serious illness, and patient health in Askeaton.

- The Human Health Survey reported a mild excess of self-reported ill health for Askeaton on many of the measures used. However similar results were found in Moyne & Littleton and Clarecastle. It is, however, hard to evaluate these results, given the high degree of environmental awareness and concern in Askeaton, and the effect this might have on this self-report measure. However the results indicate a pattern in which the areas examined fall into two groups, that mentioned above experiencing worse health, and the other group consisting of Killadysert, Ennistimon and Rathkeale experiencing better health. This pattern is not consistent with any known pollutant.

- The diary study conducted for over one year on farms in the affected area found an excess of mild ill-health on two farms in particular, and poor health on another three. Again the health diary is obviously a self-report measure and care must be taken in its interpretation.

- The cancer investigation found no evidence of an excess of cancer incidence in the risk area. The study actually revealed a significantly lower level of cancer in the risk area compared with the comparison areas, the MWHB and the State.

- The mortality study recorded generally a better than expected pattern of mortality. However, the significant excess results for all cause mortality among young people (aged 0-14) of both sexes and the rate of respiratory mortality among men of all ages in Askeaton goes against that pattern.

- The adolescent health measure (the CHQ-CF87) examining health over the month previous to the study found no evidence of worse health in the Askeaton.

- The study using school absenteeism as a proxy health measure did record significantly lower attendance in Askeaton in nine of the ten years studied.

- Given the shortage of routinely available data highlighted in this investigation, systems must be put in place that will allow routine surveillance of health status in circumstances such as those in Askeaton.

On balance it would appear that there is an excess of self-reported mild ill health in the Askeaton area that does not lead onto health service intervention. The clinical or practical significance of some of the findings is questionable, despite their statistical significance. It is impossible to be certain of the validity of the findings given the self-reported nature of much of the evidence. Environmental concern may have been high enough to raise peoples concerns about their health in the Askeaton area. The results from the Human Health Survey do not support a link to any form of local environmental pollution. The Human Health Survey demonstrated a clustering of the reported health experience of the six areas examined into two spatially scattered groups. The areas experiencing worst health included Askeaton, Moyne & Littleton and Clarecastle. Ennistymon, Killadysert and Rathkeale reported better health status. This pattern of health experience is not consistent with any known pollutant or pollution source.

In summary, this study has not found a significant degree of excessive ill health in the Askeaton area.

RECOMMENDATIONS

1. There should be a computerised system of monitoring congenital abnormalities based on the EUROCAT model of congenital abnormalities registry.

2. A system of surveillance of morbidity in general practice should be established using a series of GP sentinel practices.

3. Information systems within the health service should be structured such that they allow easy epidemiological investigation for studies such as this. This would particularly involve the use of a unique identifier and the geocoding of episodes. Such a system would need to be as real time as possible.

4. A focus of environmental epidemiological expertise and the ability to communicate such knowledge to local communities rapidly and authoritatively needs to be established.

5. If similar investigations such as this occur in the future it would be appropriate to ensure a local office and key worker(s) are put in place in the affected community to provide a easily accessible source of information or focal point for liaison with the community.

6. Investigations such as this should normally be concluded within a year. This presumes that adequate resources are made available to allow this to occur.

7. This study has not found an explicit link between pollution and ill-health, but has posed sufficient doubts that before any additional environmental pollution is allowed a more detailed surveillance system would need to be put in place.

LITERATURE REVIEW OF THE EFFECTS OF COMMON ATMOSPHERIC POLLUTANTS ON HUMAN HEALTH

INTRODUCTION

Atmospheric pollution is a problem older than civilisation and that produced by fires was likely to have been a source of irritation for our cave dwelling ancestors[1]. The use of wood and other combustible materials to produce heat had polluting effects even in a pre-industrial world. In the Bills of Mortality in 1662, Graunt attributed high week to week variability in mortality to the changing "airs" of London[2].

The onset of the Industrial Revolution saw a steady increase in the amount of industrial atmospheric pollutants beginning in the 18th century coupled with a migration of people to rapidly growing urban centres to be close to the factories where they worked. Human beings, on a mass scale, had been placed in close proximity to concentrated particulate and gaseous pollutants where they would be exposed to them throughout their lives. A suspicion that noxious smoke and people's health were linked led to the construction of tall chimneys in 18th century London in an attempt to prevent the high mortality seen among children. Over time the volumes of such pollutants increased. The rapid industrialisation seen in Western Europe and North America this century led inevitably to air pollution disasters, characterised by short term episodes of overload of the local atmospheric pollutants, notably in the Meuse Valley in Belgium in 1930, in Donora in Pennsylvania in 1948 and in London in 1952[1,3].

Following the episode in London in 1952, which was associated with approximately 4,000 more deaths than would have been expected in a similar normal time-period[3], the Clean Air Act, 1956 was passed in the United Kingdom and followed in 1963 by its equivalent in the United States of America. The first pollutant to be identified as damaging was black smoke[1] and following the 1952 smog episode in London black smoke and sulphur dioxide were the parameters adopted for monitoring. Since then several other pollutants have been identified and different categories of size of articulate matter have been established. Over the last twenty years the Environmental Protection Agency in the United States of America, the World Health Organisation and the European Economic Community have all developed their own guidelines as to the permissible level of these substances (see Appendices 1 and 2).

SOURCES OF AIR POLLUTION

Burning of fossil fuels will produce carbon dioxide, water and a range of other compounds, including sulphur, sulphur dioxide, particulates, benzene, polycyclic aromatic compounds, methane and formaldehyde. This process also takes place when petrol is burnt in internal combustion engines. The high temperatures generated within the internal combustion engine oxidises atmospheric nitrogen to nitric oxide which condenses to nitrogen dioxide.

Coal

Coal is a significant source of sulphur dioxide and other pollutants including particulates, smoke, nitrogen dioxide, carbon monoxide, organic compounds such as the polycyclic aromatic hydrocarbons and various inorganic compounds. It has, in the past, been one of the most important sources of air pollution and remains so in those parts of the British Isles where piped natural gas is unavailable e.g. Belfast in Northern Ireland.

Different types of coal produce different types of pollutants; anthracite is almost 95% carbon and produces smaller amount of pollutants than other types of coal but is a major source, however, of carbon dioxide. In the United Kingdom there has been a policy of moving fossil fuel burning power stations from urban to rural areas and the concomitant use of tall chimneys to disperse pollution more evenly. This move has led to a marked improvement in the quality of urban air. The better dispersion of pollutants by tall chimneys produces a lower concentration by improved dilution. Fossil fuel burning power stations remain, however, an important point source of some pollutants[4,5].

In the United Kingdom 90% of sulphur dioxide released into the air is produced by industrial sources with 70% produced by power generating industry. In Ireland 58% of sulphur dioxide is produced by the power generating industry. The high sulphur content of coal and oil account for the large production of sulphur dioxide from this source. De-sulphurization equipment fitted in power stations can do much to reduce the output of sulphur dioxide. Particulate materials (fly ash) and nitrogen dioxide are also produced by power stations. Currently in Ireland about 40% of all nitrogen dioxide is produced during power generation in Ireland. The equivalent figure in the United Kingdom is only 24%[4,5]. The output of the above pollutants has not increased significantly over the last few years in Ireland and between 1990 and 1994, output of nitrogen dioxide and carbon monoxide have fallen by 45% and 23% respectively[4,6].

Motor Vehicles

The recent rapid traffic growth in many countries particularly in Ireland has lead to a significant increase in motor vehicle pollution. Road transport in Ireland currently accounts for 38% of all nitrogen dioxide; this compares with a figure of 49% in the United Kingdom. Conversely, motor vehicles are responsible for only 3% of the sulphur dioxide emissions in Ireland, the equivalent figure in the UK being 2.3%.
Road transport vehicles are responsible for 32% of the output of volatile organic compounds including methane, benzene, 1,3-butadiene, polycyclic aromatic hydrocarbons and dioxins. Motor vehicles are also responsible for 71% of total carbon monoxide production in Ireland. Motor vehicles have been becoming progressively cleaner over the years and these catalytic converters, which reduce emissions of carbon monoxide, nitrogen dioxide and volatile organic compounds, became possible with the introduction of lead free petrol. Petrol vehicles, once considered much dirtier than diesel vehicles are now cleaner as a result of emission reduction measures and improved fuel use. The output of carbon monoxide and hydrocarbons from diesel engines is still less than that from petrol engines but they produce much larger quantities of particulate matter and nitrogen dioxide and increasingly diesel engines are becoming an important source of particulate material pollution[4,6].

TYPES OF ATMOSPHERIC POLLUTANTS

Pollutants in the atmosphere come from a variety of sources and in the broadest sense there are three types of general outdoor air pollution problems of concern to health[7]. The first relates to the traditional pollutants; namely sulphur dioxide, smoke and other particulates that are generated mainly from the combustion of coal or heavy oil for heating or power generation purposes. Emission of these substances is highest during the winter months[7]. The second group comprises the so-called photochemical pollutants of which ozone is a principal component. Ozone is a secondary pollutant formed in reactions, powered by sunlight, between oxides of nitrogen and volatile organic compounds. The principal precursor chemicals are derived largely from exhaust emissions from motor cars and ozone production tends to be maximal during the summer months[8]. The third group involves nitrogen dioxide, a pollutant which falls into both of the above categories, being derived from both heating/power generation sources and from motor vehicle emissions[9].

Smoke and Particles

Particulate air pollution includes air suspended mixtures of solid and liquid particles varying in size and composition[10]. Particles are classified into the following categories: -

- **Nucleation mode** (less than 0.2 μm diameter): These are particles recently emitted from a process or freshly formed within the atmosphere; present in large numbers in urban areas.

- **Accumulation mode** (0.2 to 2 µm diameter): These are particles which have grown from nucleation mode by coagulation or condensation of vapours; stable with an atmospheric lifetime of 7 to 30 days. These so-called finer particles include soot and acid condensates derived from vehicle emissions, manufacturing, power generation and agricultural burning. Sulphate and nitrate aerosols generally make up the largest fraction of small particles by mass.
- **Coarse mode** (greater than 2 µm diameter): These are formed mainly by weathering processes and uncontrolled combustion and include soil dust, sea spray and industrial dusts. Their pH is basic and their large size means that their atmospheric lifetime is short[10].

Health effects are dependent upon particle size. Particles less than 0.2 µm in diameter tend only to produce surface spoiling whereas health effects are only seen in those particles less than 10 µm diameter (known as PM_{10}'s). Particles between 5 and 10 µm in diameter are more likely to deposit in the upper airways or lower larger airways producing upper respiratory and tracheal symptoms. Those less than 5 µm diameter, however, are more likely to deposit in the smaller airways e.g. the bronchioles and alveoli. Particles deposited in the trachea and bronchioles are carried by the mucociliary layer to be expectorated or swallowed while small particles beyond the terminal bronchioles tend to be cleared largely by lung macrophages[10].

Sulphur Dioxide

Until the early 1960's, the principal source of sulphur dioxide emissions in urban areas was the domestic, commercial and industrial burning of coal[11]. With the introduction of the Clean Air Act, 1956 and the move to natural gas and electricity as the main energy sources, emissions in towns have fallen considerably, with the greatest production of sulphur dioxide coming from power station point sources situated in rural rather than urban areas[11]. Following enforcement of the Clean Air Act and as a consequence of the changing pattern of emissions source, sulphur dioxide emissions in the United Kingdom have fallen approximately 50% since 1970 (Department of the Environment, 1995). A similar reduction has also been seen in the United States and Western Europe[12].
The distribution of this pollution has altered. Formerly, emissions were derived predominately from many low level sources leading to chronically elevated long term concentrations in towns and cities which reached a peak in winter. With the move to fewer rural point sources emitting quite high into the atmosphere the high concentrations seen in winter smog episodes no longer occur. In contrast these power stations tend to produce episodes of short term peak concentration characteristically lasting only a few hours, who's effects are felt down wind of the power station where the emission plume reaches ground level[11].

Other sources of sulphur dioxide include the combustion of coal and oil by industry and commerce and use of diesel fuel in motor vehicles and whilst motor vehicles contribute only about 2% to the total annual sulphur dioxide load, they can be a significant source of sulphur dioxide in urban areas[11].

Ozone

With the declining concentrations of both smoke and sulphur dioxide in the UK and other countries following the enactment of various clean air regulations, other sources of pollution has become more prominent. Ozone is found principally in two atmospheric locations:

- **Stratospheric ozone** (10 to 15 kilometres would be of earth surface formed what is know as the ozone layer and is essential in limiting the amount of ultra-violet radiation received from the sun.
- **Tropospheric ozone**, ozone contained in a layer of air closest to the earth surface is a pollutant and can damage health and vegetation at ground level, ozone is a secondary

pollutant formed by the action of sunlight on oxides of nitrogen derived from vehicle emissions and industry and volatile organic compounds from vehicle, solvents and industry. High concentrations of ozone are particular problems in areas with high levels of sunlight such as Athens and Los Angeles where this problem of photochemical smog was first identified 50 years ago[8].

HEALTH RISKS OF ATMOSPHERIC POLLUTION

Following major environmental disasters in the earlier parts of this century the levels of air pollution has fallen steadily over the last 50 years throughout the developed world. Public awareness and community concern about the effect of air pollution are becoming increasingly common. In industrialised north east England concern in communities there has coincided with the disappearance of much of the old industrial landscape and diminishing levels of pollution. In this region decreasing numbers of people are gaining what ever are perceived to be the direct benefits of living close to heavy industry and by remaining nearby they are suffering from perceived disadvantages viewed in either health or environmental terms[13]. Research has shown that health effects due to air pollution tend to be acute, less information is available on possible long-tern effects upon health[5]. Those with respiratory disease are most likely to demonstrate ill effects due to airborne pollution, the effects being most marked in those with coexisting respiratory and cardiovascular disease.

Other research has indicated that the effects of air pollution may magnify or add to the effects of better known risks to respiratory or cardiovascular health. Chronic bronchitis and emphysema are coexisting conditions that demonstrate this. Cigarette smoking is the cardinal cause of this condition but there is evidence that atmospheric pollution may also contribute[5]. Environmental studies have shown that these diseases are more commonly found in urban areas particularly those with heavier atmospheric pollution. Evidence exists that chronic bronchitis and emphysema are aggravated by smoke, sulphur dioxide and other pollutants and that patients with these conditions do less well during these episodes[1,5].

Cardio-Respiratory Death

Cross sectional of studies in the United States of America indicate that there is an increase risk of cardiovascular death with increasing particle concentration. Myocardial infarction has recently been shown to be commoner on days when particle concentration is increased. This effect maybe compounded by exposure to environmental carbon monoxide[5].

Lung Cancer

Cigarette smoking causes 90% of all lung cancers. The overwhelming effects of cigarette smoking make assessment of any contributory role of air pollution difficult. It is now know that environmental air pollution causes a small number of lung cancer deaths each year and environmental radon trapped in buildings is known to be carcinogenic and may contribute to deaths from lung cancer. Motor vehicles and agriculture produce large amounts of volatile organic compounds including benzene, 1,3-butadiene and polycyclic aromatic hydrocarbons. Many of these are genotoxic and have the potential to cause cancer even at low levels of exposure. In 1989 the International Agency of Research on Cancer (IARC) classified diesel emissions as "probably carcinogenic" to humans based on some animal and limited human studies. They also define petrol emissions as "possibly carcinogenic" to humans.

Asthma

Asthma is characterised by heightened sensitivity to inhaled allergens and irritants. The classic response is episodic airflow obstruction brought about by a combination of small airways constriction as a result of bronchiolar muscle contraction and oedema in the airway wall and

accumulation of thick lower respiratory secretions. Childhood asthma has increased by about 50% in the last 30 years in the United Kingdom and a ten-fold increase in hospital admissions mirroring a change in medical practice. Asthma has increased in other countries as well. This increase over the past 30 years has occurred against a background of diminishing emissions of coal, smoke and sulphur dioxide and increasing levels of nitrogen dioxide and volatile organic compounds[5].
There is a perception that environmental factors including air pollution can initiate asthma in previously healthy individuals or provoke or exacerbate respiratory symptoms in those already asthmatic. Laboratory evidence that air pollution could potentially have a role in the initiation of asthma exist but no firm epidemiological evidence is available that this is happening in the United Kingdom or elsewhere. While there is some epidemiological evidence that air pollution may provoke acute asthma attacks or aggregated existing chronic asthma, the effect if any is generally small and the effect of air pollution appears to be relatively unimportant when compared to several other factors e.g. infections and allergens known to provoke asthma[5,14].
Some evidence exists that common gaseous pollutants can enhance the response of asthmatic patients to aero-allergens but this effect does not seem to be large. Day to day variations in air pollution are likely to have small effects on asthmatics and are most likely to be seen on those whose reserve is lowest; namely the elderly with chronic obstructive lung disease. Seasonal patterns of asthma attacks bare little or no relationship to seasonal patterns of air pollution[15]. Short term episodes of increased air pollution are likely to be associated with a small increase in admissions to hospital for asthma and other respiratory diseases. In the United Kingdom there is little or no association between the regional distribution of asthma and that of air pollution and there is no convincing evidence that asthma is more common in urban than rural areas of the United Kingdom[15]. Evidence exist that air pollution can affect the frequent and severity of attacks in those suffering from asthma but there is very little support for the suggestion that asthma is caused by air pollution[14,15].

MAGNITUDE OF THE HEALTH EFFECTS OF ATMOSPHERIC POLLUTANTS

The evidence of the health effects of atmospheric pollutants appears stronger in relation to day to day variations rather than chronic exposure to long term average concentrations. Some studies have lead to the assertion that there is no safe level of exposure to particles. This remains unproven. The effects on cardiovascular disease remain unquantified. It is possible that exposure to air pollutants may precipitate deaths which would have in any case occurred very soon. This would not affect the number of deaths brought about by air pollution but would affect public health importance of such pollutants. The time scale involved is unknown - were it only a few days, perhaps, it may not be so important but were lives to be considerably shortened then it would obviously become a more important public health issue.

Studies into Health Effects

Mortality Studies

The air pollution disasters in London and Donora demonstrated that high levels of pollution could lead to increased mortality. The question to be answered on foot of this was whether exposures at lower levels are also associated with such health effects and whether or not specific agents within the mixture of pollutants can be identified[16]. Dockery and Schwartz have demonstrated that daily mortality was more closely linked to particulate air pollution rather than sulphur dioxide pollution in the town of Steubenvill on the Ohio river between 1974 and 1984. They demonstrated similar findings with regard to Philadelphia between 1973 and 1980[16]. Moolgavkar and colleagues (1995) urged caution in attributing the observed mortality and the atmospheric pollutant perimeters pointing out that weather can be a possible confounder since it affects both mortality and is associated with levels of pollution[17]. This group reanalysed the two studies undertaken by Dockery

and Schwartz and concluded that although air pollution was associated with daily mortality the association could not be attributed specifically to particulates, and the debate about which pollutants product the health effects continues. Re-examination of much of the data from these studies indicated that initial studies had measured total suspended particles which included smaller respirable particles and larger normal respirable particles up to 30 to 40 micrometers in diameter. The epidemiological evidence currently suggests that combustion related fine particles less than 2.5 micrometers in aerodynamic diameter ($PM_{2.5}$) are more closely associated with human health effects than either PM_{10}'s or total suspended particles[16]. Others have suggested that even finer particles may be the main culprit[18]. These submicron ultrafine particles are produced directly in combustion processes but also often result from direct combination of sulphur dioxide and a photochemical oxidation process to produce very small particles under a micron in diameter. Since particulate matter and gaseous sulphur dioxide combine in such a way, teasing out the relative effect of each can be very difficult. The degree to which this process occurs varies with the season.
Given the variables affecting the impact of air pollution on the health of populations and their subtle interactions with one and other, methodological models are being developed which control the confounding effect of such variables as weather, seasonality and day of the week effects[3].
The studies into the health effects of atmospheric pollution generally take the form of epidemiological or environmental studies and laboratory studies[1,3,5,19,20,21,22,23,24,25]. Laboratory studies generally concentrate on the influence of individual or combinations of pollutants upon animal or human subjects. The human studies are further refined by considering the health effects on humans in general and also of specific subgroups of humans e.g. the younger, the older and those with pre-existing disease e.g. asthma[5,22,24].
Asthmatics are a common subject for study as objective changes in respiratory function can be documented, the changes occur in rapid response to stimulation and the effects are reasonably, readily reversible to insure the subject's life is not endangered.
Epidemiological studies tend to follow trends for example, all cause/cardiovascular/respiratory mortality, hospital respiratory admissions, respiratory episodes, absenteeism or physician attendances, in response to documented changes in the atmospheric concentration of known pollutants. Many measures of health particularly respiratory health are used in determining the health effects of atmospheric pollutants and these would include annual mortality rates due to respiratory conditions, annual rates of hospital admissions with respiratory diagnosis, annual rates of new diagnosis of chronic respiratory conditions and annual rates of acute respiratory episodes.

Morbidity Studies

The earliest work in this area looked at the air pollution disasters in the earlier parts of this century. From the Donora episode in 1948 limited data is available, no concurrent air monitoring was performed and all of the patients affected during the incident appear to have some element of pre-existing cardio respiratory disease[24]. In the London fog episode of December 1952 a first attempt was made to quantitatively monitor air quality and health status simultaneously. Fog persisted for 5 days and smoke and sulphur dioxide levels exceeded 4,000 $\mu g/m^3$ in central London. Peak emergency daily bed usage was increased to 150% of expected on the day after the peak pollution was recorded. Most of the excess admissions were accounted for by respiratory disease, which were increased above normal by a factor of 4. Cardiac disorders tripled but from a much lower base level and those most effected were under 5 and over 45. A Ministry of Health report is quoted as indicating a increase of upper respiratory disorders by about 100% lasting at least 2 weeks after the incident[24]. In New York in 1954, an episode producing sulphur dioxide levels of 0.85 parts per million (1530 $\mu g/m^3$) produced an increase in eye irritation, upper respiratory infection in all hospitals and in cardiac diagnosis at two hospitals[24]. In 1954 in Los Angeles episodes of increased air pollution in the autumn showed a doubling of asthma admissions during one period but no consistent relationship between levels of pollutants and morbidity or mortality could be found by the original researchers[24].

In reviewing the literature, Lipfert found an association between morbidity measures and increases in pollutants whenever a lag period of a couple of days was taken into consideration[24]. In reviewing all the major air pollution disasters from this century up to and including the Mount St. Helen's eruption in Washington state in 1980 he demonstrated that smoke concentration and sulphur dioxide levels were positively correlated with excess admissions due to respiratory disease. These studies show that demands for hospital services can be useful outcome measures for quantifying the effects of air pollution on community health. Lipfert concluded that several different studies in several different locations over time have indicated an association between air pollution and hospital use[24].

Effects on lung function

Individual pollutants produce the health effects in different ways. To study the individual effects of these pollutants researchers have, in the past, been unable to gather useful information from environmental studies and rather have undertaken studies under controlled laboratory conditions[22]. This approach is further necessary because individual pollutants can affect different people in different ways. Normal subjects tend to react to the effects of an irritating pollutant with non-specific symptoms such as chest tightness, cough, fatigue, upper airways symptoms; those with respiratory disorders tend to develop an aggravation of their respiratory symptoms. Control studies subject volunteers to a short duration of exposure to a single gas or aerosol at concentrations expected to produce only mild, acute or reversible responses[22].

Nitrogen Dioxide

U.S National Ambient Air Standards indicate a permissible background level of 0.05 parts per million (90 $\mu g/m^3$) averaging over a year increasing to 0.45 parts per million (846 $\mu g/m^3$) over 30 minutes and 0.21 parts per million (395 $\mu g/m^3$) over 24 hours. Indoor levels of this gas tend to be considerably higher than outdoor levels[5] and during gas cooking indoor nitrogen dioxide levels may reach as high as 4 parts per million (7520 $\mu g/m^3$)[22]. Most studies indicate that even quite high levels of nitrogen dioxide do not produce significant symptoms in healthy adults and adolescents where as asthmatics tended to develop decreases in pulmonary function when nitrogen dioxide levels were greater than 0.3 parts per million (564 $\mu g/m^3$)[9].

Ozone

The ambient suggested levels of ozone over an hour under U.S. National Ambient Air Quality Standards is 0.12 parts per million (240 $\mu g/m^3$).This can rise, however, during short periods around mid-day, in Los Angeles to 0.3 (600 $\mu m/m^3$) or even 0.35 (700 $\mu m/m^3$) parts per million. Levels as low as the threshold 0.12 parts per million can occur at other times during the day and persist for between 3 and 10 days in urban and even rural locations[8,24]. Ozone is an oxidising agent that readily attacks biological membranes producing inflammation. It is such a reactive substance that ozone indoors is cleared from the air by reaction of plastic and fabrics and so elevated ozone levels are only an outdoor phenomenon[8]. In general, levels in excess of 0.1 (200 $\mu g/m^3$) parts per million cause eye, nose and throat irritation, chest discomfort and cough. Most healthy adults have little effect from two to three hours in an atmosphere of 0.3 (300 $\mu g/m^3$) parts per million, however, any exercise will rapidly produce respiratory symptoms. The effects on pulmonary function are reproducible in healthy young adults exposed to levels greater than 0.13 (260 $\mu g/m^3$) parts per million under control conditions for at least 3 months following their exposure[22]. Approximately 10% of the population have an increased sensitivity to ozone[8]. Interestingly ozone does not appear to have any greater effects on pulmonary function in asthmatics or those with chronic obstructive airways disease than healthy subjects[8,22]. Paradoxically emergency admissions of asthmatics to hospital increase on days when concentrations of ozone are raised. This is partly explained by the fact that there is considerable inter-subject variation in response to ozone[5]. A possible explanation is the fact that an ozone inhibitory muscular mechanism appears to limit deep inspiration rather than producing bronchial constriction, but knowledge in this field is limited and it underlines the difficulty of trying to tease out the effects of individual pollutants on subjects in an environmental study.

Particulate Matter

Under U.S. National Ambient Air Quality standards the acceptable levels of particulates i.e. Pm_{10}'s or levels of 150 μg/m^3 and under EC guidelines 80 μg/m^3 as a daily mean with 130 μg/m^3 as a winter daily mean[5,22]. A wide range of particles is produced during the combustion of fossil fuels. Photochemical reactions of fine particles (less than 3 μm) with admitted sulphur and nitrogen oxides in the atmosphere forms strong acids such as sulphuric, nitric and hydrochloric acids. These hang airborne as aerosolised solution droplets falling as acid rain[22]. Acid sulphates are very fine particles less than 2.5 micrometers in diameter and their small size allows them to persist in the atmosphere for days and be transported down wind long distances. This is acknowledged as the most dangerous of acid particles[22]. Particles can be primary or emitted directly into the atmosphere or secondary, forming acidic particles as described above. In urban areas motor vehicles account for most particulate production, diesel vehicles producing most black smoke in those areas that have not converted to smokeless fuel, domestic coal burning remains an important source. There is no doubt now that there is a causal relationship between particulate concentration and respiratory ill health[5]. The possibility of a threshold level below which ill effects are unlikely has been suggested, however, epidemiological studies would not appear to be the appropriate tool to access this. This derives from the use of fixed monitoring and on a day where a 24 hour average was within acceptable levels individuals in different areas were close to the monitoring centre may experience much higher or much lower concentrations.

The health effects of particles is seen most strongly in respiratory conditions with a marked increase in respiratory deaths, asthmatic attacks, bronchial dilatory use and lower respiratory symptoms with quite moderate increases in the concentrations of PM_{10}'s[10]. There is new evidence at even current ambient levels of PM_{10}'s (30-150 μg/m^3 are associated with increases in daily cardio-respiratory mortality and in total mortality, these having being shown in many different communities across the United States[26]. Daily fluctuations in PM_{10} levels have been shown to be related to acute respiratory hospital admissions in children and to school absences to decreasing peak flow rate in normal children and to increase medication use of children and adults with asthma. This committee's findings have, in reviewing the literature, shed doubt on the hypothesis that acid aerosols are an important toxic component of PM_{10}'s[26].

Sulphur Dioxide

Sulphur dioxide concentrations declined during the past 50 years in many European countries due largely to the general move away from the use of coal as a means of domestic heating. High concentrations still occur in many eastern European countries[5,7]. Sulphur dioxide produces its effects by virtue of its acidic nature. U.S National Ambient Air Quality Standards dictate that levels must not rise above 0.14 parts per million (400 μg/m^3) over a 24 hour period and not higher than 0.03 parts per million (85 μg/m^3) over one year. The equivalent levels according to the WHO air quality guidelines expert group are 175 parts per billion (500 μg/m^3) in a 10 minute period, 45 parts per billion (130 μg/m^3) over a 24 hour period and no higher than 17 parts per billion (50 μg/m^3) annually. These limits were further refined by the EC to take into account the presents of smoke since the two pollutants have an addictive effect on respiratory health. (see Appendix 2)

When healthy adult volunteers are exposed to high concentrations of sulphur dioxide greater than 5 parts per million bronchoconstriction results. Lower levels 0.15 (430 μg/m^3) to 2 (5,720 μg/m^3) parts per million do not produce significant symptoms or alteration pulmonary function tests even in response to exercise[22]. Sulphur dioxide does, however, produce symptomatic effects in asthmatics or those ectopic individuals with exercise induced bronchospasm. There is marked individual variability in response however. Sulphur dioxide concentrations of more than 4,000 parts per billion (11,440 μg/m^3) can have severe effects, and concentrations of more than 1,000 parts per billion (2,860 μg/m^3) can give rise to bronco constriction in asthmatics. Reversible changes in paediatric lung function at 100 (286 μg/m^3) to 150 (430 μg/m^3) parts per billion have been noted with aggravation of bronchitis beyond 200 parts per billion (572 μg/m^3) and perhaps an increase in mortality above 200 (572 μg/m^3) to 400 (1,144 μg/m^3) parts per billion.[5] Because of the acute effects of sulphur dioxide guideline standards usually include a short term (10 to 15 minutes) volume.

One of the difficulties of studying sulphur dioxide is determining how it exerts its effect whether as raw gas, sulphuric acid or as an acid aerosol condensed around nuclei of tiny smoke and grit particles. Epidemiological data indicates an association between particles and acid aerosols and increased mortality although the association is weaker for sulphur dioxide[27]. Given the close association between particulates and sulphur dioxide and the increasing prevalence of asthma it has been postulated that the increasing levels of asthma are due to increasing atmospheric pollution. The evidence is against this[15,27] although there is no doubt that sulphur dioxide can induce exacerbations of asthma[27].

INTERPRETATION OF RESEARCH RESULTS

While mortality and air pollution, particularly that involving elevated levels of particulates and sulphur dioxide are undoubtedly associated[5], morbidity effects are also seen. Schwartz (1995) demonstrated that air concentration guideline concentrations within current guidelines were associated with increased respiratory hospital admissions of elderly patients in the cities of Newhaven, Connecticut and Tacoma, Washington[28]. The strongest evidence for an independent association was with PM_{10} followed by ozone. He further demonstrated an association between sulphur dioxide concentration and respiratory admissions. This study was unusual in that it sought to further tease out the relative impact of particulate pollutants and sulphur dioxides[28]. In reviewing European studies, he noted hospital admissions to be associated with sulphur dioxide levels but all studies demonstrated high correlation between sulphur dioxide and particulate matter. This suggests that observed sulphur dioxide associations are confounded by air borne particles and he concluded that further investigation was needed of locations with low correlation between the two pollutants[28]. In 1990, Fairley studied daily mortality and concentrations of particulate matter in Santa Clara in California, a location with virtually no sulphur dioxide in the atmosphere as a result of being far from heavy industrial emissions[29]. Santa Clara further benefitted from having its industrial and domestic heating produced exclusively by natural gas. He demonstrated that mortality rose on days with elevated particulate concentration[29]. Others have studied the short term effects of air pollution on morbidity and some shown positive correlations between either particulats and/or sulphur dioxide and respiratory morbidity episodes[30,31,32,33]. Other studies particularly at lower levels of pollutants indicate that the association may not be as strong as had been previously thought[34].

Lipfert, (1993) notes that the degree of confounding in such studies can be considerable[24]. Amongst the questions raised are the reliability of air pollution exposure estimates, in this instance monitoring of ambient pollutant levels at different locations is used as a proxy for the levels of pollutants in the respired air of people in the locality but this may be quite inaccurate particularly if a high proportion of people remain indoors. Another series of confounders can be found in natural patterns in air quality including both long and short term variations. In the longer term, seasonal trends with high ozone levels in summer and higher sulphur dioxide and particulate levels in winter or variations in the levels of nitrogen dioxide in response to varying levels of vehicle traffic use can take place as can the seasonal patterns of respiratory illnesses influence in part by levels of air pollutants but also in part by periodic winter outbreaks of viral infections[24]. In the short term traffic related pollutants often show weekly cycles and industrial sources with produce fewer pollutants at

the week-end may also contribute to this. To take such biases into consideration careful study design and statistical manipulation are often necessary.
In a wide ranging review of hospitalisation and air pollution, Lipfert (1993) concludes that studies of differing designs and over many years lead to the conclusion that there is an association between hospital use and air pollution[24]. However it has been extremely difficult to pinpoint with any degree of certainty the pollutant most "responsible" for the greatest effect. The greatest reason for admission in all these studies is because of exacerbation of pre-existing respiratory disease, and the components of atmospheric pollution identified most frequently are sulphur dioxide and particulates of varying size. A further conclusion of Lipfert was that identification of thresholds below which effects were not seen was very difficult and increasingly other authors are coming to a similar conclusion[24].
Ponka and Wirtanin in (1994) studied the effects of low levels of air pollution and weather conditions on rates of admission for chronic obstructive airways disease and emphysema in Helsinki noted an affect with sulphur dioxide in those under the age of 65 and had an affect with nitrogen dioxide in those over the age of 65. They noted that the concentration of most pollutants in the ambient air were relatively low but that even modest rises away from these low levels could produce a demonstrable health effect as shown by increased rates of admission[35]. Morgan, *et al.,* (1998) studied the effects of outdoor air pollutants in Sydney, Australia on daily mortality[36]. They too noted that modest rises in particulates, nitrogen dioxide and ozone where associated with definite increases in mortality. Walters, Griffiths and Ayers (1994) studied the daily and weekly variations in levels of smoke and sulphur dioxide in Birmingham and related these to hospital admissions for asthma and other acute respiratory diseases[37]. They concluded that daily variations and smoke and sulphur dioxide levels were significantly associated with hospital admissions for asthma and respiratory diseases during the winter months in Birmingham at levels of air pollutants which were within EC recommended guidelines. They further concluded that current levels of air pollution can still produce significant health effects[37].
Braun-Fahrländer *et al.,* (1997) investigated the impact of long term exposure to air pollution on respiratory and allergic symptoms and illnesses in school children aged 6 to 15 in ten different communities in Switzerland[38]. They found that chronic cough, dry cough and bronchitis were strongly associated with levels of PM_{10}. The comparisons were make between those communities with highest and lowest levels of pollutants. Again they concluded that rates of respiratory illness and symptoms amongst children are associated with increasing levels of air pollution even in countries with modest levels such as Switzerland. Katsouyanni *et al.,* (1997) studied the results of the time series data from the APHEA project and prospectively analysed the associations between all cause of mortality, ambient particulate matter and sulphur dioxide[39]. They concluded that modest rises of 50 $\mu g/m^3$ in sulphur dioxide or black smoke were associated with a 3% increase in daily mortality. Another further important finding was that while eastern European cities had higher ambient levels of pollution, larger increases in background pollution levels were required to produce this same mortality effects as would be seen in western cities. One possible conclusion from this is that with higher background levels of pollution, eastern Europeans are less sensitised to the effects of air pollution and so larger increases are necessary to produce the same effect[39].
A further finding was that these effects on mortality were demonstrable within what would considered moderate and even low levels of sulphur dioxide and PM_{10}'s. They conclude that while it is not possible yet to determine the long term health effects of episodic rises in air pollutants, it is possible to say that the current, relatively low levels of sulphur dioxide and particles still have detectable short term effects on health and that further reductions below what are considered acceptable limits in air pollution are advisable[39]. Several other studies have echoed these conclusions. Scarlett *et al.,* (1995) reviewed the effects of ambient smoke and sulphur dioxide in the health of a national sample of 23 year old subjects in 1991 and concluded that no symptoms were associated with sulphur dioxide but that symptoms were less likely the lower the background levels of black smoke[40]. They noted that low ambient levels of black smoke were associated with decreased prevalence of phlegm symptoms in young adults and that the effect was evident below

the current EC guidelines of 34 to 51 µg/m^3 of annual black smoke. They concluded that adverse and possibly chronic respiratory effects appeared evident at current levels of black smoke pollutants.

Increasing attention as recently been focused on the investigation of the effects on health of ambient pollution originating from point sources[13,20,41,42,43]. Halliday *et al.*, (1993) studied the effects of power station emissions on people living close to coal fired power stations and concluded that subjects living in the vicinity of such facilities were more likely to demonstrate impaired lung function and were more likely to report symptoms of asthma[42]. The report did not, however identify the emissions produced by the power stations. Dunne *et al.*, (1995) researched the influence of factory emissions (principally paraffin oil) on asthma and found an increased prevalence in that area close to a factory, particularly in those middle aged and older[20]. These two studies indicated that the increased risk for the outcome investigated was in the order of 10-24% above what would be expected.

CONCLUSIONS

Air pollutants and adverse health are undoubtedly linked. The only dispute in the last 50 years has been about the relative contribution of constituent pollutants and the ambient levels at which such pollutants are likely to produce their effects. Many of the contradictory conclusions arising from the literature over the years have been resolved by the use of advanced statistical techniques to overcome the many sources of confounding in studies into the health effects of atmospheric pollutants. Atmospheric pollution has not been demonstrated *per se* to cause disease but it can exacerbate pre-existing conditions. Those with reduced reserve, particularly respiratory or cardiovascular, are at greatest risk of suffering adverse health effects when exposed to airborne pollution.

The effects of smoke and particulate matter on mortality and morbidity are well documented[1,5] and while airborne particles appear to have the most profound influence, sulphur dioxide is increasingly recognised as being associated with increased mortality and morbidity, independent of the effect of particles[39]. The adverse short term effects of sulphur dioxide on the airways of asthmatics[44], mortality[45,46] and the admission patterns of elderly subjects[47] and children[48,49] have been extensively documented. Long term exposure has recently been recognised as having an adverse effect on survival in the general population[50].

The standards currently in place in the US and Europe are dramatically lower than was the case even 15 years ago, but health effects in response to atmospheric pollutants, are being demonstrated at levels at and below these standards[31]. If this is the case, then are the statutory guidelines sufficiently stringent, particularly given the changing nature of the pollution to which we in the West are subjected, to protect the public from harm?

Asthma in children is on the increase[5,37]. Evidence from lung function studies suggests that, in the UK, the bronchial airways of children have become increasingly hyperresponsive over the last quarter of a century or so[51]. Recent data from the APHEA European Cities Pollution Study has suggested that smaller rises in ambient pollution levels in western Europe are required to produce the same mortality effects as seen in central European cities, suggesting a greater sensitivity to pollution effects amongst the population of western Europe[39]. A subsequent study has shown that sulphur dioxide concentration and mortality for cardiovascular and respiratory conditions as more strongly associated in western Europe than in central Europe and that this effect is more pronounced for sulphur dioxide than for particulate matter[50]. These results suggest that populations who enjoy the cleanest air may be more likely to react adversely to even modest levels of air pollutants and if this trend continues that health effects may continue to be seen at levels below what are considered "safe".

A further important issue is the way pollutants are discharged into the atmosphere. In the past, multiple urban sources provided a uniform blanket of atmospheric pollution to anyone living within or downwind from an urban centre. As this century progressed and power generation became a central plank of any western economy, power stations, often located rurally became a major source of pollution. Such point sources discharge, some distance downwind, concentrated doses of pollutants[5], which can produce demonstrable health effects[20,42]. The plume from such point sources can spare surrounding areas while touching down at distances of up to 20 miles from its origin. The doses of pollutants delivered in this way can be considerable. Moreover, plume effects may be quite transitory and conventional monitoring may miss significant events[20].

APPENDICES

Appendix 1

US National Ambient Air Quality Standards[22,27]

Pollutant	**Primary Standard**	**Averaging Time**	**At-Risk Population**
Sulphur Dioxide	0.14ppm 365µm/m^3	24 hours*	Asthmatics/COPD, Elderly, Children
	0.03ppm 80µm/m^3	1 year	
Nitrogen Dioxide	0.05ppm 100µm/m^3	1 year	Asthmatics/COPD, Children
Ozone	1.12ppm 235µm/m^3	1 hour*	Asthmatics/COPD, Elderly, Children
PM10s	150µm/m^3	1 year	Asthmatics/COPD, Elderly, Children
	50µm/m^3	24 hours*	
Carbon Monoxide	35ppm 40µm/m^3	1 hour*	Pregnant women, Patients with coronary heart disease
	9ppm 10µm/m^3	8 hours	

Appendix 2

International Air Quality Standards and Guidelines

Sulphur Dioxide

Irish Air Quality Standards[a] for SO_2 and Smoke[32]

	Limit Value for SO_2 (µg/m^3)	Associated Smoke (µg/m^3)	Limit Value for Smoke (µg/m^3)
Annual Median of Daily Mean Values	80 120	>40 ≤40	80
Winter Median of Daily Mean Values	130 180	>60 ≤60	130
98-percentile of Daily Mean Values	250 350	>150 ≤150	250
Not more than 3 consecutive days	250 350	>150 ≤150	250

WHO Air Quality Guidelines[b] Expert Group (1996)[5]

1 hour guideline and the link with smoke abandoned

10 mins: 175ppm (501µm/m^3)

24 hours: 45ppb (128µm/m^3)

Annual: 17ppb (47µm/m^3)

[a] Currently in force
[b] Not yet in use

EC Directive Limit Values[5]

Annual median of daily means

30ppb (UK equiv 34) if smoke >40µm/m

45ppb if smoke <40µm/m³

Winter median of daily means

48.8ppb (UK equiv 51) if smoke>60µm/m³

67.5ppb if smoke <60µm/m³

98th percentile of the daily means

93.8ppb (UK equiv 102.8) if smoke>150µm/m³

131.1ppb if smoke <150µm/m³

Guide Values

Annual Average: 15-22.9ppb (43-65µm/m³)

Daily Average: 37.5-56.4ppb (107-161µm/m³)

Nitrogen Dioxide

WHO Air Quality Guidelines Expert Group (1996)[5]		
24 hours guideline and the link with smoke abandoned		
1 hour: 110ppm (207µm/m³)		
Annual: 21ppb (40µm/m³)		

EC Directive Limit Values[5]		
Limit Value:	98%ile hourly mean	104ppb(197µm/m³)
Guide Value:	98%ile hourly mean	70.6ppb(133µm/m³)
	50%ile hourly mean	26.2ppb(49µm/m³)

Ozone

WHO Air Quality Guidelines Expert Group (1996)[5]
8 hour: 60ppm (120µm/m³)

EC Directive[5]		
Health Protection Threshold:	8 hours 55ppb(110µm/m³)	
Population Information Threshold:	1 hour	90ppb(180µm/m³)
Population Warning Value:	1 hour	180ppb(360µm/m³)

WHO Air Quality Guidelines Expert Group (1996)[5]			
Health Effect Indicator	Estimated change in daily average concentration needed for give effect ($\mu m/m^3$)		
	Sulphates	**$PM_{2.5}$**	**PM_{10}**
Daily Mortality:			
5% change	8	29	50
10% change	16	55	100
20% change	30	110	200
Hospital Respiratory – respiratory conditions:			
5% change	8	10	25
10% change	16	20	50

EC Directive Limit Values[5]

(UK and European BS not identical; UK BS=0.85 EC BS)

Limit Values

Annual median of daily means: 80$\mu m/m^3$

Winter median of daily means: 130$\mu m/m^3$

98th centile of daily means throughout year: 250$\mu m/m^3$

Guide Values

Annual Average: 40-60$\mu m/m^3$

Daily Average: 100-150$\mu m/m^3$

WHO Air Quality Guidelines (1987)[5]

15 mins: 87ppm (109µm/m^3)

30 mins: 50ppm (62.5µm/m^3)

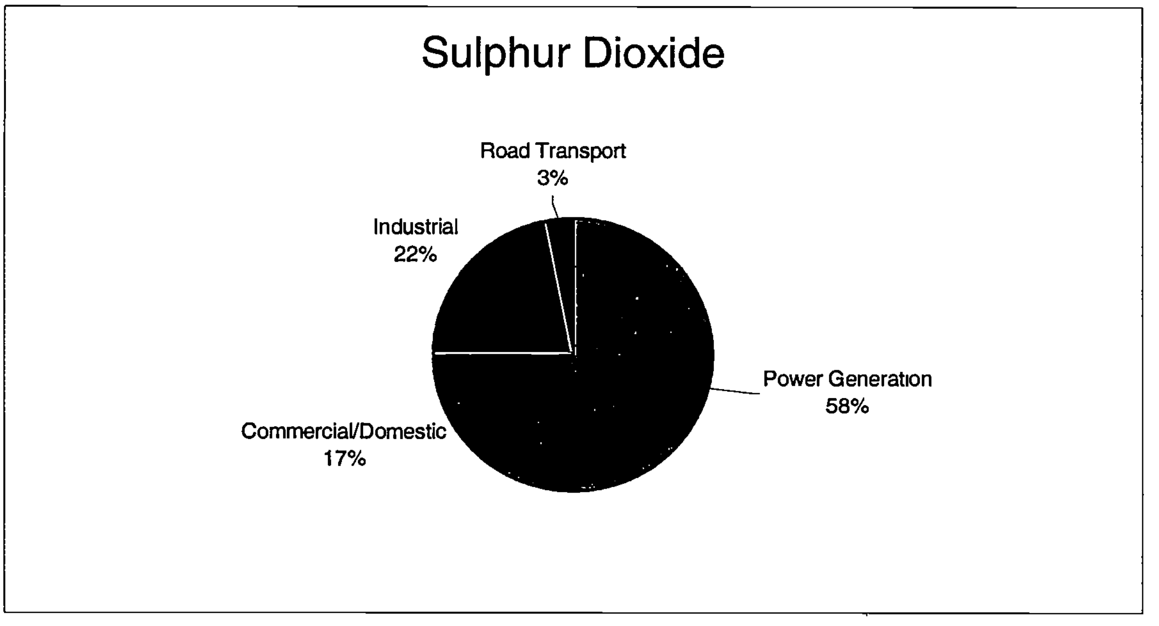
1 hour: 25ppm (31.25µm/m^3)

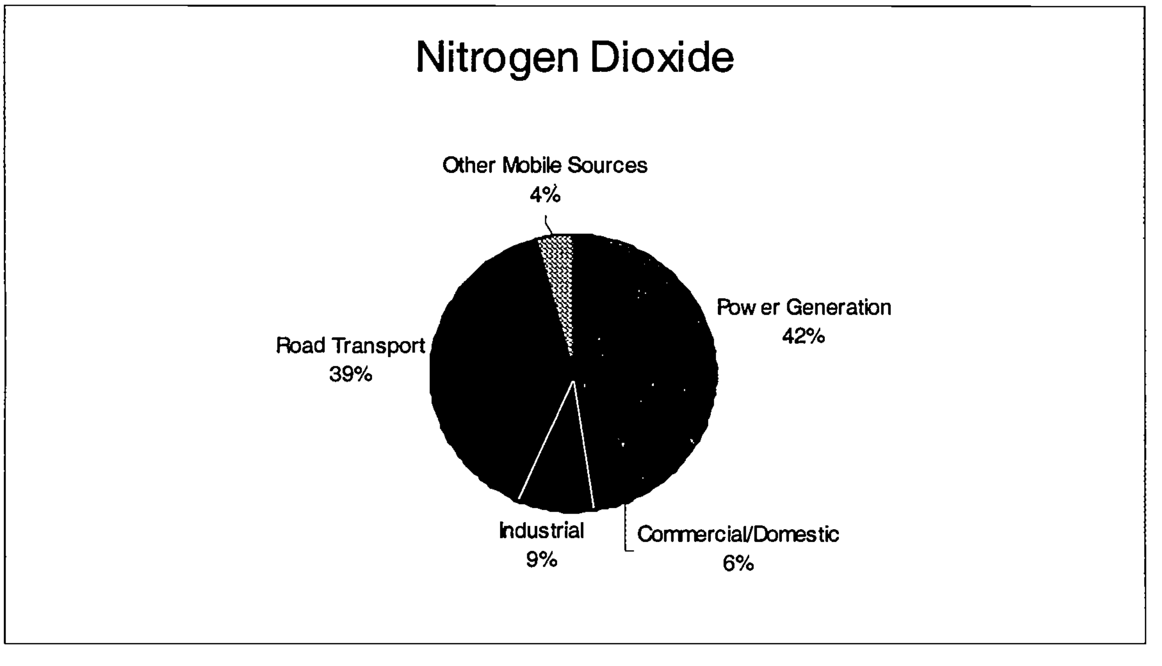
8 hours: 10ppm (12.5µm/m^3)

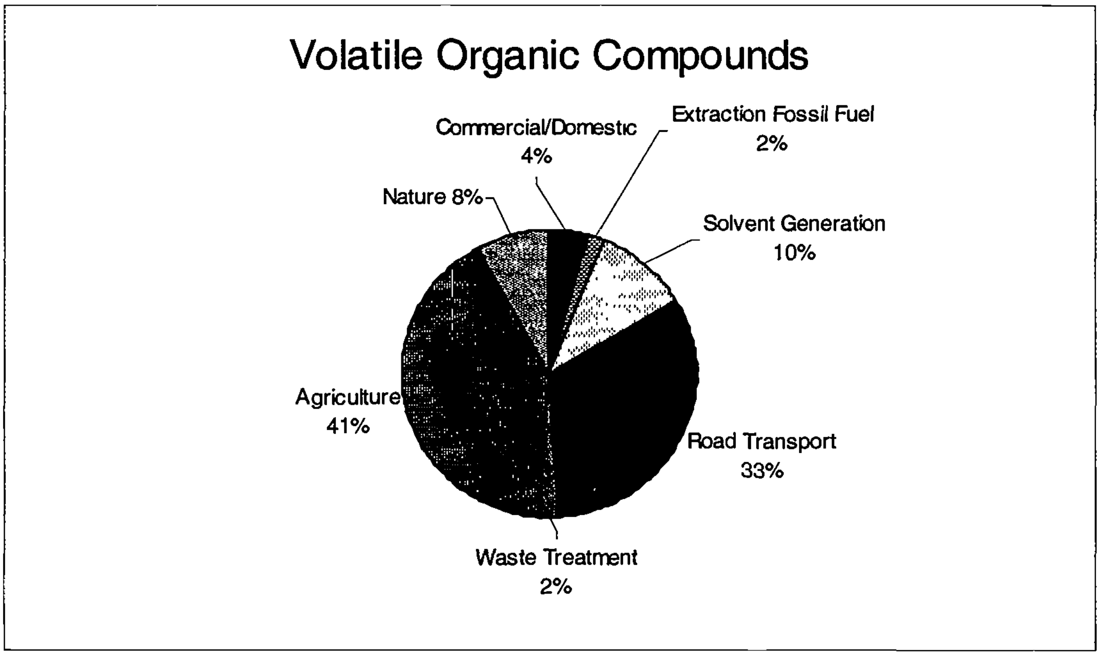
These are the estimated ambient levels which will allow a normal subject engaged in relatively heavy work to maintain his COHb levels to within 2.5%.

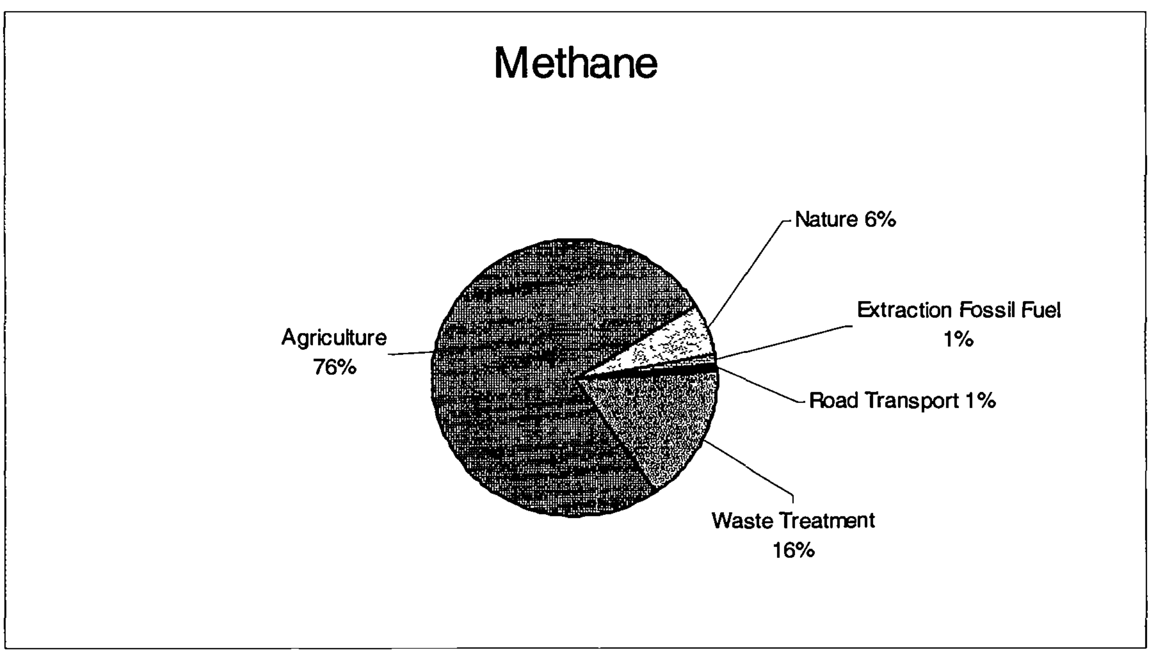
Appendix 3

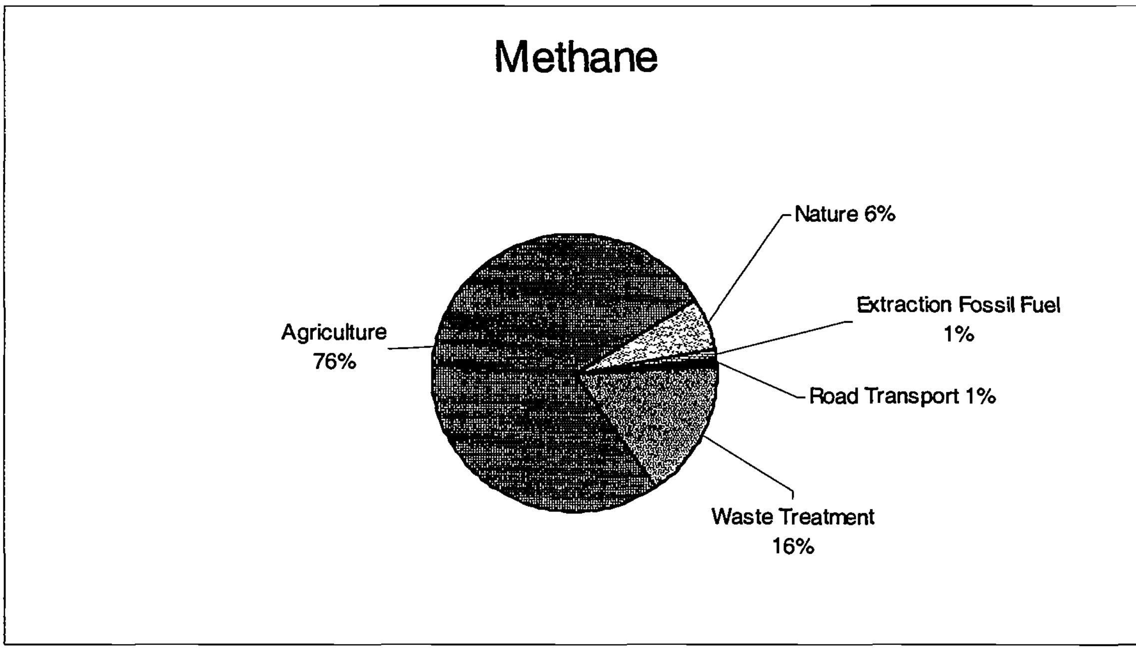
Sources of Atmospheric Pollutants, Ireland, 1994
(Adapted from Corinair, 1994[4])

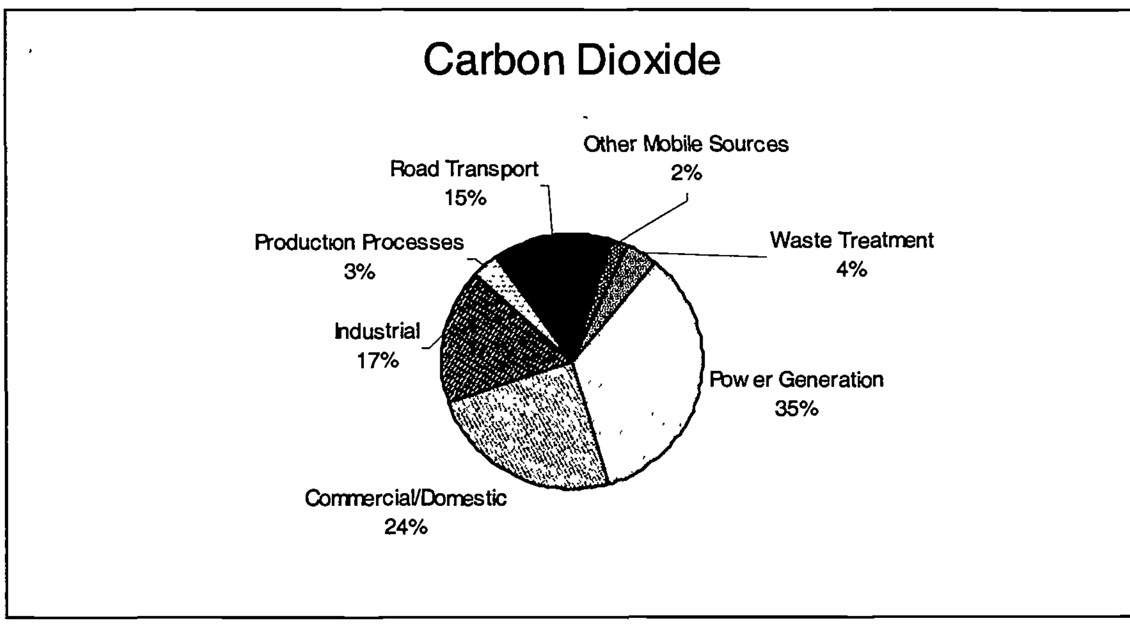


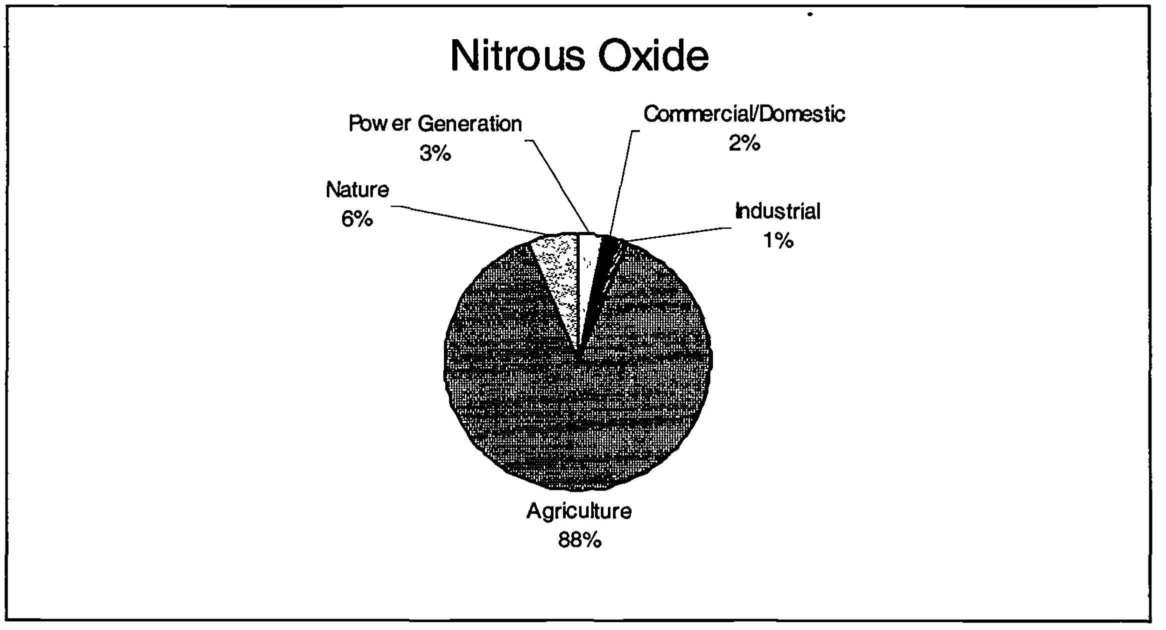


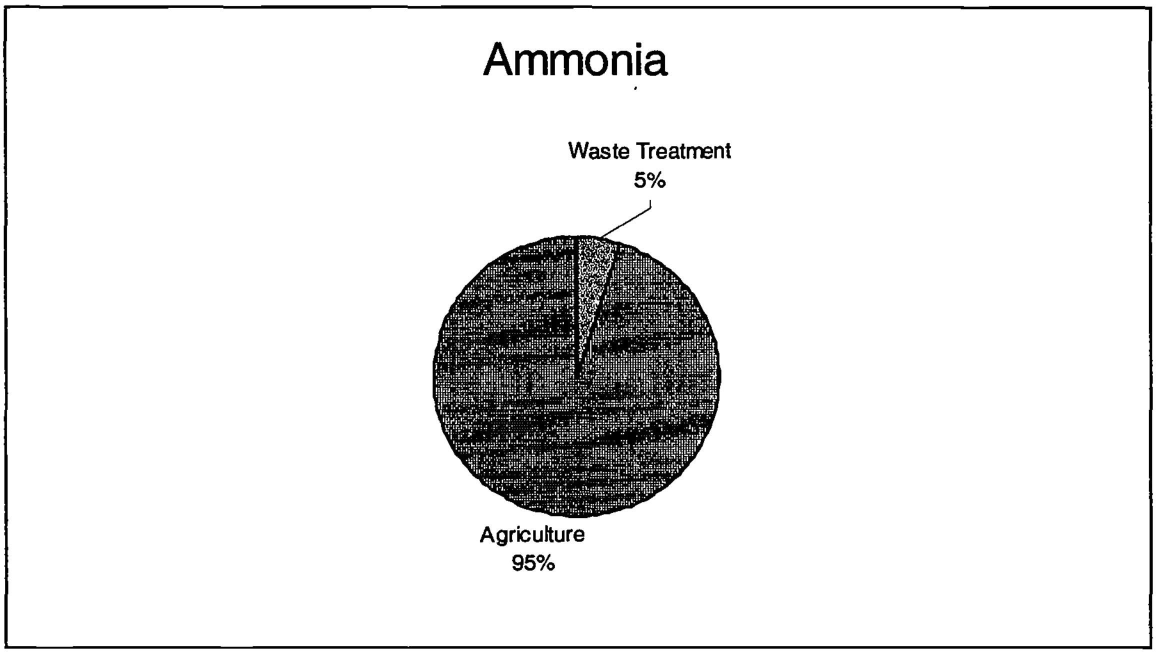

Volatile Organic Compounds
Commercial/Domestic 4%
Extraction Fossil Fuel 2%
Nature 8%
Solvent Generation 10%
Agriculture 41%
Road Transport 33%
Waste Treatment 2%


Methane
Nature 6%
Extraction Fossil Fuel 1%
Agriculture 76%
Road Transport 1%
Waste Treatment 16%


Methane
Nature 6%
Extraction Fossil Fuel 1%
Agriculture 76%
Road Transport 1%
Waste Treatment 16%

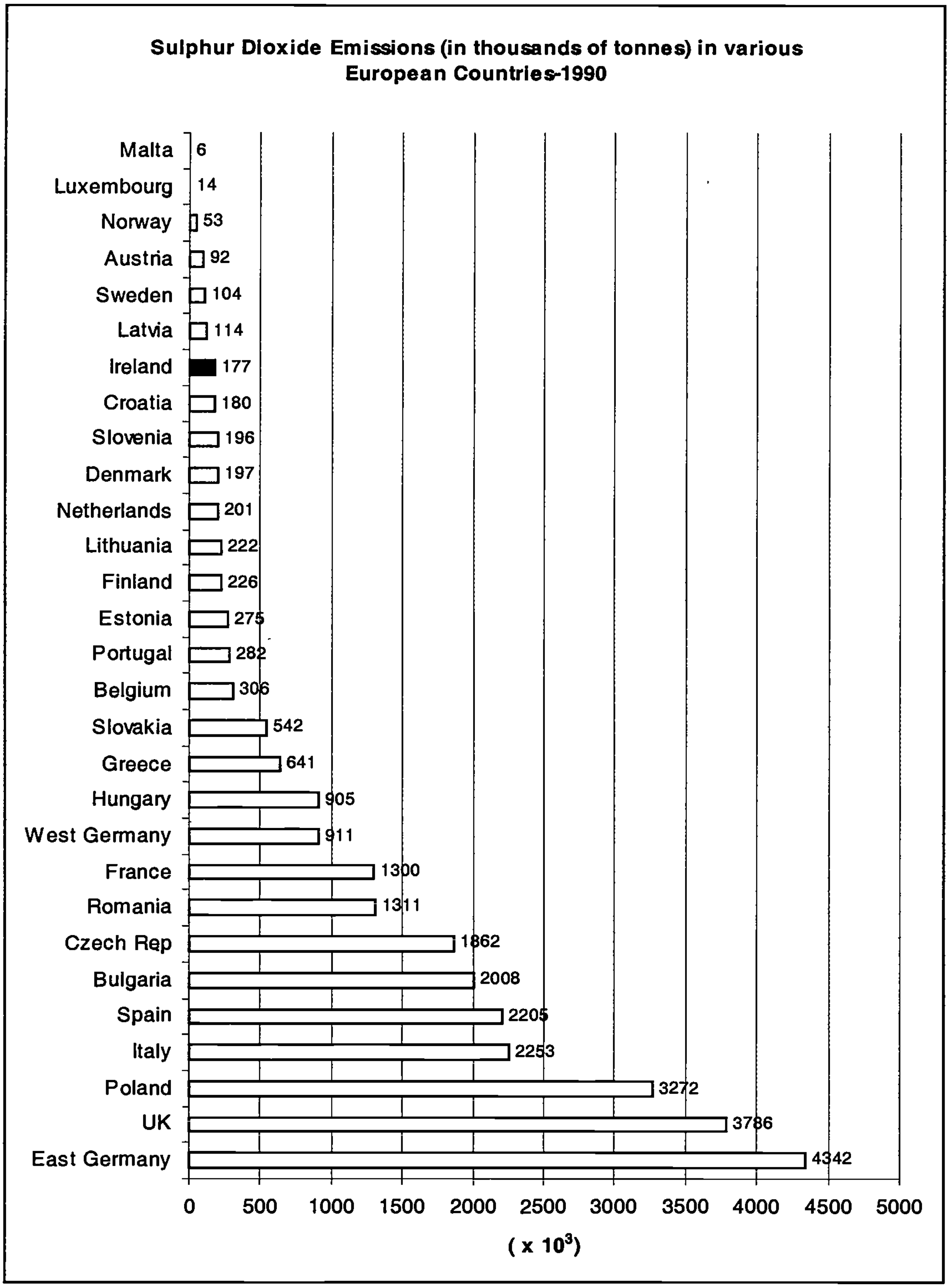

Carbon Dioxide
Other Mobile Sources 2%
Road Transport 15%
Production Processes 3%
Waste Treatment 4%
Industrial 17%
Power Generation 35%
Commercial/Domestic 24%


Nitrous Oxide
Power Generation
3%
Commercial/Domestic
2%
Nature
6%
Industrial
1%
Agriculture
88%


Ammonia
Waste Treatment
5%
Agriculture
95%

Appendix 4

European Sulphur Dioxide Emissions, 1990 *(Adapted from Corinair, 1990[6])*



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BIRTH EFFECTS STUDY

BACKGROUND

Sporadic concerns about the occurrence of animal health problems in the Askeaton area of Co. Limerick have been voiced since the late 80's and were perceived to be related to the concentration of heavy industry in the Shannon Estuary. These issues became more pronounced in 1994/95 and were also accompanied by public concerns about the potential effects on human health. The human health investigation was launched in 1995 as part of the Ministerial investigation co-ordinated by the Environmental Protection Agency. During early 1995 meetings were held with the community and the Mid Western Health Board in order to hear the various anxieties which were being raised in the media. Meetings were also held with key informants in the area.

The local community expressed concern about the numbers of miscarriages and foetal anomalies and the levels of respiratory illness and cancer in the area. Some reported episodes of upper respiratory and eye irritation, with some burning of exposed skin. They related that these concerns had existed for the last seven to eight years.

INTRODUCTION

Internationally, the rate of congenital malformation is approximately 2.2% of all births.[1 2] Minor physical anomalies which have no surgical or cosmetic significance may occur in up to a further 4% of births. Minor abnormal physical features which occur in more than 4% of births are deemed to be normal variations. While genetic causes account for 20-25% of human birth detects[3], approximately 60% of birth defects are of unknown aetiology.[4] Environmental causes which include maternal disease states, maternal infection, mechanical factors, problems of constraint, chemicals, drugs, and physical agents, are thought to be responsible for only about 10% of human birth defects.[3,4,5] With recognition of the teratotenicity of drugs and chemicals, the concern that occupational and environmental agents may contribute to birth defects of unknown cause, has stimulated much research. Public and media concern regarding birth defects is common in areas potentially at risk from environmental hazards.

Low sex ratios of births have been associated with airborne pollution from steel foundries and from incinerators. Normally male births exceed female births. The sex ratio refers to the ratio of male births to female births. Such environmental and other occupational health research suggest that change in the birth sex ratio may be an early indicator of environmental hazards of importance to public health.[6]

Media reports alleged that an increase in twin births among farm animals, especially dairy cows, has been seen in the area around Askeaton. While there is no concern expressed of an increase in human twin births in the Askeaton area an examination of twin births rates was carried out. Some years ago a study carried out in Scotland looked at the geographical distribution of twin births during the period 1975 to 1983 in defined geographic areas which were known to be most at risk from air pollution from incinerators. An increased frequency of human twin births was found in these and was accompanied by a dramatic increase in twin births among dairy cattle about the same time.[7]

The study has two intrinsic problems which would and have posed problems in the interpretation of the data and the questions posed:

1. The essence of the investigation was to identify babies with congenital anomalies. This was severely hampered by the fact that the study had to use an information system not designed for this purpose. This meant the investigation was almost

certain never going to have the same ascertainment rate as a system devised for the specific purpose as with systems available in other parts of Ireland and Europe.

2. Askeaton is a small area with a small number of births. Investigating a disease with a low incidence rate imposes even more problems. Chance begins to play an important part as one extra or less case can look like a very big increase/decrease yet all that is being seen is a chance event.

AIM OF THE STUDY

The main aim was to determine whether the rate of congenital birth defects in Askeaton and in the area around Askeaton was normal. The specific objectives were

1. To determine the rates of congenital birth defects and other possible indicators of the effects of pollution in Askeaton - "high risk area"(area 1), in the area around Askeaton - "medium risk area"(area 2) and in the rest of Limerick Community Care Area(area 3)- control area for the period 1987-1994
2. To compare the sex ratio of births the three areas from 1987-1994.
3. To compare the twin births rates of births in the three areas from 1987-1994

METHODS

Study Area

Previous studies of health effects associated with airborne pollution have identified the geographical area of concern on the basis of available meteorological data on wind direction and strength; on the local topography's influence on plume transport; on the results of environmental tests for specific pollutants; or on the basis of nuisance complaints received; or a combination of the above[6,7]. The possibility of using similar data to delineate the areas of concern in the Askeaton area was considered by the Environmental Protection Agency and the Interprofessional Group. Given the presence of a number of emission sources interspersed through the greater area and the absence of an identifiable contaminant as sufficient explanation as cause for the observed animal health problems, the group assessment was that such an approach would be of questionable value. The technical feasibility of adopting such an approach was also questioned. It was agreed that the presence of animal health problems was the best indicator of potential exposure available at the time.

The presence of animal health problems was identified as the best indicator of potential exposure to an environmental hazard for the delineation of the geographic areas potentially at risk of human adverse effects. Three geographic areas were defined. An area comprised of six District Electoral Divisions (DED) centred on the town of Askeaton contained the farms, twenty three in number, originally identified by the local Ballysteen/Askeaton Animal Health Committee as having noteworthy animal health problems was studied as the area potentially most at risk for the development of adverse effects on human health. This area within Rathkeale rural district encompasses Askeaton East, Askeaton West, Iveruss, Craggs, Aughinish, Lismakeery, Nantinan and Riddlestown (total population 4,000 approx.) and is area 1. The surrounding area, considered to be at medium risk, comprising the remaining DEDs in Rathkeale rural district and Rathkeale urban district (total pop. 10,000 approximately) was a second study area, area 2. The rest of Limerick Community Care Area (total population 100,000 approx.) served as the control area, area 3, for the investigation of human birth defects. (The use of high risk in this study means potential high risk.)

Time period

The time period of concern was determined through interviews with key informants in the area. The presence of an animal health problem of unusual degree and severity was first noted on one farm in 1987. The animal health problem peaked in the period 1993 to 1995, leading to the institution of a major interagency investigation which commenced early in 1995. It was decided that the retrospective review should go back to 1987.[8]

Case definition

Cases were defined as all malformed live and stillbirths to mothers resident in the defined geographical areas. These included structural malformations, chromosomal anomalies, metabolic disorders and hereditary diseases. Malformations were classified into subgroups indicating their mutagenic (e.g. Downs syndrome) or teratogenic origin and known association with environmental exposures. All cases where possible were coded by Eurocat code nine[1] and the British Paediatric Association of Diseases [9] which is a five digit code being an extension of the 9th revision of the International Classification of Diseases .[10]

The form in which the information was available did not allow for the identification of all anomalies where more than one major congenital abnormality was present. This report as consequence does not differentiate between individual types of anomalies, hence a case is a baby or stillbirth not an anomaly..

The EUROCAT system of coding includes metabolic and genetic diseases such as PKU and Cystic Fibrosis. Whilst these cases have been identified, they are kept apart from the rest of the study as their cause is known to be genetic.

Duration of case ascertainment

Case ascertainment was confined to possible cases detected in the first month of life except for cases identified from the counselling nurse, long term illness and domiciliary care allowance where cases were identified during early childhood.

Reference population

The reference population comprises all births to women resident in the geographically defined "high" , "low" and "medium" risk areas in county Limerick.

Case identification

Since April 1973 all congenital birth defects notified by the midwife have been compiled into a congenital abnormality register (CAR), and checked for completeness by the counselling nurse for the handicapped. The midwife notification is completed by the midwife in the labour ward and forwarded to the Superintendent Public Health Nurse as an early notification of birth to facilitate an early visit by the area public health nurse.

Supplementary sources of potential information on congenital anomalies were also examined. These were Special Care Baby Units, Public Health Nurse records, Counselling nurse records, Long Term Illness records, Domicillary care allowances and official birth notices. All still birth records were examined in the Limerick, Cork and Tralee hospitals in order to ascertain whether a congenital anomaly was present. However it was not always obvious if there was an abnormality especially if there was no structural malformation. The autopsy rate was very variable and results difficult to track down. Most of the cases with anomalies (95%) were therefore identified in livebirths. This compares with EUROCAT figures of between 88 and 98 per cent. In 1988 a relatively low number of cases were found which maybe related to loss of key documentation for that year.

Sex Ratio and Twin Birth Rate

To examine the sex ratio for births, gender details on births in the areas was obtained from the community care birth lists compiled from the midwife and official birth notifications. A check with the public health nurse area birth registers in the areas 1 and 2 was also undertaken to confirm geographic coding. Data on birth notifications without information on gender was obtained by a further check with the public health nurse. The definition of a twin births rate is the number of twin births per thousand births.

Calculation of congenital abnormality prevalence rates

In this report cases are babies who had at least one congenital abnormality. Rates are given per 10000 live and stillbirths (Unlike EUROCAT where each anomaly is treated as a case, where comparisons are made with EUROCAT this needs to be taken into account).

Data entry

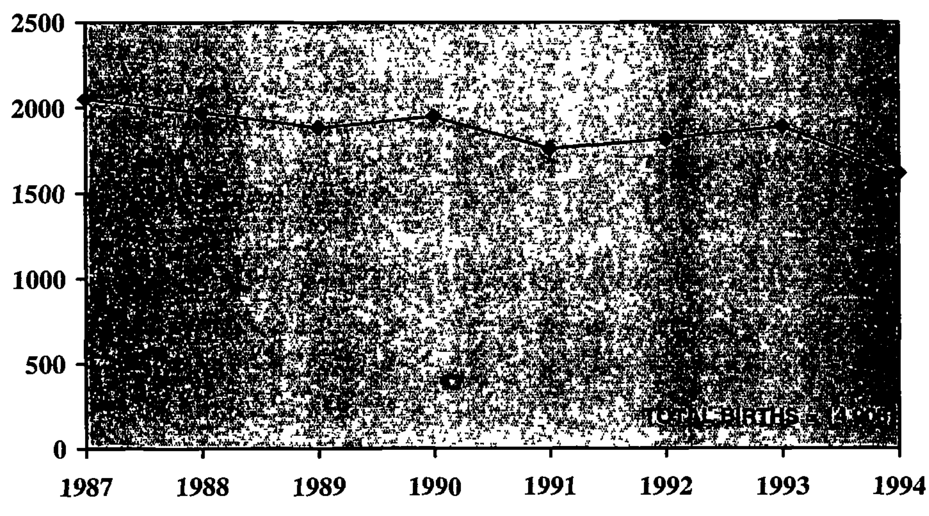
Data were entered and analysed on Epi info version 6.04[11].

RESULTS

Between 1987-1994 there were 14,906 live and still births in Limerick community care area. As shown in figure 1. there is a downward trend in births overall during this period which becomes more pronounced after 1991 as also seen in the national figures.[12] The birth rate for the area for 1991 was (15.3 per 1,000 which is similar to the national birth rate of 15/1,000 population.

Of the total number of 14,906 births, just 443(2.9%) were from area 1 while 1078(7.2%) were from area 2 and 89.7 % (13,385) infants were born to women resident in area 3. There were 98 stillbirths during the eight years giving a still birth rate of 6.6 per 1,000 live and still births. This rate is the same as the most recent national rates 1986-1992.[12,13]

Figure 1
Total births Limerick Community Care 1987-94



Sex ratio

The sex ratio overall was 1.08 males to females which is similar to national norms [14]. There was a slight increase of males in areas 1 and 2 compared with area 3 but no more than would be expected by chance.(This is what is meant by the term non-significant) If an abnormal sex ratio was present one would expect less males rather than more males which was not the case here (see table 1 and 2).

Table 1

BIRTHS SEX RATIO January 1 1987 - December 31 1994				
	Area 1	***Area 2***	***Area 3***	***Overall***
Total Births	443	1078	13385	***14,906***
Total males	234	566	6,919	***7,719***
Total Females	209	510	6,438	***7,157***
Total missing values	0	2	18	***20***
Male sex ratio	**1.12**	**1.11**	**1.07**	**1.08**

Table 2

BIRTHS SEX RATIO January 1 1987 - December 31 1994			
	Area 1+2 study area	***Area 3 control area***	***Total***
Males	800	6,919	*7,719*
Females	719	6,438	*7,157*
Totals	1521	13365	*14,884*
Male sex ratio	1.11	1.07	1.08
Not Significant			

Twin births Rate

The twin births rate overall was 12/1000 which is similar to national norms[12]. There is no increase in the twin births rate in area 1. Although area 2 has a higher rate (14.1/1000) compared with the remainder of Limerick community care area (12/1000), this difference is not greater than would be expected on chance variation.

Table 3

TWIN BIRTHS RATE January 1 1987 - December 31 1994				
	Area 1	***Area 2***	***Area 3***	***Total***
Births	439	1,063	13,222	***14,724***
Twins	4	15	159	***178***
Total	**9.1/1000**	**14.1/1000**	**12/1000**	***12/1000***
Not Significant				

Table 4

TWIN BIRTHS RATE January 1 1987 - December 31 1994			
	Area 1 +2 study area	***Area 3 control area***	***Total***
Births	1502	13,222	***14,724***
Twins	19	159	***178***
Total	**12.6/1000**	**12/1000**	***12/1000***
Not Significant			

Congenital Anomalies

Between 1st January 1987 to 31st December 1994, 191 cases of congenital anomaly were identified in Limerick community care area. Of the total number 95% (n =183) were liveborn and just 5%(n =4) were stillborn. More males (52.3%) than females (47.7%) were born with a congenital anomaly. This includes 12 cases of Cystic Fibrosis and 7 cases of Phenylketonuria (PKU). For the purposes of the analysis these cases have been excluded as they have mainly a genetic component and are not generally considered to be congenital anomalies. The total number of cases in the study was 172 of which 4 came from the high-risk area, 14 from the medium risk area and 154 from the control area 3.

The mean age of 96 women at time of delivery of infants with congenital anomalies was 30.9 years. The mode and median value was 28 and 31 years respectively. The average age of mothers giving birth nationally has been running at 29 years [11]. Over one third of the women were 35 years and over compared with 19.2% and 14.7% respectively in Dublin and Galway 1980-1992. The distribution of cases over eight years is shown in table 6. Over the 8 years a total of 154 infants were born with a congenital anomaly. In 1988 a relatively low number of cases were found which maybe related to loss of key documentation for that year. The total prevalence rate of congenital anomalies Area 3 during this period was 115/10,000 births. The annual prevalence rate fluctuated during this period which probably reflects the uneven and incomplete nature of data available in this study. Overall rates in area 3 are stable which reflects the larger sample size. The congenital anomaly prevalence rate per 10,000 was highest in area 2 and lowest in area 1. When area 1 and 2 are combined the rate is 118/10,000. Comparing area 1+ 2 with area 3 there is no significant difference between the two areas.(Tables 5&6 and Appendix 1)

Table 5-Number of Infants with Congenital anomalies in each Area

Year	*Areas*				*Total*
	1	*2*	*1+2*	*3*	
1987	1	1	2	25	27
1988	1	0	1	15	16
1989	1	1	2	22	24
1990	0	2	2	24	26
1991	0	3	3	23	26
1992	0	4	4	12	16
1993	1	2	3	16	19
1994	0	1	1	17	18
TOTAL	*4*	*14*	*18*	*154*	*172*

Table 6

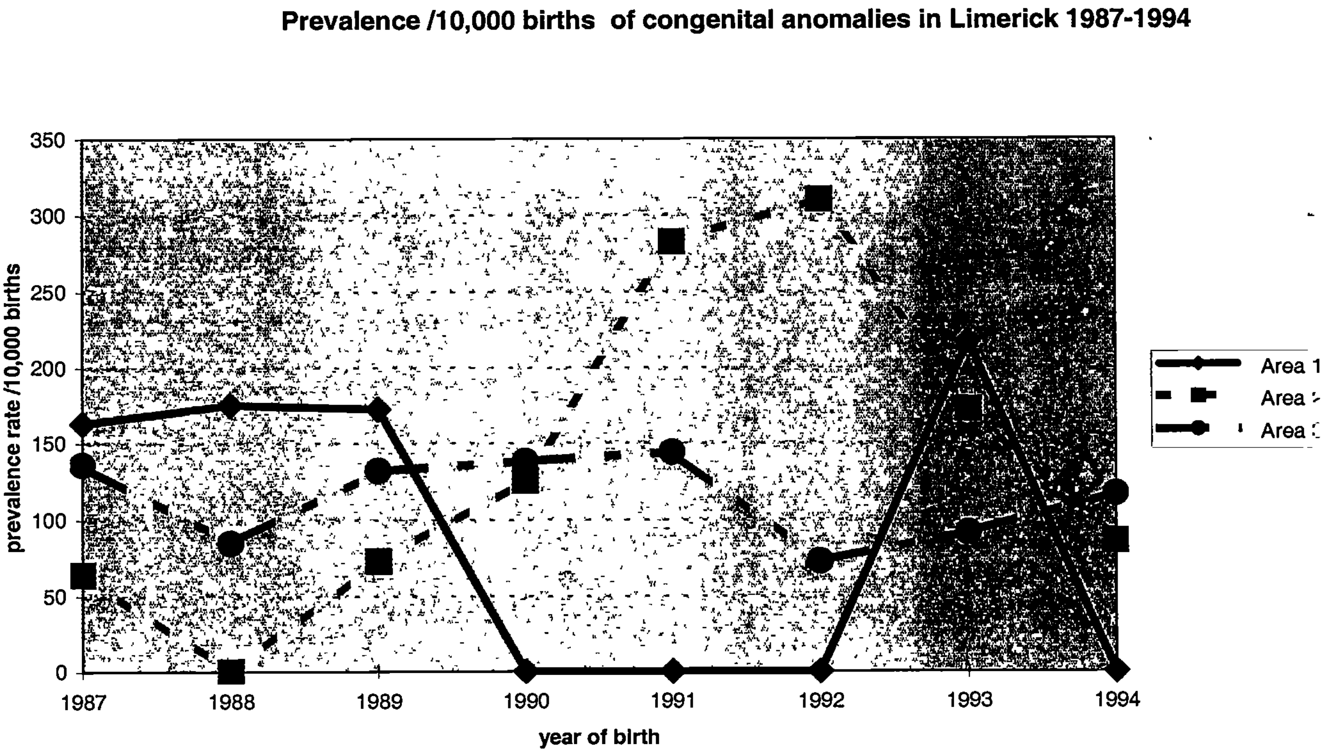
Prevalence Rate /10,000 births per year of cases of congenital anomalies in Limerick and other registries

	Year								
Area	***1987***	***1988***	***1989***	***1990***	***1991***	***1992***	***1993***	***1994***	**Total**
Area 3	136	85	132	138	144	73	92	117	115
Area 2	64	0	73	125	280	300	170	86	129
Area 1	160	170	170	0	0	0	217	0	90
Area 1+2	92	46	103	92	188	222	185	57	118
Dublin*	283	274	209	227	227	227			
Galway*	229	171	144	223	295	295			
Eurocat*	231	216	220	210	203	203			213

- prevalence rates only available to 1992 EUROCAT

The rates of congenital anomaly in all three areas is lower than the European average in 17 registries over 12 years to 1992 which was 231 /10,000. However, underlying this was considerable variation between registries ranging from 138 in Switzerland to 324 Glasgow. Over time in Europe the prevalence rates have declined from 272 to 231. The graph below illustrates the fluctuations in prevalence rates during the 8 years. However very small number are obviously distorting the picture. Area 3 with the largest population and cases numbers is relatively stable over the 8 years with an overall downward shift in prevalence. Area 2 however shows a peak in the years 1990-1992 which is likely to be a random reflection of small numbers. Both areas 2 and 3 show a trough in 1988 which is possibly due to loss of record books for that year.

Figure


Prevalence /10,000 births of congenital anomalies in Limerick 1987-1994
350
300
250
200
150
100
50
0
prevalence rate /10,000 births
1987
1988
1989
1990
1991
1992
1993
1994
year of birth
Area 1

DISCUSSION and CONCLUSIONS

This report gives the results of an investigation into whether or not there had been an increase in congenital anomalies in the Askeaton area. It is based on the information sources which were in existence during the study period (and still). Unfortunately the study has been affected by the poor quality, accessibility and structure of the data. An investigation which involved the perusal of 14,000 records manually was by necessity prolonged beyond its anticipated finish date. The quality of the data now presented is adequate to indicate the numbers of babies with anomalies but the ability to date to give a more detailed examination of individual types of anomaly is not possible at this time. Further work is required.

Overall, total prevalence rates of congenital anomaly are affected by completeness of sources of information used for ascertainment and changes in diagnostic practices and definitions. Even if an apparent increase in prevalence is found it is difficult to determine whether this is a true increase or a methodological artefact. Moreover increases may be due to random variation rather than real change. Of more importance is the size of the increase and whether the prevalence rate is significantly higher than in other registries or published literature.

Complete data collection was hampered by a number of factors.

- The absence of computerisation of the data sources examined made data collection difficult.
- Full information on stillbirths is dependent on there being a post-mortem, ideally with specialised foetal pathologists to carry out the autopsy, and on the availability of autopsy records. Even when a post-mortem had been carried out this fact was not always recorded in the notes.
- Midwife notifications for 1988 could not be found. The staff who hold the records moved office across town about that time and the records were presumably mislaid in transit. Old record stores in both buildings were searched in an effort to locate the missing files but without success.
- Diagnostic details were often insufficient to enable the precise diagnosis to be made and further records had to be sought and examined. In most cases of congenital abnormality only one defect was recorded..
- The child's' name was missing on most birth notification forms. The mother's name was not adequate to obtain the child's record from the local regional hospital.
- The medical records were often incomplete with no copy of the referral letter to or discharge letter from the tertiary referral hospital found in the hospital notes of patients that had been transferred there.
- Information on births occurring outside the Mid-Western Health Board to unmarried mothers resident in Limerick who are not keeping their baby was missed.

The main problem affecting this study is the whole issue of small numbers. The number of cases and the number of births in both areas 1 and 2 were small, especially in area 1. This can lead to a number of difficulties in interpreting the data: there is likely to be much greater year on year fluctuation; one extra case could result in a twenty percent or even hundred percent increase.

Overall the rate of congenital abnormality is lower than in other European registries but within the norms accepted internationally (1-2% births). The results show rates for the eight year period which are lower than the control area for the high risk area and very slightly higher for the medium risk area. Neither of these rates are statistically different from the rate for the control area.

Early warning systems of surveillance can be effective form the detection of very large increases in rare and well defined anomalies which are easily diagnoses at birth. Detection of smaller increases in prevalence in common anomalies a well validated data set is needed as well as longer duration of surveillance. It is desirable to conduct enhanced surveillance of public health in the Shannon Estuary Area so as to enable the timely detection of outbreaks or clusters of adverse health events; and the determine trends in the overall number of cases. Baseline health status could be determined and in time the pattern of incidence rates according to gender, age, socio-economic status and other variables could be described. Such information would offer substance for testable hypotheses in the event of public health concerns arising in the future.

Ongoing public health surveillance is needed to document changes in public health status. In the absence of such surveillance it is likely that only large deviations from the norm will be noted while smaller changes in risk which may have a significant impact on public health will go undetected. Historical baseline data on the incidence and prevalence rates of common conditions are not available for the geographic area of concern to the present investigation or indeed from a comparable reference population.

Such systematic surveillance with congenital abnormality register would enable the answering of public concerns in a timely and efficient manner without the need to undertake a lengthy and arduous study such as outlined in this paper which was costly of resources.

RECOMMENDATIONS

As a result of this study a small number of recommendations are suggested:-

- A more detailed review is undertaken of all the individual cases to ascertain the exact anomaly(ies) involved and whether they can be explained by known risk or causal factors.
- The cases of PKU/Cystic Fibrosis should be examined to ensure they are explicitly genetic.
- A structured and systematic surveillance system should be put in place to allow routine analysis of trends in congenital anomalies. This should be the EUROCAT system to allow comparison with other parts of Ireland.

Appendix 1

Area 3									
Live Births	1819	1741	1657	1721	1590	1621	1713	1437	***13,300***
Still Births	14	12	8	7	8	12	12	12	***85***
Total Births	1833	1753	1665	1729	1598	1633	1725	1441	***13,377***
Still Birth Rate									***5.7/1000***
Sex Ratio									***1.08***
Twin births Rate	1.2%	1.3%		1.1%	1.1%	.7%	1.6%	1.2%	***1.2%***
Cases Cong. Ab.	25	15	22	24	23	12	16	17	***154***
Cong. Ab. Rate	1.36%	.85%	1.32%	1.38%	1.44%	.73%	.92%	1.17%	***1.15%***
Area 2									
Live Births	153	158	135	157	103	129	116	116	***1,067***
Still Births	2	2	1	3	2	1	0	0	***11***
Total Births	155	160	136	160	105	130	116	116	***1,078***
Still Birth Rate									***10.2/1,000***
Sex Ratio									***1.11***
Twin births Rate									***1.4%***
Case Cong. Ab.	1	0	1	2	3	4	2	1	***14***
Cong. Ab. Rate	.64%	1.25%	.73%	1.25%	2.82%	3.1%	1.72%	.86%	***1.26***
Area 1									
Live Births	61	57	58	58	53	50	45	59	***441***
Still Births	0	0	0	0	1	0	1	0	***2***
Total Births	61	57	58	58	54	50	46	59	***443***
Stillbirth Rate									***4.5/1000***
Sex Ratio									***1.12***
Twin births Rate									***.9%***
Case Cong. Ab.	1	1	1	0	0	0	1	0	***4***
Cong. Ab. Rate	1.63%	1.75%	1.72%	0	0	0	2.17%	0	***.90%***
Area 2+1 (study area)									
Live Births	214	215	193	215	156	179	161	175	***1,508***
Still Births	2	2	1	3	3	1	1	0	***13***
Total Births	216	217	194	218	159	180	162	175	***1,521***
Still Birth Rate									***8.5/1,000***
Sex Ratio									***1.11***
Twin births Rate									***1.4%***
Case Cong. Ab.	2	1	2	2	3	4	3	1	***18***
Cong. Ab. Rate	.92%	.46%	1.0%	.92%	1.9%	2.2%	1.85%	.57%	***1.18%***

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SURVEY OF GENERAL PRACTITIONER'S PERCEPTIONS OF HEALTH PROBLEMS IN THEIR PRACTICES

Introduction

Sporadic concerns about the occurrence of animal health problems in the Askeaton area of Co. Limerick have been voiced since the late 80's and were perceived to be related to the concentration of heavy industry in the Shannon Estuary. These issues became more pronounced in 1994/95. Although the main concerns in the Askeaton / Ballysteen area have been related to animal health problems, local population have also expressed concern about possible human health effects. The human health investigation was launched in 1995 as part of the Ministerial investigation co-ordinated by the Environmental Protection Agency. During early 1995 meetings were held with the community and the Mid Western Health Board in order to hear the various anxieties which were being raised in the media. Meetings were also held with key informants in the area.

The local community expressed concern about the numbers of miscarriages and foetal abnormalities and the levels of respiratory illness and cancer in the area. Some reported episodes of upper respiratory and eye irritation, with some burning of exposed skin. They related that these concerns had existed for the last seven to eight years.

Preliminary investigations were carried out in 1995. In view of the animal health problems and public anxiety over possible health effects, general practitioners (GPs) in the Askeaton / Ballysteen area were requested to review the pattern of illness encountered in their own practice. The type of adverse health effects which may result from exposure to an environmental hazard could include skin rashes, mucosal irritation i.e. eye, nose and throat irritation, respiratory problems, abnormal outcome of pregnancy, change in the pattern or incidence of cancer and neurological problems. No cluster of adverse health effects that might be attributable to an environmental hazard was reported by any general practitioner although isolated reports of health problems of the type described have been received. Later one GP wrote about concerning cancers, and others contacted the board when the health status survey was being conducted to offer support.

The Mid Western Health Board has undertaken a number of studies to address the concerns raised by the population. A comprehensive review of human health has been put in place which included a births study, health status survey, acute health effects study, cancer incidence and school attendance. In the births effects study there was no significant in rates of twin births, male sex ratio and congenital abnormalities between study and control areas.(1) Analysis is currently being carried out in the health status and school attendance studies. Members of the public have during the health status survey interview indicated that they would welcome GP validation of health problems in the area. This would make sense as almost all illnesses presenting to medical services, present initially to the general practitioner. From meetings with the Animal Health Committee, however there was feedback that with some of the minor ailments, people did not go to their general practitioner. We nevertheless hoped to add to the knowledge and perceptions of the health situation by allowing general practitioners an opportunity to give their opinion. The Department of Public Health decided to conduct a postal survey of general practitioners using questions with a similar format to that used in the main health status study.

Aim and Objectives

The main aim of the study was to describe the perceptions of general practitioners regarding patient morbidity and environmental hazards in six geographically defined areas in the Mid West region and to see if there were significant differences between them. The specific objectives were to assess whether GP's in Askeaton and Rathkeale compared with other areas have noted an increase in number of patient consultations for respiratory symptoms, sinus and skin irritations, cancers and serious illness over the past one year. For fertility problems, cancer and serious conditions this extends to ten years.

Methods

General practice is relatively underdeveloped in Ireland compared to Britain. Approximately one third of the population are entitled to free medical care at the primary level. (General Medical Service entitlement - the medical card). Entitlement is based on income assessment and is highest in deprived urban areas, rural areas and in those in who self employed, have serious illness or are elderly. The remainder of the population not covered by GMS card are private patients who may shop around. Most general practices therefore do not have defined private practice populations with age sex registers of all their patients. General practice records would be a valuable source of information if there was a patient denominator. In order to accurately monitor patient morbidity in this community a prospective study would have to be done and available evidence on human health status to date could not justify this. The main limiting factors for not doing a comprehensive search was the lack of defined practice population outside the GMS. Without a reliable denominator it was not possible to analyse records of even a small number of general practitioners. Relatively few practices are computerised throughout the country. Within the Mid Western Health Board in a survey carried out in the past year, only 39/126 general practitioners were using computers with clinical packages. Not all GPs record each patient contact either on paper or on computer.

We instead decided to survey all general practitioners in the various geographic areas using a structured questionnaire to elicit their own views and perceptions on patient and environmental health. The format of the questionnaire was similar to that used in the health status survey (administered to a random sample of 2,500 people around the same time).

A questionnaire was sent to all GPs registered with the Mid Western Health Board as being in either private or public practice in one of six defined areas during the month of November 1996. Each area represented a population of 4,000 and was based on the population sampled for the human health study and included Askeaton and Rathkeale (where the population at risk resided). Another area was across the estuary in Kildysart in Clare along with areas adjacent to Clarecastle. A third was Ennistymon in north Clare and the fourth was in Littleton / Moyne a rural area near a proposed mine closed to Thurles county Tipperary. GPs in towns adjacent to the six areas were also included for practical reasons.

Doctors were asked if they had concerns about respiratory, skin and sinus/ throat diseases within the past year. Details of the age group of patients most affected were requested and other additional relevant information. GPs were asked if they had concerns about fertility problems or unusual numbers of cases of miscarriages in their practice population within the past 10 years. Doctors were asked if they had specific concerns about health problems in the practice population as well as unusual numbers of patients with serious illnesses within the past one and ten years. Serious illness was not defined but examples were given such as cancer, leukaemia and neurological problems. Finally doctors were asked to give their views on environmental hazards in their area. For the purpose of analysis the two areas Askeaton and Rathkeale were combined and called "exposed " as patients crossed boundaries and they were adjacent. All other areas were treated as "non-exposed". We also decided to look at GP perceptions by county of residence. GPs were asked to return the questionnaire with their comments within four weeks. Reminders were sent out in early January 1997. In addition to the questionnaire in depth interviews were held with six general practitioners resident in the study area later in the year. Data were entered and analysed using EPI Info Version 6.04

Results

A total of 50 general practitioners were contacted. Reminders were sent to 23 GPs who had not responded within four weeks. Altogether 34 GPs (68%) returned completed questionnaires. One GP from area 2 returned his questionnaire uncompleted as his practice did not include patients from the area. The breakdown of response rates is as follows

Table 1 Response rate of doctors and area of practice

Area	No. doctors circulated	No. Questionnaires returned (%)
Askeaton	1	1(100)
Rathkeale	15	13 (86)
Kildysart	6	3 (50)
Ennistymon	6	6 (100)
Littleton/ Moyne	10	5 (50)
Clarecastle	12	7(58.3)
Total	50	35 (70)

Figure 1 Practice size of general practitioners

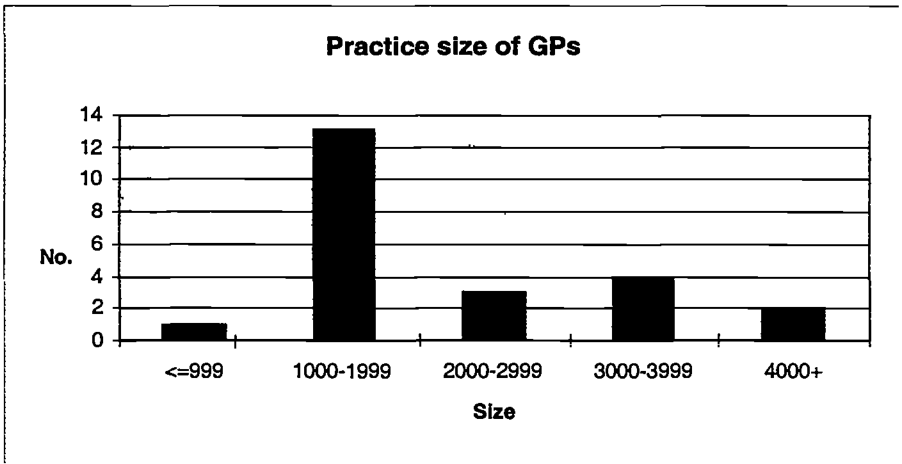
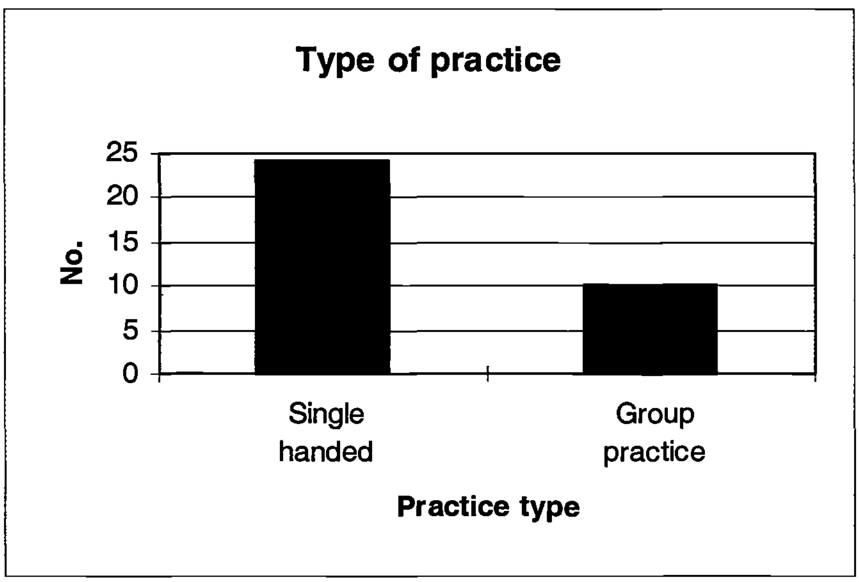


Figure 2

Practice type



Just over two thirds of general practitioners were single handed. Nine doctors were in group practices. Practice size varied from 100 - 4,000. The mean list size was 1,961 (sd 981). The median practice size was 1,000 overall (Figures 1 and 2). One GP was semi retired. Two doctors were new to their area (less than 18 months).

Table 2 shows the rate of general practitioner concerns by area of exposure. Over one third of all doctors (equal proportions between exposed and non exposed) admitted to concerns about respiratory problems in their practice - mostly in younger children. GPs commented on rising on trends in asthma. Some thought the problem was worse in their area compared to others. Doctors wrote that *"asthma cases have increased"* and *"patients express concern about asthma"*. Three out of 34 GPs altogether (8.8%) expressed concerns about skin problems (7.7% and 9.5% in exposed and non exposed areas). These were impetigo, scabies and unusual rash. Seven (20.5%) said they had concerns about sinusitis in the past year. The concerns mainly related to rhinitis, sinus, throat infections and headaches. The age group most affected was 15 - 44 year olds. One GP commented that *"patients express concern"*. Another said *"sinus problems are increasing"*. Fewer doctors in the exposed area had concerns about sinusitis / rhinitis than GP's in non exposed areas. (15.3% compared with 23.8%). Three out of 34 doctors (8.8%) had concerns regarding infertility. One GP wrote that *"I don't know if problem is greater than usual"* and another doctor said that *"the IVF referral rate has increased."* In a question about whether they had noticed an unusual number of miscarriages in the past 10 years, four doctors agreed. Amongst comments received were that miscarriages were *" ustered in areas."* A recurring theme throughout several commentaries was the lack of information or accurate statistics to answer these queries . *"patients express concerns about miscarriage but I don't have specific knowledge"* and *"this has been queried but there are no hard facts"* were some of the replies. The proportion of doctors concerned about miscarriages in the exposed area was 23% compared with 4.8% in the non exposed area (a ratio of 4.85 but the confidence level did not reach statistical significance).
Seven GPs (20.5%) said that they had experienced an unusual number of cases of serious illness in their practice in the past year. These included, brain tumour, leukaemia, pancreatic and oesophageal cancers. Proportionally *fewer* doctors replied that they were concerned about serious illness in the exposed area than in the non exposed area (ratio 0.69). Six doctors (17.6%) were concerned about the rate of serious illness over the past ten years (examples given included childhood cancers, health problems in older people, depression, deaths in young men). In contrast to the previous question proportionally *more* doctors in the exposed area were concerned about illness over the past ten years. However this was not statistically significant (ratio 1.76 CI .42-7.3).

Table 2

Ratio of GP perceptions of health problems in their practices

GP Concerns	Exposed areas		Non exposed areas		Total	Ratio	*CI*
	No.	%	No.	%	No.		
Respiratory problems	5	(38.4)	8	(38)	13	1.01	*0.42-2.43*
Skin rashes -	1	(7.7)	2	(9.5)	3	0.8	*0.08 -8.05*
Sinus/ rhinitis	2	(15.3)	5	(23.8)	7	0.65	0.15 - 2.86
Fertility past 10 years	1	(7.7)	2	(9.5)	3	0.8	*0.08 - 8.05*
Miscarriage rates past 10 years	3	(23)	1	(4.7)	4	4.85	*0.56 - 41.8*
Unusual number serious illness in last 1 year	2	(16.6)	5	(23.8)	7	.69	*0.16- 3.1*
Unusual number serious illness in last 10 years	3	(25)	3	(14.2)	6	1.76	*0.42-7.3*
Concerns about health problems in population	5	(38.4)	5	(25)	10	1.44	*0.62-3.3*
Environmental concern	4	(30.7)	5	(25)	9	1.19	*0.48 - 2.9*
Total	**13**		**21**		**34**		

About one in three general practitioners said they had concerns more than usual about specific health problems in their practice, 38% in Askeaton Rathkeale compared with 25% of the remainder. The health problems cited at least twice were asthma and chest diseases, smoking and cancer in young people. Other health problems mentioned once were obesity, hypothyroidism in women, childhood autism, air pollution, public worries about health and numbers of patients with skin rashes GPs expressed concern about lack of reliable information (see table 3).

Table 3

G.P. Comments

Comments from GP's on health problems in their practice
Information is lacking / no accurate statistics
Feel that asthma is increasing in prevalence
Patients are concerned about health / symptoms
Patients are more affected in my area
Young children are more affected
Specific concerns relate to smoking and respiratory problems

Table 4

GP concerns about the environment

Environmental concerns of general practitioners	**No**
Air pollution , Moneypoint, dirty air/ acid rain/ night smells	6
Food quality	1
River pollution / slurry / silage	2
Dioxins, Fluorocarbons, Chemicals	4
Traffic, noise	2
Total	**15**

Overall slightly more doctors in Askeaton /Rathkeale said they had concerns about environmental hazards in their area. Table 4 shows some of these concerns

GP concerns my county of practice

GP Concerns	Clare No.	Clare (%)	Limerick No	Limerick %	Tipperary No.	Tipperary %	Total No.	Total (%) %	*DF = 2*
Respiratory problems	6/16	(37.5)	5/14	(35.7)	2/4	(50)	13	(38.2)	X_2 *0.28 P =.87* *DF = 2*
Skin rashes past year	2/16	(12)	1/14	(7)	0/4	(0)	3	(8.8)	X_2.*=.71 P= .7* *DF = 2*
Sinus / rhinits past year	3/16	(18.7)	3/14	(21.4)	1/4	(25)	7	(20.5)	X_2.*=.09 P= 1* *DF = 2*
Infertility past 10 years	1/16	(6.2)	1/14	(7)	1/4	(34)	3	(8.8)	X_2.*=.1.4 P= .48* *DF = 2*
Unusual rates miscarriage	1/16	(6.2)	3/14	(21.4)	0/4	(0)	4	(11.7)	X_2.*=2.26 P=.32* *DF = 2*
Serious illness last year	3/16	(18.7)	2/13	(15.4)	2/4	(50)	7	(20.5)	X_2.*=.2.31P=.31* *DF = 2*
Serious illness last 10 years	2/16	(12)	3/13	(23)	1/4	(25)	6	(17.6)	X_2.*=.68 P= .7* *DF = 2*
Specific concerns about health problems	4/15	(26.6)	5/14	(35.7)	1/4	(25)	10	(30.3)	X_2.*=.34 P= .8* *DF = 2*
Environmental concerns	4/15	(26.6.)	4/14	(28.5)	1/4	(25)	9	(27.2)	X_2.*=.03 P= 19* *DF = 2*
Total	16		14		4				

Table 5 shows the variation in GP perception by county. There were no significant differences in GP perceptions broken down by county. Limerick GP's expressed more concerns about miscarriages compared with Clare and Tipperary. However, in relation to their perception of unusual rates of serious illnesses in the practice populations,Tipperary GP's were more concerned than Clare or Limerick about experiences in the past one and ten years. A similar proportion in all counties were concerned about environmental problems.
The results indicate that general pracitioners have a variety of concerns about their patients health. GPs in Askeaton / Rathkeale were more likely to be concerned about rates of miscarriages, incidence of serious illness and specific health problems in their practice compare with those in "non exposed areas". However doctors in the latter areas had proportionally more concerns about other illnesses including repiratory problems sinusitis and incidence of serious illness within the past years. Over a third of doctors in Askeaton / Rathkeale compared to a quarter of GPs elsewhere concerned about environmental hazards in their area.

Report Of Discussions Held With GPs June / July 1997

Discussions were held during the summer of 1997 with the GPs who had patients within the area concerned.

Dr. A
Generally Dr. A feels that bronchiolitis in small children is more common. Dr. A is concerned about young men with cancer. People have also mention to them their worries about number of miscarriages in the Ballysteen area but Dr. A has no direct experience of this.

Dr. B
Dr. B has a deep knowledge and understanding of people in the area. Dr. B along with other local people felt "quite sceptical" about environmental concerns, initially, in relation to Aughinish. Dr. B didn't particularly like to see " billowing black smoke" from the factory. Now however, Dr. B says with all the attention and investigation that people are beginning to worry that there is something wrong. The main health problem that is encountered in the practice is hypertension.

Dr. C
Dr. C made the observation that the farmers who complain about the affects of Aughinish would be known to be good farmers and therefore Dr. C would be inclined to take them seriously. However the only experience of ill health is an increase in respiratory problems in children. The main concerns are with the air pollution from coal dust at Foynes docks. A major problem is the effect of intermittent high wages on the labourers who work in the docks. Alcoholism is a huge problem within the practice.

Dr. D
Dr. D does not believe that there is an animal health problem and wanted to know on what basis the health investigation was being carried out, especially the evidence for human health problems. Patients have not expressed concern to Dr. D. The majority of consultations are related to patient anxiety (70%). In relation to respiratory problems he states that there is a general increase over the past 10 years. Dr. D is unimpressed with the environmental hazards due to industry and more concerned about high anxiety and the stress overlay in patients in his practice.

Dr. E
Dr. E has a number of patients who are convinced that their throat/allergy problems are related to environmental pollution. Dr. E says that farmers and workers (i.e. Aughinish) are worried about the effect of the environment on their health but denies that they personally are concerned. Dr. E keeps

animals and they have not suffered any ill effects. Dr. E personally has had no experience of strange clouds, smells etc.

Dr. F

Dr. F has experience of a number of adults with respiratory problems and skin rashes and headaches, viruses. Dr. F says that " patients are annoyed, irritated and angry" - Their anger is not always expressed. Patients are angry about air pollution and dust from power stations. Generally people are more and more aware about issues in the environment. They are especially concerned of farmer pollution (slurry, nitrates, and fertiliser). When Moneypoint and Tarbert power stations were first opened people were glad to have the extra money in their pockets but now they are more concerned about the impact on their lives. Dr. F feels that the minor rashes and allergy/sinus problems seen in his practice are related to air pollution. When asked what were the biggest problems facing people in the practice Dr. F said "unhappiness" On the other hand Dr. F is " not impressed with Aughinish and Moneypoint / Tarbret doing their own monitoring". Overall, Dr. F is concerned about acid rain, fluorocarbons, and the pollution of rivers and estuaries especially the Shannon and its tributaries. Dr. F observed that porpoises are rarely seen in the sea now.

Dr. G

Dr. G was not visited but in their written questionnaire they expressed particular worries about pollution from local power plants, cancers in young people.

Dr. H

Dr. H discussed some of these issues on the phone. Dr H has many anxious patients in the practice. Dr. H feels that " there must be something" in the general worry about Askeaton. However there is nothing specific about the health problems or patient concerns.

Discussion

It is estimated that 99% of all illnesses presenting to medical services present first to the general practitioner. (2) Records should therefore contain a dated sequence of events in a person's medical history with each contact recorded, treatment given, investigations done, patients referred. Information from general practice should be therefore very valuable in obtaining a clear picture of health problems of patients. However even in countries with well developed systems routine consultations would not normally be computerised and a paper search would be necessary. General practice in Ireland is however relatively undeveloped compared to Britain.

Of the illnesses presenting to the GP about 5% are estimated to be referred to secondary care.(2) The illness seen by general practitioners, is in itself , only a fraction of the health problems experienced in the community. Logically therefore illness recording should start in the community and then move on to hospital setting. In practice, however illness recording in primary care has lagged well behind that in hospital. In fact there is no routine surveillance of patient morbidity in general practice in Ireland. Prior to the changes in the GMS in all patient contact was recorded and consultation rates for each practice could be compared. Since the captitation fee was introduced in 1992 however there is no systematic recording of consultations in the private or public system. A system of general practice sentinel surveillance was introduced into Ireland in 1988 in 72 practices using six conditions including asthma.(2) This system has lapsed over the years and there are few practices currently involved although there are proposals to put a workable surveillance system in place.

In 1989 Lyons reported on a prospective study of of general practice morbidity in middle aged person in Dublin and found that the distribution of asthma was not social class related. However other conditions including chronic bronchitis, diabetes, depression had a higher community prevalence in deprived areas.(7) In the United Kingdom 98 % of the population are registered with general practitioners and 90% of all illness presents through general practice. (3) Yet there is a largely under-utilised potential for using high quality primary care data for other purposes such as needs assessment and evaluating health programmes. Addressing these issues would pose a significant burden on practitioners time and resources. Previous studies of patient morbidity in relation to air pollution have been done in Teeside and Sunderland in the United Kingdom. (4) The study aimed to find out whether or not a relationship existed between the occurrence of patient morbidity such as otitis media with effusion in schoolo children and the proximity of their hoime to industry. A retrospective cohort study of general practitioner records on a subset of subjects included in a comprehensive health status survey was performed. This had to be a paper based study of general practitioner notes in patients charts. With few exceptions, however, results showed that general practice consultation rates for all conditions and for respiratory conditions including asthma, the prevalence of chronic conditions, hospitalisation rates and prescribing patterns showed equal or less morbidity and health care use in the exposed area compared with non exposed areas. Notably, asthma and bronchitis was not highest in the risk area.

The illnesses recorded by general practitioners for sentinel surveillance in Ireland were measles, mumps, otitis media, chicken pox, herpes zoster and miscarriage - General practitioners from the report 1990-92 recorded an average of 6.6 cases per 1,000 population per year (estimated) compared with 60/1,000 per years cases of otitis media.(2)

A study of the incidence of allergic rhinits in general practice 1982-1992 was reported by Ross and Fleming from the Royal College of General Practitioners Weekly Returns Service.(5) The results showed that while data varied from year to year there was no trend. No important difference was found between urban and rural locations or different parts of the country with respect to timing and size of the peaks The study did however support an important role for local pollutants in hay fever. Other studies have found that indoor environmental pollution due to tobacco has been found to be a factor in childhood illness.(4)

Since the early 90s there has been an increasing need for health to monitor the health of its population and to access the need for appropriate intervention as services to meet problems associated with ill health. There is also a need to demonstrate variations in incidence and prevalence of disease. In Northern Ireland the Data Retrieval in General Practice project developed by Queens University has now a data base of 30 practices in 4 health boards. using morbidity data the project includes not only incidence but also prevalence data and more recently standardises information allowing comparisons between practices and populations.(6) However the project is still in relatively early days and will require maximum participation and co-operation from general practitioners. In its recent review asthma prevalence in the majority of practices ranges between 6-8%.(6)

Conclusions

Overall the 34 general practitioners who responded to the questionnaire did not indicate undue worry among their patients health. There was a trend throughout all areas of a perception of an increase in respiratory problems especially asthma and in younger patients. General practitioners in all areas were also concerned about specific health problems in their practice which were mainly related to smoking, air pollution, chest diseases and patient perceived worry. Overall just under one third of doctors had concerns about the environment and these related mainly to air pollution, food and water pollution and road traffic accidents.

There was no consistent variation in the perceptions of general practitioners regarding patient morbidity in their practice although GP's from the exposed area did express proportionally more worries about rates of miscarriage, serious illness over five years and had more health concerns about their patients. This may reflect the level of anxiety conveyed to general practitioners by their patients and their own proximity to major industry. Overall there was no statistically significant difference in frequencies of perception among general practitioners between exposed and non exposed areas and between counties Clare Limerick and Tipperary.

The GPs spoken to really knew their communities. Overall we did not get the impression that they were truly concerned about the health effects of environmental pollution apart from some minor respiratory problems. They were concerned about a high level of stress in the population, the on going worries that something might be wrong and a high level of alcoholism and unhappiness in people General practitioners in the Mid Western Health Board do not have accessible information on patient morbidity in their practices. The study was unable to answer questions about patient morbidity because of lack of routine recorded or computerised records.

Appendix 1

Mid Western Health Board GP Survey

Confidential

*Name:*____________________________________
*Address:*___________________________________
Date:

Practice Type

Group / .....Single ***Principal*** *Practice size (approx)* -----------	*No. partners ------* *Assistant*

(Circle 1 for Yes - 2 for No)

		Yes	No	Office only
1	In the past 12 months have you had concerns more than usual in your practice about respiratory illness/asthma? If "no" go to question 2. If yes please give details	1	2	
	____			
	____			
	Age group tick which most affected			
	0-4 years	1	2	
	5-14 years	1	2	
	15-44 years	1	2	
	45-69 years	1	2	
	70+ years	1	2	
2	In the past 12 months have you had concerns more than usual in your practice about skin problems? If "no" go to question 3. If yes please give details	1	2	
	____			
	____			
	Age group tick which most affected			
	0-4 years	1	2	
	5-14 years	1	2	
	15-44 years	1	2	
	45-69 years	1	2	
	70+ years	1	2	
3	In the past 12 months have you had concerns more than usual in your practice about sinusitis / hay fever / nose throat irritation. If "no" go to question 4. If yes please give details.	1	2	
	____			
	____			
	Age group tick which most affected			
	0-4 years	1	2	
	5-14 years	1	2	
	15-44 years	1	2	
	45-69 years	1	2	
	70+ years	1	2	

	(Circle 1 for Yes - 2 for No)	Yes	No	Office only
4	In the past 10 years have you had concerns about fertility problems in your practice population? If yes please give details.	1	2	
5	In the past 10 years have you noticed an unusual number of cases of miscarriage? If yes please give details.	1	2	
6	In the past one year have you experienced an unusual number of cases of serious illness such as cancer, leukaemia, neurological problems? If yes please give details.	1	2	
	Age group tick which most affected			
	0-4 years	1	2	
	5-14 years	1	2	
	15-44 years	1	2	
	45-69 years	1	2	
	70+ years	1	2	
7	In the past 10 years have you experienced an unusual number of cases of serious illness? If yes please give details	1	2	
	Age group tick which most affected			
	0-4 years	1	2	
	5-14 years	1	2	
	15-44 years	1	2	
	45-69 years	1	2	
	70+years	1	2	
8	Do you have specific concerns about health problems in your practice? If yes please give details	1	2	
9	Do you have concerns relating to environmental hazards in your area? If yes please give details	1	2	

Comments: please write overleaf if necessary.

Thank you for completing this questionnaire: please return to -
Dr. Margaret Fitzgerald, Senior Registrar Public Health Medicine,
31-33 Catherine Street, Limerick
Tel: 061-483337 Fax no. 061-316870

The Askeaton Human Health Study

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Abbreviations

Askeaton Human Health Study AHHS

Department of Health DH

Economic and Social Research Institute ESRI

Environmental Protection Agency EPA

Mid-Western Health Board MWHB

SUMMARY

As part of a series of investigations into concerns about animal and human health in the Askeaton area, a survey of the health of the people of Askeaton, and of five other rural areas in the Mid-Western Health Board was done. This is known as the Askeaton Human Health Study (AHHS). Questions about their health were asked of a random sample of the population, identified through the Economic and Social Research Institute.

Two thousand four hundred and eighty interviews were completed. Response rates were acceptable. Most completed interviews were of good quality, with a low proportion of missing or incomplete answers. The demographic pattern of the final sample was close to that of the target sample.

The main objective of the human health study was to examine geographical patterns in human health to see if there was any association with the reported pattern of animal ill health. There were six study areas, Askeaton, from where animal health problems had been reported, Rathkeale, adjacent to Askeaton, and four comparison areas - Ennistymon, Killadysert, Moyne & Littleton and Clarecastle. Seven health outcome measures were defined, based on the questionnaire results. These were the SF-36 score, three scores of respiratory symptoms, two scores of skin symptoms, and a score of other symptoms, which is called the general health score. Study areas were compared with and without statistical adjustment for other factors, such as age and socio-economic status. Results were similar irrespective of this adjustment.

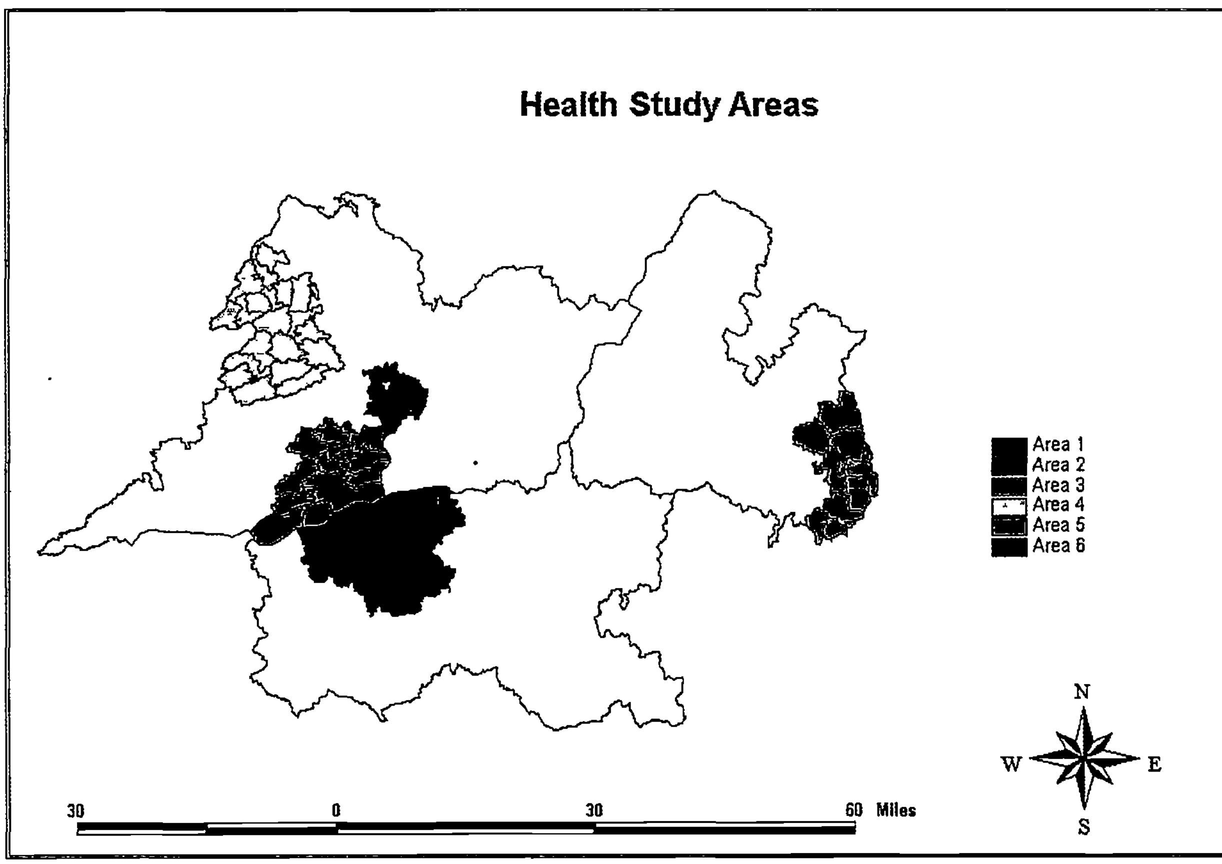
Small differences in health outcomes were detected among the six study areas, but most were of no practical significance. A general pattern was noted with Askeaton, Clarecastle and Moyne & Littleton tending to have a similar level of health that was somewhat poorer than that observed in Rathkeale, Ennistymon and Killadysert. This pattern is not consistent with any geographical relationship between animal and human ill health. There is no evidence for any link between human health and reported ill health in animals from the Askeaton area.

BACKGROUND TO THIS REPORT

Following local concern and media reports of serious ill health amongst cattle on a number of farms in Askeaton, there was extensive public concern, both about animal health, and about human health in the Askeaton area. The Department of Health (DH), the Environmental Protection Agency (EPA), and the Mid-Western Health Board (MWHB) commissioned a series of studies on human and animal health in the area.

A very wide range of studies were undertaken. There were extensive studies on potentially toxic materials in air, water, soil, plants and cattle in the Askeaton area; studies of cattle from the Askeaton area, and of the health of imported cattle; studies of mortality, school attendance, births, diary studies and family doctors in the Askeaton area and in the wider Health Board area; and the current study - the Askeaton Human Health Study (AHHS). This study is one of the reports on human health in the Askeaton area.

Figure 1



PURPOSE OF THE ASKEATON HUMAN HEALTH STUDY

The purpose of the AHHS was to examine the health of people living in the areas from which ill health amongst animals had been reported. The study is part of a larger series of studies of human health, and not in itself a definitive study of these issues.

The other studies of human health in Askeaton are all based on records, mostly on various sorts of routine health or school data. These records were not collected with the needs of the Askeaton studies in mind. While they do provide important information on the health of people living near Askeaton, and on how it compares with other people living in the health board area, they were not intended to form the basis of a study of the health effects of living near the focus of the reported animal health problems.

Issues in the design and implementation of the AHHS

The AHHS is an example of an ecological study, that is a study based on a comparison between areas. The main purpose was to examine the health effects, if any, of living near where complaints of ill health amongst farm animals originated. For this reason the study was centred on Askeaton. Five other areas, as shown in the map, were chosen for comparison. Rathkeale, which is immediately adjacent to Askeaton, but from where no animal ill health has been reported, provides an opportunity to study the effects of living near the area where the animal problems were noted.

It is intended to compare the health status of the six study areas in various ways, and to see if any consistent pattern of disease emerges. In general a pattern of worse health in Askeaton and Rathkeale, with better health in the other four study areas, would suggest that something requiring an investigation, and linked to reported animal ill health, might be happening.

Issues covered by the Askeaton Human Health Study

After talking to local people, local health care workers, and experts in animal and human health studies, we identified a few key themes that form the heart of the AHHS. These are measures of general health (the Short-Form 36 or SF-36, of which more below); symptoms of chest disease, skin disease, allergies and other health problems; pregnancies and pregnancy outcomes; lifestyle, including work, smoking and drinking; environmental concerns and actions.

The questionnaire

The questionnaire used in the survey is presented in full at the end of report. It starts with some basic identifying information in the first section, Section 0. After this there are nine sections. The last section is about animal health, and the results of this are being studied by others, and will be reported separately.

Section 1 - The SF-36

The largest single piece of the questionnaire is the Short-Form 36 questionnaire, usually just called the SF-36. This is a set of 36 questions, developed and evaluated by the Medical Outcomes Trust in the USA. Their purpose is to provide a general measure of health, the SF-36 score, and a set of more specific measures of health and well being. You can draw up a profile for people, that is a graph of their scores on each subscale, and on the SF-36 as a whole, and compare these with the profiles from other people. The SF-36 is not appropriate for children, and was asked only of those aged 15 and over.

Sections 2,3 and 4 - The Symptom questionnaires

The SF-36 is followed by a set of questions on specific symptoms. The first of these are a set of questions on chest symptoms, such as coughing, wheezing, treatment for asthma, and hay fever. The next is a set of questions about skin disease. These include questions on itching, flaking skin, dry skin and so on. Then there is a set of questions about general health, including questions on tiredness, on aches and pains, dizzy spells, ear problems, sickness, and allergies. Everyone who took part in the survey was asked these questions.

Section 5 - Pregnancy, fertility and Childbirth

This section asks about pregnancies, babies, and difficulties in getting pregnant. Every pregnancy mentioned by the women interviewed is recorded, and basic details of the outcome are documented. Only women aged between 15 and 44 were asked these questions.

Section 6 - Lifestyle

This section was a series of questions about diet, changes in diet, smoking and drinking, attempts to reduce both, exercise and use of televisions, computers and video games. Only people aged 15 and over were asked these questions.

Section 7 - Social details

This section asked about social and demographic factors such as housing, work, education, farm or land ownership, as well as asking for self-reported weight and height. Everyone was included.

Section 8 - Concerns about the environment

Here we tried to find out both how worried each person was about the environment, and what action they had taken about this worry. We also wanted to know what aspects of the environment concerned them most. Only people aged 15 and over were included.

Section 9 - Animal health

This is a set of questions for people who live on farms where cattle are kept. As we mentioned this section of the study is being analysed and reported separately.

HOW THE STUDY WAS DONE

The purpose of the study was to get an accurate representation of the health of the people of Askeaton, and to see how their health compared with that of people living nearby, and with that of people living in other rural parts of the MWHB. To do this six areas were identified, (1) Askeaton itself, that is the district electoral divisions (DED's) of Askeaton East and West, Sughinish, Lismakeery, Nantinan and Riddlestown, (2) the rest of Rathkeale rural district (RD), (3) Killadysert RD, (4) Ennistymon RD, (5) Moyne and Littleton dispensary districts from Thurles RD, and (6) Clarecastle (Figure 1.1). These areas were intended to be broadly representative of rural parts of the health board, and to include areas close to Askeaton itself, like Rathkeale, and areas much further away.

It was not possible to ask all of the people in each of the six study areas to take part in the survey. This is because there would be too many people, and the survey would be too expensive. Instead we chose to take a sample of the people in each area. If there was a list of the people living in each area, with their age and sex, this would be easy. We would just take a random sample from this list for each area. Unfortunately there is no such list. The only available list is the electoral register, which records names, and, outside urban areas, does not include full addresses, and does not uniquely identify households.

Because we needed to take a sample of a specific size, and with predefined numbers of people of each sex, and of specific ages, the electoral register was not sufficient for our purposes. We asked the Economic and Social Research Institute (ESRI) to use the electoral register to identify households, and then to go around asking who lived in each household, and whether or not they would be willing to take part in the study.

From amongst the people who agreed to take part we chose a sample of people, ranging in age from 1 year old to 69 years old. We wanted to recruit more children than adults and more women aged 15 to 44 than men aged 15 to 44. We decided that we needed to study over 2500 people to have a good idea of what was really happening in Askeaton, and in the five comparison areas. Table 1 shows the details of the sample that we hoped to achieve in each of the six study areas. We intended to recruit 2700 people in total.

Table 1 Target Sample Size in each Study Area.

Age	Males	Females	Total
1 - 4	50	50	100
5 - 14	50	50	100
15 - 44	50	100	150
45 - 69	50	50	100
All ages	200	250	450

RESPONSE RATES

Response to the ESRI survey

The ESRI survey was a study of households. On our behalf they approached a large number of households identified from the electoral register, and asked the names, sex and ages of the people living in each household, and asked them whether or not they would be willing to take part in the AHHS survey.

For many reasons the Electoral Register is imperfect. Other workers have found that between 10 and 20% of people listed on the electoral register do not exist at the address given (Kelleher C et al. and O'Connell T et al. unpublished observations). No other publicly available population lists exist, and we had no alternative but to use it for our study.

Table 2 Rates of valid Households, household response rates, and interview rates as a proportion of the initial sample by area.

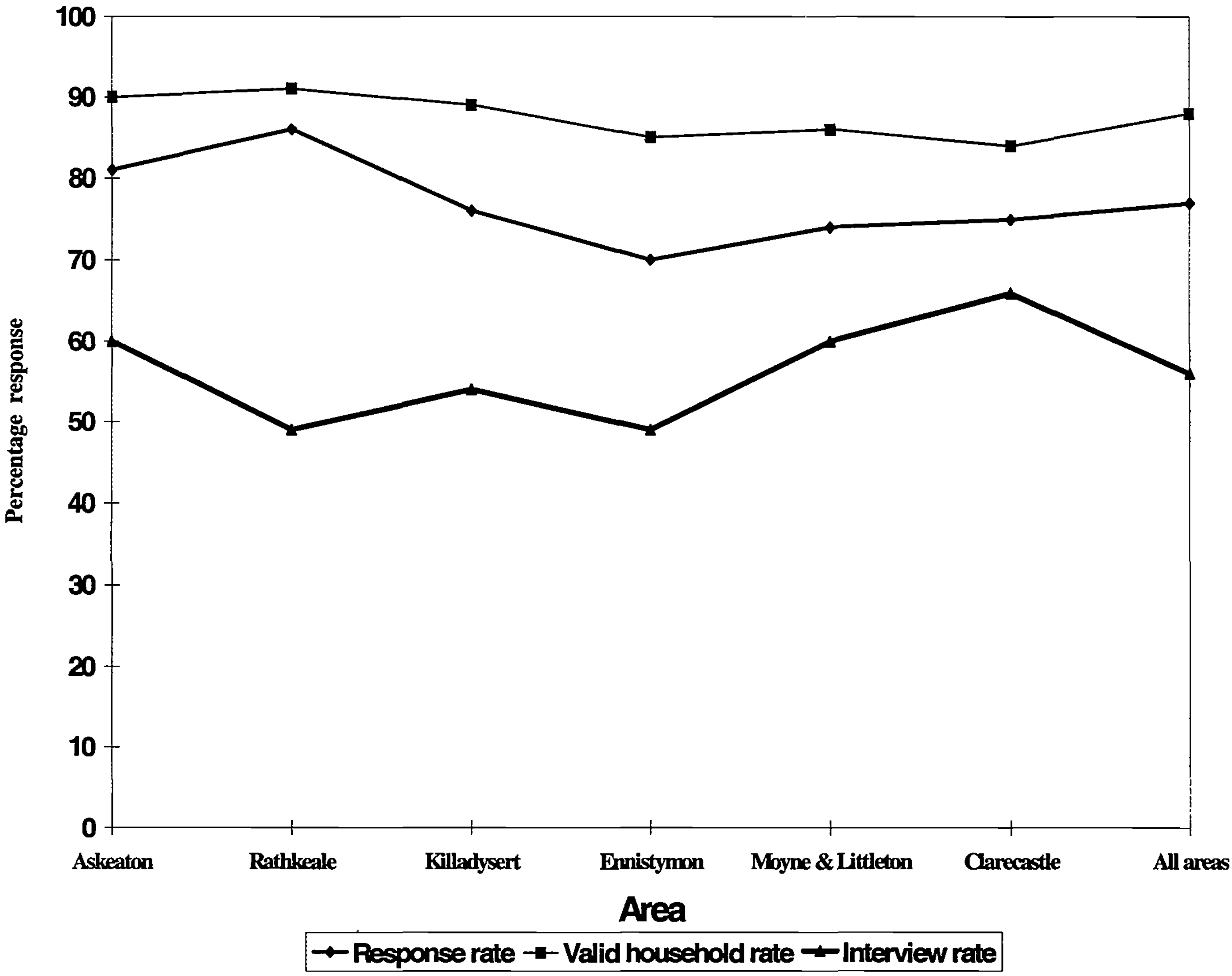
Households approached	Study areas						All areas
	Askeaton	Rathkeale	Killadysert	Ennistymon	Moyne & Littleton	Clarecastle	
Total quota	956	1160	1081	1357	921	1142	6617
Invalid households	95	107	117	199	127	180	825
Valid households	861	1053	964	1158	794	962	5792
Valid % (of quota)	90%	91%	89%	85%	86%	84%	88%
Household responded	694	907	730	812	591	717	4451
Response % (Of valid households)	81%	86%	76%	70%	74%	75%	77%
Refusal rate % (Of valid households)	8%	7%	11%	16%	15%	10%	11%
Interviews achieved	415	446	393	398	357	471	2480

It took two attempts for the ESRI to get enough people for the study, partly because of non-response, and partly because of invalid addresses. Table 2 shows the results of the response to the ESRI survey. For ease of comparison we include the number of interviews finally obtained in each area. The ESRI had a list of 6617 households, and of these 12% (825) were invalid, that is to say the people named on the list were not at the address given. Overall, in the 88% (5792) of valid households, in 1% everyone was too ill to take part; in 11% everyone living there refused to take part; in 8%, despite repeated visits and letters, no-one could be contacted by the team; 3% did not take part for other reasons. Of the valid households, 4,451 or 77% agreed to take part in the study, if asked

Thus the ESRI provided the study team with a list of 4,451 people, one per household, from an original list of 6,617 households. The sample of people to be interviewed for the Askeaton study was drawn from these lists.

Figure 1, which is derived from Table 2, shows the proportion of valid households in each area, the proportion of valid households where one person agreed to take part in the survey, and, for ease of comparison, the number of interviews obtained as a proportion of those households which agreed to take part (the 'interview rate').

Figure 1 Response rates by area (ESRI survey)



Response to the AHHS

As shown in Table 2 just less than two and a half thousand people took part in our survey. It had been intended to enrol 2,700, but only 2,480 interviews were completed. This was due to difficulty in identifying potential interviewees; to people deciding not to take part after all; to limitations of time and resources; and to movement of people between the two sets of visits, from ESRI and from the study team. Table 3 shows the age and sex distribution of those who responded to the survey. There were a small number of people aged over seventy years included, people aged 69 when ESRI came around, who had had their 70th birthdays before the main survey. These people have been included in the results reported here.

Table 3

Age group	Sex		
	Men	Women	Total
0 - 4	262	249	511
5 - 9	100	99	199
10 - 14	138	165	303
15 - 19	96	148	244
20 - 24	44	96	140
25 - 29	41	79	120
30 - 34	28	61	89
35 - 39	37	72	109
40 - 44	31	96	127
45 - 49	66	66	132
50 - 54	61	77	138
55 - 59	56	58	114
60 - 64	62	62	124
65 - 69	62	54	116
70 and over	4	10	14
Total	1088	1392	2480

Table 4

Age group and Sex	Study area						Intended sample
	Askeaton	Rathkeale	Killadysert	Ennistymon	Moyne & Littleton	Clarecastle	
Males	**199**	**199**	**170**	**160**	**142**	**218**	**200**
1-4	61	53	44	23	28	53	50
5-14	36	54	34	41	32	41	50
15-44	49	46	43	41	39	59	50
45-69	53	46	49	55	43	65	50
Females	**216**	**247**	**223**	**238**	**215**	**253**	**250**
1-4	35	50	48	33	33	50	50
5-14	45	42	46	43	36	52	50
15-44	89	97	76	106	83	101	100
45-69	47	58	53	56	63	50	50

Table 4 compares the age and sex of the final sample in each area, with what we had hoped to achieve originally. While most of the samples are close to the intended age and sex distribution, there are some deficiencies, notably of young male children in Ennistymon and Moyne & Littleton. Table 5 compares the overall response to the study, with the intended study numbers in each sex and age group. Older people, those aged 45 to 69, were over-represented in the final sample, compared with the initial plan, and younger people, especially children and adolescents, were significantly under-represented.

Table 5

Sex and Age group	Sample Intended (number)	Sample achieved (number)	Sample achieved (% of intended)
Male + Female	**2700**	**2480**	**92**
0-4	600	511	85
5-15	600	502	84
15-44	900	829	92
45-69	600	638	106
Male	**1200**	**1088**	**91**
0-4	300	262	87
5-15	300	238	79
15-44	300	277	92
45-69	300	311	104
Female	**1500**	**1392**	**93**
0-4	300	249	83
5-14	300	264	88
15-44	600	552	92
45-69	300	327	109

INFLUENCES ON HEALTH IN THE AHHS

A very wide range of things can influence human health. Age, sex, poverty, work or unemployment, place of residence, diet, use of tobacco, alcohol and drugs, marriage, education, inherited illness, and a multitude of other factors affect peoples' health. Although this study is mostly about the effect on human health of living in an area where animal health problems were reported, if we are to interpret this, we need to know how the other things affecting human health come into play.

Ideally we would like to study groups of people who were identical in every way, except that some lived in Askeaton, others in Clarecastle and so on. Obviously this isn't possible. One reason for the design of the AHHS, with the emphasis on getting equal numbers of each sex, and equal numbers in each age group was to reduce the effects of difference in age and sex on the results.

To take an absurd example, if we only studied people aged over 50 in Askeaton, and those aged under 50 in Rathkeale, then we would expect to find the Rathkeale people far healthier than the Askeaton people. It would be very foolish to conclude that living in Askeaton was bad for you. Such a study would only show that older people are, on average, less healthy than younger people.

What this means is that when we try to interpret the data gathered for this study we must take very careful account of important ways in which the people in the study area differ from each other. The statistical methods used to do this are generally known as 'multivariate analysis', and the two methods which we specifically used are called 'logistic regression' and 'linear regression'. There are more details in Appendix A.

There is a convention, a general agreement amongst scientists, as to how statistical results should be used. Let's consider a specific example. Suppose that we were interested in the relationship between how worried someone was about the environment (Question 73 in Questionaire) and their overall level of health, as measured by the SF-36 score. Put crudely, statistical tests of a relationship like this tell you how likely you are to see such a relationship in the study, if there is really no relationship, in other words if the apparent relationship is just due to chance. By convention, if this value (the p-value) is under 1 in 20 , that is 0.05, then we say that we think that the relationship is probably real, and unlikely to be due to chance. Such results are said to be statistically significant. In this report statistically significant results in tables are marked with a * in the table.

For this, and for other reasons, the interpretation of the results of a large and complex study like the AHHS, requires careful thought. Detailed consideration has to be given both to the results of single tests, and to the general pattern of the results. A set of similar results on related measures is far more convincing than any individual statistical test.

SYMPTOMS OF DISEASE

The responses in this section of the questionnaire were converted into a series of scores - one for symptoms of asthma, one for other respiratory symptoms, a score which was the sum of these two , a score for skin symptoms, a score for the severity of skin symptoms, and a score for all of the other symptoms, which we have termed the general health score. Each score is simply the number of positive responses to questions about the presence of symptoms. For each score the large majority of the people in the study scored zero (Tables 6 to 10).

Table 6 Asthma

No of Symptoms	Number of people	Percentage of total	Cumulative percentage
0	1854	74.8	74.8
1	129	5.2	80.0
2	148	5.9	86.0
3	134	5.4	91.4
4	128	5.2	96.5
5	85	3.4	100.0

Table 7 Respiratory

No of Symptoms	Number of people	Percentage of total	Cumulative percentage
0	1344	54.3	54.3
1	555	22.4	76.7
2	253	10.2	87.0
3	121	4.8	91.9
4	80	3.2	95.1
5	56	2.3	97.4
6	34	1.4	98.8
7	30	1.2	100.0

TABLE 8 Total Asthma and Respiratory

No of Symptoms	Number of people	Percentage of total	Cumulative percentage
0	1340	54.2	54.2
1	387	15.6	69.8
2	158	6.4	76.2
3	118	4.8	81
4	92	3.7	84.7
5	100	4	88.7
6	75	3	91.7
7	48	1.9	93.6
8	40	1.6	95.2
9	42	1.7	96.9
10+	73	3	99.9

TABLE 9 Skin Symptoms

Total Score	Number of people	Percentage of total	Cumulative percentage
0	1939	78.4	78.4
1	326	13.2	91.6
2	119	4.8	96.4
3	46	1.9	98.3
4	24	1	99.3
5	16	0.6	99.9
6	3	0.1	100
7	1	0	100

TABLE 10 All Other Symptoms

Total Score	Number of people	Percentage of total	Cumulative percentage
0	1621	65.4	65.4
1-9	606	24.4	89.8
10-19	193	7.8	97.6
20-29	43	1.7	99.3
30-39	10	0.4	99.7
40+	7	0.3	100

Table 11 and Figure 3 shows the mean value of each of the scores for each area. There are significant differences between the areas for each of the five scores. Generally Askeaton, Moyne & Littleton and Clarecastle have the highest (worst) scores, and Rathkeale, Ennistymon and Killadysert have the lowest (best) scores. The differences, while statistically significant are small, and are of little practical significance. For example for the asthma score the difference between the worst and the best areas is one-third of a symptom per person.

TABLE 11 Symptom Scores by Area

Mean Symptom Score	Study area						All areas
	Askeaton	Rathkeale	Killadysert	Ennistymon	Moyne & Littleton	Clarecastle	
Asthma *	0.86	0.76	0.50	0.54	0.74	0.83	0.71
Respiratory disease *	1.18	0.97	0.65	0.91	1.08	1.10	0.99
Both *	2.04	1.72	1.14	1.46	1.82	1.94	1.70
General Health*	4.16	2.97	1.04	1.46	3.94	3.05	2.78
Skin disease*	0.40	0.39	0.23	0.27	0.53	0.39	0.37

The * beside a variable name indicates that the difference between the results for that variable amongst the six study areas is statistically significant.

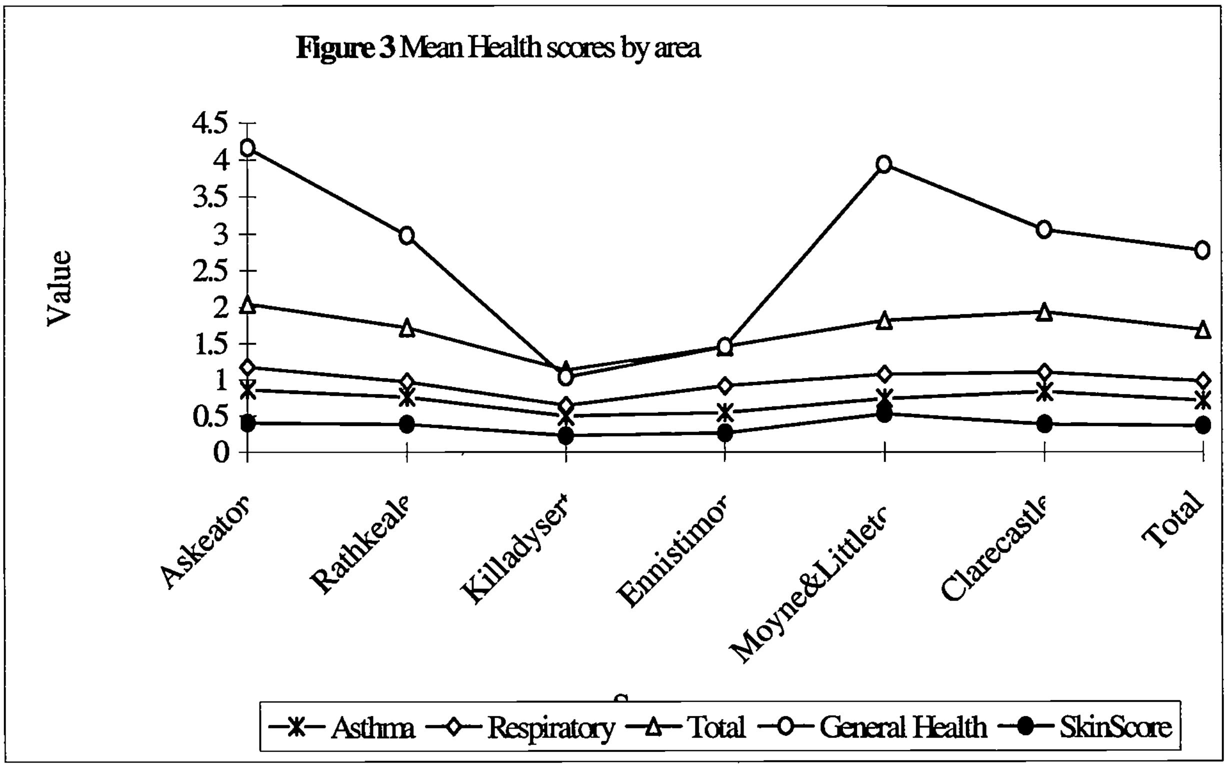


Figure 3 Mean Health scores by area
Value
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Askeaton
Rathkeale
Killadysert
Ennistimon
Moyne&Littleton
Clarecastle
Total
Asthma
Respiratory
Total
General Health
SkinScore

FERTILITY, PREGNANCY AND CHILDBIRTH

There were 552 women aged between 15 and 44 inclusive in the AHHS (Table 12). These women only were eligible for the questionnaire on pregnancy, fertility and birth. Of these women 190 reported ever being pregnant, but for one of these women no pregnancy details were recorded. Of the 552 women 31 reported trying to conceive for more than a year without success (5.6% overall), but 16 of these women had at least one pregnancy.

TABLE 12 Female Fertility by Area

Area	Women		
	Total	Never pregnant	Pregnant
Askeaton	89	53	36
Rathkeale	97	72	25
Killadysert	76	51	25
Ennistymon	106	74	32
Moyne & Littleton	83	53	30
Clarecastle	101	59	42
Total	552	362	190

The 190 women who had at least one pregnancy had between them 515 pregnancies (Range 1 to 7). Of these 515 pregnancies, there were 449 livebirths, 4 stillbirths, 60 miscarriages, and 2 outcomes coded as 'other' (Table 13). It is unclear what these last two births were. Eighty pregnancies finished before 37 weeks of gestation, but 44 of these were miscarriages, four were stillbirths, and two were the two births coded as other, leaving only 30 (6.7%) liveborn premature infants.

TABLE 13 Results of Pregnancies

Area	Pregnancies				
	Total	Livebirths	Stillbirth	Miscarriage	Other
Askeaton	98	80	0	18	0
Rathkeale	56	51	0	5	0
Killadysert	73	63	4	6	0
Ennistymon	97	84	0	13	0
Moyne & Littleton	81	69	0	11	1
Clarecastle	110	102	0	7	1
Total	515	449	4	60	2

There are no statistically significant differences between the six areas in any of the pregnancy outcomes, and the results are not different from those expected on the basis of available Irish data.

LIFESTYLES OF PEOPLE IN THE AHHS

The questions in this section were about diet, drinking (alcohol), smoking, physical activity and exercise. Only people aged 15 and over were eligible for this part of the study. The main results are shown in Tables 14 and 15

The only question on diet was about changes in diet of recent years. Of the people who answered this question only 31% had neither made nor tried to make beneficial changes in their diet in the last year. Using a scoring system in which high scores were obtained for changing diet in a healthy direction there were substantial differences between the six area, with scores in Askeaton, Moyne and Littleton and Clarecastle nearly twice those in Rathkeale and Killadysert.

The overall prevalence of drinking was over 60% in each area, with the highest prevalence in Ennistymon. The mean number of units of alcohol per week ranged from 6.0 in Moyne and Littleton up to 7.3 in Askeaton. The proportion of people who were drinking more than recommended limits (two units per day for women and three units per day for men) varied between the six areas for women, but not for men. The proportion of heavy drinkers among the men was much higher than among the women, as one would expect. Using a system in which high score were obtained for reductions in alcohol, while most people (85%) had made no attempt to change their alcohol intake, the mean score for reduction in alcohol intake was highest in Askeaton and Ennistymon, and lowest in Killadysert and Moyne & Littleton.

TABLE 14 Diet and Alcohol

	Study area						All areas
	Askeaton	Rathkeale	Killadysert	Ennistymon	Moyne & Littleton	Clarecastle	
Dietary change*†	6.5	3.8	2.8	5.1	6.1	6.8	5.4
Current drinkers	68%	68%	62%	76%	62%	72%	68%
Units of alcohol*	7.2	6.7	5.4	7.0	6.0	6.2	6.5
Male heavy drinking ‡	17%	18%	8.8%	15%	19%	7.8%	14%
Female heavy drinking*‡	6.5%	3.3%	1.6%	5.5%	0.0%	6 1%	4.0%
Change in drinking*†	0.26	0.19	0.12	0.27	0.13	0.24	0.21

The * beside a variable name indicates that the difference between the results for that variable amongst the six study areas is statistically significant. † A high score signifies a change in a healthy direction. ‡ Males > 3 units/day; Females > 2 units per day.

A high proportion of people in all of the study areas had been smokers, or were still smokers. Just under 500 people were still smokers, and almost all of these smoked cigarettes, an average smoker smoking between 15 and 20 cigarettes per day. Over the previous year 15% of the smokers had stopped, and 24% cut down their intake. Using a scoring system in which reduction in smoking produced high scores, Ennistymon had the best score, and Askeaton the worst.

TABLE 15 Smoking and Activity

	Study area						All areas
	Askeaton	Rathkeal e	Killadyser t	Ennistymo n	Moyne & Littleton	Clarecastle	
Ever smoked*	48%	37%	28%	39%	42%	47%	41%
Cigarettes per day*	18	17	17	19	16	18	18
Change in smoking*†	0.86	0.96	1.23	1 35	1.07	1.22	1.12
Work Activity*	1.19	0 91	1 20	1.11	1.09	0.91	1.06
Leisure Activity*	1.01	0.91	0.72	1 05	1.09	1.05	0.98
Change in Activity*†	0.98	0 72	0.55	1.43	1.41	1.20	1.06

The * beside a variable name indicates that the difference between the results for that variable amongst the six study areas is statistically significant. † A high score signifies a change in a healthy direction.

Measure of physical activity available were the amount of physical activity at work, the amount of physical activity in leisure time, and any changes in physical activity over the previous year. Overall 20% of people reported high or very high levels of physical activity at work and as part of their leisure time. Half of the people had increased, or tried to increase their level of physical activity in the last year. Using a system in which high scores were obtained for high levels of activity, or for increases in physical activity, people in Askeaton had the highest levels of activity at work, and people in Rathkeale and Clarecastle the lowest; people in Ennistymon and Clarecastle had the highest levels of leisure time physical activity and people in Killadysert the lowest; people in Ennistymon had the highest level of increase in physical activity, and people in Killadysert the lowest.

In general these results show six communities aware of the issues surrounding a healthy lifestyle, and trying to make those changes. Alcohol intake is relatively high in these communities.

SOCIAL AND DEMOGRAPHIC FACTORS

A range of social and demographic factors were studied. These are known to be closely associated with health status. For example people who are poorer, and of lower social status, have worse health than those who are richer. Other social factors associated with health include marital status, educational attainment, occupation, housing tenure, and employment status.

If these factors were ignored differences in health, which were in fact due to differences in wealth and other social factors between areas, could be misinterpreted as being related to the reported animal ill-health, or to other proposed explanations for differences between areas. For this reason it is important to make as precise a measure of wealth as is feasible. One obvious way to do this is to ask directly about wealth and income. However, it is believed that Irish people are unlikely to answer such questions directly. For this reason a set of surrogates for wealth were asked about instead. These included educational level, housing tenure, marital status, land holdings (for farmers), employment status, and medical insurance status. Questions of this type are known to work well in urban populations, but some work indicates that they may not be as useful in rural populations.

TABLE 16 Social Characteristics

Percentage	Study area						All areas
	Askeaton	Rathkeale	Killadysert	Ennistymon	Moyne & Littleton	Clarecastle	
VHI*	54%	50%	38%	38%	36%	63%	48%
Medical card*	18%	24%	21%	35%	34%	18%	25%
Unemployed	8%	6%	7%	10%	14%	8%	9%
Home owners*	96%	95%	98%	94%	80%	91%	93%
Over-crowded (>1.5 people per room)*	1%	4%	1.9%	2.7%	1.9%	1.1%	2%

The * beside a variable name indicates that the difference between the results for that variable amongst the six study areas is statistically significant.

The principal results are shown in tables 16 to 20. For some of the social (wealth) measures, namely unemployment and marital status there were no significant differences between areas. For others, specifically educational level achieved, having a medical card, having VHI cover, home ownership and overcrowding at home there were significant differences between the six study areas. Although all six areas are prosperous, Ennistymon and Moyne&Littleton were the least affluent areas, and Askeaton, Rathkeale and Clarecastle were more affluent (Tables 16,17, and 19).

TABLE 17 Marital status

Marital Status	Askeaton	Rathkeale	Killadysert	Ennistymon	Moyne & Littleton	Clarecastle	All Areas
Single	108	122	99	105	95	115	644
Married	123	114	113	133	122	141	746
Widowed	6	7	6	14	6	10	49
Separated	1	4	0	5	1	8	20
Total	238	247	218	257	225	274	1459

One important consideration is the average length of time for which people had lived in their current homes. The median length of stay was thirteen years, and this varied from 11 years in Clarecastle to 14 years in Ennistymon and Moyne&Littleton. These differences are statistically significant, but overall these figures suggest that the population living in these areas is quite stable.

The figures on land ownership and rental suggest that most farms are not very large (Table 18). Overall half of all farms are under 70 acres. Most farmers rent no land (therefore the median number of acres rented is 0), but some increase their holdings substantially by renting. The areas with the largest farms are also those where most land is rented. There is significant variation between the six areas in all of the measures of land use.

TABLE 18 Land Owned

Median (mean) number of acres	Study area						All areas
	Askeaton	Rathkeale	Killadysert	Ennistymon	Moyne & Littleton	Clarecastle	
Owned*	83	75	55	56.5	80	60	63
Rented	0 (17)	0 (12)	0 (5)	0 (6)	0 (24)	0 (8)	0 (11)
Held	93	88	57	60	94	60	70

The * beside a variable name indicates that the difference between the results for that variable amongst the six study areas is statistically significant.

TABLE 19 Education Level

Educational level (Number of people)	Study area						All areas
	Askeaton	Rathkeale	Killadysert	Ennistymon	Moyne & Littleton	Clarecastle	
None	2	4	1	1	1	2	11
Primary	66	64	81	61	69	72	413
Intermediate	79	84	66	71	75	83	458
Leaving	78	73	64	108	81	81	485
Higher	31	54	35	63	35	55	273

Height and weight were also recorded. Although self-reported height and weight are probably not very reliable, the results looked reasonable, and the distribution of body-mass indices (weight divided by height squared), which are a measure of obesity, was very similar between the six areas (Tables 20).

TABLE 20 Weight

Weight category	Study area						All areas
	Askeaton	Rathkeale	Killadysert	Ennistymon	Moyne & Littleton	Clarecastle	
Underweight	63	51	50	51	49	82	346
Acceptable	117	98	92	151	117	169	744
Overweight	104	82	87	101	89	118	581
Obese	49	40	35	46	41	63	274
Total	333	271	264	349	296	432	1945

Overall the six study areas are moderately prosperous, with a fairly well educated population and generally reasonable living circumstances.

CONCERN ABOUT THE ENVIRONMENT

The final section of the questionnaire addressed concerns about the environment. In particular people were asked to say how worried they were about the environment in general, to rank several potential environmental hazards, to describe the extent of their involvement, if any in environmental activity, and to compare several stressful life events with their level of concern about environmental hazards. The scores are derived by adding up positive responses, and higher scores mean higher levels of concern.

TABLE 21 Environmental Awareness

	Study area						All areas
	Askeaton	Rathkeale	Killadysert	Ennistymon	Moyne & Littleton	Clarecastle	
Not at all	24%	30%	27%	36%	27%	30%	27%
A little	29%	23%	27%	30%	33%	28%	28%
Somewhat	21%	35%	30%	19%	25%	29%	27%
Very	26%	12%	15%	15%	15%	23%	18%
Total	235	247	220	257	227	275	1461

TABLE 22 Involvement in Environmental Issues

Percentage or score	Study area						All areas
	Askeaton	Rathkeale	Killadysert	Ennistymon	Moyne & Littleton	Clarecastle	
Involved*	6%	4%	2%	21%	15%	25%	13%
Actively involved*	0.31%	0.08%	0.03%	0.34%	0.15%	0.64%	0.27%

The * beside a variable name indicates that the difference between the results for that variable amongst the six study areas is statistically significant.

TABLE 23 Concern about Environmental Issues

	Study area						All areas
	Askeaton	Rathkeale	Killadysert	Ennistymon	Moyne & Littleton	Clarecastle	
Dumpsite*	0.67	0.88	0.86	0.87	0.9	0.72	0.8
Water pollution*	0.58	0.69	0.73	0.81	0.88	0.64	0.72
Cars*	0.56	0.44	0.67	0.68	0.77	0.61	0.63
Air pollution*	0.83	0.69	0.84	0.71	0.84	0.61	0.75
Industry*	0.88	0.85	0.86	0.75	0.86	0.75	0.83
Pylon*	0.75	0.5	0.62	0.84	0.75	0.56	0.63

The * beside a variable name indicates that the difference between the results for that variable amongst the six study areas is statistically significant.

Overall people in Askeaton and Clarecastle are nearly twice as likely to be very concerned about environmental matters as people in Rathkeale (Table 21). Curiously people in Clarecastle are the most likely to be involved in environmental activity (at 25%) while only 6% of those responding from Askeaton were so involved (Table 22). To measure the degree of activity respondents were given a set of possible activities, and received a score of 1 for each activity in which they took part. The sum of these scores is a measure of the degree of involvement in environmental activity. The mean of these scores is the row labelled as 'actively involved' in Table 22. Again there are substantial differences between the six areas, with high levels of active involvement in Clarecastle, Ennistymon and Askeaton.

There were moderate differences between the six areas in the level of concern about different environmental hazards, and in the comparison between the distress caused by various adverse life events, compared with that of living near an environmental hazard (Table 23 and 24). There is no obvious pattern to these responses, and people in Askeaton do not have a very different pattern of responses from people living in the other five areas. What is most striking is that for the average person included in this study living in an area with environmental problems is seen to be only a little less distressing than a death in the family. It seems unlikely that this reflects the real level of distress that would be experienced in such circumstances.

TABLE 24 Concern about Life-Events

	Study area						All areas
	Askeaton	Rathkeale	Killadysert	Ennistymon	Moyne & Littleton	Clarecastle	
Death*	9.3	9.3	9.5	9.6	9.6	9.6	9.5
Environmental hazards*	7.5	7.1	7.1	8.3	8.1	8	7.7
Redundancy*	6.8	6.7	5.1	6	7.3	7.1	6.5
Late for an appointment*	5.5	5.3	3.9	6	5.4	5.5	5.3
Appendicitis*	4.3	3.2	4.9	4.7	4.2	5.3	4.5
Bad weather*	3.8	3.4	3.1	3.6	3.8	4.2	3.7

The * beside a variable name indicates that the difference between the results for that variable amongst the six study areas is statistically significant.

MULTIVARIATE ANALYSES OF DIFFERENCES BETWEEN THE SIX STUDY AREAS.

Choice of outcome measures

The AHHS, like many other large and complex studies, has measured a large number of variables. From these we needed to identify a set of measures of human health, which are widely applicable, and have some interest. After careful consideration we have decided to look at seven scores - the SF-36 score; a general health score, a list of common symptoms; an asthma score; a respiratory symptom score; a total respiratory score, the sum of the two preceding scores; a skin symptom score; and a skin symptom severity score. Note that for the SF-36 score higher values denote better health, while for the other scores lower values, that is fewer symptoms, denote better health. Between them we feel that these describe many aspects of the health of an individual, and they will provide enough information to explore the effects of things likely to affect human health.

Choice of explanatory variables

The key questions in the AHHS have to do with links between where you live, and levels of health. We have already shown some differences between the six study areas in their levels of various measures of health, lifestyle, behaviour, and environmental concern. We now need to look and see if the differences in health between the six areas are due to something in the areas themselves, or if they are due to differences between the people living in the areas in other factors.

Specifically we propose to investigate the effects, if any, of sex, age, measures of social status, measures of environmental activity and concern. This gives rise to two problems - one statistical and one practical. There were over two hundred different questions in the AHHS. The practical problem is that showing the relationship between two hundred answers and say, three different measures of health would give us 600 results. This would be hard to interpret. There is also a statistical problem. If we do 600 tests, then 1 in 20 of these, that is 30, will have p-values under 1 in 20, even if there are no real relationships in the study at all. For this reason a great deal of thought is needed before any analyses are done.

Our goal is to see if living near the areas in which animal health problems were reported (Askeaton) was associated with ill-health. To study this we need to look at the effect of several variable at once on measures of health. To do this we must use statistical models. In this case we decided that for every such test we would include the effects of age and sex, as these are often closely associated with health, We included the effect of area, as this is what we want to study. We divided up the other variables into several groups, biological variables, lifestyle variables, social variables and so on. For each test we picked a selection of variables from each group, which we already knew to be linked to the particular health outcome under study. Further details are in Appendix B.

Principal results

The seven figures show the principal results of this study (Figures 4 to 10). Each graph compares two models for the effect of area of residence on the seven health outcomes. The first model, shown in black, is the effect of area of residence alone. The second model, shown in Gary, is the effect of area of residence, when the effects of age, sex, and a range of other explanatory variables are first taken into account. For each model, the average effect, and the 95% upper and lower confidence limits for the size of the effect are given. Note carefully that all of the graphs are drawn so that scores above the x axis are better, and those below the x-axis are worse. Thus a positive contribution to the SF-36 score indicates a positive effect on health, while a positive contribution to the symptom scores indicates worse health.

For each model people living in Askeaton are the comparison group. Their score is set to zero, and the residents of the other five areas are compared with those of Askeaton. In each case the effect of adding area is statistically significant, that is to say that the patterns shown by these graphs are unlikely to be due to chance, and are more likely to be due to real differences between the effects of living in each area

FIGURE 4

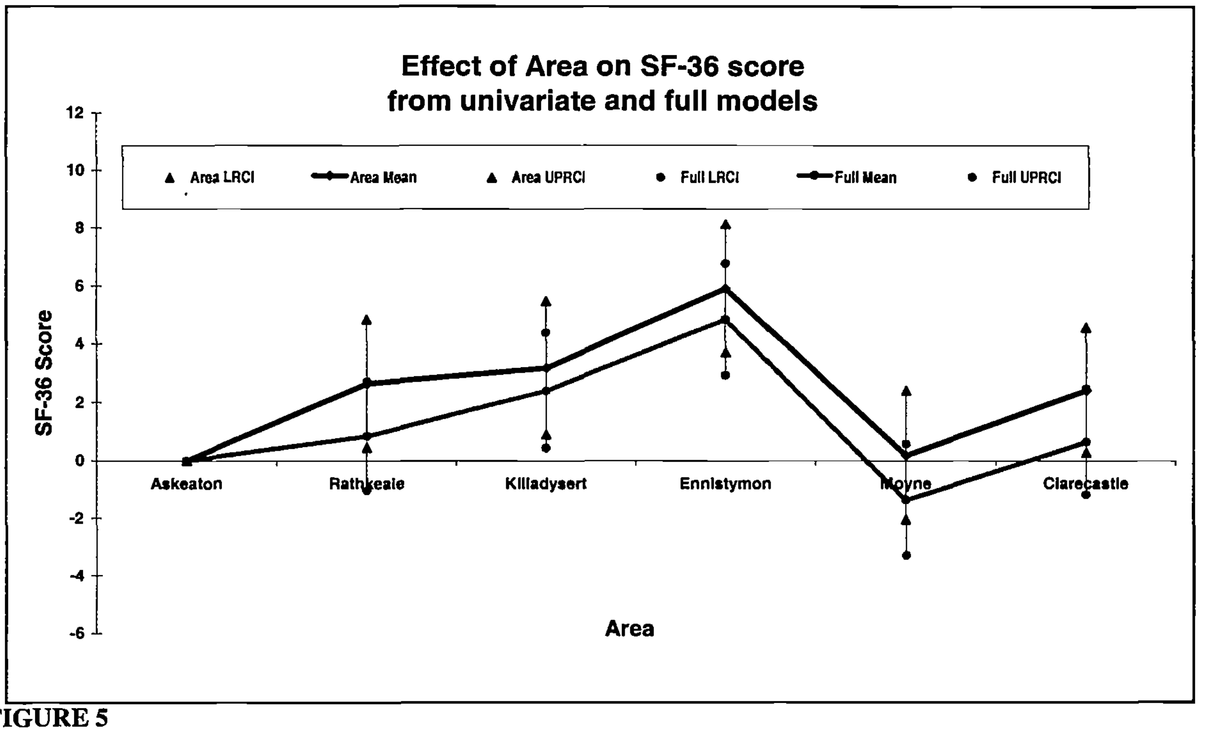
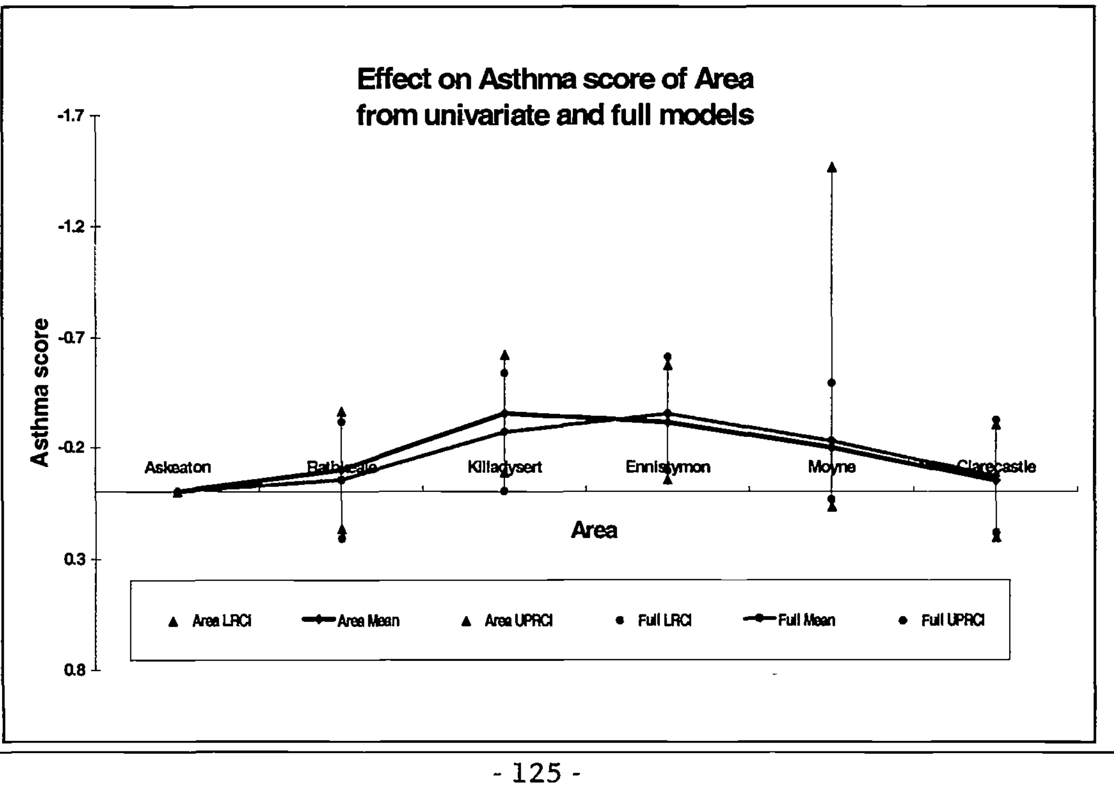


FIGURE 5



The other key feature is that there is very little difference between the two sets of models. The differences between areas are very similar whether the other possible explanatory factors are taken into account or not. In the technical jargon, the effect of area of residence on these health outcome measures is not confounded by age, sex, and the other variables included in the model. In less technical language the differences between the six study areas are not due to differences, as measured by our questionnaires, between the people living in the six areas.

FIGURE 6

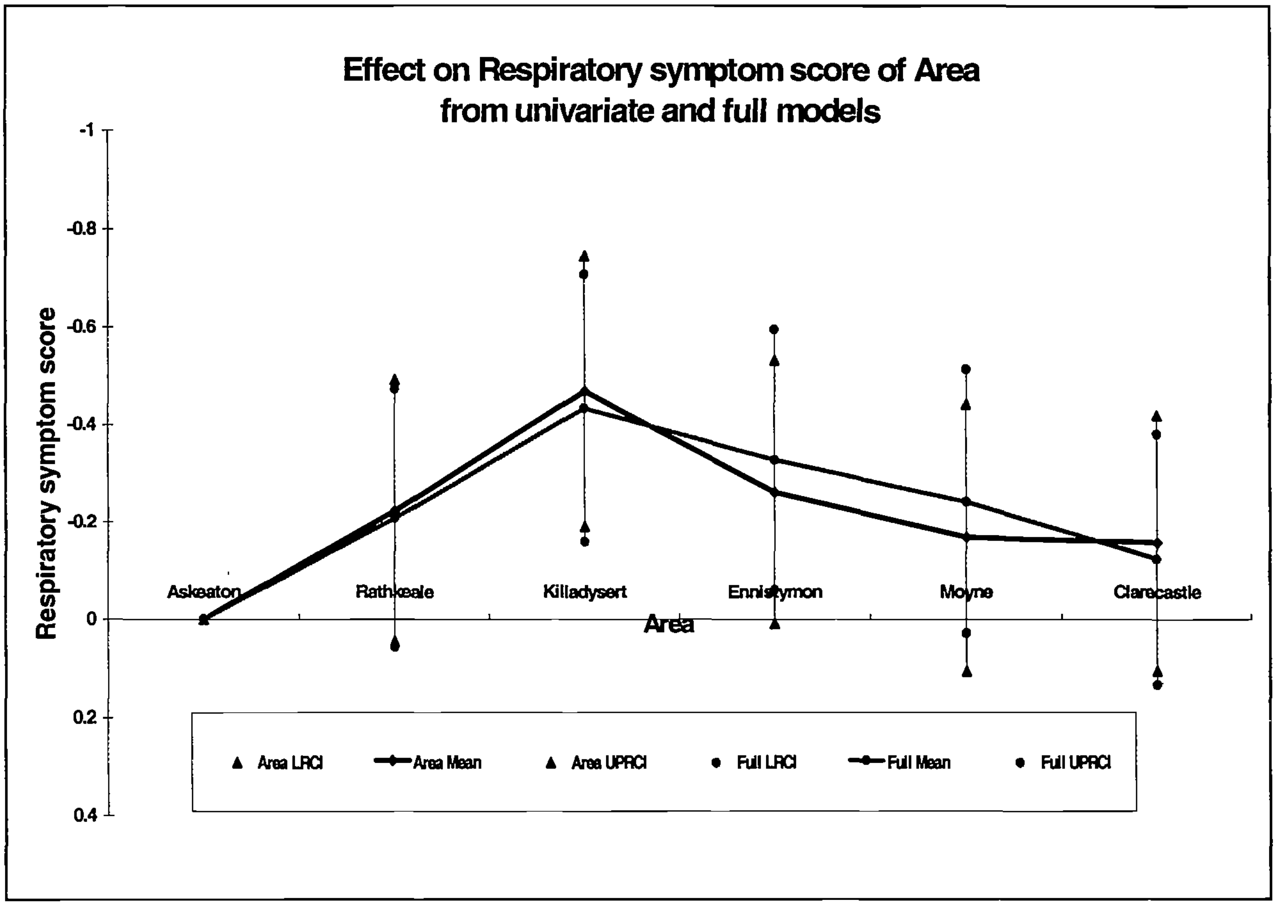


FIGURE 7

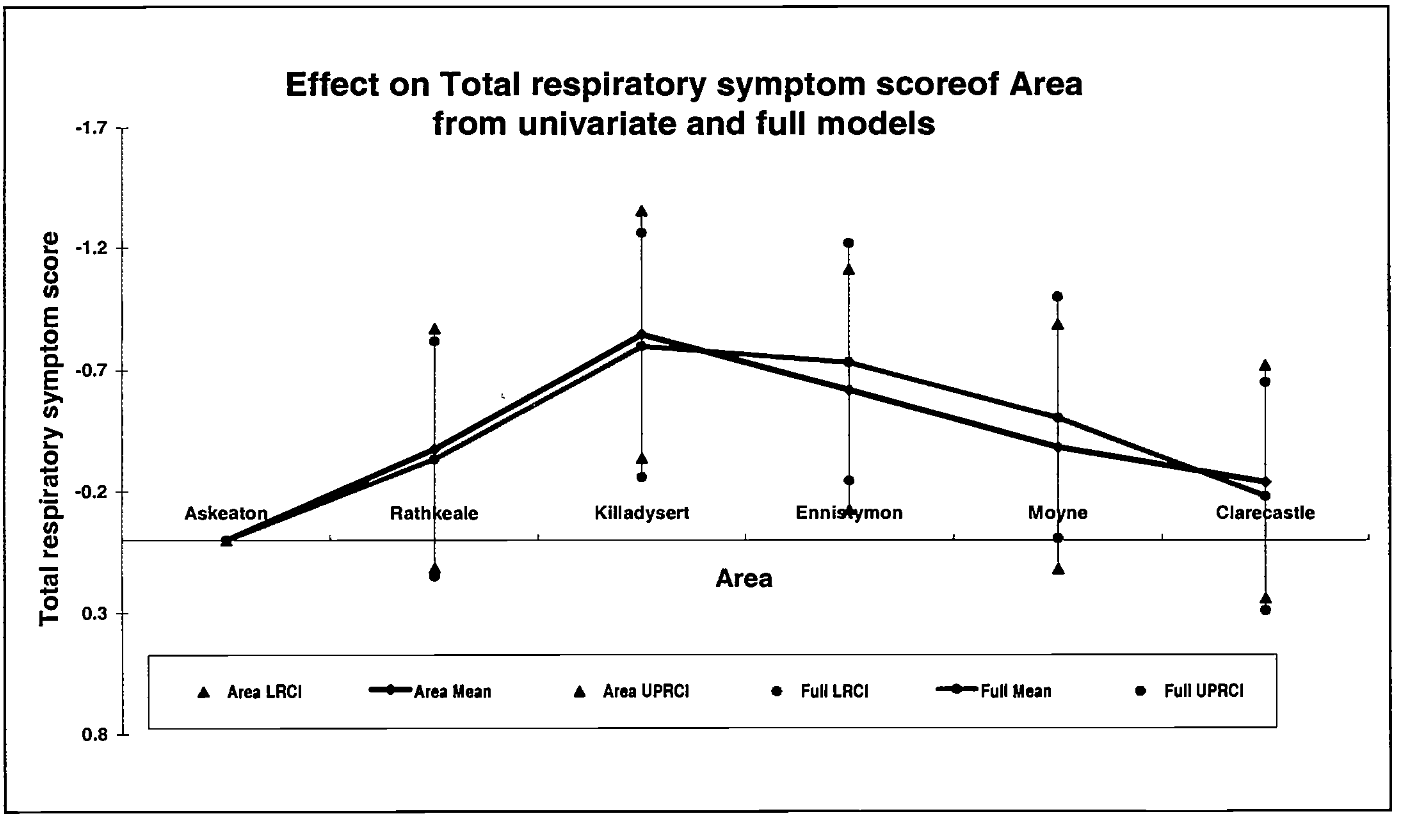


FIGURE 8

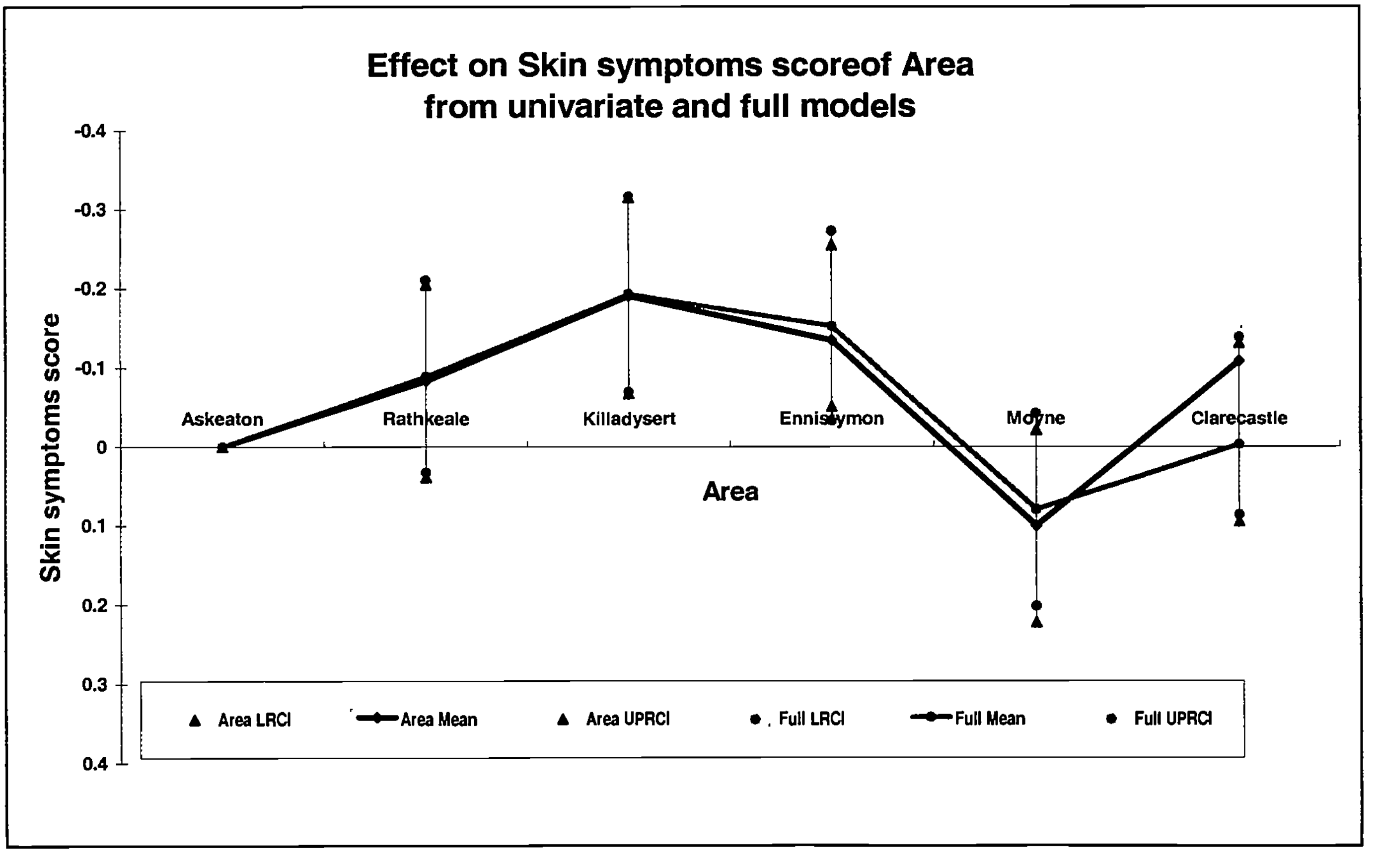


FIGURE 9

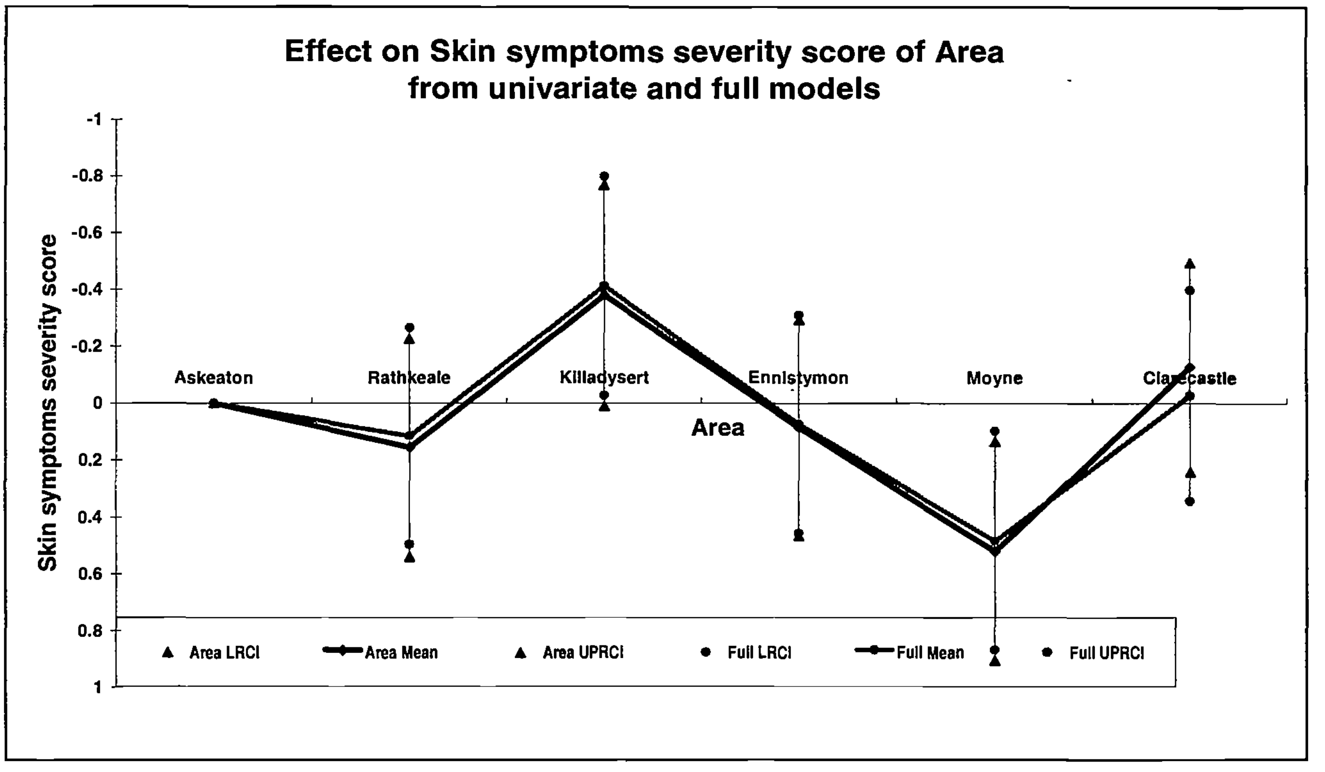
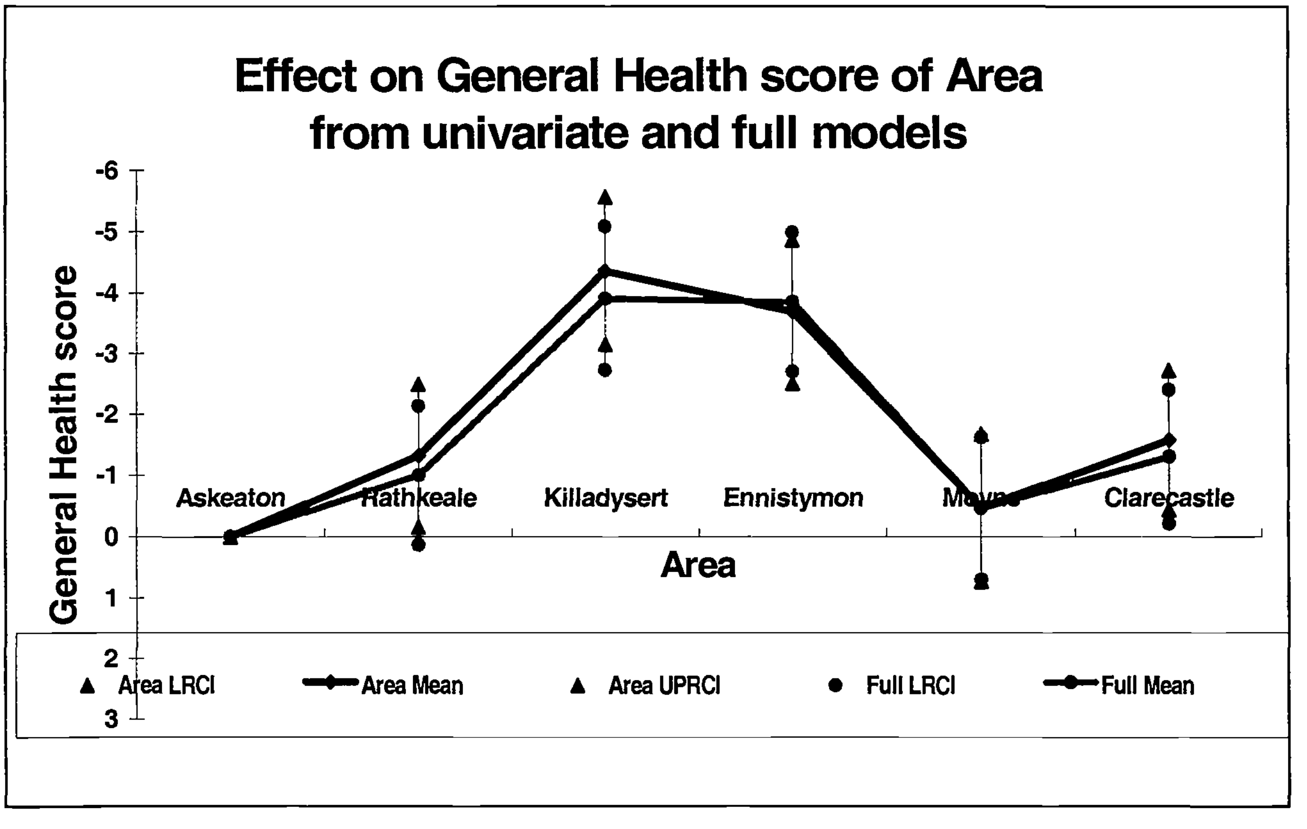


FIGURE 10



In summary each graph shows a roughly similar pattern. There is generally better health in Killadysert and Ennistymon, with health in Rathkeale possibly a little better than that in Askeaton, Moyne & Littleton and Clarecastle. These effects are small in comparison with the range of values for these scores, which is shown as the maximum and minimum rows in Table 25

TABLE 25 Multi-Variate Analysis

Area	SF-36	Skin symptoms	Skin severity	Respiratory score	Asthma score	Total score	General health
Askeaton	0	0	0	0	0	0	0
Rathkeale	0.8	-0.1	0.1	-0.2	-0.1	-0.3	-1.0
Killadysert	2.4	-0.2	-0.4	-0.4	-0.3	-0.8	-3.9
Ennistymon	4.9	-0.2	0.1	-0.3	-0.4	-0.7	-3.8
Moyne & Littleton	-1.4	-0.1	0.5	-0.2	-0.2	-0.5	-0.5
Clarecastle	0.7	0.0	0.0	-0.1	-0.1	-0.2	-1.3
Maximum	14.2	0	0	0	0	0	0
Minimum	92.4	7	28	7	5	12	53

CONCLUSIONS

It is difficult to summarise a large and complex survey like the AHHS. To begin with there are very few studies of the health of rural populations, either in Ireland, or elsewhere in the developed world. This means that there is little context in which to place the results of the survey.

Some general conclusions can be drawn. Most people are healthy. By far the commonest response to all of the questions on symptoms of disease was 'No'. The commonest value of each of the health scores studied here was 0, where zero means no symptoms reported. This is accurately reflected in the very small differences in average scores between the six areas studied. The SF-36 scores were similar to those reported from other populations.

There are real differences between the six areas in health outcomes, differences that are not explained by any of the variables that we chose for study. It is doubtful if these differences are of much practical significance. For the symptom scores, for example, the differences amount to an average of much less than one symptom reported per person. Why reported symptoms are higher in Askeaton, Moyne&Littleton and Clarecastle, than in Rathkeale, Ennistymon and Killadysert is not known. The results for the SF-36 scores are similar.

To the principal question of this study, namely 'Is there a difference in health between people living in the area where animal health problems were reported (Askeaton) or beside this area (Rathkeale), compared with other people living in rural areas in the Mid-Western Health Board?' there is a clear answer. As far as this study can detect there are no such differences. Rathkeale is similar to Ennistymon and Killadysert. Askeaton is similar to Moyne & Littleton and Clarecastle. This pattern cannot be explained by animal ill health in Askeaton itself.

Appendix A - Statistical details

Most of the questions were self-coding. Limited additional coding was done centrally. The data were keypunched directly from the questionnaires. Double punching was used to reduce punching errors. One hundred and fifty questionnaires, selected from the top of numerically ordered bundles of 200 questionnaires, were examined, and compared with the data entered. In no case was any keying error found.

Data cleaning

The data required extensive cleaning. No attempt was made to check the validity of data entered on the questionnaire, either after the interview, or before keypunching. A very large number of anomalous codes were identified, that is codes not defined on the questionnaire. The overwhelming majority of these were '8' or '9' used to indicate that the question was not answered by the informant and related to Sections of the questionnaire which were not administered to certain groups, for example the pregnancy section was restricted to women aged between 15 and 44, while the SF-36 section was restricted to those over 15. Following discussions with the MWHB, all codes of '8', '9', and (for certain questions, '88','888','99' and '999' were treated as missing values. For analysis of sections of the questionnaire restricted to certain age groups, or to women, all ineligible questionnaires are omitted. A small number of anomalies, for example men with a completed pregnancy history, and values which were neither in the codebook, nor missing values, were identified. In some cases it was possible to correct these anomalies. For example the two 'men' with pregnancy histories recorded, had female names, and had sex entered elsewhere on their questionnaire as female, and were reassigned. In other cases, for example people under 15 who completed SF-36 questionnaires, the age was taken to be correct, and the results ignored in analysis. In a few cases no resolution was possible, despite consultation with those involved in the conduct of the study, and the codes were set to missing values. Overall, while these problems made data analysis difficult, it is very unlikely that they were large enough to have had any substantial impact on the conclusions of the study.

Statistical methods

The reason for using statistical techniques is simple enough. We want to be able to identify differences between areas that are likely to be real, and to ignore differences between areas that are likely to be due to chance alone. To do this we need to use a range of different statistical methods. In this project the following methods were used - $\square^2$ tests for categorical variables, supplemented by exact tests when expected numbers were small; one and two way ANOVA; linear regression and logistic regression. Genstat and StatXact were used to carry out the analyses. One technical point worth further discussion is the choice of method to analyse difference between the study areas for the various ordinal-valued variables. Typically ordinal variables are analysed using techniques based on the distributional properties of random permutations. Typical example include the Wilcoxon rank-sum test, the Kolmogorov-Smirnov test and the sign test. There are many others. Unfortunately none of these methods work well when there are very large numbers of ties, that is observations with the same value, in the data analysed. For this reason the many ordinal variables analysed were treated as simple numerical variables, and analyses performed were based on comparisons of means, rather than comparison of medians, which would be technically more correct.

Appendix B Variable selection

As discussed in the text, it was necessary to decide carefully which variables to include in models testing the hypothesis that there were differences in health outcomes between areas, which persisted after adjustment for other possible explanatory variables.

To accomplish this the variables available were divided into eight groups - Biological variables - weight, height and body mass index; Demographic variables - sex age and age group; Health variables - which were the outcome variables; Lifestyle variables like alcohol intake, changes in diet, smoking, levels of physical activity and others; Social variables like land tenure, education, area farmed, having VHI, or a medical card, number of rooms in a house and others; Study related variables - study number, date of interview and interviewer; Environmental concern variables - level of activity in environmental work, degree of concern about environmental hazards, and degree of involvement in the environmental movement.

These eight groups contained 63 variables selected because they seemed likely to be of substantive interest, and not to be unduly repetitious. It was decided to include age group, sex and area in all analyses. From the other six groups of other explanatory variable it was decided to include one, or exceptionally two from each group, and in each case the variable which had the strongest univariate relationship with the particular outcome variable under consideration was chosen. The purpose of this was to provide a stringent test of the hypothesis of an association between area of residence and the major health outcomes.

The variables included in each of the seven models are as follows: -

SF-36	Area, Age, Sex, Medical card holder, Ever smoker, Ever drinker, Exercise
Skin symptoms	Area, Age, Sex, Medical card holder, Weight
Skin severity	Area, Age, Sex, Medical card holder, Involvement in environmental activity
Respiratory score	Area, Age, Sex, Medical card holder, Ever smoker, Long term illness card
Asthma score	Area, Age, Sex, Medical card holder, Ever smoker, Level of involvement in environmental activity
Total score	Area, Age, Sex, Medical card holder, Ever smoker
General health Score	Area, Age, Sex, Medical card holder, Ever smoker, Ever drinker

Area is the area in which the person lived.

Age is the age in years.

Sex is either male or female.

Medical cardholder is either yes or no.

Ever smoker is either yes or no.

Ever drinker is either yes or no (for alcoholic drinks).

Weight is the weight in kilograms.

Involvement in environmental activity is either yes or no.

Level of involvement in environmental activity is from 0 to 5.

INVESTIGATION OF MORBIDITY USING A HEALTH DIARY

EXECUTIVE SUMMARY

Morbidity with all symptoms included in the analysis

The diary methodology was used to enable participants to record health symptoms. A total of 1,353 **separate symptom episodes** were reported by all the participants (N=76) from 18 families. These symptoms were categorised under the following categories: Respiratory, Eye, Skin, Ear, Nose & Throat, Mental Health, Skeletal-Muscular, Gastrointestinal, Fatigue and Other. The findings revealed that each participant recorded, on average, **18 symptom episodes** over the year of investigation or **1.5 symptom episodes** per month. This number may appear to be very low but when investigated in more detail a different pattern emerges. The total number of days in the year when the respondents were ill was 11,827 symptom days. To reiterate the data was entered in a manner that recorded the number of separate symptom types experienced by each respondent and the number of days in the month the person was ill. For example, if a respondent had a sore throat for five days, this is recorded as one symptom episode and days of illness are recorded as five days. If a respondent had a sore throat for five days and also reported fatigue on two of same five days this is recorded as **two** symptom episodes and the number of days ill is recorded as five, as the respondent was ill for only five days of the month. From this it can be concluded that **1353 separate symptom episodes** were recorded (18 symptom episodes per year or 1.5 per month) which persisted for 11,827 symptom days. That is, respondents were recorded a symptom for an average **of 158 days during the year** of investigation or, in other words, respondents were ill or recorded a symptom for an average of **13 days for each month** of the study.
Bias may be associated with this methodology, especially when the investigator studying families requests one member to report for others. In addition censorship may operate when respondents only record those symptoms which meet certain minimum requirements of severity and duration, so crucial data may be omitted. In fact, the diary method may be a more sensitive measure of freedom from morbidity or asymptomatic days and perhaps may be more useful for studying illness-free periods. In addition it may be the case that respondents were more aware to record symptoms that were related to air pollution. However, respondents generally remarked 'no one sick' if that was the case rather than leaving the diary empty.

Morbidity with explainable symptoms (i.e., attributed to a cause other than air pollution) removed from the analysis

When explainable symptoms were removed from the analysis, that is, they had explainable causes and were not attributed to air pollution according to the informant, there was a slight decrease in the number of **symptom episodes** and the number of **symptom days.** The number of symptom episodes was reduced from 1353 to 1234, a decrease of 119 symptom episodes. On average each respondent recorded 16 symptom episodes on average per year, (*compared to the previous 18 symptom episodes when all symptoms were included in the analysis*) or 1.3 symptom episodes per month (*compared to the previous 1.5 symptom episodes per month when all symptoms were included in the analysis*). Symptom days dropped by 482 days from 11,827 to 11,345 symptom days over the year of the study when explainable symptoms were removed from the analysis Respondents were ill 151 days on average during the year (*compared to 158 days when all symptoms were included in the analysis*) or 12.6 days per month on average (*compared to 13 days on average when all symptoms were included in the analysis*). Reports of respiratory, ENT, gastrointestinal and 'other' symptoms were reduced when explainable symptoms were removed from the analysis.
Detailed analysis revealed that three families accounted for the majority of respiratory, eye and skin complaints. Moreover, the findings revealed that five persons accounted for many symptoms and as a result of this the findings were skewed. Analysis was conducted with this group excluded from the analysis. The findings are presented below.

Group removed from the analysis

The total number of symptom episodes reduced from 1353 to 803 symptom episodes in one year. In other words a group of five individuals accounted for 550 symptom episodes. The number of symptom days decreased to 5352 days. These five individuals accounted for 6475 symptom days and the fatigue symptom days were almost halved. The reduction in symptom episodes to 803 in one year can be interpreted as each individual, on average, experiencing 11 symptom episodes per year. The reduction in symptom days to 5352 in one year revealed that, on average, individuals were ill approximately one day in five or 20% of the time. On average, when the group were removed from the analysis, the number of symptom days per person was 71 days or six days per person per month.

Differences between adult and child morbidity

There were 45 adults (59.2%) and 31 children (40.8%) in the study. Adults accounted for 79% of all symptoms reported with children accounting for the remainder. The percentage of symptoms reported by adults was relatively stable over the year of the study except for a drop in the spring months. The percentage of symptoms reported by children peaked in the winter months. Moreover, the percentage of respiratory symptoms reported peaked in the winter months for both adults and children.

There was quite a dramatic difference between adults and children regarding the proportion of eye symptoms reported with the maximum number of three children reporting eye symptoms over the year of the study. The proportion of children with skin symptoms was also low (N=5, 16.1%) compared to the number of adults (N=11, 24.4%) who reported skin complaints. Adults also reported considerably more ENT symptoms and mental health symptoms than children did. The pattern of 'other' symptoms reported by adults and children were similar, however adults reported more than children did. Few children reported skeletal-muscular symptoms and this pattern was replicated with regard to gastrointestinal symptoms. Adults reported more symptoms of fatigue than the children did however the pattern of symptoms reported by both groups was relatively consistent over the year of the study.

When explainable symptoms were removed from the analysis, as before, there was a decline in the number of respiratory and ENT symptoms reported by both groups, and as before, there was little change in the pattern of eye and skin symptoms. There were changes in the number of mental health symptoms reported when explainable symptoms were removed from the analysis, especially for children. Reports of 'other' symptoms by children were also greatly reduced when explainable symptoms were removed from the analysis. There were few changes in reports of skeletal-muscular and fatigue symptoms, while gastrointestinal symptoms declined somewhat when explainable symptoms were removed from the analysis for adults and children.

Symptom severity and action taken to alleviate symptoms

While completing the diary respondents were asked to record the symptoms experienced, to rate symptom severity, to record any action taken to alleviate symptoms and to report the symptom causes if known. While respondents detailed the nature of symptoms many respondents did not rate symptom severity and even fewer respondents outlined the action taken to alleviate the symptoms experienced. As a result of this it is difficult to draw any general conclusions about the severity of symptoms and the action taken to alleviate symptoms.

For all the different symptom types symptom severity was generally rated as marked. Action taken to alleviate symptoms was usually in the form of a self-administered treatment. Few respondents attended the GP with symptoms despite the fact that symptoms were rated as causing marked discomfort. Moreover, it was evident from the diary records that some respondents attended different GPs throughout the year of investigation.

Differences between adult male and adult female morbidity symptoms

For the majority of symptom types adult females experienced more symptoms than adult males except in the case of skeletal-muscular symptoms and fatigue. However, differences between the males and females were not statistically significantly different except in the case of skeletal-muscular symptoms where males experienced significantly more symptoms than females. This may be due to the fact that males spend considerably more time engaged in manual labour. Differences between male and female children were not investigated in this manner due to the low number of symptoms reported by children overall.

Interview findings

Interview findings revealed that respondents working outdoors were more susceptible to illness, this may support the finding reported above. However, few respondents rated health symptoms as being disabling which may explain why few symptoms were presented to a GP. Only one respondent reported that physical health problems interfered 'a great deal' in normal daily activities, while three reported that health problems had interfered with their daily lives in the past but not any longer. Others reported a decline in health status. The most common physical complaints experienced by families when problems were first noticed included fatigue, muscle aches and pains and a blocked nose.

Conclusion

Overall, the number of symptoms reported by respondents was 18 symptom episodes on average per year. The number of symptom days was 11,827 or 13 days per month. The findings suggest that symptoms recurred on a daily basis or persisted for a long period of time. It is noteworthy however the bias may be associated with this methodology since one person reported for all family members. Additional analysis revealed that certain individuals were more susceptible to illness than others. A group of five individuals accounted for a large proportion of the symptom days recorded. When excluded from the analysis the number of symptom episodes per year declined to 11 and symptoms persisted or recurred for average of six days per person per month. Adults accounted for the majority of symptoms reported with adult females experiencing slightly more symptoms than females. Although symptom severity was generally rated as 'marked' few respondents presented these symptoms to a GP. However there was considerable missing data for the 'symptom severity' and 'action taken' variables. This latter finding confirms comments made during interviews conducted with families that symptoms were not generally disabling. The interpretation of the findings are however, hampered by the lack of baseline morbidity data. The availability of such data would allow for empirical comparisons to be made between the incidence of ill health reported in this study and that experienced by the general population.

BACKGROUND TO THE STUDY

Sporadic concerns about the occurrence of animal health problems in the Askeaton area of County Limerick have been voiced since the late 1980s and were perceived to be related to the concentration of heavy industry in the Shannon Estuary. These issues became more pronounced in 1994/95 and were accompanied by public concerns about the potential effects on human health. An investigation into human health was instigated in 1995 by the Public Health Department of the Mid-Western Health Board as part of the ministerial investigation co-ordinated by the Environmental Protection Agency. At this time meetings were held with the community and key informants in the area. Local people expressed concern about the rate of miscarriages and foetal abnormalities and the levels of respiratory illness and cancer in the area. Episodes of upper respiratory, eye and skin irritation were also reported.

This report deals with the results of the diary study conducted with farmers and their families. All the farmers in the study had experienced mysterious animal ill health or animal death.

AIM OF THE STUDY

To monitor human health status prospectively for a cohort of families whose farm animals have suffered from mysterious ill health or death:-

- To identify acute health problems recorded prospectively by family members in a one year period.
- To determine prevalence rates for symptoms of the upper respiratory tract, eye and skin irritation.
- To investigate if some family members are more susceptible to health problems than others, for example, the young and the elderly.
- To investigate seasonal differences in the health status of family members.
- To investigate possible causes of health problems.
- To correlate current health status with retrospective health status.
- The documentation of perceived overall health status using a battery of tested and validated questionnaires.

LITERATURE REVIEW

Health diaries defined

The daily diary has been used sporadically as a data collection method in health services since the 1950s with only a limited interest in the diary's unique characteristic as a research instrument (Faithfull, 1992). The diaries referred to here are not those intimate journals people ordinarily keep for their own private purposes. The term diary is used to refer to an annotated chronological record or log which individuals are asked to maintain over time according to a set of instructions (Richardson, 1994). Diaries refer to detailed prospective records of exposure kept by the subject, health diaries are used to measure symptoms, minor illnesses, medication use and medical care. Diaries are assumed to be highly accurate in measuring current behaviour because they do not rely on memory. Freer (1980b) felt that the health diary would yield more information than a retrospective health interview. Yet according to Woods (1981) "use of a health diary (sometimes referred to as a health calendar) has been common in nursing *practice* settings for many years, with nurses incorporating the diary as a means of helping clients document their symptoms and factors which precipitated them. To date, however, there has been little exploration of this tool in a nursing *research* context" (pp.76-77). Butz & Alexander (1991) referred to health diaries as a relatively new method in data collection.

The health diary allows researchers to study health-seeking behaviour as a multi-faceted construct giving a fuller picture of morbidity, not merely as a reflection of the uptake of health services. Diary-use allows documentation of symptoms and associated coping strategies by the individual or family experiencing them from the unique perspectives of the respondent(s) rather than that of a clinician or interviewer (Woods, 1981). It is these unique perceptions that serve as the basis for health seeking behaviour (Chrisman, 1977). In addition, individuals and families use a variety of strategies in promoting their health and coping with illness, and do not merely rely on the help of professionals. Data obtained from health diaries result in a dramatically different perspective on health and illness than that obtained from physician utilisation data (Norman *et al.*, 1982).

The nature of data collected with diaries has varied with the purpose of the study. Diaries have elicited data regarding days on which the respondent experienced symptoms, days on which the respondents were unable to perform their usual activities and days on which the individual engaged in self care, health seeking activities, or took no action in response to symptoms (Kasl *et al.*, 1975, Rakowski, *et al.*, 1988). Diaries have been used to collect information about individual family members' health and illness behaviours. Individuals usually report for themselves, although in some instances one person is asked to report for the entire family (Roghman & Haggerty, 1972). Little is known about how children function as diary respondents, although their specific use by school-aged children has been reviewed by Butz & Alexander (1991).

Linking diary data with other methods is considered as a potentially valuable approach according to Zimmerman & Weider (1977) who emphasise the role of diaries as an observational log maintained by subjects which can then be used as a basis for intensive interviewing. Roghmann & Haggerty (1972) found the diary to be a more valid approach to collecting data than interviews. They also argued that a combination of diary and interview adds new dimensions for the study of health and illness behaviour. Clinton (1987) used several instruments to investigate the physical and emotional responses of expectant fathers including a health diary for expectant fathers. Allen *et al.* (1954) compared interviewing versus diary keeping in eliciting information in a morbidity study and found that diary elicited incidence rates are about twice as high as rates elicited by interview. The advantages and disadvantages associated with health diaries are outlined below.

Advantages and disadvantages of the diary method

The primary advantage associated with the use of a diary as a data source and as a data collection procedure is the richness of data that can be obtained about an individual's and family's health. Other advantages are outlined below followed by an account of the disadvantages associated with diary methodologies which should not be viewed uncritically according to Platt (1981).

Advantages of the diary method

- Diaries lead to increased reports of most symptoms and disability
- Diaries are able to elicit reports of acute and chronic episodes that do not cause disability or require medical attention
- Lower recall errors in diaries is interpreted as a sign of more valid data
- Participants can prospectively unfold a series of events and perceptions relevant to their subsequent action rather than rely on past events (Roghman & Haggerty, 1972)
- Diaries are used as memory aides to improve recall of events in a later retrospective interview
- The time sequence involved in the development of a symptom episode and the illness behaviour related to it can be documented, helping to determine the temporal relationship between the two events.

Verbrugge (1980) counters many of the persistent arguments levelled against diaries as a research instrument concluding the diary is superior to the single interview in:

- reducing recall error and producing higher levels of reporting
- counts of diffuse symptoms for which people do not know the underlying medical condition, and for acute non-disabling and non-attended illnesses.[1]
- providing a more comprehensive view of people's health and illness behaviour.

Roghmann & Haggerty (1972a) also concluded that the social desirability response set seems less apparent in this method as compared to the interview.

Disadvantages of the diary method

The main drawback of the method lies in the very wealth of material it generates. Another key limitation associated with the use of diaries is that only current exposure can be measured. Some other disadvantages are outlined below.

- Expense in terms of interviewer time needed for instruction, follow-up and coding of results, elimination of those participants who cannot read or write or those who choose not to keep the diary.
- Inability of the researcher to immediately probe for additional data beyond that provided.
- Bias associated with this method occurs when an investigator studying families requests one member to report for others.
- Censorship may operate when members only record those symptoms which meet certain minimum requirements of severity and duration and crucial data may be omitted / skipped.
- Representatives of the sample may suffer due to non-participants, potential subjects may decline to commence the diary and subjects may skip days or suspend diary completion prior to the intended end of the data collection.
- The amount of data strains the capacity of analytical and statistical techniques (Verbrugge, 1980).
- There is often a decline in respondent participation and completeness over time.

Using a modified format of Roghmann & Haggerty's (1972) family health diary to collect data about health symptoms, Woods (1981) concluded that the diary as a research instrument has many strengths and limitations. It appeared to be a weak measure of mental ill health or poor health, but proved to be a much more sensitive measure of freedom from morbidity, its specificity seems to far exceed its sensitivity. Because of this feature, the diary may be better able to document asymptomatic days, and perhaps may be more useful for studying illness-free periods than for documenting specific kinds of illnesses. This study demonstrated conflicting utility of the diary as a research instrument as it appeared to be a weak measure of mental ill health or poor health on this occasion.

[1] The diary produces higher rates for virtually every type of acute condition including respiratory, accidents, gastrointestinal, mental (including headache), muscular-skeletal, and a residual group "other" (Wilcox, 1963).

To conclude: "Diaries seem to be as flexible and, in principle, as widely applicable research instruments as questionnaires. The issue is not their feasibility, but their relatively high cost, the degree of co-operation required from the respondent, and the vastly increased work involved in a complete analysis of all the data collected" (Roghmann & Haggerty, 1972, p.144).

Medical records versus health diaries
There cannot be much doubt that medical records furnish more accurate and reliable information than lay reports, but medical records also have serious limitations. The overwhelming majority of symptoms experienced by patients are not brought before a physician and are not noted in medical records; the accuracy of such records is restricted mainly to those more serious episodes which are treated by medical personnel. Moreover, people as a rule use multiple medical facilities, and the records of each facility are characterised by discontinuities and completeness. Hence, for each continuous, long-range series of health related data, which include medically non-attended symptoms also, we must, and do, rely on information coming from lay people (Kosa *et al.*, 1967). Health diaries represent a sensitive measure of a dimension of illness that could not be assessed by other means (Norman *et al.*, 1982). The physicians knowledge of the health status of his patients' families has been compared to a small part of the iceberg which is visible, the greater part being submerged and hidden (Last, 1963). Diary studies, defined broadly as studies that record the health status of each study participant repeatedly over time, provide a powerful method for assessing the impact of short-term changes in the environment on human health.
Diaries permit more accurate measurements of events over time than is possible in retrospective questionnaires (Roghmann & Hegarty, 1972). The data obtained from the diaries result in a dramatically different perspective on health and illness than that obtained from physician utilisation data. In Norman *et al.* (1982) it was found that although subjects visited a family physician only once, on average, in a six-month interval, and half the sample reported no visits in each time period, they reported symptoms on one day in three. Kosa et al. (1967) used three instruments to assess family health information including (i) a questionnaire on the utilisation of health facilities, (ii) a child health index and (iii) a family health calendar. There was no significant overall correlation between the records derived from different instruments. The greatest number of health related episodes were reported in the health calendar.

Format of health diaries
As mentioned earlier the term 'diary' is used to refer to an annotated chronological record or log (Zimmerman & Wieder, 1977). Individuals are usually asked to maintain a record over time according to a set of instructions which are congruent with the research interests. According to Richardson (1994) diaries are constructed according to one or two formats:

- as a *ledger*, where separate pages are used for different types of events, e.g. medication use and visits to the doctor
- as a *journal*, where all health events are entered on the same page for each day

There are several specific designs for a *journal* according to Verbrugge (1980). It may look like a calendar with a box for each day of the diary period. It may look like a log book with lines on which dates and details are entered when an illness occurs. Or it may be a questionnaire with printed questions about health events. Diaries of any format vary in their emphasis on closed-ended items (which respondents simply check) and open-ended items (which require written descriptions). Many diary studies require entries only on days when health events occur rather than on every day of the diary period. A sample of some health diaries are presented below.

Butz & Alexander (1991) reviewed the use of health diaries by school-aged children. They reported that school-aged children can participate in diary studies with *intense* follow-up procedures including the child receiving fast-food coupons or child stickers by mail, weekly telephone calls to each child and $10.00 upon completion of the diary study (the diary period was limited to eight weeks). The diary format was specially adapted for children and was similar to an advent calendar in which each day of a month has a door to open with a picture behind the door, the questions asked are shown in Figure 1. A cardboard cover with seven doors was constructed for daily recording of health events. A variety of stickers were placed on the inside of each door as an added incentive for daily recording, minimising multiple day recording at the end of each week. Familiarity with child cognitive development is useful in diary design, for example, having diary items written at the appropriate reading level.

1. Did you have any of the following today?
Night: (Check box for each item you had)
Wheezing Cough Fever Sore throat Runny nose

Day: (Check box for each item you had)
Wheezing Cough Fever Sore throat Runny nose

2.. Did you take asthma medicine today? Yes____ No____

3.. Were you upset or worried today? Yes____ No____

Figure 1: Health Diary used by Butz & Alexander (1991)

Alpert *et al.* (1967) used a semi-structured research instrument to measure illness and health care for a four week period among low-income families. Space was provided on the diary to note each day (i) any medical symptom observed, (ii) any upsetting event experienced in the family, and (iii) any action taken in response to these symptoms and events (see Figure 2). Explanatory notes regarding diary completion were also provided. The diary card and explanatory notes were compiled into a six-page booklet with holes at the top so that the mother can hang it in a convenient place. On days without symptoms mothers were instructed to mark "No one sick". The category of upsetting events was included to provide information on the emotional-social aspects of family health and on the problems relating to mental health, which are seldom brought to medical attention. After the four week period the interviewers visited or telephoned the mothers as a reinforcement technique.

Note	Symptoms	Upsetting Events	Action Taken
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Figure 2: Health diary used by Alpert *et al.* (1967)

There was an 85% response rate and although the data could not be checked they were indicative of family health as perceived by the mothers and represented a more comprehensive description of health than any combination of professional health records. Alpert *et al.* (1967) reported that any single research instrument is likely to yield only a partial view of total family health and the data compiled document the importance of medically non-attended symptoms in the evaluation of the total health of the family unit.

Unstructured diary sheets in health research have been found to yield disappointing results. Structuring the situation as much as possible allows even the less-articulate respondents to provide daily information, for example, by ticking boxes. However the use of structured diaries is contested.

Allport (1942) does not consider formally structured documentation as a true diary. Burgess (1984) said that structure forces the subject into a narrow view of their life events, decreasing spontaneity achieved with this format. Overall little is known about the technical aspects of diary design which aid respondents. Its salience may lead to high co-operation in those most affected by the problem under investigation. Freer (1980a) provides useful information on the organisation, planning and management of a health diary study. Firstly, it should be established that the respondent interprets the question in the same way as the organiser. In addition the respondent should be able to complete the diary in less than 5 minutes. It was suggested also that each respondent should be visited at home once a week during the study to collect the previous week's material, distribute the next week's diary, and discuss the problems. Most studies have used a running-in or practice week and then a study period of four weeks according to Freer (1980a). In another study investigating self-care Freer (1980) showed respondents completed diary sheets from previous studies.

Reliability and validity of health diaries

Little is known about the psychometric properties of diaries since they have been used relatively rarely. However, as the method does not require the respondent to recall past events, it seems likely to provide more valid and reliable descriptions of minor and frequent events than the interview approach (Allen *et al.*, 1954). Collins (1951) reported that non-disabling illnesses will be forgotten more rapidly than will disabling illnesses.

Carp & Carp (1981) analysed five sets of data to assess the reliability, validity and generalisability of diary data. The results suggested that scores obtained from 1-week diaries had satisfactory construct validity. Moreover for salient activities they were less subject to retrospective bias than interview data. However, Carp & Carp (1981) revealed that attrition related to diary-keeping resulted in the under-representation of certain groups (for example, low income, little education, minority ethnicity and poor health) thus affecting the generalisability of the findings. "The quality of the data provided seems closely related to the effect devoted by the researchers in encouraging diary-keepers to maintain them" (Richardson, 1994, p.785). Roghmann & Haggerty (1972) suggested assessing validity by comparing self-reported health events with clinical and hospital records of health care visits. This allows for an estimate of criterion validity of health diaries although this method is only possible for health events that involve medical care. Roghmann & Haggerty (1974) reported a 97% agreement between medical records and diary responses at two weeks and 77% agreement at 12 months following initiation of the diary study. Another method is to interview respondents about events recorded in a diary within a given time frame.

Reliability and validity estimates have been attempted by using different measuring instruments to measure the same category of concern to the researcher. Geddes *et al.* (1990) used this approach when studying the utility of the daily card diary to study the quality of life of patients receiving chemotherapy. Comparisons were made between the diary card, nurse ratings using the card, the European Organisation for Research and Training in Cancer questionnaire (Aaronsen, 1993) and the Spitzer quality of life index (Spitzer *et al.*, 1981). These comparisons revealed expected convergent and divergent validity. The study also demonstrated the sensitivity of the diary card to short-term changes compared with the other measures.

The criteria used for validation of the health diary by Woods (1981) included a recognised index of mental health, Cornell Medical Index M-R scale (Brodman *et al.*, 1956), and the individual's assessment of self-perceived health. Scores and self-ratings from interviews were compared with the data obtained from family health diaries. Diary symptoms were only weakly correlated with the scores from the Cornell Medical Index M-R scale and poorly correlated with a self-perceived health rating. Woods (1981) concluded that the diary was better suited to the documentation of asymptomatic days, and thus more useful for studying disease or problem-free periods rather than documenting specific symptoms. This study demonstrated conflicting utility of the diary as a research instrument as it appeared to be a weak measure of mental ill health or poor health on this occasion.

Compliance and respondent co-operation

Researchers often doubt that respondents will agree to do the sizeable task of keeping a health diary. However prior studies have achieved very high rates of agreement to keep a diary and high rates of continuation to the end of the diary period and attrition during the diary period tends to happen early (Sudman & Lannon, 1980) with only 1-2% of the sample loss beyond the first month. This type of data collection method obviously demands more time and effort on the part of the respondent than, for example, single interviews, and constitutes a clerical task to which people will respond with differing levels of skill and enthusiasm.

Studies have used strategies such as remuneration, follow-up telephone calls and follow-up interviews and visits to collect diaries and checks for completeness. Financial remuneration may not be important in influencing the decision to participate, but probably influences commitment to complete the diary (Richardson, 1994). Other factors influencing compliance include respondent age and socio-economic status (SES), and saliency of the diary task (Sudman & Lannon, 1980). Diary completion rates are high as compared to other types of data collection methods, such as mailed or telephone surveys. Completion rates are reported between 80-88% in adult, white, non-institutionalised populations (Verbrugge, 1980; Verbrugge, 1981) and 70-91% for parental recording (Gold *et al.*, 1989; Barr *et al.*, 1988). Diaries collected by the pick-up method produce higher completion rates than diaries returned by mail (Sudman & Lannon, 1980).

Norman *et al.* (1982) argued that the total duration of diary usage should be limited. Furthermore, initial compliance may be high amongst those who participate, but there is a consistent drop in the reporting of incidents with the passage of time. In order to overcome the problem Norman *et al.* (1982) asked respondents to complete a randomly selected 3-day block every 2 weeks. In addition, telephone contact was made 48 hours prior to the scheduled day of completion and lottery tickets were given. As a result of these strategies high compliance was maintained in a study spanning 2 years for over 400 individuals. However Norman *et al.* (1982) reported that some subjects were irritated by the repeated telephone calls. Mooney (1962) suggested that non-compliance may be attributable to fatigue, a lack of willingness to complete the diary in the same detail as time passes. Verbrugge (1980) reported that diary data are subject to conditioning effects, that is, changes in reporting health behaviour that result from diary keeping. For example sensitisation occurs as the respondent becomes more sensitive to the items reported by participation in the study. Over-reporting of diary items over the diary period can also occur. Overall diary respondents become more aware of poor health and respond with more curative or preventive actions. Other conditioning effects include fatigue and boredom with the task and become less thorough in recording items. Usually the longer the study period, the more likely fatigue will affect the recording of the data. If conditioning affects are significant, reporting levels are not valid. Verbrugge (1980) reported that during a two to three month reporting period, approximately 5-25% of respondents experience some conditioning effects, with sensitisation more common than fatigue. However Morrell & Wale (1976) revealed that analysis of the frequency of medical consultations before and after keeping a diary did not reveal any significant change in consulting behaviour.

The length of the data collection period for which diaries have been maintained spans from anything from 1 to 2 weeks (Kasl *et al.*, 1975) to over 1 year (Freer, 1980b) or 2 years (Norman *et al.*, 1982). Schwartz & Zegers' (1990) diary study lasted 3 years. Oleske *et al.* (1990) used the diary as a method of data collection with a sample of cancer patients and oral comments given by diary keepers to the research assistants (when calling to instruct the respondent) indicated that they found keeping diaries a helpful outlet. Data collection and compliance therefore appears feasible for longitudinal research of older individuals with a chronic condition such as cancer. It should be noted that a monetary incentive was also offered to these patients.

Analysis of diary data

"Diaries provide a continuous stream of daily data from each individual. This holds enormous analytical potential for the analyses of variations over the entire diary period and day-by-day. It makes possible both individual-level and aggregated analysis with the use of multiple perspectives, investigating change both within and across groups. The objectives of analysis invariably involve the summary of patterns and detecting changes over time, comparing patterns of variables in differing groups for similarity or divergence with time. The *individual* and the *day* can be used as the unit of analysis" (Richardson, 1994, p.786). Data collection and processing may become more labour-intensive than for other survey procedures, and the data more difficult to analyse, partly because "they strain the capacity of statistical techniques now available" (Verbrugge, 1980). Statistical analysis is not always suitable for studying change over time (Gabriel & Dush, 1988) yet the utilisation of time-series analysis may be of value (Metzger & Schultz, 1982). The salient feature of time series analysis lies in the fact that successive observations are not usually independent, so analysis must take into account the chronological order of observations. This technique also allows for the development of a framework for predicting future changes in an individual's behaviour.

Alpert *et al.* (1967) developed the concept of (i) a family day and (ii) a patient day to summarise results. A family day denotes a calendar day for each family, while a patients day is computed by multiplying the family day by the number of family members.

Use of health diaries in previous studies

As mentioned earlier the nature of the data collected with diaries has varied with the purpose of the study. For example, some diaries have elicited data regarding days on which the respondent experienced symptoms, days on which the respondents were unable to perform their usual activities and days on which the individual engaged in self-care, health seeking activities, or took no action in response to symptoms (Kasl *et al.*, 1975, Rakowski, *et al.*, 1988). Recently, diaries have received interest in respect to data collection during a cancer patient's treatment (e.g., Fraser *et al.*, 1993). The diary employed by Frank-Stromberg (1986) to investigate health promotion behaviours in ambulatory cancer patients had daily ratings, closed responses and open-ended questions and as such seems to incorporate a structured and an unstructured format.

Vedal *et al.* (1987) used a health diary that spanned eight months, the diary was structured with space for entry of numbers corresponding to symptoms for each day. Possible symptom entries included hoarseness, sore throat, phlegm from the chest, pain in the chest, wheezing, fever, ear pain or discharge, runny or stuffed nose, headache or muscle ache, and burning, aching, or redness of the eyes. In addition parents were contacted every two weeks to ensure that the diary was being completed. Responses were read from the diary at those times and recorded independently by the staff. An average of 79% of subjects completed diaries in each month. Fewer subjects completed diaries in the last study month.

Coghlin *et al.* (1989) designed a diary for the subject to record each exposure to environmental tobacco smoke during one week, according to location, number of hours, number of smokers, proximity, and intensity. Subjects were asked not to enter the study during atypical periods (e.g., holiday time, out of town guests). In this study subjects wore a nicotine monitor. Study results revealed that it is possible to develop questionnaires and diaries that predict nicotine levels collected in the breathing zone of passive smokers.

Daily diaries of acute symptoms were handed out and collected each Monday for three years in Schwartz & Zeger's (1990) study. Symptoms reported in the diaries were the presence of headache, cough, sore throat, phlegm or sputum, chest discomfort, and eye irritation. Subject co-variates (smoking and allergies) were also examined.

White *et al.* (1991) used the diary method to gather information on respiratory symptoms, eye irritation, chest colds and lost days from work resulting from exposure to second-hand tobacco smoke. Diaries were collected on the third Friday of each month and the data was coded and entered into a database and returned to the subject on the next collection date. The study spanned nine months from September to the end of May in order to bypass the holiday period.

Use of health diaries to investigate baseline measures of morbidity

According to Lipscomb *et al.* (1992) information for chronic diseases, infectious diseases, and injuries are readily available for epidemiological studies. "However, baseline rates for *non-specific self-reported* symptoms are currently unavailable. Although symptoms are often not the choice of outcome measures in studies for which a more objective outcome can be assessed, self-reported symptoms are utilised frequently as the outcome of interest in environmental and occupational epidemiological studies" (p264). Lipscomb *et al.* (1992) went on to purport that self reported symptoms may be a sensitive and non-invasive measure of adverse health associated with low-level chemical exposure. However, self-reported symptoms were collected via questionnaire and interviews and the findings are not directly comparable with health diary data.

Freer (1980) conducted an exploratory diary study in a group of 26 women for 4 weeks to investigate self-care. Health episodes are reported in table below, emotional/psychological problems, tiredness and headache were the most common with a frequency of a new medical problem every 2 days. In addition 81% (N=26) women used one or more medicines during four weeks. The symptoms reported in this study are presented in Table 1.

Morrell & Wale (1976) asked 198 randomly chosen women to keep a health diary for a period of 28 days. The findings revealed that symptoms were recorded one day in three and on 57% of symptom days women self-administered medication. Morrell & Wale (1976) argued that even a minor shift from self-care to doctor-care would place considerable demands on the British GP service. When the same symptom was recorded on consecutive days this was described as one episode of symptoms. On average each woman reported six symptom episodes in the dairy period. The nature of the symptoms reported are presented in the table below. Headache was the most commonly recorded symptom followed by changes in energy, backache and cold. In the same study Morrell & Wale (1976) compared the findings of the diary study with the symptoms most often presented to the GP. These included sore throat, cough, abdominal pain and skin rash. Only one symptom episode in 37 led to consultation. It might be argued that the act of keeping a health diary encouraged patients to consult by drawing attention to their symptoms. However, analysis of the frequency of consultation before and after keeping a health diary did not reveal any significant change in consulting behaviour. Moreover, differences between the spectrum of symptoms recorded in the health diaries presented to doctors confirms that patients are selective in determining which symptoms to present.

Table 1 Types of medical problems reported showing relative frequency of each expressed as a percentage of all medical problems episodes.

	Freer (1980) Self-care Study	Morrell & Wale (1976) Self-care Study	Alpert *et al.* (1967) Illness/health care
Respiratory	6%	10%	43%
Ear,nose,throat	-	7%	-
Mental Health	35%	23%	11%
Skin	3%	-	8%
Eye	1%	-	-
Skeletal-muscular	14%	7%	-
Gastrointestinal	17%	9%	9%
Tired/Fatigue	17%	10%	-
Other	7%	33.8%	29%
TOTAL	**100%**	**100%**	**100%**

Alpert *et al.* (1967) investigated health care among 78 low income families, comprised of 156 adults and 254 children, for 4 weeks using a health diary. Over 85% of the respondents returned completed calendars. On average a symptom was reported on 1 of every 3 days and 93% of families reported one or more symptoms. Symptoms were recorded for almost two-thirds of the children, one-half of the mothers and for one-third of the fathers. Of the 834 symptoms reported the most frequent were related to respiratory ailments, accidents and gastrointestinal complaints. The data also indicates that only a small percentage of illnesses experienced by the families result in a medical contact.

In a study conducted by Upton (1999) baseline information was gathered from approximately 2,320 respondents investigating the presence of (a) sore throat, (b) cold/flu, (c) cough, catarrh or phlehm and (d) diarrhoea. A total of 12.2% reported the presence of a sore throat in the last week, 15.9% reported a cold/flu, 29.1% reported the presence of a cough and 6.9% of respondents reported having diarrhoea. The last symptom is somewhat comparable to the gastrointestinal incidences reported in the table above and in comparison with the three studies discussed the 6.9% reported in the Upton study is much lower. The report for sore throat in this study is higher than that reported by Morrell & Wale (1976). The incidence of respiratory symptoms is also higher in this study than those reported in the table above. It is noteworthy that the sample in this study were asked the above questions whilst participating in a large two generation cardiorespiratory investigation. The research nurse asked participants the above questions before a cardiorespiratory examination was conducted. Moreover, participants were from an urban area in Scotland with high levels of social deprivation.

Diary developed for this study

An unstructured format was chosen for the diary design making it possible to report any health symptoms, the diary is presented in Appendix A. As mentioned earlier the use of structured diaries is contested. Allport (1942) does not consider formally structured documentation as a true diary. It was decided that the diary collection period should span a 12 month period to avoid a seasonal bias in reported illness and as such the diary had to be short if respondents were expected to complete it every day for a year. If a checklist of all possible health symptoms related to air pollution were to be devised it would be very time-consuming to complete each day for each family member.

Diary informants were instructed to record in the diary any health symptoms reported by any family members. A coding frame was devised to identify each family member. Secondly diary informants were asked to record any actions taken to alleviate health symptoms. In addition informants were also asked to identify any possible explanations for health symptoms experienced. To aid diary informants examples of possible responses were provided. A page of instructions for diary completion was given to the diary informant (see Appendix B). Informants were also shown by the project co-ordinator how to complete the diary. It was planned to collect diaries on a regular basis, approximately every 5 to 6 weeks, since this "pick-up" method had previously been shown to produce higher completion rates than the having diaries returned by mail (Sudman & Lannon, 1980). The first month of data collected was used as a running-in or practice session as suggested by Freer (1980a) and the data collection period spanned a year (13 months including the practice month) so as to avoid any seasonal biases. In addition it was possible to complete the diary in less the 5 minutes as recommended by Freer (1980a).

Conclusion

Diaries seem to be flexible and widely applicable research instruments. The diary method is a potentially efficient and sensitive tool with which to reveal health information that could not be assessed by other means, particularly for non-specific, self-reported symptoms. The diary is a valuable strategy for detecting change in individuals or groups over time but as a data collection method in longitudinal designs it has been exploited very little.

METHODOLOGY

Subjects

Initially, a total of 26 farms agreed to take part in the study. The study co-ordinator visited 25 farms, one farm was omitted from the outset at the family's request due to family illness. During the first few months of the study at total of six families dropped out of the study. Three families dropped out due to serious family illness. The three remaining families had not kept diary records up to date and did not continue with the study. In total 19 families participated in this study for 13 months. However at the end of the study one farmer had only partially completed the diaries and was omitted from the final analysis leaving a total of 18 families or 76 individuals. The gender and age breakdown of the respondents are outlined below. There were 39 males (51.3%) and 37 females (48.7%) in the study. The majority of these were adults (N=45, 59.2%) with the remainder under 18 years (N=31, 40.8%).

TABLE 2 The gender and age breakdown of the 76 respondents participating in the diary study.

Gender	Males N=39 (51.3%) Females N=37 (48.7%)
Age breakdown	Under 18 N=31 (40.8%) Over 18 N=45 (59.2%)

Tests & Procedure

The health diary was completed for all family members on a daily basis by a *family co-ordinator*. As mentioned earlier this involved recording: the presence of any health problems, the action taken in relation to the health problem (e.g., medication, visit doctor), any possible explanation for the health problem and the level of discomfort incurred. Diaries were collected on a regular basis (usually every 5-6 weeks) by the *study co-ordinator* and health diaries were distributed for the following month. These visits were always preceded by a telephone call in order to arrange a convenient time to visit. In order to gather other health information measures of health status were administered to all of the participants:

- Mid-Western Health Board Health Status survey (including the SF-36)
- The General Health Questionnaire

It was planned to administer other questionnaires throughout the study period however the poor response rate for the General Health Questionnaire, administered in the fourth month of the study, was very poor. Respondents also voiced concerns over completing such questionnaires since the study was primarily concerned with the investigation of physical health symptoms and the diary alone was deemed sufficient. The questionnaires omitted included (i) the Health Locus of Control Scale, (ii) the Coping Resources Inventory and (iii) the Social Problems Questionnaire. Demographic information was obtained on household members. Respondents were also asked to describe the following:

- previous health problems and the actions taken
- recent consumption of medication (e.g., inhalers, regular prescriptions)
- health behaviour (including smoking, allergies)
- ability to conduct normal activities.

These items were based on a modified format of questions developed by Murray (1985).

Data entry procedure

In order to cope with the large volume of data collected for each individual a data entry procedure was devised. Data was entered in the following format:

- Demographic information for each individual

- Number of family members reporting symptoms in each month
- Number of symptoms reported by each family member, when the same symptom was recorded on consecutive days this was described as one episode of symptoms
- Symptoms recorded by family were re-coded into the following symptom categories:
    - Respiratory
    - Eye
    - Skin
    - Ear, Nose & Throat
    - Mental Health
    - Other
    - Skeletal-muscular
    - Gastrointestinal
    - Fatigue
- the number of recurring days each symptom persisted for a month
- the mean severity of each symptom
- action taken to alleviate symptoms
- cause of symptoms

Codes for 'action taken to alleviate symptoms' are outlined in the following table.

TABLE 3 Actions taken to deal with health symptoms.

Action taken:
Self administered medication
Attend GP
Rest only, no medication
Attend GP & medication prescribed
Self administered medication, attend GP, & medication prescribed

If respondents indicated that no action was taken this was recorded, as were hospital visits, and dental visits. Some respondents reported this category was not significant since he/she was not sick with the symptom. This was also recorded. The codes for 'cause of symptoms' are outlined in the following table.

TABLE 4 The answers regarding the causes of ill health according to the respondents.

Pollution	**Not pollution related**	**Accident**	**Respiratory illnesses**
Strong smell	'flu / virus	Old injury	Asthma
Air pollution	Gynaecology	Sport accident	Pleurisy
Air 'unhealthy'	Peptic ulcer	Farm accident	Whooping cough
Caustic air	Dietary		
Wind direction	Contact with others		
	Ear problems		
	Dental problems		
	Dehydration		
	Appendix		

Other possible explanations for symptoms included "don't know" and "cold weather / winter time".

At the end of the diary study a semi-structured interview was conducted with each family. This questionnaire is detailed in Appendix B and C. Families were asked a series of questions about when health problems were first noted and the circumstances which precipitated them. The findings are outlined in the next chapter.

RESULTS AND DISCUSSION

The sample size was not consistent for the twelve months. The number of respondents from October to June, the first nine months of the study, was 76 per year (N=76). However for July, the number of respondents was N=69. In August the sample size has further dropped to N=68. The lowest number of respondents (N=62) was in September.

Total Number of Symptoms reported by Respondents
A total of 1353 symptoms were recorded over the year of the investigation by 76 individuals from 18 families. In the table below these symptoms are broken down into the nine symptom types including (i) respiratory (resp), (ii) eye, (iii) skin, (iv) ear, nose & throat (ENT), (v) mental health (mh), (vi) other, (vii) skeletal muscular (sm), (viii) gastrointestinal (gi) and (ix) fatigue. The symptoms in each category were outlined in the method section.

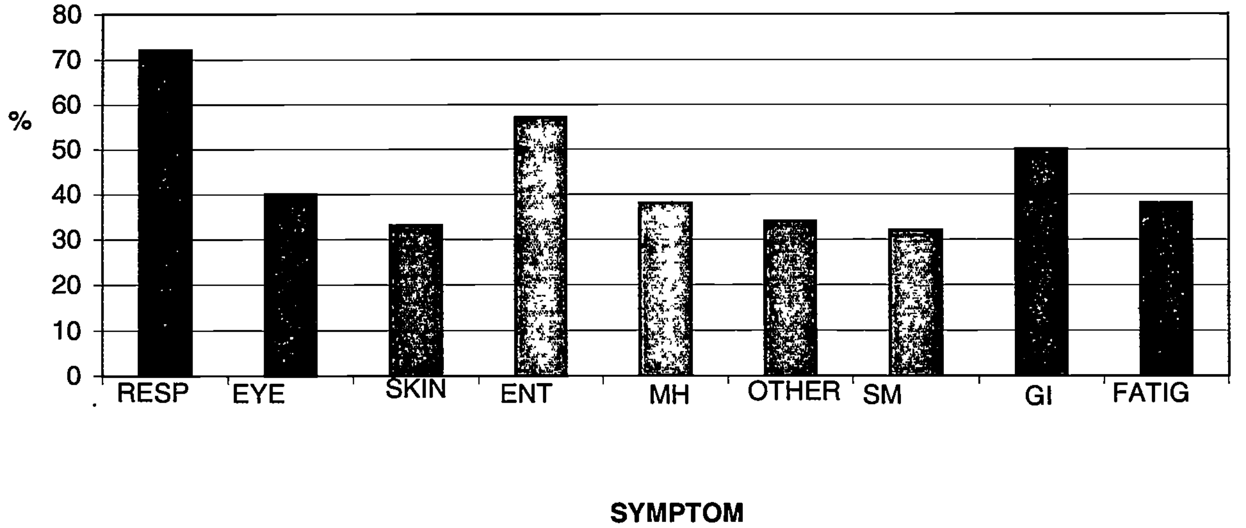
TABLE 5 The number and percentage of symptoms reported by respondents over the year of the study.

Resp	Eye	Skin	ENT	MH	Other	SM	GI	Fatigue	Total
264	107	176	222	140	49	137	88	170	1353
19.5%	**7.9%**	**13%**	**16.4%**	**10.3%**	**3.6%**	**10.1%**	**6.5%**	**12.6%**	**100%**

A more detailed examination of these findings reveal each respondent experienced an average of 18 symptoms in one year or 1.5 symptoms per month. This figure is based on the total number of symptoms recorded, that is, if a respondent reported a sore throat for five days this is recorded as one symptom and the symptom duration is recorded as five days. In total, 11,827 days were reported as ill days by the respondents over the year of the study, giving an average of 158 ill days per person per year or 13 ill days per person per month. This is discussed in more detail in the next section.[2]
Respiratory symptoms were the most commonly reported symptoms (19.5%), followed by ENT symptoms (16.4%), skin symptoms (13%) and fatigue (12.6%). This is in contrast to the findings of Freer (1980) who reported that emotional/psychological problems were the most frequently reported problems in a group of 26 women who kept a health diary for 4 weeks. Other frequently reported symptoms included tiredness and headaches. Morrell & Wales (1976) study of 198 women who also kept a diary for 4 weeks reported that headaches were the most commonly reported symptoms followed by changes in energy, backache and colds. Moreover, symptoms reported in Morrell & Wales' (1976) diary study differed considerably from those presented to the GP which included sore throat, cough, abdominal pain and skin rash. Alpert *et al.* (1967) recorded respiratory ailments as the most common complaint, as was the case in the study, followed by accidents and gastrointestinal complaints. It is difficult to discuss the significance of these findings as there are few studies related to baseline measures of morbidity. Additionally, the findings discussed above spanned three decades during which time the nature of health care and health practices would have changed significantly. Indeed other studies discussed were conducted for a period of one month on average in comparison to this study which was one year in duration.
In the following graph the number of persons experiencing symptoms over the year of investigation are presented. A total of 72% of respondents reported a respiratory complaint during the year. ENT symptoms were reported by 57% of the respondents while gastrointestinal symptoms were reported by 50% of the group. Over the year 40% of respondents reported eye symptoms while approximately one third of the group had skin, mental health, other, skeletal muscular and fatigue symptoms.

[2] This is based on a average of 74 respondents, as the number changed over the course of the study.

Figure 3 Percentage of respondents reporting each symptom over the investigation.



Duration of Symptoms

The number of symptom days was 26, 885 days, this is the number of days in the study multiplied by the number of the respondents participating. The calculations are presented in the table below. As mentioned earlier respondents were ill for 11,827 days in total over the year of the study.

TABLE 6: The number of symptom days in the study and the number of days respondents were ill.

	Symptom days	Days ill
OCTOBER	31x76=2356	1275= (54.1%)
NOVEMBER	30x76=2280	1389= (60.9%)
DECEMBER	31x76=2356	1350= (57.3%)
JANUARY	31x76=2356	1037= (44.0%)
FEBRUARY	28x76=2128	676= (31.7%)
MARCH	31x76=2356	812= (34.5%)
APRIL	30x76=2280	656= (28.8%)
MAY	31x76=2356	859= (36.5%)
JUNE	30x76=2280	961= (42.1%)
JULY	31x69=2139	831= (38.8%)
AUGUST	31x68=2108	980= (46.4%)
SEPTEMBER	30x62=1860	1001= (53.8%)
TOTAL	**26,855**	**11,827= (44.0%)**

Respondents were ill 44% of the time and more were ill during autumn and winter months. In other words on one of every two days a symptom was reported. This suggests that although respondents reported 1.5 symptoms on average per month these symptoms persisted for a long period of time. The number of days each symptom type persisted are presented in the table 3.3. As can be seen from the table fatigue accounted for the majority of symptom days (24.2%) followed by respiratory symptoms (15.6%), skin symptoms (15.1%) and mental health symptoms (13.2%). Skeletal-muscular symptoms and ENT symptoms accounted for approximately 10% of the total symptom days each. Eye symptoms accounted for approximately 5% of symptom days with gastrointestinal and 'other' symptoms accounting for approximately 3% of symptom days.

TABLE 7 The number of days each symptom type persisted over the year of the study

Symptom type	Symptom days
Respiratory	1848 (15.6%)
Eye	576 (4.9%)
Skin	1788 (15.1%)
ENT	1252 (10.6%)
Mental Health	1556 (13.2%)
Other	341 (2.9%)
Skeletal-Muscular	1297 (10.9%)
Gastrointestinal	306 (2.6%)
Fatigue	2863 (24.2%)
TOTAL	**11,827 (100%)**

In the next section the number of symptoms experienced by respondents over the year of the investigation are presented. The number and percentage of respondents who experienced symptoms are presented in the table below and the sum of symptoms is also presented. In October the sum of respiratory symptoms experienced by those with respiratory complaints was 30. As can be seen from table 3.4 the number of respiratory symptoms increased in November, December and January as did the number of respondents experiencing symptoms. In the following table the number of days symptoms persisted is presented. The number and percentage of those reporting symptoms is also reported again for ease of reading. The mean (SD) and range of days symptoms persisted is also presented as is the sum of days symptoms occurred. In October the average number of days respiratory symptoms occurred was 19 days (SD=12.2), ranging from 4 days to 31 days, that is, some respondents experienced respiratory symptoms for the whole month.

TABLE 8 The number of symptoms, broken into respiratory, eye, skin, ENT, mental health, other, skeletal muscular, gastrointestinal, and fatigue experienced by respondents over the year of the study (October to September).

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
RESP	N= 12, 16% Sum=30	N= 20, 26% Sum=31	N= 25, 33% Sum=40	N= 26, 34% Sum=36	N= 17, 22% Sum=23	N= 10, 13% Sum=16	N= 11, 15% Sum=14	N= 11, 15% Sum=12	N= 11, 15% Sum=13	N= 8, 12% Sum=13	N= 8, 12% Sum=18	N= 12, 19% Sum=18
EYE	N= 9, 12% Sum=10	N= 9, 12% Sum=15	N= 13, 17% Sum=18	N= 2, 3% Sum=2	N= 4, 5% Sum=4	N= 13, 17% Sum=13	N= 5, 7% Sum=5	N= 6, 8% Sum=6	N= 8, 11% Sum=8	N= 8, 12% Sum=8	N= 9, 13% Sum=9	N= 9, 15% Sum=9
SKIN	N= 10, 13% Sum=15	N= 9, 12% Sum=9	N= 6, 8% Sum=21	N= 11, 15% Sum=21	N= 7, 9% Sum=14	N= 8, 11% Sum=18	N= 12, 16% Sum=28	N= 11, 15% Sum=11	N= 11, 15% Sum=11	N= 8, 12% Sum=8	N= 7, 10% Sum=11	N= 5, 8% Sum=9
ENT	N= 20, 26% Sum=31	N= 17, 22% Sum=25	N= 16, 21% Sum=27	N= 16, 21% Sum=16	N= 14, 18% Sum=16	N= 17, 22% Sum=26	N= 14, 18% Sum=19	N= 9, 12% Sum=11	N= 12, 16% Sum=16	N= 9, 13% Sum=10	N= 14, 21% Sum=14	N= 11, 18% Sum=11
MH	N= 13, 17% Sum=19	N= 13, 17% Sum=24	N= 10, 13% Sum=11	N= 12, 16% Sum=14	N= 4, 5% Sum=5	N= 2, 3% Sum=2	N= 7, 9% Sum=7	N= 8, 11% Sum=8	N= 12, 16% Sum=12	N= 11, 16% Sum=11	N= 13, 19% Sum=13	N= 13, 21% Sum=14
OTHER	N= 12, 16% Sum=12	N= 3, 4% Sum=3	N= 3, 4% Sum=30	N= 6, 8% Sum=6	N= 4, 5% Sum=5	N= 4, 5% Sum=4	N= 4, 5% Sum=4	N= 2, 3% Sum=2	N= 2, 3% Sum=2	N= 1, 1% Sum=1	N= 1, 2% Sum=1	N= 5, 8% Sum=5
SM	N= 11, 15% Sum=23	N= 11, 15% Sum=18	N= 8, 11% Sum=10	N= 8, 11% Sum=13	N= 12, 16% Sum=18	N=9, 12% Sum=9	N= 1, 1% Sum=1	N= 6, 8% Sum=7	N= 5, 7% Sum=10	N= 6, 9% Sum=11	N= 13, 19% Sum=13	N= 4, 7% Sum=4
GI	N= 13, 17% Sum=13	N= 10, 13% Sum=11	N= 12, 16% Sum=14	N= 7, 9% Sum=8	N= 1, 1% Sum=1	N= 10, 13% Sum=11	N= 5, 7% Sum=5	N= 2, 3% Sum=2	N= 4, 5% Sum=5	N= 2, 3% Sum=2	N= 8, 12% Sum=9	N= 6, 10% Sum=7
FATIG	N= 19, 25% Sum=19	N= 16, 21% Sum=16	N= 15, 20% Sum=15	N= 18, 24% Sum=18	N= 11, 15% Sum=11	N= 14, 18% Sum=14	N= 12, 16% Sum=12	N= 14, 18% Sum=14	N= 12, 16% Sum=12	N= 9, 13% Sum=9	N= 15, 22% Sum=15	N= 15, 24% Sum=15

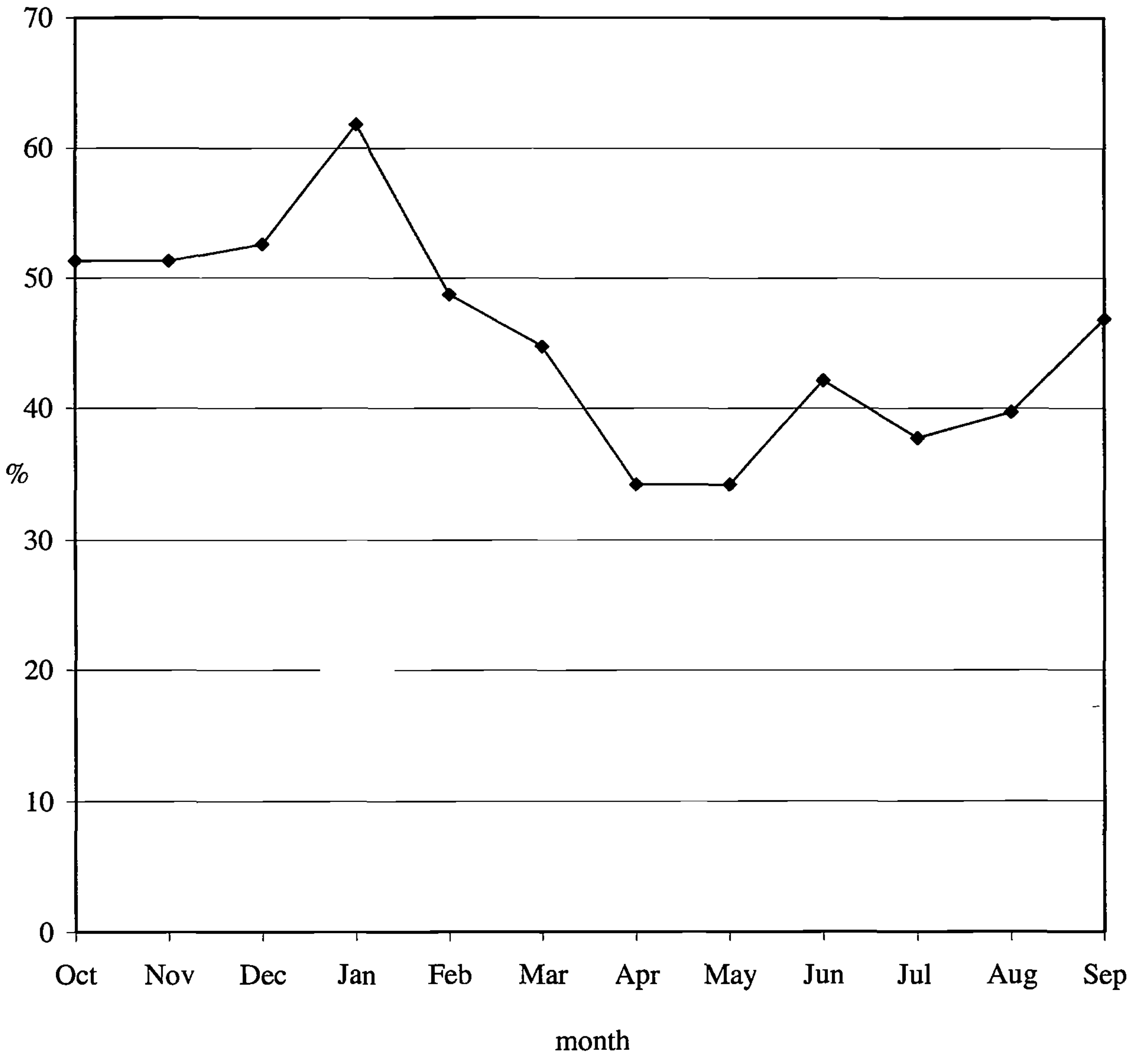
TABLE 9 The number of days symptoms persisted, broken into respiratory, eye, skin, ENT, mental health, other, skeletal muscular, gastrointestinal, and fatigue over the year of the study (October to September).

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
RESP	Mean 19.5 SD=12.2 Range=4-31 Sum=234 N=12, 16%	Mean 11.2 SD=12.3 Range=1-30 Sum=224 N=20, 26 %	Mean 10.6 SD=11.0 Range=1-31 Sum=267 N=25, 33 %	Mean 7.0 SD=5.3 Range=1-19 Sum=183 N=26, 34%	Mean 4.8 SD=2.4 Range=2-10 Sum=82 N=17, 22%	Mean 13.8 SD=7.5 Range=1-20 Sum=138 N=10, 13%	Mean 4.5 SD=2.6 Range=1-9 Sum=49 N=11, 15%	Mean 9.3 SD=4.6 Range=1-13 Sum=102 N=11, 15%	Mean 9.6 SD=8.2 Range=1-18 Sum=106 N=11, 15%	Mean 14.9 SD=7.6 Range=2-28 Sum=119 N=8, 12%	Mean 21.5 SD=13.5 Range=1-31 Sum=172 N=8, 12%	Mean 14.3 SD=14.0 Range=1-30 Sum=172 N=12, 19%
EYE	Mean3.1 SD=3.0 Range=1-11 Sum=28 N=9, 12%	Mean 5.6 SD=2.5 Range=2-8 Sum=50 N=9, 12%	Mean 4.8 SD=3.7 Range=1-9 Sum=62 N=13,17%	Mean 4.0 SD=2.8 Range=2-6 Sum=8 N=2, 3%	Mean 2.8 SD=1.7 Range=1-5 Sum=11 N=4, 5%	Mean 6.2 SD=5.7 Range=1-13 Sum=81 N=13, 17%	Mean8.0 SD=0.0 Range=8-8 Sum=40 N=5, 7%	Mean 11.0 SD=2.4 Range=6-12 Sum=66 N=6, 8%	Mean 8 4 SD=3.7 Range=2-11 Sum=67 N=8, 11%	Mean 5.5 SD=2.8 Range=1-11 Sum=44 N=8, 12%	Mean6.3 SD=3.0 Range=3-14 Sum=57 N=9, 13%	Mean6.9 SD=8.8 Range=1-30 Sum=62 N=9, 15%
SKIN	Mean8.6 SD=5.4 Range=1-15 Sum=86 N=10, 13%	Mean17.6 SD=11.4 Range=1-27 Sum=158 N=9, 12%	Mean27.8 SD=7.8 Range12-31 Sum=167 N=6, 8%	Mean16.3 SD=14.8 Range=1-31 Sum=179 N=11, 15%	Mean23.1 SD=8.8 Range=6-28 Sum=162 N=7, 9%	Mean19.9 SD=15.4 Range=1-31 Sum=159 N=8, 11%	Mean14.7 SD=13.8 Range=2-30 Sum=176 N=12, 16%	Mean14 8 SD=14.7 Range=1-30 Sum=163 N=11, 15%	Mean16.5 SD=13.8 Range=1-30 Sum=181 N=11, 15%	Mean18.5 SD=13.8 Range=1-31 Sum=148 N=8, 12%	Mean11.6 SD=6.8 Range=3-17 Sum=81 N=7, 11%	Mean25.6 SD=9.8 Range=8-30 Sum=128 N=5, 8%
ENT	Mean6.9 SD=7.3 Range=1-31 Sum=138 N=20, 26%	Mean14.0 SD=12.9 Range=1-31 Sum=238 N=17, 22%	Mean16.2 SD=11.9 Range=2-31 Sum=259 N=16, 21%	Mean3.2 SD=2.3 Range=1-10 Sum=51 N=16, 21%	Mean3.5 SD=1.5 Range=1-5 Sum=49 N=14, 18%	Mean7.5 SD=8.0 Range=1-19 Sum=127 N=17, 22%	Mean2.4 SD=0.6 Range=1-3 Sum=33 N=14,18%	Mean9.7 SD=4 8 Range=1-16 Sum=87 N=9, 12%	Mean7.3 SD=4.2 Range=1-12 Sum=87 N=12, 16%	Mean2.1 SD=1.8 Range=1-6 Sum=19 N=9, 13%	Mean5.1 SD=3.8 Range=1-17 Sum=72 N=14, 21%	Mean8.4 SD=6.1 Range=2-16 Sum=92 N=11, 18%
MH	Mean13.9 SD=14.2 Range=1-31 Sum=181 N=13, 17%	Mean11.5 SD=9.7 Range=1-24 Sum=150 N=13, 17%	Mean16.1 SD=14 7 Range=1-30 Sum=161 N=10, 13%	Mean6.6 SD=4.9 Range=1-12 Sum=79 N=12, 16%	Mean2.0 SD=1.4 Range=1-4 Sum=8 N=4, 5%	Mean2.0 SD=1 4 Range=1-3 Sum=4 N=2, 3%	Mean21.9 SD=13.9 Range=1-30 Sum=153 N=7, 9%	Mean21.0 SD=13.8 Range=2-31 Sum=168 N=8, 11%	Mean13 8 SD=14 4 Range=1-30 Sum=165 N=12, 16%	Mean14.1 SD=14.0 Range=1-31 Sum=155 N=11, 16%	Mean12.3 SD=13.5 Range=1-31 Sum=160 N=13, 19%	Mean13 2 SD=13.8 Range=1-30 Sum=172 N=13, 21%
OTHER	Mean7.4 SD=11.8 Range=1-31	Mean1.0 SD=0.0 Range=1-1	Mean18.5 SD=17.7 Range=6-31	Mean8.2 SD=12.0 Range=1-31	Mean9.5 SD=12.4 Range=2-28	Mean3.5 SD=3.8 Range=1-9	Mean4 3 SD=4 6 Range=1-11	Mean4.5 SD=0.7 Range=4-5	Mean4.0 SD=4.2 Range=1-7	Mean7.0 SD=0.0 Range=7-7	Mean10.0 SD=0.0 Range=10	Mean13.6 SD=5.4 Range=4-16

	Sum=81 N=12, 16%	Sum=3 N=3, 4%	Sum=37 N=3, 4%	Sum=49 N=6, 8%	Sum=38 N=4, 5%	Sum=14 N=4, 5%	Sum=17 N=4, 5%	Sum=9 N=2, 3%	Sum=8 N=2, 3%	Sum=7 N=1, 1%	Sum=10 N=1, 2%	Sum=68 N=5, 8%
SM	Mean18.9 SD=14.1 Range=1-31 Sum=208 N=11, 15%	Mean17.5 SD=12.2 Range=1-30 Sum=193 N=11, 15%	Mean4.4 SD=3 3 Range=1-11 Sum=35 N=8, 11%	Mean17.6 SD=8.9 Range=1-23 Sum=141 N=8, 11%	Mean13.3 SD=10.2 Range=1-24 Sum=159 N=12, 16%	Mean10.4 SD=6.8 Range=1-19 Sum=94 N=9, 12%	Mean1.0 SD=0.0 Range=1-1 Sum=1 N=1, 1%	Mean10.2 SD=2.0 Range=6-11 Sum=61 N=6, 8%	Mean30.0 SD=0.0 Range=30 Sum=150 N=5, 7%	Mean23.3 SD=12.3 Range=3-31 Sum=140 N=6, 8%	Mean4.8 SD=3.8 Range=3-15 Sum=63 N=13, 19%	Mean13.0 SD=13.6 Range=2-30 Sum=52 N=4, 7%
GI	Mean4.7 SD=3.1 Range=1-11 Sum=61 N=13, 17%	Mean3 8 SD=6.1 Range=1-21 Sum=38 N=10, 13%	Mean2.5 SD=2.5 Range=1-8 Sum=30 N=12, 16%	Mean2.0 SD=1.4 Range=1-4 Sum=14 N=7, 9%	Mean5.0 SD=0.0 Range=5-5 Sum=5 N=1, 1%	Mean2.1 SD=1.1 Range=1-4 Sum=21 N=10, 13%	Mean1.4 SD=0.5 Range=1-2 Sum=7 N=5, 7%	Mean3.0 SD=0.0 Range=3-3 Sum=6 N=2, 3%	Mean3.0 SD=2.3 Range=1-5 Sum=12 N=4, 5%	Mean3.0 SD=0.0 Range=3-3 Sum=6 N=2, 3%	Mean8.1 SD=6.3 Range=2-14 Sum=65 N=8, 12%	Mean6.8 SD=11.4 Range=1-30 Sum=41 N=6, 10%
FATIG	Mean13 6 SD=11.6 Range=1-31 Sum=258 N=19, 25%	Mean21.0 SD=11.4 Range=2-31 Sum=335 N=16, 21%	Mean22.1 SD=13.0 Range=2-31 Sum=332 N=15, 20%	Mean18.5 SD=14.4 Range=1-31 Sum=333 N=18, 24%	Mean14.7 SD=12.8 Range=1-28 Sum=162 N=11, 15%	Mean12.4 SD=14.4 Range=1-31 Sum=174 N=14, 18%	Mean15.0 SD=13.5 Range=2-30 Sum=180 N=12, 16%	Mean14.1 SD=9.7 Range=1-25 Sum=197 N=14, 18%	Mean15 4 SD=13.2 Range=1-30 Sum=185 N=12,16%	Mean21.4 SD=12.0 Range=3-31 Sum=193 N=9, 13%	Mean20.0 SD=12.5 Range=1-31 Sum=300 N=15, 22%	Mean14.3 SD=10.8 Range=3-30 Sum=214 N=15, 24%

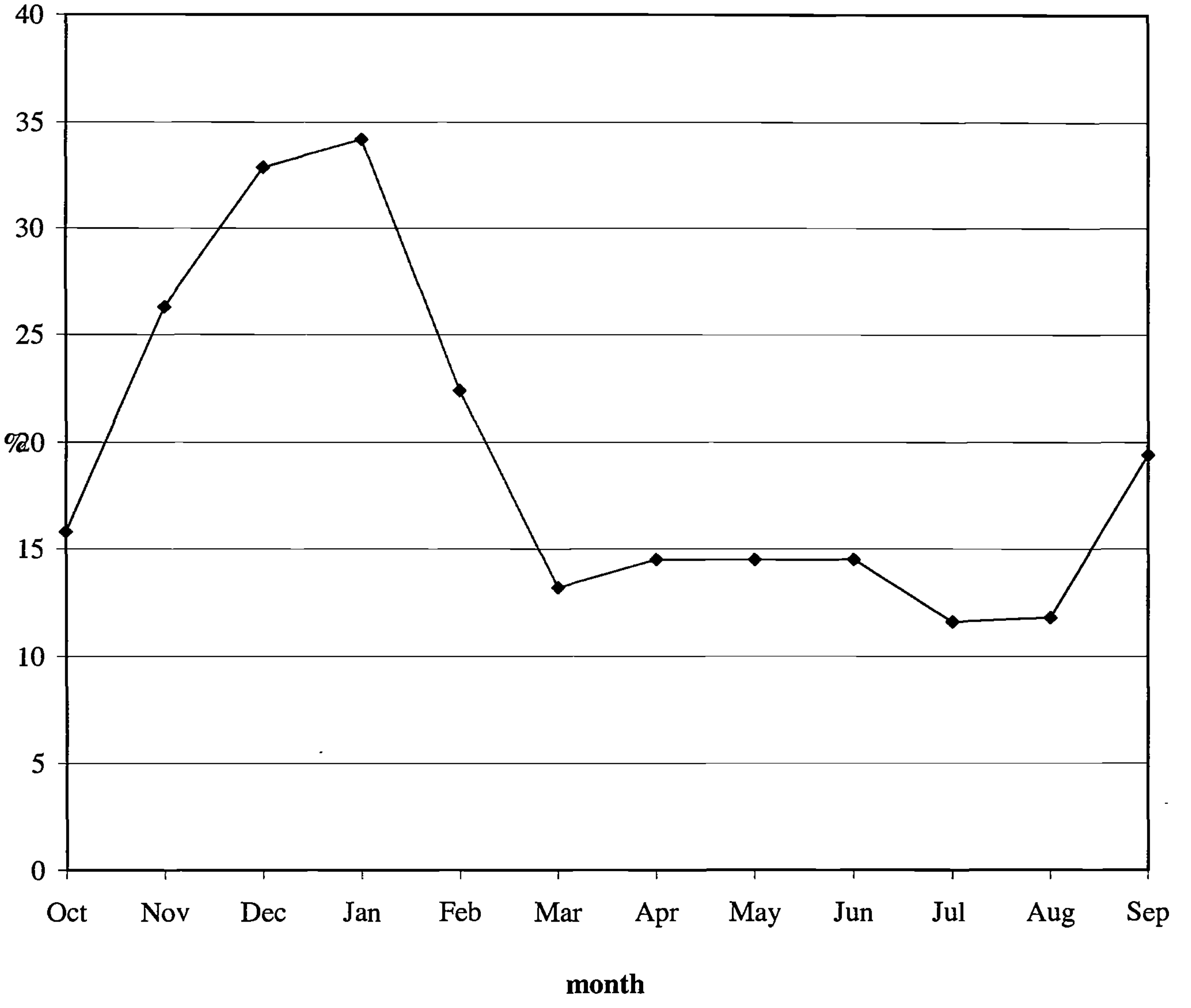
The percentage of respondents reporting symptoms over the course of the study and the percentage of respondents reporting each symptom type is presented in the next series of graphs. The percentage of respondents who experienced any symptom over the year of the study are presented in the following graph. The percentage of respondents who reported a health symptom varies throughout the twelve months.

Figure 4 Percentage of respondents who reported a health symptom throughout the year of investigation



Approximately half of all the respondents experienced symptoms in the first three months of the study (October through to December) increasing to and peaking at 62% in January. The percentage of respondents reporting symptoms was lowest in the months of April and May (34%).
The percentage of respondents who reported respiratory symptoms are reported in the figure below. As can be seen from the graph respiratory symptoms began to increase in November with 26% of all respondents reporting symptoms.

Figure 5 Percentage of respondents who reported respiratory symptoms throughout the year of investigation



In December and January approximately one third of respondents (N=25, 33%) reported respiratory ailments. The number of individuals reporting symptoms declined and stabilised at this lower level during the Summer months. September saw an increase in the number of individuals reporting respiratory symptoms (N=12, 19.4%). The exact findings are presented in Table 8.

The percentage of respondents reporting eye symptoms are presented in the graph below. Reports of eye symptoms peaked in December and March (N=13, 17.1%) with a rather erratic drop in January and February where two and four persons respectively reported eye symptoms.

Figure 6 Percentage of respondents who reported eye symptoms throughout the year of investigation

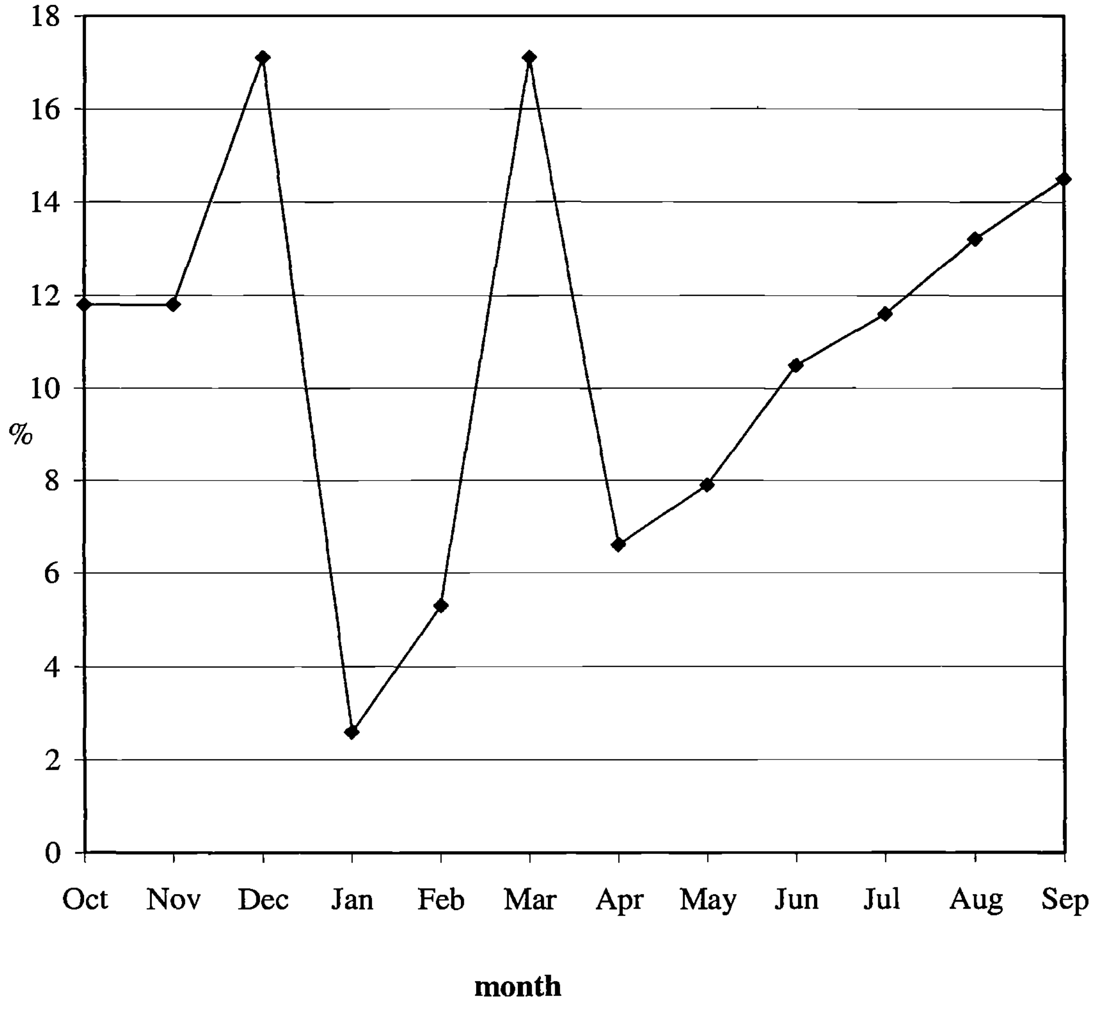
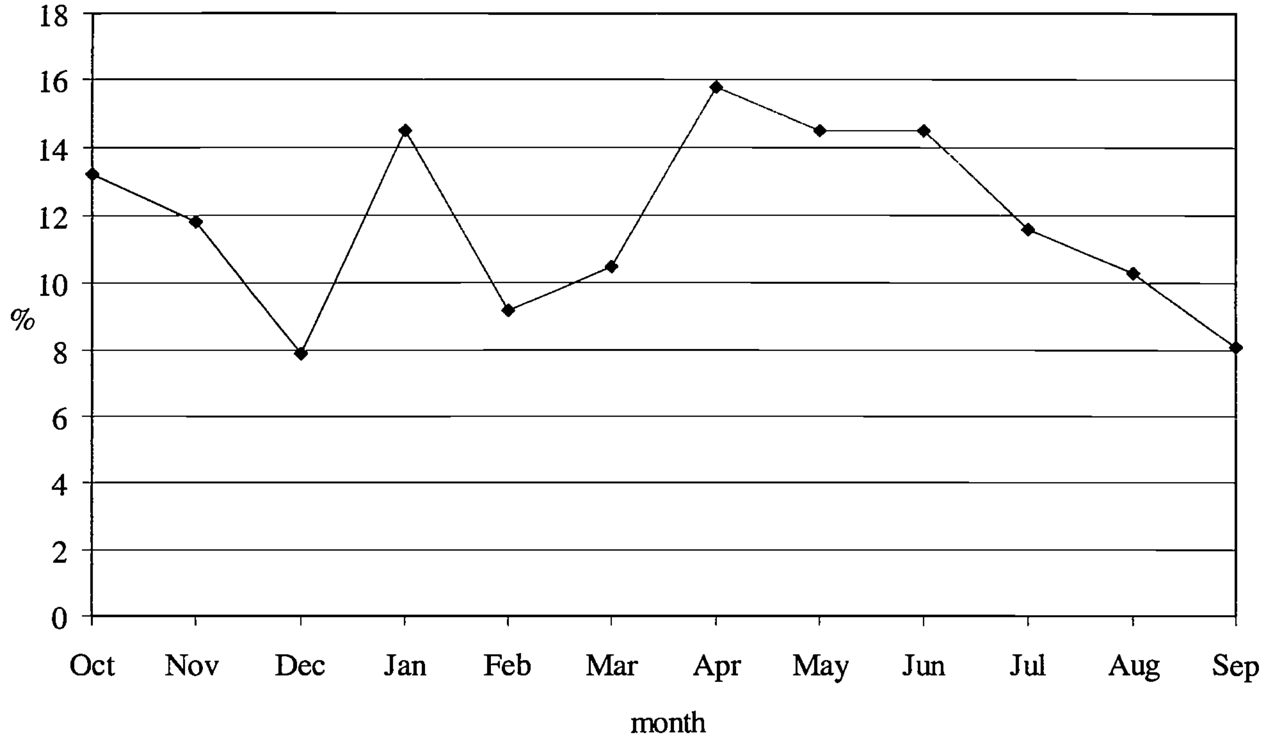


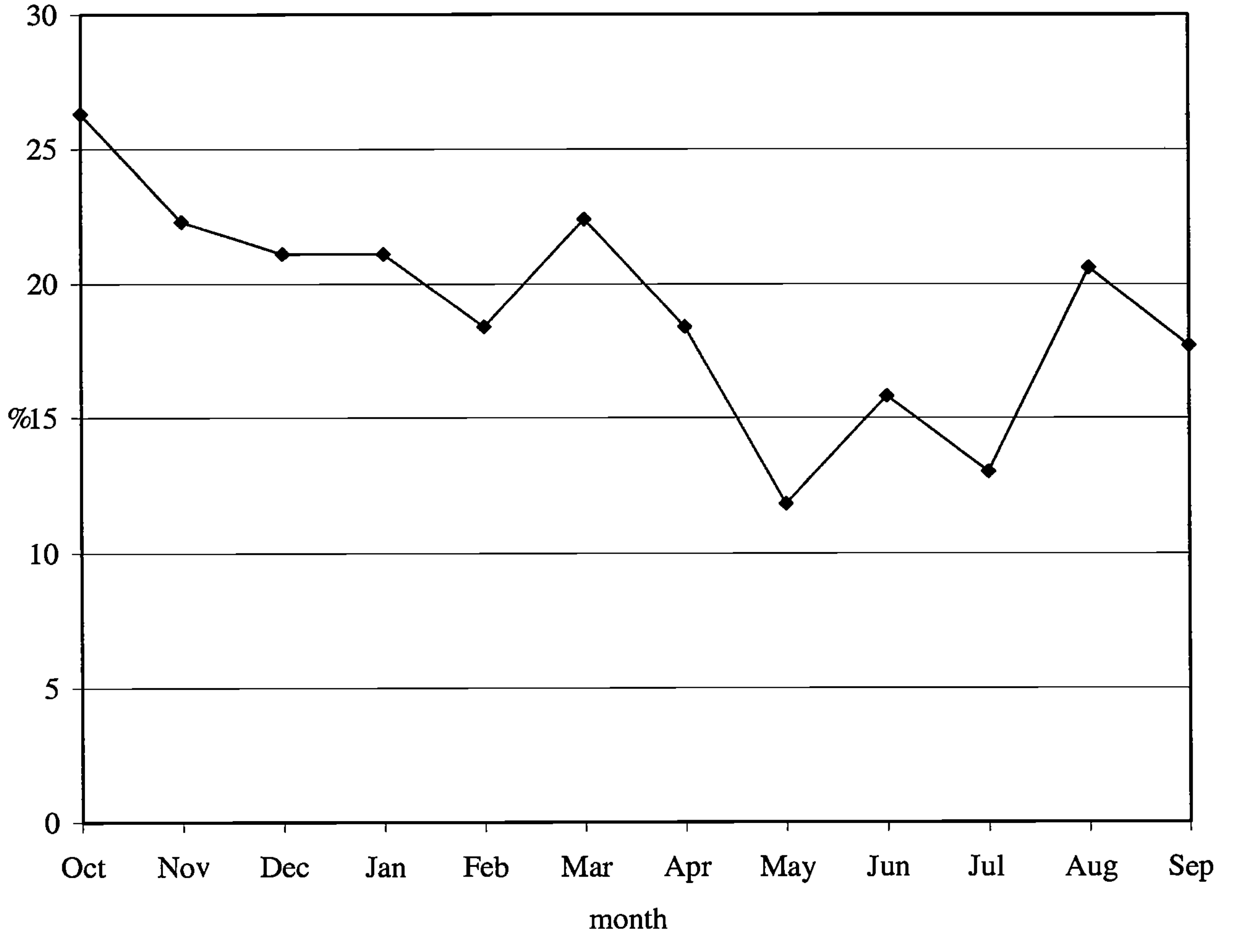
Figure 7 Percentage of respondents who reported skin symptoms throughout the year of investigaton.



The number reporting eye symptoms started to increase again during the Summer months and continued to rise with between six and nine persons complaining of eye symptoms. The number of individuals reporting skin problems, presented in the following graph, was somewhat more consistent peaking in late Spring where 12 respondents (15.8%) reported skin problems. The fewest number of skin ailments were reported in December (N=6, 7.9%).

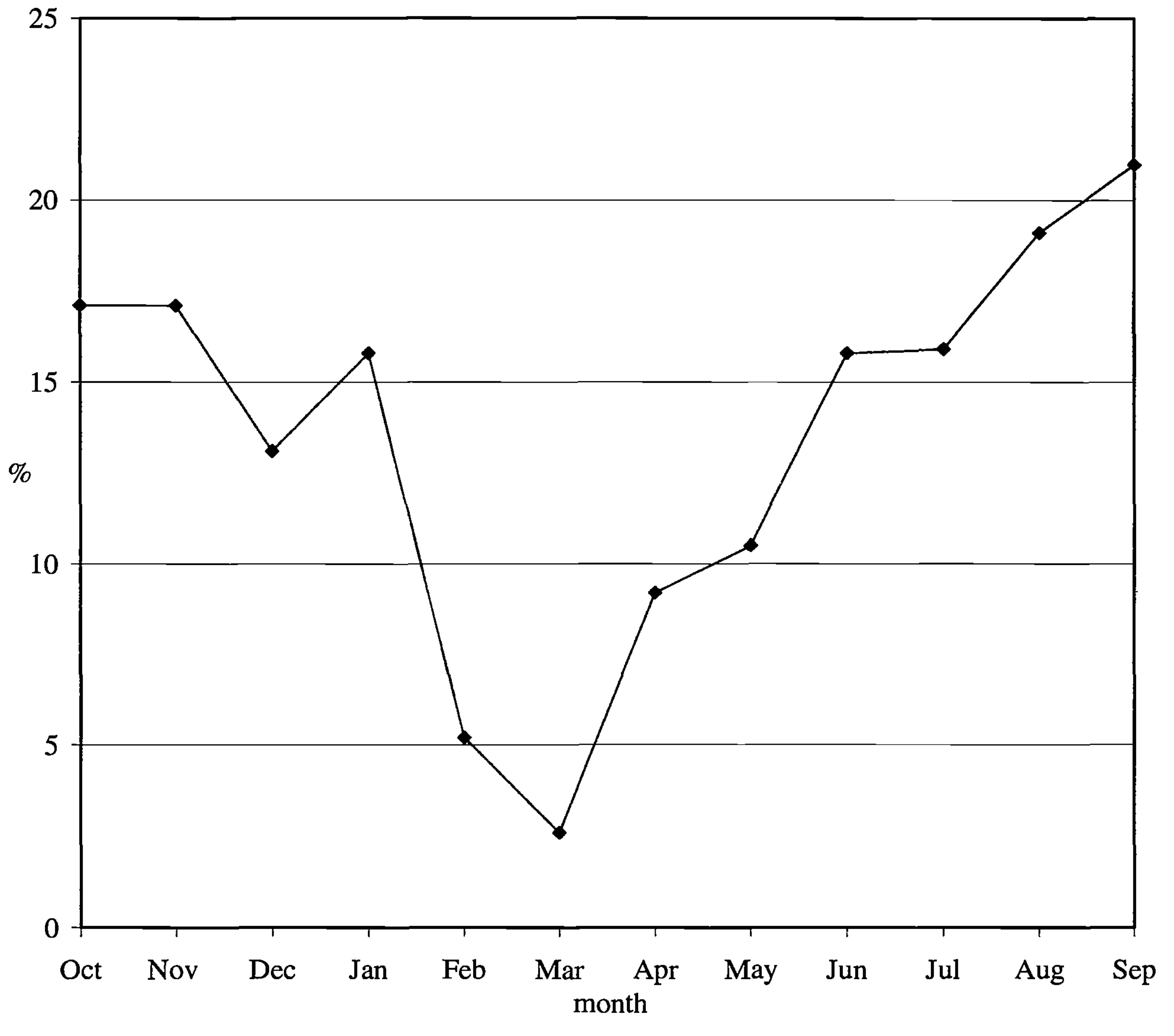
The pattern of respondents reporting ear, nose and throat symptoms was relatively consistent over the year of investigation. The most symptoms were reported in October (N=20, 26.3%) while the fewest were reported in May (N=9, 11.8%).

Figure 8 Percentage of respondents who reported ear nose and throat symptoms throughout the year of investigation



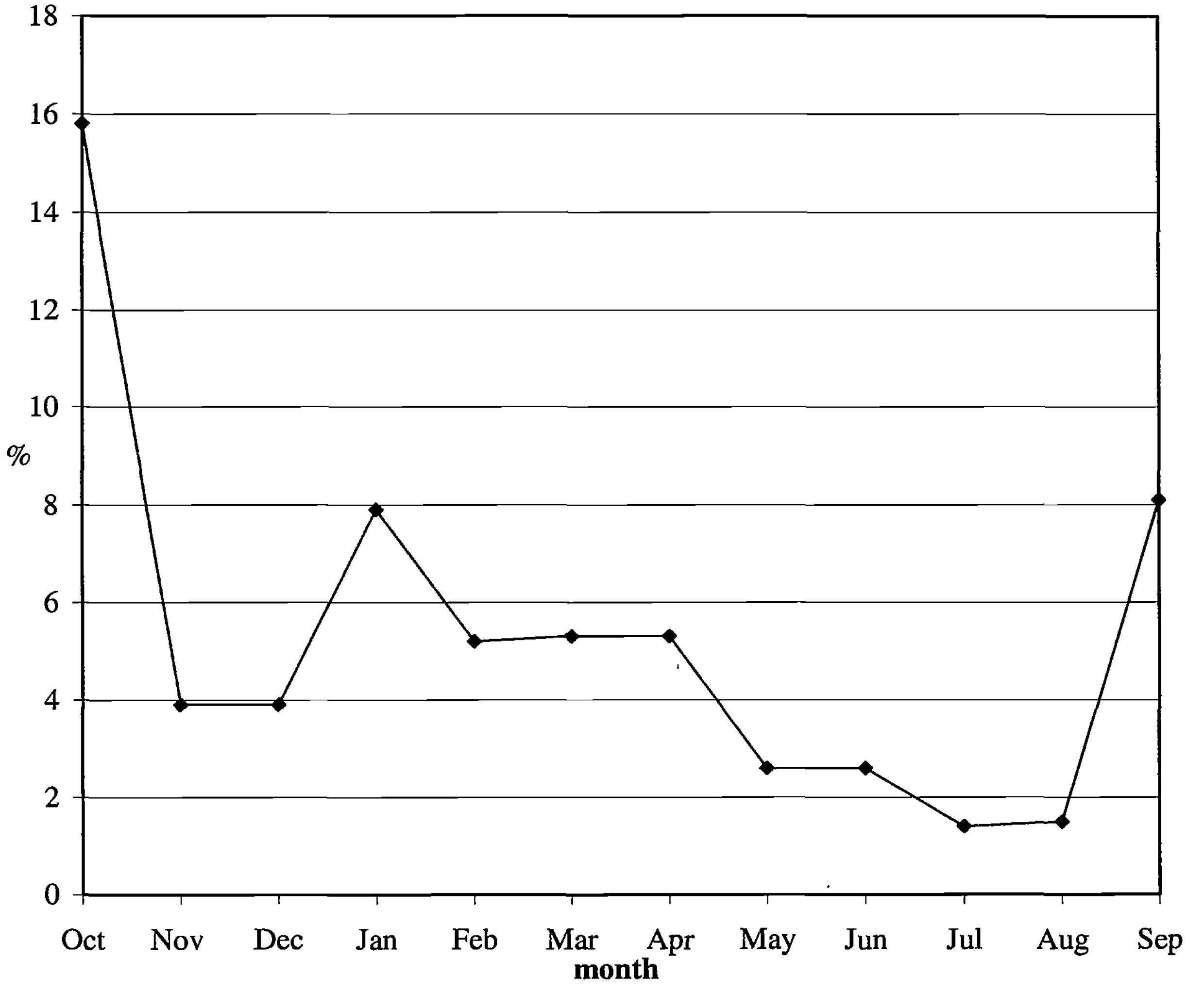
The pattern of mental health symptoms are reported in the graph below. As can be seen from the graph the pattern of respondents reporting symptoms is very erratic with only two persons (2.6%) reporting mental health symptoms in March. In April the number of persons reporting symptoms began to increase (N=7, 9.2%). The pattern of 'other' symptoms reported is discussed next.

Figure 9 Percentage of respondents who reported mental health symptoms throughout the year of investigation.



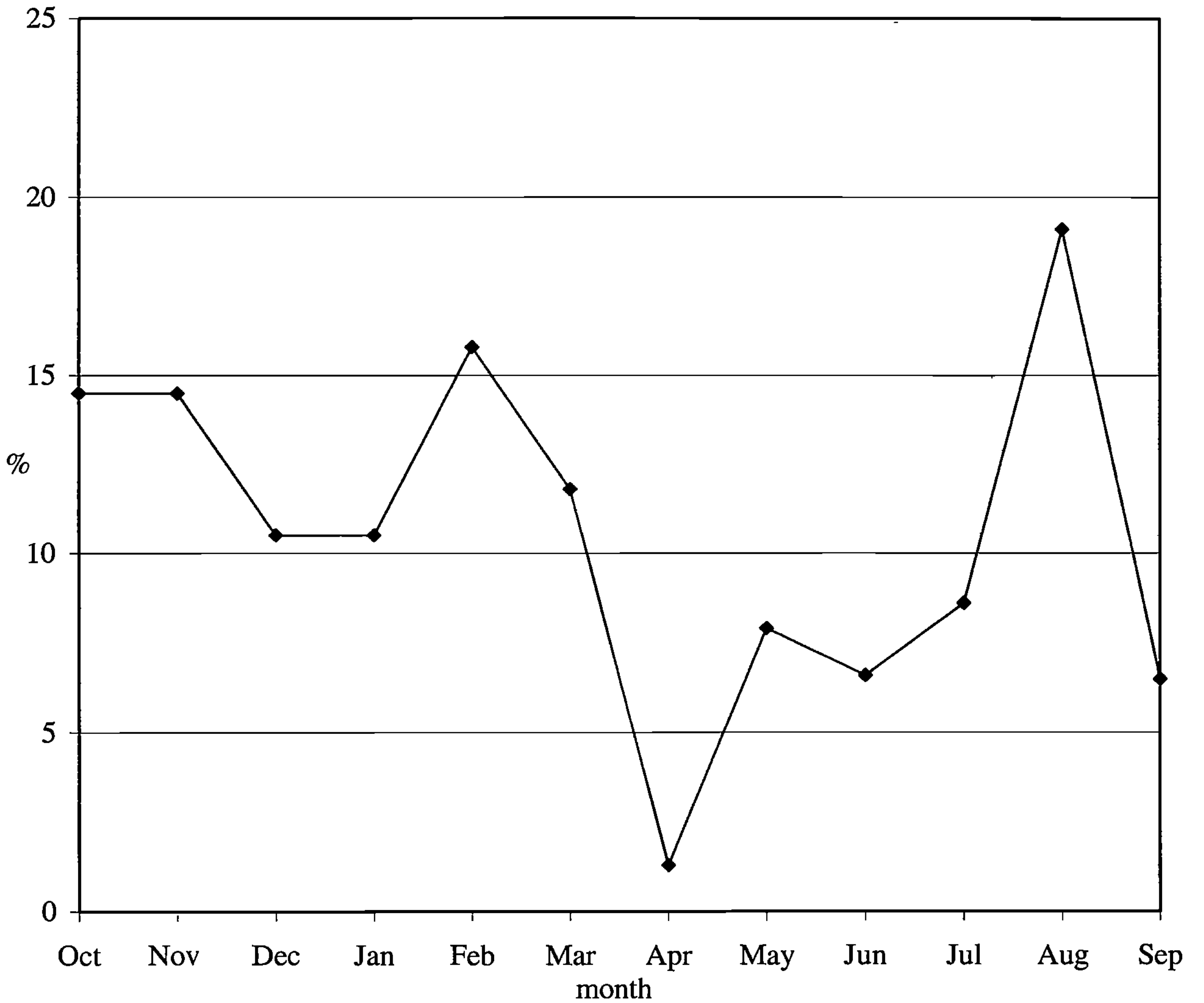
The number of 'other' symptoms reported is very low with between one person and five persons on average reporting other symptoms. In October, the first month of the study, 12 persons (15.8%) reported other symptoms.

Figure 10 Percentage of respondents who reported other symptoms throughout the year of investigation.



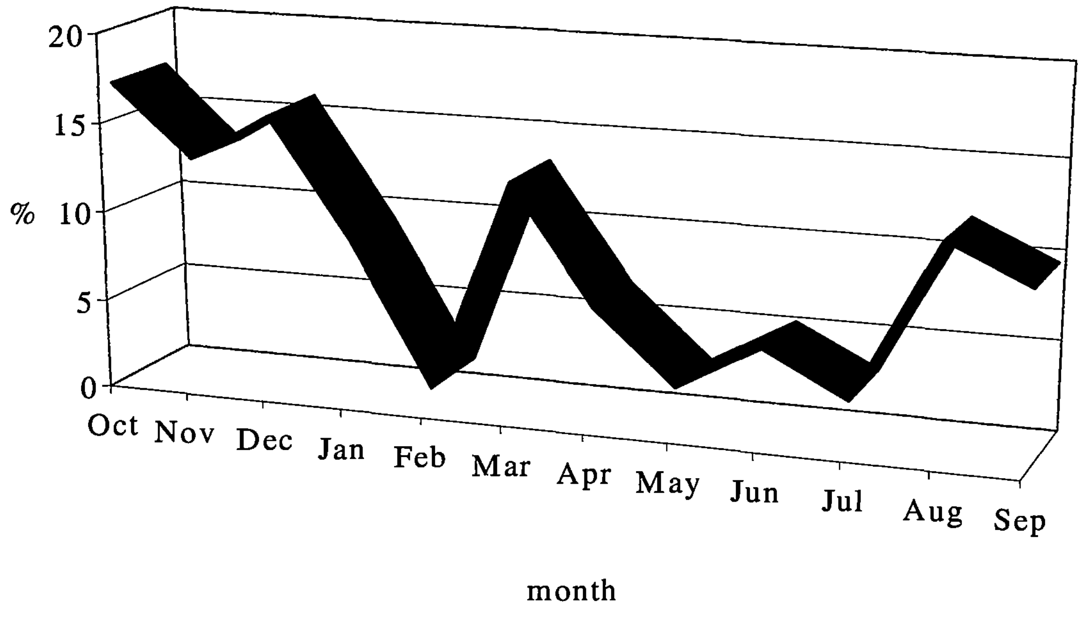
The number of respondents reporting skeletal-muscular symptoms are reported in the graph below. The pattern of symptoms is somewhat random with only one person reporting a symptom in April. The highest number of symptoms were reported in August where 13 persons (19.1%) reported skeletal-muscular symptoms. However this dropped to four persons (6.5%) in September.

Figure 11 Percentage of respondents who reported skeletal-muscular symptoms throughout the year of investigation



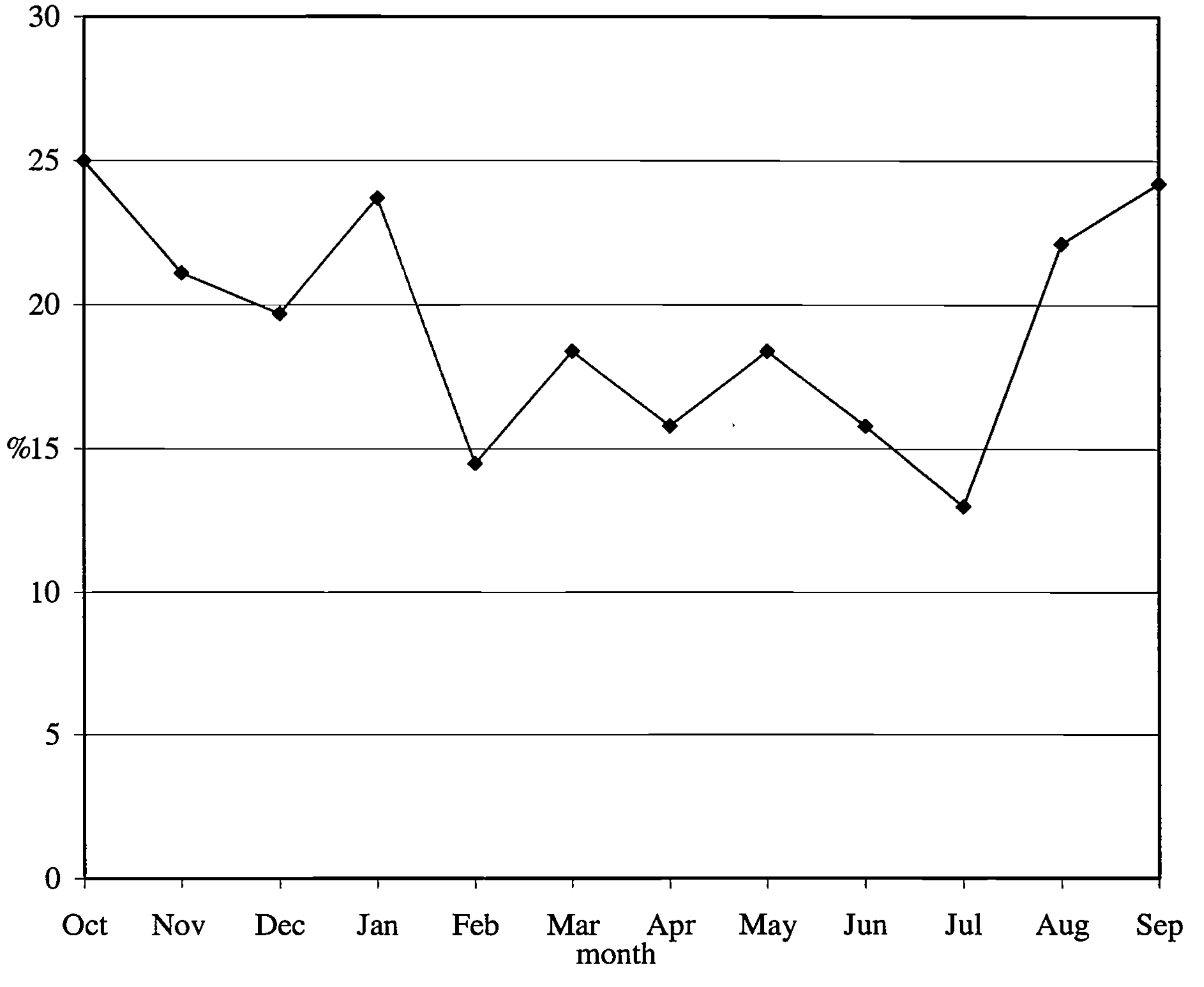
The pattern of respondents reporting gastrointestinal symptoms are presented in the graph below. One person reported a symptom in February while the majority were reported in October (N=13, 17.1%), December (N=12, 15.8%) and March (N=10, 13.1%). As can be seen from the graph the pattern is somewhat random.

Figure 12 Percentage of respondents who reported gastro intestinal throughout the year of investigation.



The number of individuals reporting fatigue symptoms are presented in the following graph. After respiratory and ear, nose and throat symptoms fatigue is most commonly reported symptom. The highest number of respondents to report fatigue (N=19, 25%) was in October. A similar number reported fatigue in January (N=18, 23.7%) and September (N=15, 24.2%). The fewest reports of fatigue were in February (N=11, 14.5%) and April (N=12, 15.8%).

Figure 13 Percentage of respondents who reported fatigue symptoms throughout the year of investigation.



Summary of morbidity symptoms reported for one year

Approximately one half of the respondents in the study experienced symptoms in the first three months of the study (October to December) peaking in January where 62% of the respondents reported a symptom. A total of 34% of respondents reported a symptom in April and May, however, the number of respondents reporting health symptoms increased again in September, the final month of the study.

Reports of respiratory symptoms peaked in the winter months and approximately one third of all respondents (N=25) reported respiratory symptoms in November and December. The numbers reporting respiratory symptoms declined in the Summer months where approximately 14% of respondents (N=11) reported symptoms. In September, the final month of the study, there was an increase in the numbers (N=12, 19.4%) reporting respiratory symptoms. The highest percentage of respondents reporting eye symptoms at any one time was 17.1% (N=13) in December and March. The lowest percentage of respondents with eye complaints was 2.6% (N=2) in the month of January. The number of eye symptoms reported increased again during the Summer months with between six and nine persons experiencing eye problems. The pattern of eye symptoms reported was quite erratic in the initial stages of the study, stabilising in the later stages. The greatest number of respondents reporting skin symptoms at any one time was 15.8% (N=12) dropping to a low of

7.9% (N=6). Overall, the percentage of respondents reporting skin symptoms remained relatively consistent throughout the year at approximately 12% (N=9).

As with respiratory symptoms reports of ENT symptoms peaked in the winter months and most were reported in October (N=20, 26.3%) while the least amount of symptoms were reported in May (N=9, 11.8%). On average 19% (N=14) reported ENT symptoms at any one time. The pattern of symptom reports remained relatively consistent over the year. The pattern of mental health symptoms was erratic initially but increased steadily from March where only two persons (2.6%) reported symptoms compared to September where 21% (N=13) reported mental health symptoms. Overall, reports of 'other' symptoms were very low. In October, the first month of the study, 15.8% (N=12) reported 'other' symptoms. However, for the rest of the year between one and five persons reported 'other' symptoms. The highest number of respondents reporting skeletal-muscular symptoms at any one time was 19% (N=13) while the lowest number reporting skeletal-muscular symptoms was 1 person in April. On average 10% (N=7) reported skeletal-muscular symptoms throughout the year of investigation. The pattern of respondents reporting gastrointestinal symptoms was irregular. Only one person reported a symptom in February while the greatest number reporting gastrointestinal symptoms at any one time was 17.1% (N=13).
After respiratory and ENT symptoms fatigue was the most commonly reported symptom. The highest number of respondents reporting feeling fatigued at any one time was 25% (N=19) in the first month of the study. The fewest number to report fatigue symptoms was 13% (N=9). On average, throughout the year of investigation, 19% (N=15) of respondents reported fatigue.

Conclusion of morbidity symptoms reported for one year

- A total of 1353 separate symptom episodes were reported by all the participants
- 18 symptom episodes over the year or 1.5 symptom episodes per month
- Days in the year when the respondents were ill was 11,827 symptom days
- For one day in every two a respondent recorded a symptom
- Respondents recorded a symptom for an average of 158 days during the year
- Respondents recorded a symptom for an average of 13 days for each month
- Approximately one-half of the respondents recorded symptoms of poor health in the first three months of the study (October to December)
- Reports of respiratory and ENT symptoms peaked in the Winter months
- Reports of eye, skin, mental health, 'other', skeletal-muscular and gastrointestinal symptoms varied greatly throughout the 12 months of the study
- Respiratory, ENT and fatigue were the most commonly reported symptoms

Explainable symptoms removed from Analysis

A more detailed examination of the results revealed that some ailments were attributed to the time of the year, for example, winter colds. In addition contact with other children, past injuries, accidents on the farm and sports accidents were also reported as causes of symptoms. It was decided to remove these symptoms from the analysis and include symptoms related to environmental causes according to the respondents. In situations where causes were not known or where no cause was identified data was still included in the analyses. When explainable symptoms were removed the number of symptoms reported were reduced from 1353 symptoms to 1234 symptoms. On average each respondent recorded 16 symptoms over the year of the study (or 1.3 symptoms per month) when explainable symptoms were removed from the analyses compared with 18 symptoms when all symptoms were included in the analyses. The number of symptoms reported for each symptom type with explainable symptoms removed are presented in the following table. The initial findings are also presented for comparison purposes.

TABLE 10 The number (%) of symptoms reported by respondents over the year of the study and the number (%) of symptoms reported with *explainable symptoms* removed.

Resp	Eye	Skin	ENT	MH	Other	SM	GI	Fatigue	Total
264 **19.5%**	107 **7.9%**	176 **13%**	222 **16.4%**	140 **10.3%**	49 **3.6%**	137 **10.1%**	88 **6.5%**	170 **12.6%**	**1353** **100%**
Symptoms removed									
224 **18.0%**	104 **8.4%**	175 **14.1%**	206 **16.6%**	136 **11.7%**	31 **2.5%**	128 **10.3%**	61 **4.9%**	169 **13.5%**	**1234** **100%**

The overall pattern of findings for each symptom type was consistent with the initial findings. There were very little changes for eye, skin and fatigue symptoms. Reports of respiratory, ENT, gastrointestinal and 'other' symptoms were noticeably reduced when *explainable symptoms* were removed from the analyses. The number of days symptoms persisted also declined from 11,827 symptom days to 11,345 symptom days or 42% of total symptom days. The number of days each symptom persisted are presented in the following table. The initial findings are also presented for comparison purposes. There was very little change regarding the duration of symptoms of fatigue. The number of symptom days for all of the other symptom types decreased especially so for respiratory, gastrointestinal, skeletal-muscular and 'other' symptoms.

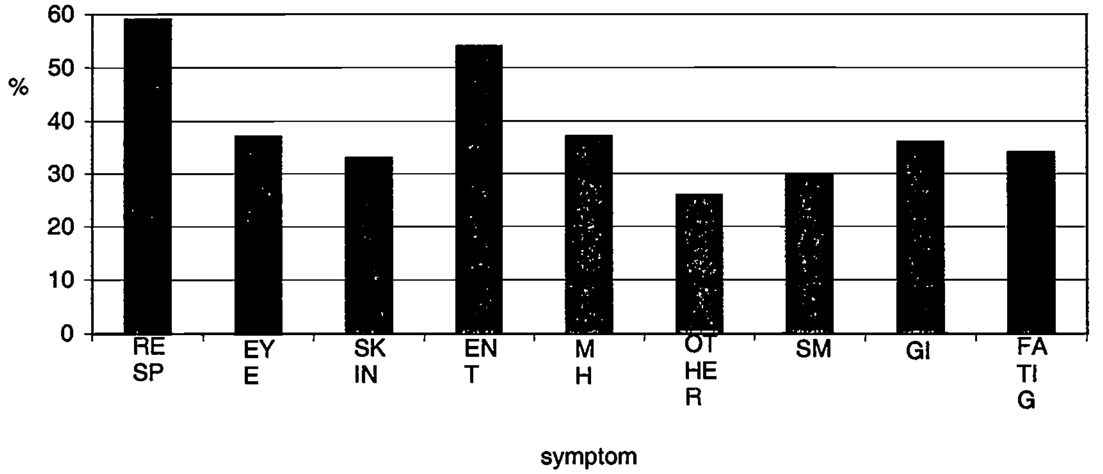
TABLE 11 The number of days each symptom type persisted over the year of the study compared with the number of days symptoms persisted *with explainable symptoms* removed.

Symptom type	**Symptom days**	***Explainable symptoms* removed**
Respiratory	1848 (15.6%)	1660 (14.6%)
Eye	576 (4.9%)	568 (5.0%)
Skin	1788 (15.1%)	1787 (15.8%)
ENT	1252 (10.6%)	1212 (10.7%)
Mental Health	1556 (13.2%)	1546 (13.6%)
Other	341 (2.9%)	289 (2.5%)
Skeletal-Muscular	1297 (10.9%)	1222 (10.8%)
Gastrointestinal	306 (2.6%)	199 (1.8%)
Fatigue	2863 (24.2%)	2862 (25.2%)
TOTAL	**11,827 (100%)**	**11,345 (100%)**

The numbers of respondents reporting symptoms also changed. The number reporting respiratory symptoms dropped from 72% to 59%. The number of respondents reporting ENT symptoms dropped slightly and the number of gastrointestinal symptoms dropped from 50% to 36%. The number of respondents reporting other symptoms also dropped from 34% to 26% when explainable symptoms were removed. These findings are presented in the graph below.
The exact numbers and percentages of symptoms experienced by subjects with the 'explainable symptoms removed' are presented in the table below and the average number of days symptoms persisted with 'explainable symptoms removed' are presented in the following tables.

In October the number of people experiencing respiratory symptoms was 12 or 16% of the entire sample, the sum of symptoms was 30. In this case there were no symptoms with explainable causes that could be removed. However in November and December the number of subjects reporting respiratory symptoms was 16 and 17 respectively, previously the number of respondents was 20 and 25 respectively. In the following table the average length of time symptoms persisted are displayed. For example the average number of days eye symptoms persisted in October, the first month of the study, was 3 days (sd=3.0) ranging from one to 11 days.

Figure 14 Percentage of respondents reporting each symptom type explainable symptoms removed over the year of investigation.



In the series of bar charts following the tables the number of symptoms reported for each month of the study is presented with the 'reduced number of symptoms' as explained above.

TABLE 12 The number of respondents experiencing symptoms during the year of investigation with explainable symptoms removed.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
RESP	N= 12, 16% Sum=30	N= 16, 21% Sum=27	N= 17, 22% Sum=30	N= 17, 22% Sum=24	N= 12, 16% Sum=18	N= 9, 12% Sum=15	N= 8, 11% Sum=10	N= 11, 15% Sum=12	N= 11, 15% Sum=13	N= 7, 10% Sum=12	N= 6, 9% Sum=16	N= 11, 18% Sum=17
EYE	N= 9, 12% Sum=10	N= 9, 12% Sum=15	N= 11, 15% Sum=16	N= 2, 3% Sum=2	N= 4, 5% Sum=4	N= 13, 17% Sum=13	N= 5, 7% Sum=5	N= 6, 8% Sum=6	N= 8, 11% Sum=8	N= 7, 10% Sum=7	N= 9, 13% Sum=9	N= 9, 15% Sum=9
SKIN	N= 10, 13% Sum=15	N= 9, 12% Sum=9	N= 6, 8% Sum=21	N= 10, 13% Sum=20	N= 7, 9% Sum=14	N= 8, 11% Sum=18	N= 12, 16% Sum=28	N= 11, 15% Sum=11	N= 11, 15% Sum=11	N= 8, 12% Sum=8	N= 7, 10% Sum=11	N= 5, 8% Sum=9
ENT	N= 16, 25% Sum=30	N= 15, 20% Sum=23	N= 15, 20% Sum=26	N= 12, 16% Sum=12	N= 12, 16% Sum=13	N= 15, 20% Sum=24	N=13, 17% Sum=18	N= 9, 12% Sum=11	N= 12, 16% Sum=16	N= 9, 13% Sum=10	N= 12, 18% Sum=12	N= 11, 18% Sum=11
MH	N= 12, 16% Sum=18	N= 13, 17% Sum=24	N= 10, 13% Sum=11	N= 11, 15% Sum=13	N= 4, 5% Sum=5	N= 2, 3% Sum=2	N= 5, 9% Sum=5	N= 8, 11% Sum=8	N= 12, 16% Sum=12	N= 11, 16% Sum=11	N= 13, 19% Sum=13	N= 13, 21% Sum=14
OTHER	N= 8, 11% Sum=8	N= 3, 4% Sum=3	N= 1, 1% Sum=1	N= 2, 3% Sum=2	N= 4, 5% Sum=5	N= 2, 3% Sum=2	N= 0, 0% Sum=0	N= 1, 1% Sum=1	N= 2, 3% Sum=2	N= 1, 1% Sum=1	N= 1, 2% Sum=1	N= 5, 8% Sum=5
SM	N= 10, 13% Sum=22	N= 10, 13% Sum=17	N= 8, 11% Sum=10	N= 7, 9% Sum=12	N= 11, 14% Sum=17	N=8, 11% Sum=8	N= 0, 0% Sum=0	N= 6, 8% Sum=7	N= 5, 7% Sum=10	N= 6, 9% Sum=11	N= 11, 16% Sum=11	N= 3, 5% Sum=3
GI	N= 12, 16% Sum=12	N= 6, 8% Sum=6	N= 4, 5% Sum=4	N= 5, 7% Sum=6	N= 0, 0% Sum=0	N= 8, 11% Sum=8	N= 4, 5% Sum=4	N= 2, 3% Sum=2	N= 3, 4% Sum=3	N= 2, 3% Sum=2	N= 7, 10% Sum=8	N= 5, 8% Sum=6
FATIG	N= 19, 25% Sum=19	N= 16, 21% Sum=16	N= 15, 20% Sum=15	N= 18, 24% Sum=18	N= 10 13% Sum=10	N= 14, 18% Sum=14	N= 12, 16% Sum=12	N= 14, 18% Sum=14	N= 12, 16% Sum=12	N= 9, 13% Sum=9	N= 15, 22% Sum=15	N= 15, 24% Sum=15

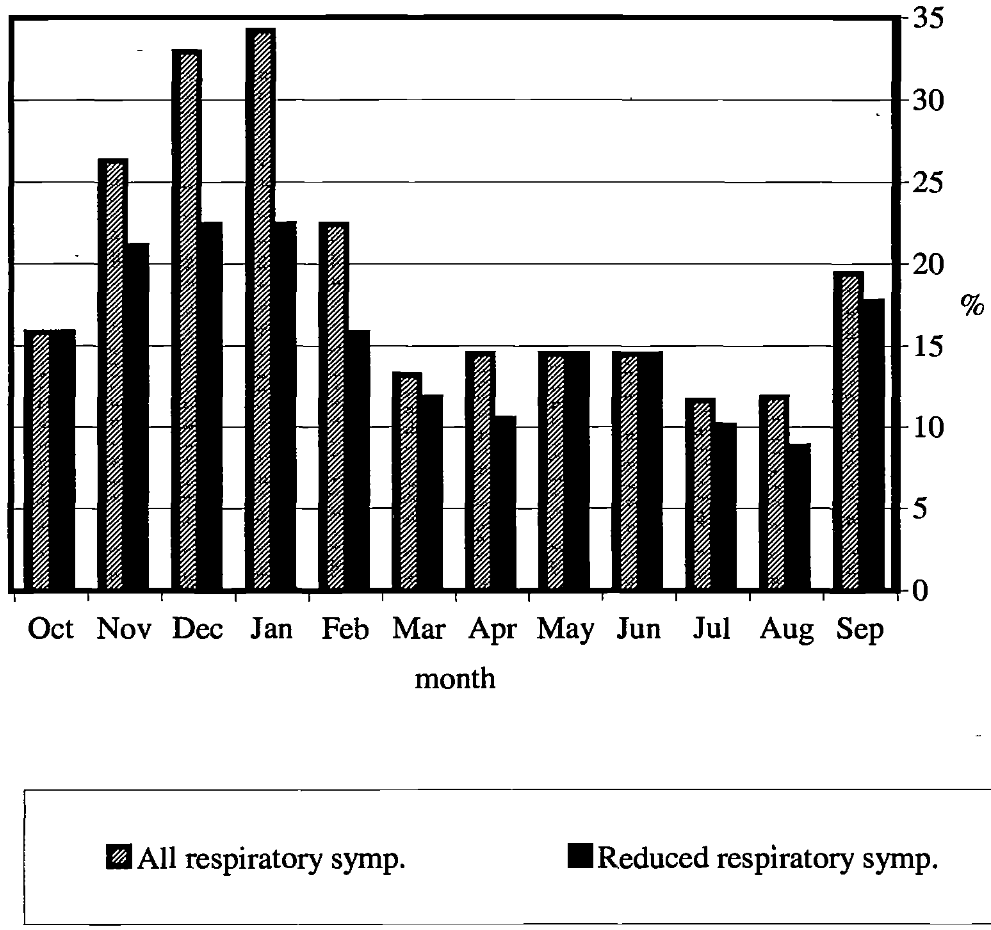
TABLE 13 The average (SD) and range of days symptoms persisted over the year of investigation with explainable symptoms removed.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
RESP	Mean 19.5 SD=12.2 Range=4-31 Sum=234 N=12, 16%	Mean 13.6 SD=12.7 Range=1-30 Sum=217 N=16, 21 %	Mean 13.8 SD=11.9 Range=3-31 Sum=235 N=17, 22 %	Mean 5.5 SD=4.2 Range=1-12 Sum=93 N=17, 22%	Mean 5.8 SD=2.3 Range=2-10 Sum=69 N=12, 16%	Mean15 SD=6 9 Range=1-20 Sum=135 N=9, 12%	Mean 4.0 SD=2.6 Range=1-9 Sum=32 N=8, 11%	Mean 9.3 SD=4 6 Range=1-13 Sum=102 N=11, 15%	Mean 9.6 SD=8.2 Range=1-18 Sum=106 N=11, 15%	Mean15 9 SD=7.7 Range=2-28 Sum=111 N=7, 10%	Mean 26.0 SD=12.2 Range=1-31 Sum=156 N=6, 9%	Mean15.5 SD=14.1 Range=1-30 Sum=170 N=11, 18%
EYE	Mean3.1 SD=3.0 Range=1-11 Sum=28 N=9, 12%	Mean 5.6 SD=2.5 Range=2-8 Sum=50 N=9, 12%	Mean5.0 SD=4.0 Range=1-9 Sum=55 N=11,15%	Mean4 0 SD=2.8 Range=2-6 Sum=8 N=2, 3%	Mean 2.8 SD=1.7 Range=1-5 Sum=11 N=4, 5%	Mean 6.2 SD=5.7 Range=1-13 Sum=81 N=13, 17%	Mean8 0 SD=0.0 Range=8 Sum=40 N=5, 7%	Mean 11.0 SD=2.4 Range=6-12 Sum=66 N=6, 8%	Mean 8.4 SD=3.7 Range=2-11 Sum=67 N=8, 11%	Mean 6.1 SD=2 3 Range=5-11 Sum=43 N=7, 10%	Mean 6.3 SD=3 0 Range=3-14 Sum=57 N=9, 13%	Mean6 9 SD=8.8 Range=1-30 Sum=62 N=9, 15%
SKIN	Mean8.6 SD=5 4 Range=1-15 Sum=86 N=10, 13%	Mean17.6 SD=11.4 Range=1-27 Sum=158 N=9, 12%	Mean27.8 SD=7.8 Range=12- 31 Sum=167 N=6, 8%	Mean17.8 SD=14.7 Range=1-31 Sum=178 N=10, 13%	Mean23.1 SD=8.8 Range=6-28 Sum=162 N=7, 9%	Mean19.9 SD=15.4 Range=1-31 Sum=159 N=8, 11%	Mean14.7 SD=13.7 Range=2-30 Sum=176 N=12, 16%	Mean14.8 SD=14 7 Range=1-30 Sum=163 N=11, 15%	Mean16.5 SD=13 8 Range=1-30 Sum=181 N=11, 15%	Mean18 5 SD=13.8 Range=1-31 Sum=148 N=8, 12%	Mean11.6 SD=6 8 Range=3-17 Sum=81 N=7, 11%	Mean25 6 SD=9.8 Range=8-30 Sum=128 N=5, 8%
ENT	Mean7.1 SD=7.5 Range=1-31 Sum=135 N=19, 25%	Mean15.7 SD=12.9 Range=3-31 Sum=235 N=15, 20%	Mean17.1 SD=11.7 Range=2-31 Sum=257 N=15, 20%	Mean3.2 SD=2.7 Range=1-10 Sum=38 N=12, 16%	Mean3.4 SD=1.5 Range=1-5 Sum=41 N=12, 16%	Mean8.2 SD=8.3 Range=18 Sum=123 N=15, 20%	Mean2.3 SD=0.6 Range=1-3 Sum=30 N=13,17%	Mean9.7 SD=4.8 Range=1-16 Sum=87 N=9, 12%	Mean7 3 SD=4 2 Range=1-12 Sum=87 N=12, 16%	Mean2.1 SD=1 8 Range=1-6 Sum=19 N=9, 13%	Mean5 7 SD=3.9 Range=2-17 Sum=68 N=12, 17%	Mean8.4 SD=6.1 Range=2-16 Sum=92 N=11, 18%
MH	Mean14.7 SD=14.5 Range=1-31 Sum=176 N=12, 16%	Mean11.5 SD=9.7 Range=1-24 Sum=150 N=13, 17%	Mean16.1 SD=14.7 Range=1-30 Sum=161 N=10, 13%	Mean7.0 SD=4.9 Range=1-12 Sum=77 N=11, 15%	Mean2.0 SD=1.4 Range=1-4 Sum=8-8 N=4, 5%	Mean2 0 SD=1.4 Range=1-3 Sum=4 N=2, 3%	Mean30.0 SD=0.0 Range=30 Sum=150 N=5, 7%	Mean21.0 SD=13.8 Range=2-31 Sum=168 N=8, 11%	Mean13.8 SD=14.4 Range=1-30 Sum=165 N=12, 16%	Mean14.1 SD=14.0 Range=1-31 Sum=155 N=11, 16%	Mean12.3 SD=13.5 Range=1-31 Sum=160 N=13, 19%	Mean13.2 SD=13.8 Range=1-30 Sum=172 N=13, 21%
OTHER	Mean9.5 SD=13.4 Range=1-31 Sum=76	Mean1.0 SD=0.0 Range=1-1 Sum=3	Mean31.0 SD=0.0 Range=31 Sum=31	Mean16.0 SD=21.2 Range=1-31 Sum=32	Mean9.5 SD=12.4 Range=2-28 Sum=38	Mean6.0 SD=4.2 Range=3-9 Sum=12	Mean0 0 SD=0 Range=0 Sum=0	Mean4.0 SD=0.0 Range=4-4 Sum=4	Mean4.0 SD=4.2 Range=1-7 Sum=8	Mean7.0 SD=0.0 Range=7-7 Sum=7	Mean10.0 SD=0.0 Range=10 Sum=10	Mean13.6 SD=5.4 Range=4-16 Sum=68

	N=8, 11%	N=3, 4%	N=1, 1%	N=2, 3%	N=4, 5%	N=2, 3%	N=0, 0%	N=1, 1%	N=2, 3%	N=1, 1%	N=1, 2%	N=5, 8%
SM	Mean20.4 SD=14.0 Range=1-31 Sum=204 N=10, 13%	Mean19.2 SD=11.5 Range=1-30 Sum=192 N=10, 13%	Mean4.4 SD=3.3 Range=1-11 Sum=35 N=8, 11%	Mean19.3 SD=8.2 Range=1-23 Sum=135 N=7, 9%	Mean13.7 SD=10.5 Range=1-24 Sum=151 N=11, 15%	Mean9.4 SD=6.4 Range=1-14 Sum=75 N=8, 11%	Mean0.0 SD=0.0 Range=0 Sum=0 N=0, 0%	Mean10.2 SD=2.0 Range=6-11 Sum=61 N=6, 8%	Mean30.0 SD=0.0 Range=30 Sum=150 N=5, 7%	Mean23.3 SD=12.3 Range=3-31 Sum=140 N=6, 8%	Mean4.1 SD=3.6 Range=3-15 Sum=45 N=11, 16%	Mean11.3 SD=16.2 Range=2-30 Sum=34 N=3, 5%
GI	Mean4.2 SD=2.6 Range=1-7 Sum=50 N=12, 16%	Mean2.0 SD=1 1 Range=1-3 Sum=12 N=6, 8%	Mean1.3 SD=0 5 Range=1-2 Sum=5 N=4, 5%	Mean2.2 SD=1.6 Range=1-4 Sum=11 N=5, 7%	Mean0.0 SD=0.0 Range=0 Sum=0 N=0, 0%	Mean2.4 SD=1.1 Range=1-4 Sum=19 N=8, 11%	Mean1.3 SD=0.5 Range=1-2 Sum=5 N=4, 5%	Mean3.0 SD=0.0 Range=3-3 Sum=6 N=2, 3%	Mean3.7 SD=2.3 Range=1-5 Sum=11 N=3, 4%	Mean3.0 SD=0.0 Range=3-3 Sum=6 N=2, 3%	Mean9.0 SD=6.2 Range=2-14 Sum=63 N=7, 10%	Mean2.2 SD=1.1 Range=1-4 Sum=11 N=5, 8%
FATIG	Mean13.6 SD=11.6 Range=1-31 Sum=258 N=19, 25%	Mean21.0 SD=11.4 Range=2-31 Sum=335 N=16, 21%	Mean22.1 SD=13.0 Range=2-31 Sum=332 N=15, 20%	Mean18.5 SD=14.4 Range=1-31 Sum=333 N=18, 24%	Mean16.1 SD=12.6 Range=1-28 Sum=161 N=10, 13%	Mean12.4 SD=14.4 Range=1-31 Sum=174 N=14, 18%	Mean15.0 SD=13.5 Range=2-30 Sum=180 N=12, 16%	Mean14.1 SD=9.7 Range=1-25 Sum=197 N=14, 18%	Mean15.4 SD=13.2 Range=1-30 Sum=185 N=12,16%	Mean21 4 SD=12 0 Range=3-31 Sum=193 N=9, 13%	Mean20.0 SD=12.5 Range=1-31 Sum=300 N=15, 22%	Mean14.3 SD=10.8 Range=3-30 Sum=214 N=15, 24%

As can be seen from the graph below when 'symptoms with causes' were excluded there was a considerable drop in the number of respiratory symptoms reported especially for the winter months. The greatest number of symptoms were reported in December and January (N=17, 22.4%) and the fewest were reported in August (N=6, 8.8%). The number of days symptoms persisted also decreased.

Figure 15 Percentage of respondents who reported 'all respiratory symptoms' and 'reduced respiratory symptoms' throughout the year of investigation.



The number of families who accounted for these symptoms are presented in the following table. This table is divided into the number of families who accounted for all respiratory symptoms and the number accounting for reduced respiratory symptoms.

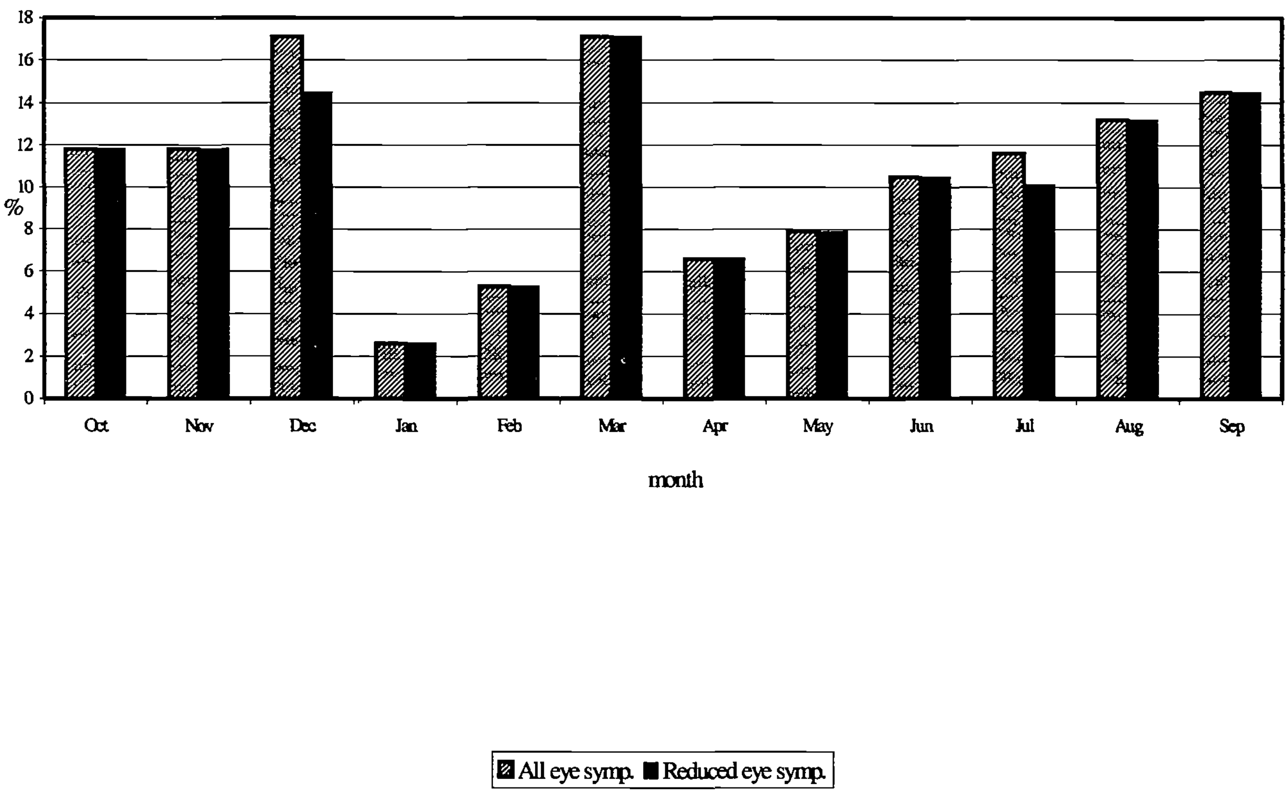
TABLE 14 The number of families accounting for all respiratory symptoms and reduced respiratory symptoms reported from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	7	9	11	10	7	5	6	6	6	4	4	4
reduced	7	7	8	7	6	4	4	6	6	3	2	4

As can be seen from the above table in October seven families in total reported respiratory symptoms and this did not change when explainable symptoms were removed from the analysis. The eleven families who reported respiratory symptoms in December accounted for the 25 respondents (33%) of the overall sample. This number dropped to eight families when explainable symptoms were removed. The number of respondents reporting respiratory symptoms in August was 8 (12%) and these were experienced by four families. The number dropped to 6 (9%) when explainable symptoms were removed and these six individuals came from 2 families. The same seven families accounted for the majority of respiratory symptoms experienced throughout the year of investigation. Two families did not report any respiratory ailments over the year.

There were very little changes in the pattern of results with regard to eye symptoms as evident from the graph below. There were slight changes in December and July. The number of families reporting eye symptoms are presented in the table below. In general the same four families repeatedly experienced eye symptoms over the course over the study. The number of families for December and July dropped by one for each case when explainable symptoms were removed. A

Figure 16 Percentage of respondents who reported 'all eye symptoms' and 'reduced eye symptoms' throughout the year of investigation.



total of six families did not report any eye symptoms over the year of the study.

TABLE 15 The number of families accounting for all eye symptoms reported throughout the year of investigation from a total number of 18 families participating in the study.

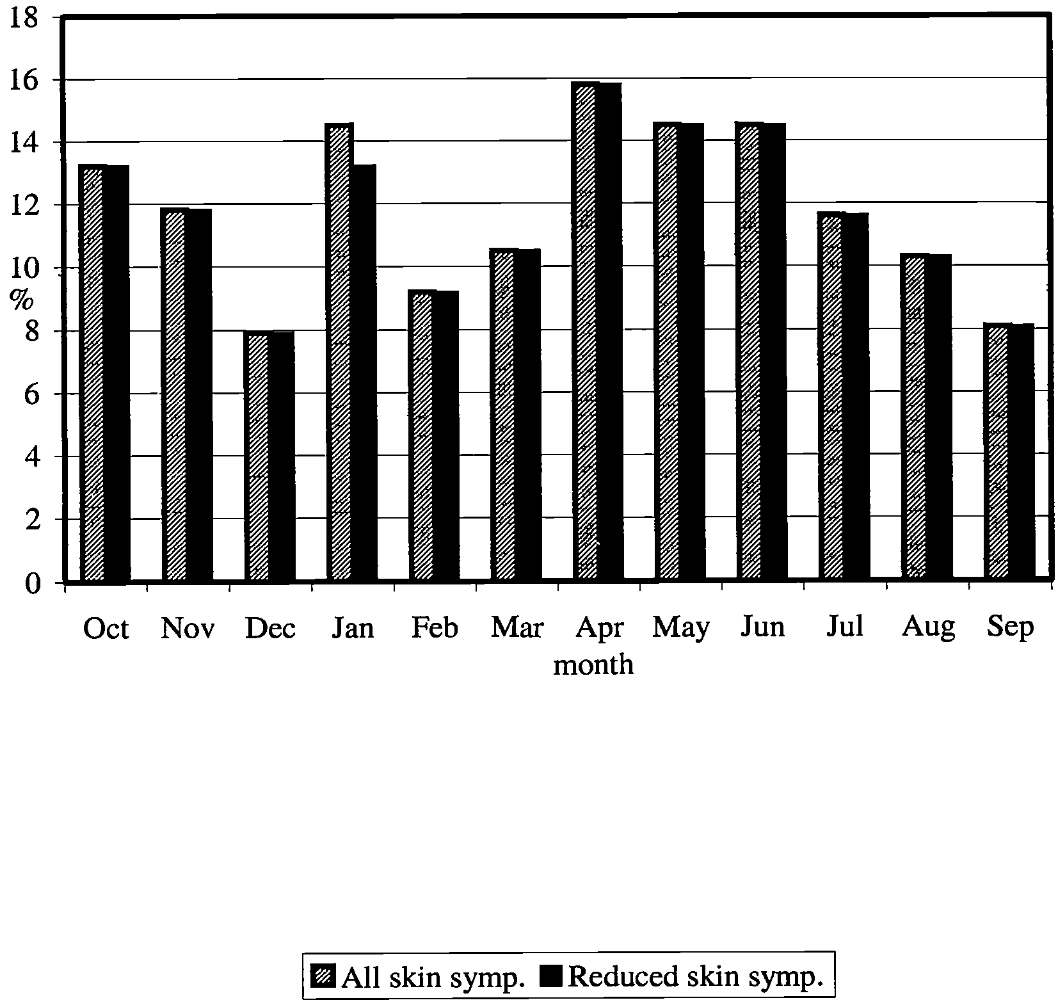
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	4	5	4	2	4	4	1	2	3	4	4	4

The findings regarding skin symptoms are presented in the graph below. As with eye symptoms there was very little difference with regard to skin symptoms when 'explainable symptoms' were removed. There was only one change in January. The number of families who reported the skin symptoms described above are presented in the following table. The highest number of families to report symptoms was five with only two families reporting skin problems in December and September. Eight families did not report any skin symptoms throughout the year of investigation. A core number of four families reported skin symptoms regularly over the 12 months of the study.

TABLE 16 The number of families accounting for all skin symptoms reported throughout the year of investigation from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	5	5	2	4	3	3	4	3	5	4	3	2

Figure 17 Percentage of respondents who reported 'all skin symptoms' and 'reduced skin symptoms' throughout the year of investigation.



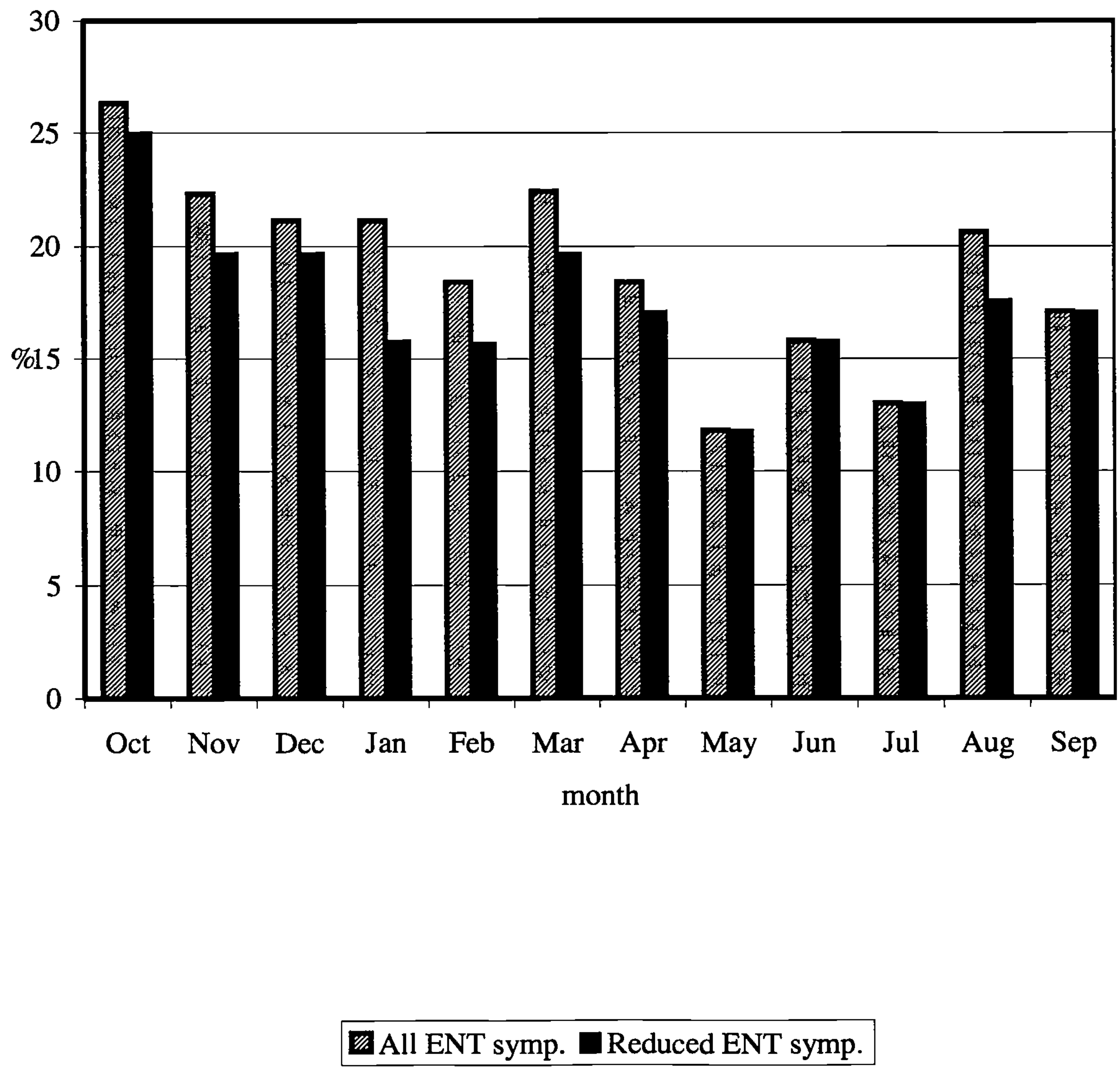
The pattern of ENT symptoms are presented in the following graph. As with respiratory symptoms there was a drop in the number of ENT symptoms reported when 'explainable symptoms' were removed. In October 19 persons (25%) reported ENT symptoms. There were considerable drops in January and February (N=12, 15.8%). The number of families accounting for ENT symptoms over the course of the study are presented in the following table.

TABLE 17 The number of families accounting for all ENT symptoms and reduced ENT symptoms reported from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	9	7	6	9	5	7	6	4	5	5	7	4
reduce	8	6	6	8	4	6	5	4	5	5	6	4

Four families did not report any ENT symptoms over the year of investigation while a core number of six families accounted for most of the ENT complaints experienced over the year of investigation.

Figure 18 Percentage of respondents who reported 'all ear nose and throat symptoms' and 'reduced ear nose and throat symptoms' throughout the year of investigation.



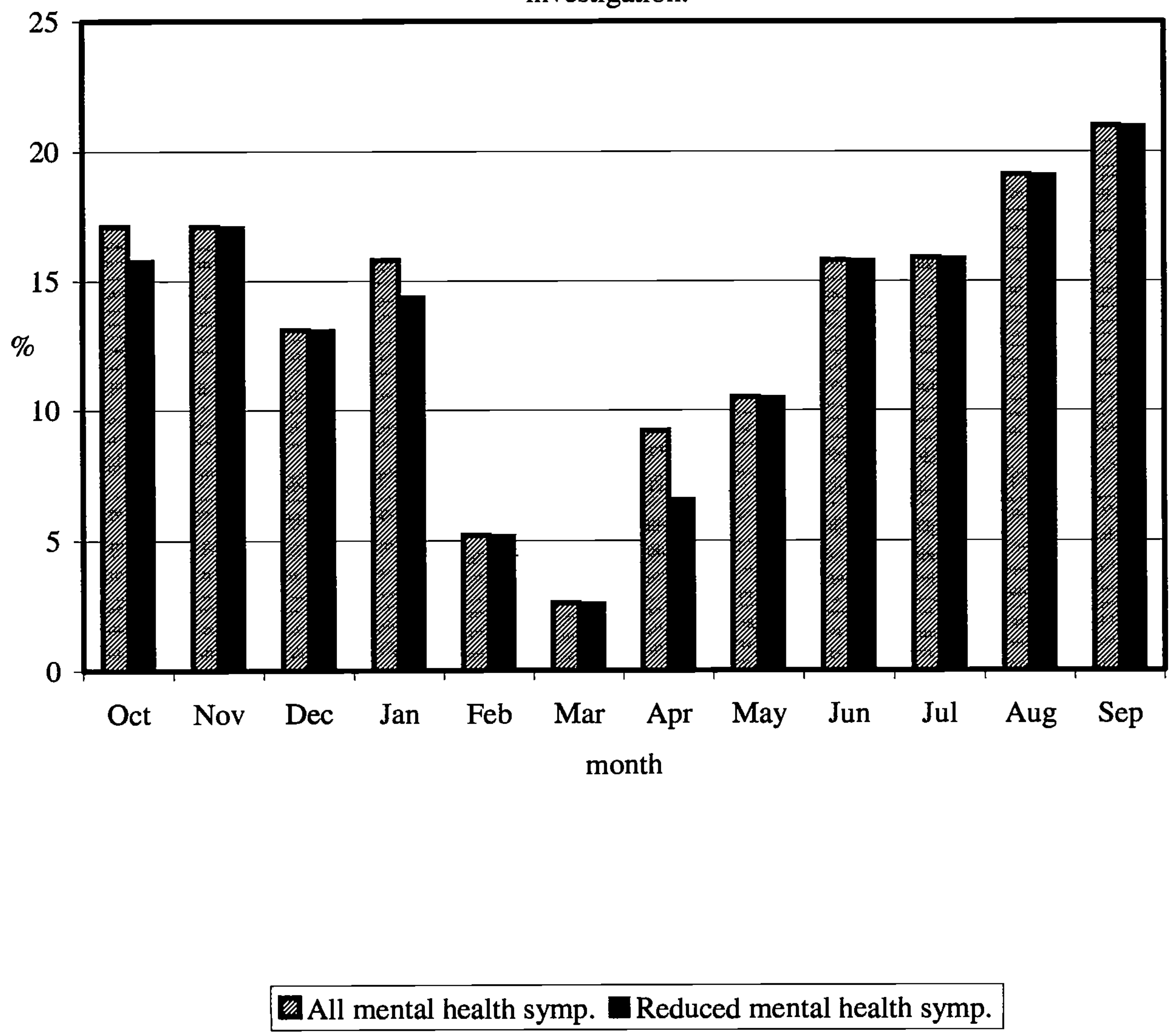
The pattern of results for mental health symptoms are presented in the following graph. The number of mental health symptoms reported also dropped slightly when 'explainable symptoms' were removed with the overall pattern remaining the same. There were also slight changes in October, January and April where 12 persons (16%), 11 persons (15%) and 5 persons (9%) respectively reported mental health symptoms. The number of families accounting for the mental health symptoms reported in the study are presented in the following table. The highest number of families to report such symptoms at any one time was seven families.

TABLE 18 The number of families accounting for all mental health symptoms reported from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	6	7	5	7	4	2	2	3	5	6	7	7

When explainable symptoms were removed the number of families dropped by one family for the months of October, January and April. Seven of the 18 families who participated in the study did not report any mental health symptoms. Four families repeatedly reported such symptoms throughout the study.

Figure 19 Percentage of respondents who reported 'all mental health symptoms' and 'reduced mental health symptoms' throughout the year of investigation.



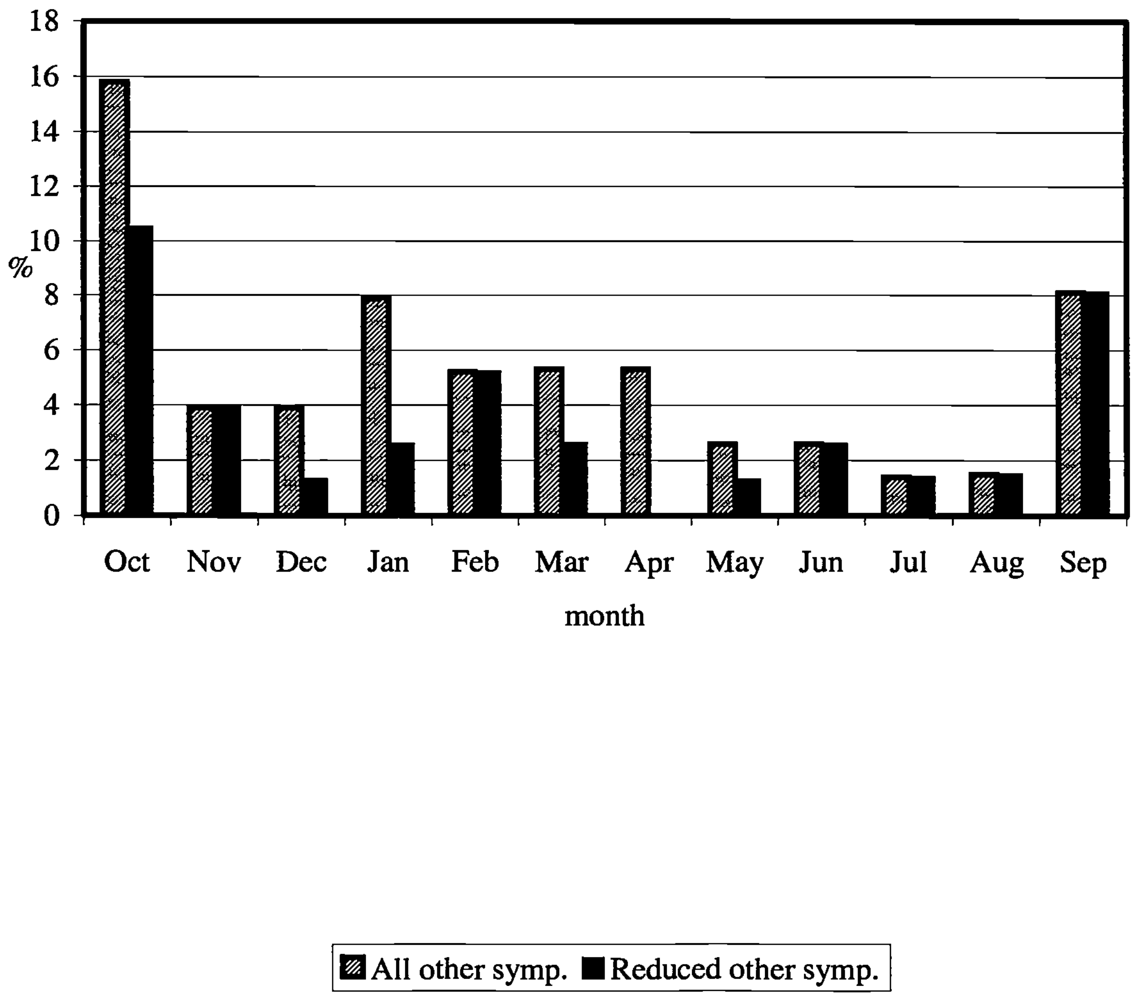
The 'other' symptoms reported by respondents with explainable symptoms removed are presented in the following graph. Many of the symptoms experienced dropped considerably when 'explainable symptoms' were removed. In April when 'explainable symptoms' were removed there were no other symptoms experienced by respondents. In December, May, July and August only one person reported 'other' symptoms. The most 'other' symptoms reported was in October where 10 persons (10.5%) from a total of 76 reported other symptoms. Other discrepancies are apparent from the figure below.
The number of families reporting 'other' symptoms are presented in the following table.

TABLE 19 The number of families accounting for all 'other' symptoms and reduced 'other' symptoms reported from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	7	1	2	5	4	3	1	2	2	1	1	2
reduce	4	1	1	2	4	2	0	1	2	1	1	2

Seven families did not report any 'other' symptoms throughout the year of investigation while two families repeatedly reported 'other' symptoms. The highest number of families to report such symptoms was seven and this dropped to four families when explainable symptoms were removed.

Figure 20 Percentage of respondents who reported 'all other symptoms' and 'reduced other symptoms' throughout the year of investigation.



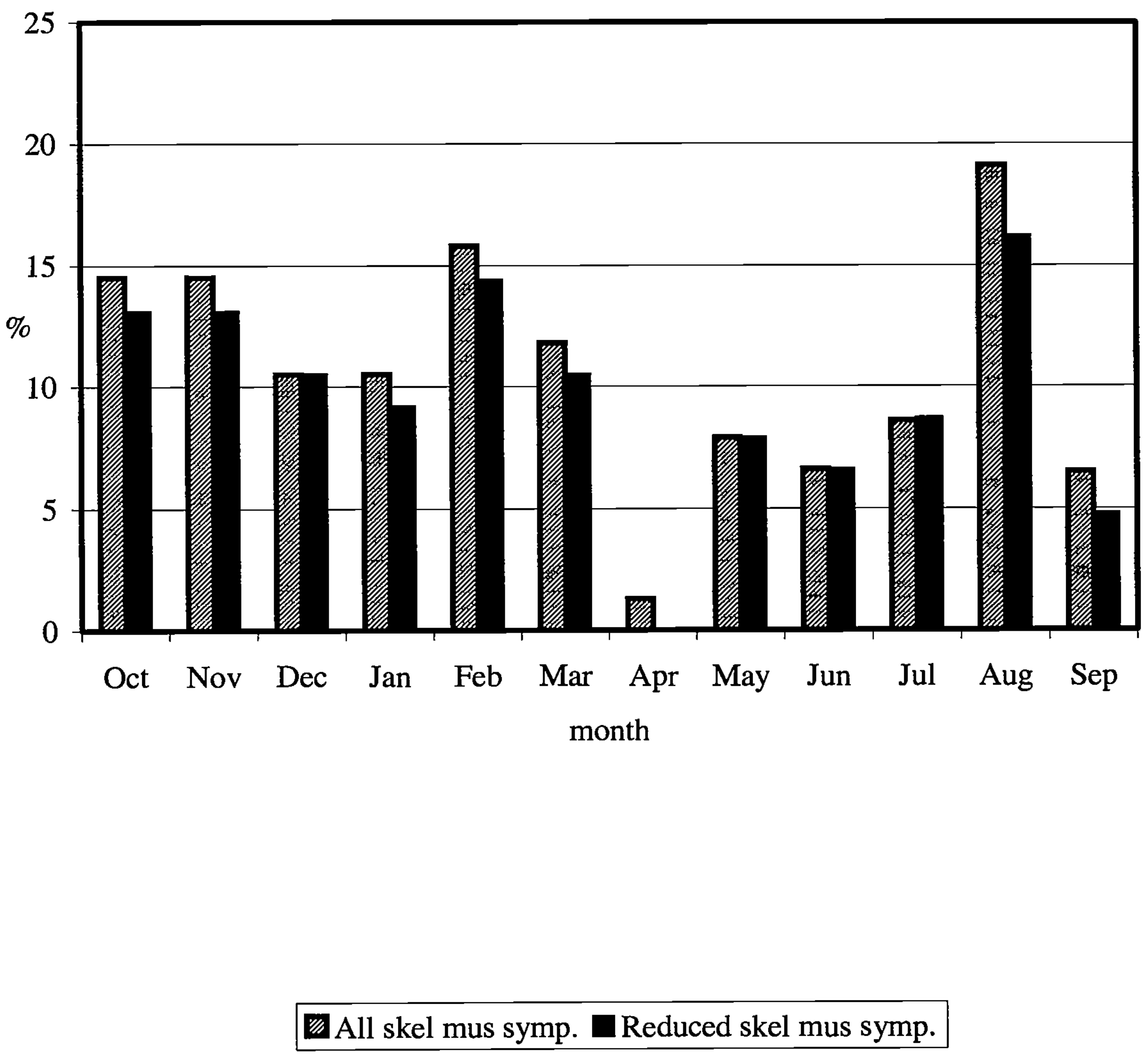
The number of individuals reporting skeletal-muscular symptoms dropped somewhat when explainable symptoms were removed. The highest number of skeletal-muscular symptoms reported was in August (N=11, 16.2%) and the fewest in April where nobody reported any skeletal-muscular symptoms. Other months changed slightly or remained constant. The number of families reporting skeletal-muscular symptoms are outlined in the table below.

TABLE 20 The number of families accounting for all skeletal-muscular symptoms and reduced skeletal-muscular symptoms reported from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	6	6	4	4	6	5	1	2	1	2	6	4
reduce	5	5	4	3	5	4	0	2	1	2	4	3

A total of seven families did not report any skeletal-muscular symptoms at all throughout the year of investigation while a group of three families reported such symptoms regularly during the study. The number of families reporting skeletal-muscular symptoms did not change much when explainable symptoms were removed. Gastrointestinal symptoms are discussed next.

Figure 21 Percentage of respondents who reported 'all skeletal muscular symptoms' and 'reduced skeletal muscular symptoms' throughout the year of investigation.



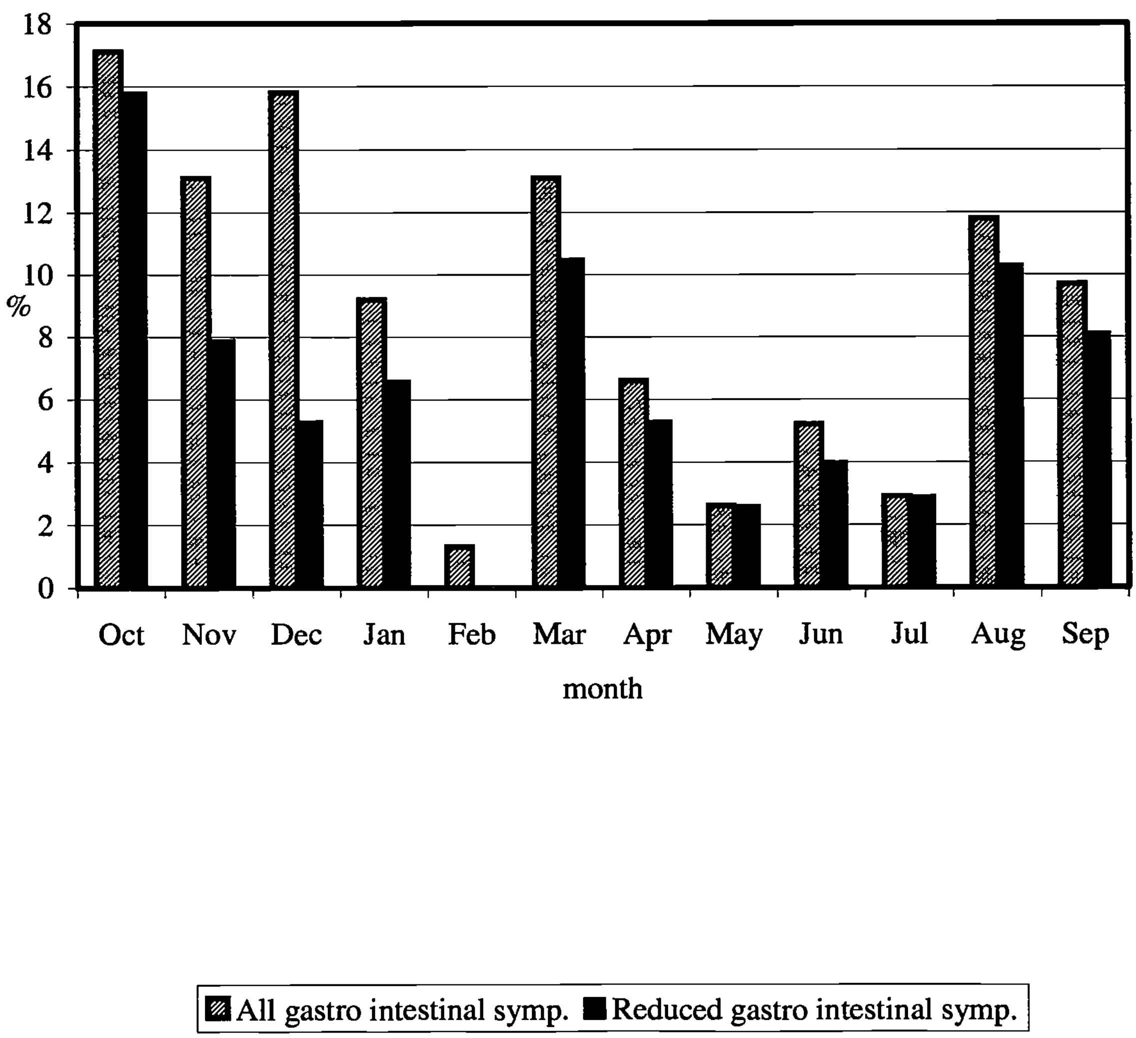
As can be seen from the graph below gastrointestinal symptoms dropped considerably when explainable symptoms were removed. In February no symptoms were experienced and most symptoms were experienced in October (N=12, 15.8%). There was a large drop in the number of symptoms in December where four persons (5.3%) reported gastrointestinal symptoms. Other changes are apparent from the graph below.

TABLE 21 The number of families accounting for all gastrointestinal symptoms and reduced gastrointestinal symptoms reported from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	7	7	6	6	1	5	4	1	2	1	4	5
reduce	6	5	3	4	0	3	3	1	2	1	3	4

A total of five families did not report any gastrointestinal symptoms during the study and as can be seen from the table above the number of families dropped when explainable symptoms were removed. Four families accounted for the majority of gastrointestinal symptoms reported during the year of investigation.

Figure 22 Percentage of respondents who reported 'all gastro intestinal symptoms' and 'reduced intestinal symptoms' throughout the year of investigation.

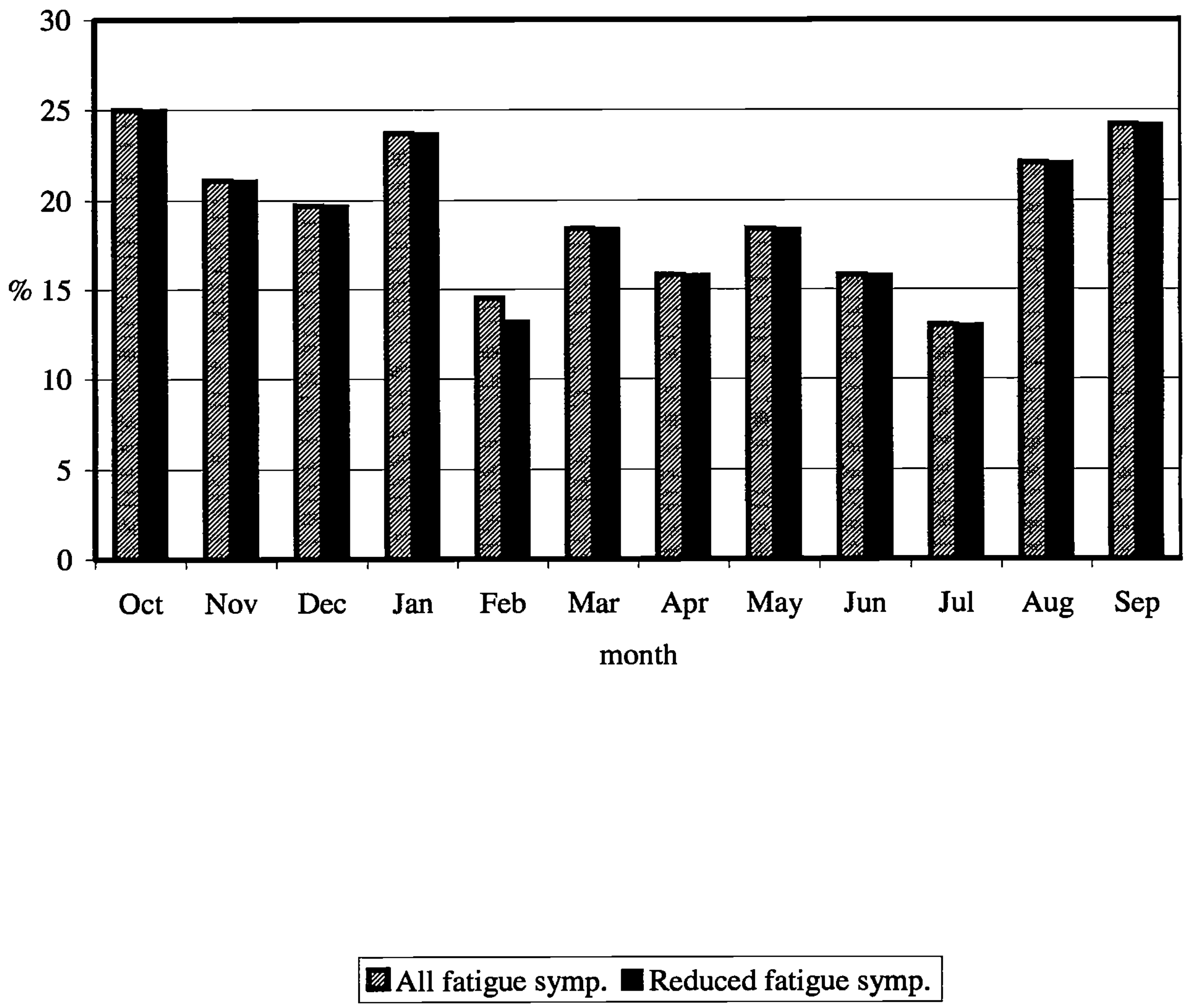


There was very little change in the number of respondents with fatigue during the year of investigation when explainable symptoms were removed. There was one slight change in February with all other months remaining constant. The number of families accounting for fatigue during the study are presented in the table below. The number of families when explainable symptoms were removed is not presented as there was only one change in the month of February. In this case one less family member was included but the number of families remained the same. Eight families of the 18 taking part in the study did not report experiencing fatigue during the year. Four families reported feeling fatigued regularly throughout the study.

TABLE 22 The number of families accounting for all fatigue symptoms and reduced fatigue symptoms reported from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	7	6	6	6	5	4	4	4	5	5	5	6

Figure 23 Percentage of respondents who reported 'all fatigue symptoms' and 'reduced fatigue symptoms ' throughout the year of investigation.



Summary of symptoms reported for one year with explainable symptoms removed from the analyses

As can be seen from the results above when explainable symptoms were removed the number of symptoms diminished considerably especially for respiratory, ENT, gastrointestinal and 'other' symptoms. Changes in respiratory and ENT symptoms can possibly be accounted for by winter cold and 'flu's. Such causes were reported by the respondents when symptoms were recorded in the daily diary. Many gastrointestinal symptoms were usually attributed to '24 hour bugs' or something ingested while 'other' symptoms generally had an unusual cause, such as dental problems, and as a result of this were removed from the analysis. The fact that certain ailments were removed from the results indicates that many respondents did report all, or almost all, symptoms experienced during the year of the study. Symptoms which were the result of previous injuries or sporting / farm accidents were also excluded from the analysis. The number of skeletal muscular symptoms changed somewhat when those with explainable causes were removed. There was little change in the number of eye, skin, mental health and fatigue symptoms when those with explainable causes were removed. The reason being that many people did not know the causes or did not report any causes in the diary.

There was a considerable drop in the number of respiratory symptoms reported when explainable symptoms were removed from the analysis, especially so for the Winter months. The greatest number of respondents reporting respiratory symptoms was 22.4% (N=17) dropping from one third of respondents when all symptoms were included in the analyses. The least number of respondents reporting respiratory symptoms was 8.8% (N=6), a drop by almost 50% when all symptoms were included (N=11, 14%). Moreover, the same seven families accounted for the majority of respiratory symptoms reported. Two families did not report any respiratory ailment at all throughout the year of investigation.

There was very little change in the number of eye symptoms reported when *explainable symptoms* were removed form the analyses. In general the same four families repeatedly experienced eye symptoms over the course of the study. A total of six families (33%) did not report any eye symptoms at all.
As with eye symptoms there were very little differences with regard to skin symptoms when *explainable symptoms* were removed from the analyses. The highest number of families to report skin symptoms was five while only two families reported skin problems in December and September. Eight families (44%) did not have any skin symptoms at all over the course of the study. Moreover, a core of four families reported skin symptoms regularly throughout the year of investigation.

There was a considerable drop in the number of ENT symptoms reported when *explainable symptoms* were removed from the analyses especially in the months of January and February. However, the overall number of respondents reporting ENT symptoms did not change substantially. Six families reported ENT symptoms regularly over the course of the study while four families (22%) did not report ENT symptoms at all.

There were very little changes in the number of mental health symptoms reported. The highest number of families to report mental health symptoms at any one time was seven from a total of 18 families. Four families reported mental health symptoms regularly throughout the year of investigation however seven families (39%) did not report any mental health symptoms at all.

Many of the 'other' symptoms experienced declined when *explainable symptoms* were removed from the analyses. In the month of April no 'other' symptoms were experienced at all. In four months only one person reported 'other' symptoms. Moreover, seven families (39%) did not report any 'other' symptoms. The highest number of families reporting 'other' symptoms with *explainable symptoms* removed was four families from a total of 18 families. In addition two families regularly recorded 'other' symptoms over the course of the study.

There were some changes in the number of skeletal-muscular symptoms reported. The highest number of respondents reporting symptoms at any one time was 16.2% (N=11) when *explainable symptoms* were removed, a drop from 19% (N=13). Seven families (39%) did not report any skeletal-muscular symptoms over the course of the study while two families regularly reported such symptoms.
Gastrointestinal symptoms declined considerably when *explainable symptoms* were removed from the analyses. In February no gastrointestinal symptoms were recorded and the highest number reporting symptoms was 15.8% (N=12). Five families (28%) did not report any gastrointestinal symptoms while four families reported such symptoms on a regular basis over the course of the study.

There were very little changes in the number of respondents reporting symptoms of fatigue. However, eight families (44%) from a total of 18 families did not report such symptoms at all, while four families suffered from fatigue extensively during the year of investigation.

The *percentage of respondents* reporting the different symptom types and the percentage reporting the different symptom types with *explainable symptoms removed from the analysis* are outlined below. The percentages for the latter are italicised.

Respiratory	72%	*59%*
Eye	40%	*37%*
Skin	33%	*33%*
ENT	57%	*54%*
Mental Health	38%	*37%*
'Other'	34%	*26%*
Skeletal-Muscular	32%	*30%*
Gastrointestinal	50%	*36%*
Fatigue	38%	*34%*

There was a drop in the number of respondents reporting respiratory, gastrointestinal and 'other' symptoms. There was no change in the number of respondents reporting skin symptoms while the number reporting eye, ENT, mental health, skeletal-muscular and fatigue symptoms changed slightly.

As mentioned earlier a primary aim of the study was to investigate the prevalence rates for symptoms of respiratory tract, eye and skin irritation. As can be seen from the results above only two families did not report any respiratory symptoms at all during the study, six families did not report any eye symptoms while eight families did not have any skin complaints. Three of the families accounting for the majority of skin complaints were also three of the four families with the majority of eye complaints. The same three were also in the seven families accounting for the majority of respiratory complaints.

Conclusion of symptoms reported for one year with explainable symptoms removed from the analyses

- When symptoms were removed from the analysis, that is, they had explainable causes and were not attributed to air pollution according to the informant, there was a slight decrease in the number of **symptom episodes** and the number of **symptom days**

- The number of symptom episodes reduced from 1353 to 1234, a decrease of 119 symptom episodes
- On average each respondent recorded 16 symptom episodes on average per year, (*compared to the previous 18 symptom episodes when all symptoms were included in the analysis*) or 1.3 symptom episodes per month (*compared to the previous 1.5 symptom episodes per month when all symptoms were included in the analysis*)
- Reports of respiratory, ENT, gastrointestinal and 'other' symptoms were reduced when explainable symptoms were removed from the analysis
- Symptom days dropped by 482 days from 11,827 to 11,345 symptoms day over the year of the study when explainable symptoms were removed from the analysis
- Respondents were ill 151 days on average during the year (*compared to 158 days when all symptoms were included in the analysis*) or 12.6 days per month on average (*compared to 13 days on average when all symptoms were included in the analysis*)
- Seven families accounted for the majority of respiratory symptoms experienced, while two families did not report any respiratory symptoms at all
- The pattern of eye symptoms reported changed little when explainable symptoms were removed from the analysis. Four families repeatedly experienced eye symptoms over the year. However, six families did not report any eye symptoms.
- The number of skin complaints changed little when explainable symptoms were removed from the analysis. Four families in the study repeatedly experienced skin complaints over the year while eight families did not report any skin symptoms.
- Six families accounted for the majority of ENT complaints, four did not report any at all
- The greatest number of families to report mental health symptoms at any one time was seven with four families repeatedly reporting such symptoms. Seven families did not report any mental health symptoms at all
- Two families experienced many 'other' symptoms
- The presence of skeletal-muscular symptoms did not change much when explainable symptoms were removed from the analysis and three families reported these symptoms on a regular basis
- Four families experienced gastrointestinal symptoms on a regular basis
- There was little change in the numbers experiencing fatigue when explainable symptoms were removed from the analysis. Four families reported fatigue regularly over the year of the study.
- Three families accounted for the majority of respiratory, eye and skin complaints
- Findings revealed that five persons accounted for many symptoms and as a result of this the findings were skewed

TABLE 23 The number (%) of symptoms reported by respondents over the year of the study and the number (%) of symptoms reported with *explainable symptoms* removed.

Resp	Eye	Skin	ENT	MH	Other	SM	GI	Fatigue	Total
264 **19.5%**	107 **7.9%**	176 **13%**	222 **16.4%**	140 **10.3%**	49 **3.6%**	137 **10.1%**	88 **6.5%**	170 **12.6%**	**1353** **100%**
Symptoms removed									
224 **18.0%**	104 **8.4%**	175 **14.1%**	206 **16.6%**	136 **11.7%**	31 **2.5%**	128 **10.3%**	61 **4.9%**	169 **13.5%**	**1234** **100%**

TABLE 24 The number of days each symptom type persisted over the year of the study compared with the number of days symptoms persisted *with explainable symptoms* removed.

Symptom type	Symptom days	*Explainable symptoms* removed
Respiratory	1848 (15.6%)	1660 (14.6%)
Eye	576 (4.9%)	568 (5.0%)
Skin	1788 (15.1%)	1787 (15.8%)
ENT	1252 (10.6%)	1212 (10.7%)
Mental Health	1556 (13.2%)	1546 (13.6%)
Other	341 (2.9%)	289 (2.5%)
Skeletal-Muscular	1297 (10.9%)	1222 (10.8%)
Gastrointestinal	306 (2.6%)	199 (1.8%)
Fatigue	2863 (24.2%)	2862 (25.2%)
TOTAL	**11,827 (100%)**	**11,345 (100%)**

Figure 24 Percentage of respondents reporting each symptom type explainable symptoms removed over the year of investigation.

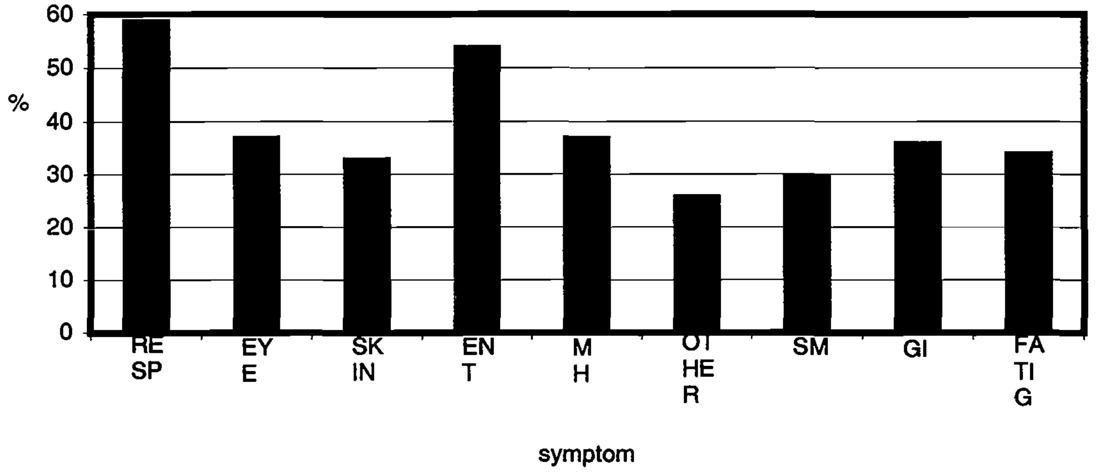


TABLE 25 The number of respondents experiencing symptoms during the year of investigation with explainable symptoms removed.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
RESP	N= 12, 16% Sum=30	N= 16, 21% Sum=27	N= 17, 22% Sum=30	N= 17, 22% Sum=24	N= 12, 16% Sum=18	N= 9, 12% Sum=15	N= 8, 11% Sum=10	N= 11, 15% Sum=12	N= 11, 15% Sum=13	N= 7, 10% Sum=12	N= 6, 9% Sum=16	N= 11, 18% Sum=17
EYE	N= 9, 12% Sum=10	N= 9, 12% Sum=15	N= 11, 15% Sum=16	N= 2, 3% Sum=2	N= 4, 5% Sum=4	N= 13, 17% Sum=13	N= 5, 7% Sum=5	N= 6, 8% Sum=6	N= 8, 11% Sum=8	N= 7, 10% Sum=7	N= 9, 13% Sum=9	N= 9, 15% Sum=9
SKIN	N= 10, 13% Sum=15	N= 9, 12% Sum=9	N= 6, 8% Sum=21	N= 10, 13% Sum=20	N= 7, 9% Sum=14	N= 8, 11% Sum=18	N= 12, 16% Sum=28	N= 11, 15% Sum=11	N= 11, 15% Sum=11	N= 8, 12% Sum=8	N= 7, 10% Sum=11	N= 5, 8% Sum=9
ENT	N= 16, 25% Sum=30	N= 15, 20% Sum=23	N= 15, 20% Sum=26	N= 12, 16% Sum=12	N= 12, 16% Sum=13	N= 15, 20% Sum=24	N=13, 17% Sum=18	N= 9, 12% Sum=11	N= 12, 16% Sum=16	N= 9, 13% Sum=10	N= 12, 18% Sum=12	N= 11, 18% Sum=11
MH	N= 12, 16% Sum=18	N= 13, 17% Sum=24	N= 10, 13% Sum=11	N= 11, 15% Sum=13	N= 4, 5% Sum=5	N= 2, 3% Sum=2	N= 5, 9% Sum=5	N= 8, 11% Sum=8	N= 12, 16% Sum=12	N= 11, 16% Sum=11	N= 13, 19% Sum=13	N= 13, 21% Sum=14
OTHER	N= 8, 11% Sum=8	N= 3, 4% Sum=3	N= 1, 1% Sum=1	N= 2, 3% Sum=2	N= 4, 5% Sum=5	N= 2, 3% Sum=2	N= 0, 0% Sum=0	N= 1, 1% Sum=1	N= 2, 3% Sum=2	N= 1, 1% Sum=1	N= 1, 2% Sum=1	N= 5, 8% Sum=5
SM	N= 10, 13% Sum=22	N= 10, 13% Sum=17	N= 8, 11% Sum=10	N= 7, 9% Sum=12	N= 11, 14% Sum=17	N=8, 11% Sum=8	N= 0, 0% Sum=0	N= 6, 8% Sum=7	N= 5, 7% Sum=10	N= 6, 9% Sum=11	N= 11, 16% Sum=11	N= 3, 5% Sum=3
GI	N= 12, 16% Sum=12	N= 6, 8% Sum=6	N= 4, 5% Sum=4	N= 5, 7% Sum=6	N= 0, 0% Sum=0	N= 8, 11% Sum=8	N= 4, 5% Sum=4	N= 2, 3% Sum=2	N= 3, 4% Sum=3	N= 2, 3% Sum=2	N= 7, 10% Sum=8	N= 5, 8% Sum=6
FATIG	N= 19, 25% Sum=19	N= 16, 21% Sum=16	N= 15, 20% Sum=15	N= 18, 24% Sum=18	N= 10 13% Sum=10	N= 14, 18% Sum=14	N= 12, 16% Sum=12	N= 14, 18% Sum=14	N= 12, 16% Sum=12	N= 9, 13% Sum=9	N= 15, 22% Sum=15	N= 15, 24% Sum=15

TABLE 26 The average (SD) and range of days symptoms persisted over the year of investigation with explainable symptoms removed.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
RESP	Mean 19.5 SD=12.2 Range=4-31 Sum=234 N=12, 16%	Mean 13.6 SD=12 7 Range=1-30 Sum=217 N=16. 21 %	Mean 13.8 SD=11.9 Range=3-31 Sum=235 N=17, 22 %	Mean 5.5 SD=4 2 Range=1-12 Sum=93 N=17, 22%	Mean 5.8 SD=2.3 Range=2-10 Sum=69 N=12, 16%	Mean15 SD=6.9 Range=1-20 Sum=135 N=9, 12%	Mean 4.0 SD=2 6 Range=1-9 Sum=32 N=8. 11%	Mean 9.3 SD=4.6 Range=1-13 Sum=102 N=11, 15%	Mean 9 6 SD=8.2 Range=1-18 Sum=106 N=11, 15%	Mean15.9 SD=7.7 Range=2-28 Sum=111 N=7, 10%	Mean 26.0 SD=12.2 Range=1-31 Sum=156 N=6, 9%	Mean15 5 SD=14 1 Range=1-30 Sum=170 N=11, 18%
EYE	Mean3.1 SD=3.0 Range=1-11 Sum=28 N=9, 12%	Mean 5.6 SD=2.5 Range=2-8 Sum=50 N=9, 12%	Mean5.0 SD=4.0 Range=1-9 Sum=55 N=11,15%	Mean4.0 SD=2.8 Range=2-6 Sum=8 N=2, 3%	Mean 2.8 SD=1.7 Range=1-5 Sum=11 N=4, 5%	Mean 6.2 SD=5 7 Range=1-13 Sum=81 N=13, 17%	Mean8.0 SD=0 0 Range=8 Sum=40 N=5, 7%	Mean 11 0 SD=2 4 Range=6-12 Sum=66 N=6, 8%	Mean 8.4 SD=3.7 Range=2-11 Sum=67 N=8. 11%	Mean 6.1 SD=2.3 Range=5-11 Sum=43 N=7. 10%	Mean 6 3 SD=3 0 Range=3-14 Sum=57 N=9, 13%	Mean6.9 SD=8.8 Range=1-30 Sum=62 N=9, 15%
SKIN	Mean8.6 SD=5.4 Range=1-15 Sum=86 N=10, 13%	Mean17.6 SD=11.4 Range=1-27 Sum=158 N=9. 12%	Mean27.8 SD=7.8 Range=12- 31 Sum=167 N=6, 8%	Mean17.8 SD=14.7 Range=1-31 Sum=178 N=10, 13%	Mean23 1 SD=8.8 Range=6-28 Sum=162 N=7, 9%	Mean19 9 SD=15.4 Range=1-31 Sum=159 N=8, 11%	Mean14 7 SD=13 7 Range=2-30 Sum=176 N=12, 16%	Mean14.8 SD=14.7 Range=1-30 Sum=163 N=11, 15%	Mean16.5 SD=13.8 Range=1-30 Sum=181 N=11. 15%	Mean18 5 SD=13.8 Range=1-31 Sum=148 N=8, 12%	Mean11.6 SD=6.8 Range=3-17 Sum=81 N=7. 11%	Mean25 6 SD=9.8 Range=8-30 Sum=128 N=5. 8%
ENT	Mean7.1 SD=7.5 Range=1-31 Sum=135 N=19, 25%	Mean15.7 SD=12 9 Range=3-31 Sum=235 N=15, 20%	Mean17 1 SD=11.7 Range=2-31 Sum=257 N=15, 20%	Mean3.2 SD=2.7 Range=1-10 Sum=38 N=12. 16%	Mean3.4 SD=1.5 Range=1-5 Sum=41 N=12, 16%	Mean8.2 SD=8 3 Range=18 Sum=123 N=15, 20%	Mean2 3 SD=0 6 Range=1-3 Sum=30 N=13,17%	Mean9.7 SD=4 8 Range=1-16 Sum=87 N=9, 12%	Mean7.3 SD=4.2 Range=1-12 Sum=87 N=12. 16%	Mean2.1 SD=1.8 Range=1-6 Sum=19 N=9, 13%	Mean5.7 SD=3.9 Range=2-17 Sum=68 N=12, 17%	Mean8 4 SD=6.1 Range=2-16 Sum=92 N=11, 18%
MH	Mean14.7 SD=14.5 Range=1-31 Sum=176 N=12, 16%	Mean11.5 SD=9.7 Range=1-24 Sum=150 N=13, 17%	Mean16.1 SD=14.7 Range=1-30 Sum=161 N=10, 13%	Mean7.0 SD=4.9 Range=1-12 Sum=77 N=11, 15%	Mean2.0 SD=1.4 Range=1-4 Sum=8-8 N=4, 5%	Mean2 0 SD=1.4 Range=1-3 Sum=4 N=2, 3%	Mean30.0 SD=0 0 Range=30 Sum=150 N=5, 7%	Mean21.0 SD=13.8 Range=2-31 Sum=168 N=8, 11%	Mean13.8 SD=14.4 Range=1-30 Sum=165 N=12, 16%	Mean14 1 SD=14.0 Range=1-31 Sum=155 N=11, 16%	Mean12.3 SD=13.5 Range=1-31 Sum=160 N=13, 19%	Mean13.2 SD=13 8 Range=1-30 Sum=172 N=13. 21%
OTHER	Mean9.5 SD=13.4 Range=1-31	Mean1.0 SD=0.0 Range=1-1	Mean31.0 SD=0.0 Range=31	Mean16.0 SD=21 2 Range=1-31	Mean9.5 SD=12.4 Range=2-28	Mean6.0 SD=4.2 Range=3-9	Mean0 0 SD=0 Range=0	Mean4.0 SD=0.0 Range=4-4	Mean4.0 SD=4.2 Range=1-7	Mean7.0 SD=0.0 Range=7-7	Mean10.0 SD=0.0 Range=10	Mean13.6 SD=5.4 Range=4-16

	Sum=76 N=8, 11%	Sum=3 N=3, 4%	Sum=31 N=1, 1%	Sum=32 N=2, 3%	Sum=38 N=4, 5%	Sum=12 N=2, 3%	Sum=0 N=0, 0%	Sum=4 N=1, 1%	Sum=8 N=2, 3%	Sum=7 N=1, 1%	Sum=10 N=1, 2%	Sum=68 N=5, 8%
SM	Mean20.4 SD=14.0 Range=1-31 Sum=204 N=10, 13%	Mean19.2 SD=11.5 Range=1-30 Sum=192 N=10, 13%	Mean4.4 SD=3 3 Range=1-11 Sum=35 N=8, 11%	Mean19.3 SD=8.2 Range=1-23 Sum=135 N=7, 9%	Mean13.7 SD=10.5 Range=1-24 Sum=151 N=11, 15%	Mean9.4 SD=6.4 Range=1-14 Sum=75 N=8, 11%	Mean0.0 SD=0.0 Range=0 Sum=0 N=0, 0%	Mean10.2 SD=2.0 Range=6-11 Sum=61 N=6, 8%	Mean30.0 SD=0.0 Range=30 Sum=150 N=5, 7%	Mean23.3 SD=12.3 Range=3-31 Sum=140 N=6, 8%	Mean4.1 SD=3.6 Range=3-15 Sum=45 N=11, 16%	Mean11.3 SD=16.2 Range=2-30 Sum=34 N=3, 5%
GI	Mean4.2 SD=2.6 Range=1-7 Sum=50 N=12, 16%	Mean2.0 SD=1.1 Range=1-3 Sum=12 N=6, 8%	Mean1.3 SD=0 5 Range=1-2 Sum=5 N=4, 5%	Mean2.2 SD=1.6 Range=1-4 Sum=11 N=5, 7%	Mean0 0 SD=0.0 Range=0 Sum=0 N=0, 0%	Mean2.4 SD=1.1 Range=1-4 Sum=19 N=8, 11%	Mean1.3 SD=0.5 Range=1-2 Sum=5 N=4, 5%	Mean3.0 SD=0.0 Range=3-3 Sum=6 N=2, 3%	Mean3.7 SD=2.3 Range=1-5 Sum=11 N=3, 4%	Mean3.0 SD=0.0 Range=3-3 Sum=6 N=2, 3%	Mean9.0 SD=6.2 Range=2-14 Sum=63 N=7, 10%	Mean2.2 SD=1.1 Range=1-4 Sum=11 N=5, 8%
FATIG	Mean13.6 SD=11.6 Range=1-31 Sum=258 N=19, 25%	Mean21.0 SD=11.4 Range=2-31 Sum=335 N=16, 21%	Mean22.1 SD=13.0 Range=2-31 Sum=332 N=15, 20%	Mean18 5 SD=14 4 Range=1-31 Sum=333 N=18, 24%	Mean16.1 SD=12.6 Range=1-28 Sum=161 N=10, 13%	Mean12.4 SD=14.4 Range=1-31 Sum=174 N=14, 18%	Mean15.0 SD=13.5 Range=2-30 Sum=180 N=12, 16%	Mean14.1 SD=9.7 Range=1-25 Sum=197 N=14, 18%	Mean15.4 SD=13.2 Range=1-30 Sum=185 N=12,16%	Mean21.4 SD=12.0 Range=3-31 Sum=193 N=9, 13%	Mean20.0 SD=12.5 Range=1-31 Sum=300 N=15, 22%	Mean14 3 SD=10.8 Range=3-30 Sum=214 N=15, 24%

Figure 25 Percentage of respondents who reported 'all respiratory symptoms' and 'reduced respiratory symptoms' throughout the year of investigation.

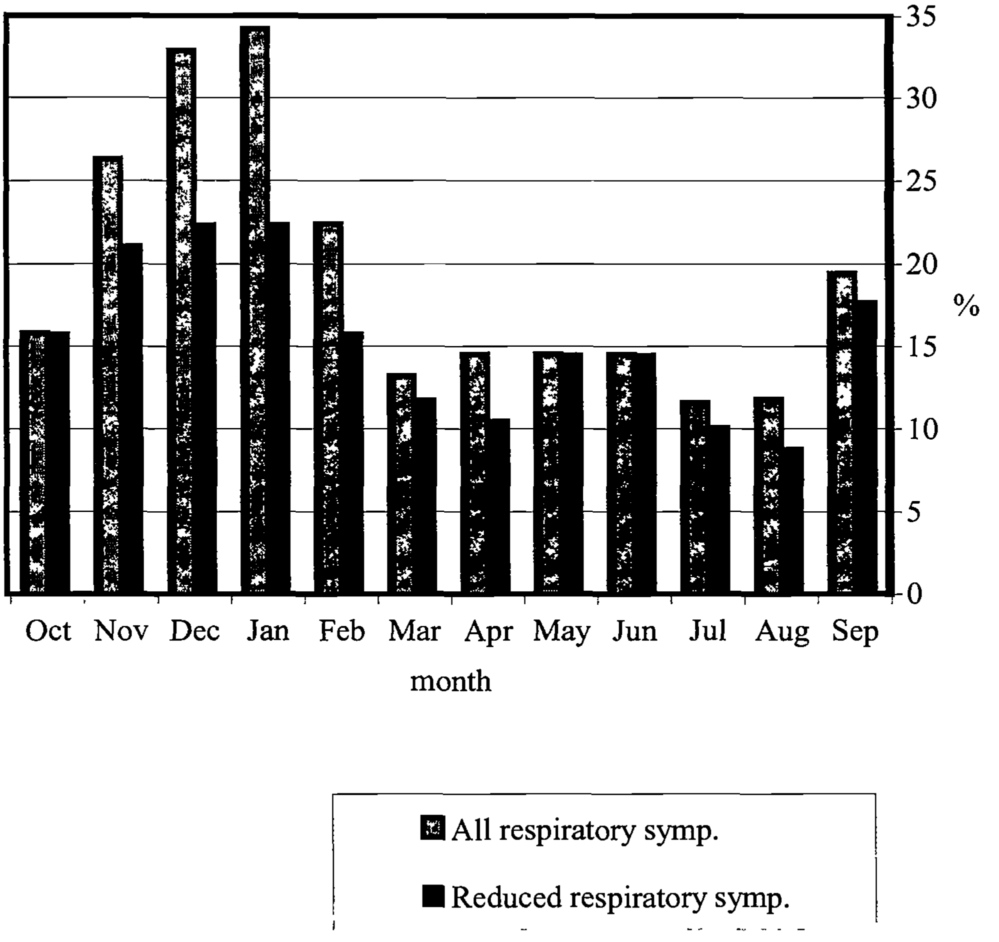


TABLE 27 The number of families accounting for all respiratory symptoms and reduced respiratory symptoms reported from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	7	9	11	10	7	5	6	6	6	4	4	4
reduced	7	7	8	7	6	4	4	6	6	3	2	4

TABLE 28 The number of families accounting for all eye symptoms reported throughout the year of investigation from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	4	5	4	2	4	4	1	2	3	4	4	4

TABLE 29 The number of families accounting for all skin symptoms reported throughout the year of investigation from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	5	5	2	4	3	3	4	3	5	4	3	2

TABLE 30 The number of families accounting for all ENT symptoms and reduced ENT symptoms reported from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	9	7	6	9	5	7	6	4	5	5	7	4
reduce	8	6	6	8	4	6	5	4	5	5	6	4

TABLE 31 The number of families accounting for all mental health symptoms reported from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	6	7	5	7	4	2	2	3	5	6	7	7

TABLE 32 The number of families accounting for all 'other' symptoms and reduced 'other' symptoms reported from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	7	1	2	5	4	3	1	2	2	1	1	2
reduce	4	1	1	2	4	2	0	1	2	1	1	2

TABLE 33 The number of families accounting for all skeletal-muscular symptoms and reduced skeletal-muscular symptoms reported from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	6	6	4	4	6	5	1	2	1	2	6	4
reduce	5	5	4	3	5	4	0	2	1	2	4	3

TABLE 34 The number of families accounting for all gastrointestinal symptoms and reduced gastrointestinal symptoms reported from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	7	7	6	6	1	5	4	1	2	1	4	5
reduce	6	5	3	4	0	3	3	1	2	1	3	4

TABLE 35 The number of families accounting for all fatigue symptoms and reduced fatigue symptoms reported from a total number of 18 families participating in the study.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
all	7	6	6	6	5	4	4	4	5	5	5	6

Group removed from the analysis

It was apparent during the analyses that five persons experienced many symptoms during the study, moreover these symptoms lingered for a long time. As a result of this the findings were somewhat skewed. It was decided to re-run the analysis with this group excluded. The number of symptoms experienced by respondents and the average length of time symptoms persisted are presented in the following two tables. The findings are discussed next. In these analyses symptoms with explainable causes removed (as described earlier) were also excluded. The overall number of symptoms was reduced to 803 symptoms or an average of 11 symptoms per person in one year (0.9 symptoms per month). Almost all of the symptom types decreased especially respiratory, skin, ENT, mental health, skeletal-muscular and fatigue. There was little change in the number of 'other' and gastrointestinal symptoms recorded.

The overall number of symptom days was greatly reduced with one group removed from the analysis. The number of symptom days for each symptom type is presented in the following table. The overall trend remained the same with the majority of symptom days associated with fatigue, respiratory and ENT symptoms. The number of symptom days associated with skeletal-muscular symptoms was reduced from 1297 days to 263 days. Mental health symptom days was 240 days compared to the initial total of 1556 days and symptom days for skin symptom was 212 days from 1788 days initially. Fatigue symptom days were almost halved. The total number of symptom days decreased from 11,827 days to 5,352 days. The initial findings revealed that symptoms were recorded 44% of the time or one day in every two. The number of days with one group removed revealed that symptoms were recorded 20% of the time or on one day in every five. These findings clearly highlight how one group of respondents skewed the findings.

TABLE 36 The number (%) of symptoms reported by respondents over the year of the study, the number (%) of symptoms reported with *explainable symptoms* removed and the number (%) of symptoms reported with a group removed.

Resp	Eye	Skin	ENT	MH	Other	SM	GI	Fatigue	Total
264 **19.5%**	107 **7.9%**	176 **13%**	222 **16.4%**	140 **10.3%**	49 **3.6%**	137 **10.1%**	88 **6.5%**	170 **12.6%**	**1353** **100%**
Symptoms removed									
224 **18.0%**	104 **8.4%**	175 **14.1%**	206 **16.6%**	136 **11.7%**	31 **2.5%**	128 **10.3%**	61 **4.9%**	169 **13.5%**	**1234** **100%**
Symptoms removed & group removed									
184 **22.9%**	79 **9.8%**	54 **6.7%**	167 **20.8%**	68 **8.5%**	27 **3.4%**	44 **5.5%**	52 **6.5%**	128 **15.9%**	**803** **100%**

TABLE 37 The number of days each symptom type persisted over the year of the study compared with the number of days symptoms persisted *with explainable symptoms* removed.

Symptom type	**Symptom days**	***Explainable symptoms* removed**	***Explainable symptoms* and group removed**
Respiratory	1848 (15.6%)	1660 (14.6%)	1330 (24.9%)
Eye	576 (4.9%)	568 (5.0%)	478 (8.9%)
Skin	1788 (15.1%)	1787 (15.8%)	212 (4.0%)
ENT	1252 (10.6%)	1212 (10.7%)	953 (17.8%)
Mental Health	1556 (13.2%)	1546 (13.6%)	240 (4.5%)
Other	341 (2.9%)	289 (2.5%)	225 (4.2%)
Skeletal-Muscular	1297 (10.9%)	1222 (10.8%)	263 (4.9%)
Gastrointestinal	306 (2.6%)	199 (1.8%)	108 (2.0%)
Fatigue	2863 (24.2%)	2862 (25.2%)	1543 (28.8%)
TOTAL	**11,827 (100%)**	**11,345 (100%)**	**5,352 (100%)**

TABLE 38 The number of symptoms experienced by respondents over the year of the study with a group of five removed from the analysis.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
RESP	N= 7, 10% Sum=10	N= 11, 16% Sum=12	N= 12, 17% Sum=25	N= 17, 24% Sum=24	N= 12, 17% Sum=18	N= 9, 13% Sum=15	N= 8, 11% Sum=10	N= 11, 16% Sum=12	N= 11, 16% Sum=13	N= 7, 11% Sum=12	N= 6, 9% Sum=16	N= 11, 19% Sum=17
EYE	N= 4, 6% Sum=5	N=4, 6% Sum=5	N= 6, 8% Sum=6	N= 2, 3% Sum=2	N= 4, 7% Sum=4	N= 13, 18% Sum=13	N= 5, 7% Sum=5	N= 6, 8% Sum=6	N= 8, 11% Sum=8	N= 7, 11% Sum=7	N= 9, 14% Sum=9	N= 9, 16% Sum=9
SKIN	N= 5, 7% Sum=5	N= 4, 6% Sum=4	N= 1, 1% Sum=1	N= 5, 7% Sum=5	N= 2, 3% Sum=4	N= 3, 4% Sum=3	N= 7, 10% Sum=13	N= 6, 8% Sum=6	N= 6, 8% Sum=6	N= 3, 5% Sum=3	N= 3, 5% Sum=3	N= 1, 2% Sum=1
ENT	N= 14, 20% Sum=20	N= 10, 14% Sum=18	N= 10, 14% Sum=16	N= 12, 17% Sum=12	N= 12, 17% Sum=13	N= 10, 14% Sum=19	N= 8, 11% Sum=13	N= 9, 13% Sum=11	N= 12, 17% Sum=16	N= 9, 14% Sum=10	N= 12, 19% Sum=12	N= 7, 12% Sum=7
MH	N= 7, 10% Sum=8	N= 8, 11% Sum=9	N= 5, 7% Sum=6	N= 6, 8% Sum=8	N= 4, 6% Sum=5	N= 2, 3% Sum=2	N= 0, 0% Sum=0	N= 3, 4% Sum=3	N= 7, 10% Sum=7	N= 6, 9% Sum=6	N= 9, 14% Sum=9	N= 9, 16% Sum=5
OTHER	N= 8, 11% Sum=8	N= 3, 4% Sum=3	N= 1, 1% Sum=1	N= 2, 3% Sum=2	N= 4, 6% Sum=5	N= 2, 3% Sum=2	N= 0, 0% Sum=0	N= 1, 1% Sum=1	N= 2, 3% Sum=2	N= 1, 2% Sum=1	N= 1, 2% Sum=1	N= 1, 2% Sum=1
SM	N= 5, 7% Sum=7	N= 5, 7% Sum=7	N= 3, 4% Sum=5	N= 2, 3% Sum=2	N= 6, 8% Sum=7	N=3, 4% Sum=3	N= 0, 0% Sum=0	N= 1, 1% Sum=2	N= 0, 0% Sum=0	N= 1, 2% Sum=1	N= 7, 11% Sum=7	N= 3, 5% Sum=3
GI	N= 7, 10% Sum=7	N= 6, 8% Sum=6	N= 4, 6% Sum=4	N= 5, 7% Sum=6	N= 0, 0% Sum=0	N= 8, 11% Sum=8	N= 4, 6% Sum=4	N= 2, 3% Sum=2	N= 3, 4% Sum=3	N= 2, 3% Sum=2	N= 3, 5% Sum=4	N= 5, 9% Sum=6
FATIG	N= 14, 20% Sum=14	N= 11, 15% Sum=16	N= 11, 15% Sum=11	N= 10, 14% Sum=10	N= 13, 18% Sum=13	N= 5, 7% Sum=5	N= 7, 10% Sum=7	N= 9, 13% Sum=9	N= 12, 17% Sum=12	N= 9, 14% Sum=9	N= 11, 17% Sum=11	N= 11, 19% Sum=11

TABLE 39 The average (SD) and range of days symptoms persisted over the year of investigation with explainable symptoms removed and a group of five removed.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
RESP	Mean 11 3 SD=9 1 Range=4-31 Sum=79 N=7, 10%	Mean 6.5 SD=8 3 Range=1-30 Sum=72 N=11, 16 %	Mean 17 1 SD=12 9 Range=3-31 Sum=205 N=12, 17%	Mean 5.5 SD=4 2 Range=1-12 Sum=93 N=17, 24%	Mean 5 8 SD=2.3 Range=2-10 Sum=69 N=12, 17%	Mean 15 0 SD=6 9 Range=1-20 Sum=135 N=9, 13%	Mean 4.0 SD=2.6 Range=1-9 Sum=32 N=8, 11%	Mean 9 3 SD=4.6 Range=1-13 Sum=102 N=11, 16%	Mean 9.6 SD=8 2 Range=1-18 Sum=106 N=11, 16%	Mean15 9 SD=7.7 Range=2-28 Sum=111 N=7, 11%	Mean 26.0 SD=12 2 Range=1-31 Sum=156 N=6, 9%	Mean 15.5 SD=14.1 Range=1-30 Sum=170 N=11, 19%
EYE	Mean4.5 SD=4.4 Range=1-11 Sum=18 N=4, 6%	Mean 3 8 SD=2.9 Range=2-8 Sum=15 N=4, 6%	Mean1.7 SD=1.6 Range=1-5 Sum=10 N=6, 8%	Mean 4.0 SD=2 8 Range=2-6 Sum=8 N=2, 3%	Mean 2.8 SD=1 7 Range=1-5 Sum=11 N=4, 6%	Mean 6 2 SD=5.7 Range=1-13 Sum=81 N=13, 18%	Mean 8.0 SD=0 0 Range=8-8 Sum=40 N=5, 7%	Mean 11.0 SD=2.4 Range=6-12 Sum=66 N=6, 8%	Mean 8.4 SD=3.7 Range=2-11 Sum=67 N=8, 11%	Mean 6 1 SD=2 3 Range=5-11 Sum=43 N=7, 11%	Mean 6 3 SD=3.0 Range=3-14 Sum=57 N=9, 14%	Mean 6.9 SD=8.8 Range=1-30 Sum=62 N=9, 16%
SKIN	Mean5.2 SD=6 0 Range=1-15 Sum=26 N=5, 7%	Mean5 8 SD=3.6 Range=1-9 Sum=23 N=4, 6%	Mean12 0 SD=0 0 Range=12 Sum=12 N=1, 1%	Mean4 6 SD=7.0 Range=1-17 Sum=23 N=5, 7%	Mean11 0 SD=7.1 Range=6-16 Sum=22 N=2, 3%	Mean1 3 SD=0.6 Range=1-2 Sum=4 N=3, 4%	Mean3 7 SD=3 4 Range=2-11 Sum=26 N=7, 10%	Mean2 2 SD=2.9 Range=1-8 Sum=13 N=6, 8%	Mean5.2 SD=6 7 Range=1-18 Sum=31 N=6, 8%	Mean3.7 SD=2 5 Range=1-6 Sum=11 N=3, 5%	Mean4 3 SD=1 2 Range=3-5 Sum=13 N=3, 5%	Mean8.0 SD=0 0 Range=8-8 Sum=8 N=1, 2%
ENT	Mean5 0 SD=7 7 Range=1-31 Sum=70 N=14, 20%	Mean20 5 SD=13 4 Range=3-31 Sum=205 N=10, 14%	Mean17 2 SD=14.6 Range=2-31 Sum=172 N=10, 14%	Mean3 2 SD=2.7 Range=1-10 Sum=38 N=12, 17%	Mean3 4 SD=1 5 Range=1-5 Sum=41 N=12, 17%	Mean11 8 SD=7.9 Range=1-19 Sum=118 N=10, 14%	Mean2 5 SD=0 8 Range=1-3 Sum=20 N=8, 11%	Mean9.7 SD=4.8 Range=1-16 Sum=87 N=9, 13%	Mean7 3 SD=4 2 Range=1-12 Sum=87 N=12, 17%	Mean2.1 SD=1.8 Range=1-6 Sum=19 N=9, 14%	Mean 5.7 SD=3.9' Range=2-17 Sum=68 N=12, 19%	Mean4.0 SD=1 2 Range=2-6 Sum=28 N=7, 12%
MH	Mean3 0 SD=2 2 Range=1-7 Sum=21 N=7, 10%	Mean5 6 SD=7 7 Range=1-24 Sum=45 N=8, 11%	Mean2.2 SD=1 3 Range=1-4 Sum=11 N=5, 7%	Mean2.8 SD=1 2 Range=1-4 Sum=17 N=6, 8%	Mean2 0 SD=1 4 Range=1-4 Sum=8 N=4, 6%	Mean2.0 SD=1 4 Range=1-3 Sum=4 N=2, 3%	Mean0 SD=0.0 Range=0 Sum=0 N=0, 0%	Mean4 3 SD=2 1 Range=2-6 Sum=13 N=3, 4%	Mean2 1 SD=1.0 Range=1-3 Sum=15 N=7, 10%	Mean3.0 SD=4 0 Range=1-11 Sum=18 N=6, 9%	Mean4 0 SD=4.4 Range=1-14 Sum=36 N=9, 14%	Mean5 8 SD=9 2 Range=1-30 Sum=52 N=9, 16%
OTHER	Mean9 5 SD=13 4 Range=1-31	Mean1.0 SD=0 0 Range=1-1	Mean31 SD=0 0 Range=31	Mean16 0 SD=21 2 Range=1-31	Mean9.5 SD=12 4 Range=2-28	Mean6.0 SD=4.2 Range=3-9	Mean0 SD=0 Range=0	Mean4 0 SD=0 0 Range=4-4	Mean4 0 SD=4.2 Range=1-7	Mean7 0 SD=0 0 Range=7-7	Mean10.0 SD=0 0 Range=10	Mean4 0 SD=0.0 Range=4-4

	Sum=76 N=8, 11%	Sum=3 N=3, 4%	Sum=31 N=1, 1%	Sum=32 N=2, 3%	Sum=38 N=4, 6%	Sum=12 N=2, 3%	Sum=0 N=0, 0%	Sum=4 N=1, 1%	Sum=8 N=2, 3%	Sum=7 N=1, 1%	Sum=10 N=1, 2%	Sum=4 N=1, 2%
SM	Mean9.8 SD=12 5 Range=1-31 Sum=49 N=5, 7%	Mean12.4 SD=13 5 Range=1-30 Sum=62 N=5, 7%	Mean6 7 SD=5.1 Range=1-11 Sum=20 N=3, 4%	Mean10 0 SD=12 7 Range=1-19 Sum=20 N=2, 3%	Mean5 2 SD=5 4 Range=1-13 Sum=31 N=6, 8%	Mean1 7 SD=0 6 Range=1-2 Sum=5 N=3, 4%	Mean0 SD=0 Range=0 Sum=0 N=0, 0%	Mean6.0 SD=0 0 Range=6-6 Sum=6 N=1, 1%	Mean0 SD=0 Range=0 Sum=0 N=0, 0%	Mean3.0 SD=0.0 Range=3-3 Sum=3 N=1, 2%	Mean4 7 SD=4 5 Range=3-15 Sum=33 N=7, 11%	Mean11 3 SD=16 2 Range=2-30 Sum=34 N=3, 5%
GI	Mean2 1 SD=1.0 Range=1-3 Sum=15 N=7, 10%	Mean2 0 SD=1 1 Range=1-3 Sum=12 N=6, 8%	Mean1 3 SD=0 5 Range=1-2 Sum=5 N=4, 6%	Mean2.2 SD=1.6 Range=1-4 Sum=11 N=5, 7%	Mean0 SD=00 Range=0 Sum=0 N=0, 0%	Mean2 4 SD=1 1 Range=1-4 Sum=19 N=8, 11%	Mean1 3 SD=1 5 Range=1-2 Sum=5 N=4, 6%	Mean3.0 SD=0 0 Range=3-3 Sum=6 N=2, 3%	Mean3 7 SD=2 3 Range=1-5 Sum=11 N=3, 4%	Mean3 0 SD=0 0 Range=3-3 Sum=6 N=2, 3%	Mean2.3 SD=0 6 Range=2-3 Sum=7 N=3, 5%	Mean2 2 SD=1 1 Range=1-4 Sum=11 N=5, 9%
FATIG	Mean13.8 SD=13.6 Range=1-31 Sum=193 N=14, 20%	Mean18 6 SD=13 3 Range=2-31 Sum=205 N=11, 15%	Mean17.7 SD=14 1 Range=2-31 Sum=177 N=10, 14%	Mean13 7 SD=14 3 Range=1-31 Sum=178 N=13, 18%	Mean4.2 SD=1.9 Range=1-6 Sum=21 N=5, 7%	Mean2 1 SD=1 5 Range=1-5 Sum=19 N=9, 13%	Mean4 3 SD=3 9 Range=2-13 Sum=30 N=7, 10%	Mean8.0 SD=6 0 Range=1-13 Sum=72 N=9, 13%	Mean15.4 SD=13 2 Range=1-30 Sum=185 N=12,17%	Mean21 4 SD=12 0 Range=3-31 Sum=193 N=9, 14%	Mean16 0 SD=12 4 Range=1-27 Sum=176 N=11, 17%	Mean8 5 SD=5 4 Range=3-23 Sum=94 N=11, 19%

Findings with a group of five removed from the analyses
Each of the symptom types are discussed separately and findings are compared with the findings when '*explainable symptoms*' were removed.

Changes in respiratory symptoms with one group removed.
The number of respiratory symptoms reported by all respondents differed from those reported when one group was removed. The biggest differences can be seen in the early months of the study, October, November, December and January. With all of the respondents considered, the number of respiratory symptoms reported in October was 12 (16%). This number drops when one group is removed (N=7, 10%). However, these differences are more notable in November. The number of respiratory symptoms reported was 16 (21%). Following the removal of one group from the study, this number drops to 11 (16%). In December a reduction in the number of respiratory symptoms was also apparent with the group removed. These numbers fall from N=17 (22%) to N=12 (17%). As the year progresses, the numbers of respiratory symptoms remain similar when examining those reported by all respondents and one group removed. More noteworthy is the fact that the average length of time symptoms persisted declined. In October the average length of time declined from 19.5 days to 11.3 days with one group removed. The number of days in November declines from an average of 13.6 days to 6.5 days.

Changes in eye symptoms with one group removed.
With regard to the number of eye symptoms reported throughout the year of investigation, there is not much variation between those reported by all respondents and those with one group removed. Once again, any difference between the number of eye symptoms reported can be noted in the winter months of October, November and December. To illustrate, throughout the month of October and November, the number of eye symptoms reported was N=9 (12%) (for both months) compared to N=4 (6%) (for both months) following the removal of one group. The average length of time eye symptoms persisted during each month also declined significantly. In December the average length of time dropped from 5 days to 1.7 days with one group removed. In September, the final month of the study, the average length of time eye symptoms persisted declined from 6.9 days to only 1 day.

Changes in skin symptoms with one group removed.
The number of skin symptoms experienced by respondents over the year of study differs with regard to every month when the group was removed. The greatest difference can be seen in January. The number of skin symptoms experienced by respondents was N=11, (15%). However, when one group was removed from the study, the number of skin symptoms reported in the same month was N=5 (7%). Other differences are apparent in October with N=10 (13%) reported and N=5 (7%) following the removal of one group. During the month of December, the number of skin symptoms reported when the group was removed was N=1 (1%). This compares to N=6 (8%) when all respondents were included in the analyses. The average length of time skin symptoms persisted also declined. In November and December the average length of time skin symptoms persisted was 17.6 days and 27.8 days respectively and these figures declined to 5.8 days and 12 days when one group was removed. The average length of time skin symptoms persisted in March was 20 days and this declined to 1.3 days when one group was removed. This clearly reveals how some results were skewed by a group of five individuals with very persistent health problems.

Changes in ENT symptoms with one group removed.
The percentage of ear nose and throat symptoms experienced by respondents is reduced for the majority of months when the group was removed from the study. To illustrate, during the months of November and December the numbers reporting ENT symptoms were N=15 (20%) for both months and this declines to 10 persons (14%) when the group was removed. During the Summer months of May, June and July, the number of ear nose and throat symptoms reported remained the

same. There were some changes in the number of days ENT symptoms persisted, for example, in September the average number of days symptoms persisted declined from 8.4 days to 4 days.

Changes in mental health symptoms with one group removed.
There is obvious variation between the number of mental health symptoms reported by all respondents and the findings with a group removed throughout the year of investigation. The most apparent drop in such figures can be seen in the month of April. For this month, the number of mental health symptoms reported was N=5, 9%. However, following the removal of a group of five, this number drops to N=0, 0%. Other variations are apparent in January where 11 (15%) mental health symptoms were reported. This figure was almost halved (N=6, 8%) when the group was removed. During the months of February and March, there was no difference between the numbers of mental health symptoms reported when the group was removed from the analyses. The average length of time symptoms persisted also declined considerably, for example, in April the average length of time symptoms persisted was 30 days and this declined to 0 when the group was removed. The average length of time symptoms persisted in May was 21 days and this dropped to 4 days with one group removed.

Changes in 'other' symptoms with one group removed.
With regard to 'other' symptoms reported throughout the year of investigation, there was slight variation in the findings with one group of respondents removed. The number of other symptoms reported during the month of September was N=5, 8% with everyone included. However, following the elimination of one group from the study, these numbers dropped to N=1, 2%. The number of days symptoms persisted for this month also dropped from 13.6 days to 4 days. There were no other changes.

Changes in skeletal muscular symptoms with one group removed.
The number of skeletal muscular symptoms experienced over the year of the study differed in every month when the group was removed. In October, the number of skeletal muscular symptoms experienced by the respondents was N=10, 13%. However, with one group removed, this figure decreased by over half (N=5, 7%). During the month of December, the number of skeletal-muscular symptoms reported was N=8, 11%. The number reported with the group removed was smaller for the same month (N=3, 4%). Throughout the month of June, no skeletal muscular symptoms were reported when one group was removed. This was not the case with everyone included (N=5, 7%). As expected the number of days skeletal muscular symptoms persisted also declined, for example, in October the average number of days symptoms prevailed declined from 20 days to 10 days. In June the average number of days fell from 30 days to 0 days.

Changes in gastrointestinal symptoms with one group removed.
The percentage of gastrointestinal symptoms reported in October was 16%, (N=12). This percentage falls to 10% (N=7) when the group was removed. In August the percentage with gastrointestinal symptoms was 10% (N=7) and this declined to 5% (N=3). There was little change in the average length of time symptoms persisted.

Changes in fatigue symptoms with one group removed.
The number of fatigue symptoms reported by all families differed from those reported with a group of respondents removed. The biggest difference was seen in March. The number of fatigue symptoms experienced in this month by respondents was N=14, 18%. However, with the removal of one group this number decreased to N=5, 7%. In January, the percentage of fatigue symptoms experienced was N=18, 24%. Once again, this percentage decreased following the removal of one group (N=10, 14%). No such difference can be found in June and July. The average length of time symptoms persisted also declined, for example, in February the average length of time dropped from 16 days to 4 days.

Conclusion with one group removed from the analysis

As can be seen from the above findings the numbers experiencing symptoms and the average length of time symptoms persisted declined considerably when one group of five respondents was removed from the analyses.

- The total number of symptom episodes reduced from 1353 to 803 symptom episodes. In other words a group of five individuals accounted for 550 symptom episodes.
- The number of symptom days decreased to 5352 days. These five individuals accounted for 6475 symptom days.
- The fatigue symptom days were almost halved.
- The reduction in symptom episodes to 803 in one year can be interpreted as each individual, on average, experiencing 11 symptom episodes per year.
- The reduction in symptom days to 5352 in one year can be interpreted as, on average, individuals were ill approximately one day in five or 20% of the time.

TABLE 40 The number (%) of symptoms reported by respondents over the year of the study, the number (%) of symptoms reported with *explainable symptoms* removed and the number (%) of symptoms reported with a group removed.

Resp	Eye	Skin	ENT	MH	Other	SM	GI	Fatigue	Total
264 **19.5%**	107 **7.9%**	176 **13%**	222 **16.4%**	140 **10.3%**	49 **3.6%**	137 **10.1%**	88 **6.5%**	170 **12.6%**	**1353** **100%**
Symptoms removed									
224 **18.0%**	104 **8.4%**	175 **14.1%**	206 **16.6%**	136 **11.7%**	31 **2.5%**	128 **10.3%**	61 **4.9%**	169 **13.5%**	**1234** **100%**
Symptoms removed & group removed									
184 **22.9%**	79 **9.8%**	54 **6.7%**	167 **20.8%**	68 **8.5%**	27 **3.4%**	44 **5.5%**	52 **6.5%**	128 **15.9%**	**803** **100%**

TABLE 41 The number of days each symptom type persisted over the year of the study compared with the number of days symptoms persisted *with explainable symptoms* removed.

Symptom type	**Symptom days**	***Explainable symptoms* removed**	***Explainable symptoms* and group removed**
Respiratory	1848 (15.6%)	1660 (14.6%)	1330 (24.9%)
Eye	576 (4.9%)	568 (5.0%)	478 (8.9%)
Skin	1788 (15.1%)	1787 (15.8%)	212 (4.0%)
ENT	1252 (10.6%)	1212 (10.7%)	953 (17.8%)
Mental Health	1556 (13.2%)	1546 (13.6%)	240 (4.5%)
Other	341 (2.9%)	289 (2.5%)	225 (4.2%)
Skeletal-Muscular	1297 (10.9%)	1222 (10.8%)	263 (4.9%)
Gastrointestinal	306 (2.6%)	199 (1.8%)	108 (2.0%)
Fatigue	2863 (24.2%)	2862 (25.2%)	1543 (28.8%)
TOTAL	**11,827 (100%)**	**11,345 (100%)**	**5,352 (100%)**

TABLE 42 The number of symptoms experienced by respondents over the year of the study with a group of five removed from the analysis.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
RESP	N= 7, 10% Sum=10	N= 11, 16% Sum=12	N= 12, 17% Sum=25	N= 17, 24% Sum=24	N= 12, 17% Sum=18	N= 9, 13% Sum=15	N= 8, 11% Sum=10	N= 11, 16% Sum=12	N= 11, 16% Sum=13	N= 7, 11% Sum=12	N= 6, 9% Sum=16	N= 11, 19% Sum=17
EYE	N= 4, 6% Sum=5	N=4, 6% Sum=5	N= 6, 8% Sum=6	N= 2, 3% Sum=2	N= 4, 7% Sum=4	N= 13, 18% Sum=13	N= 5, 7% Sum=5	N= 6, 8% Sum=6	N= 8, 11% Sum=8	N= 7, 11% Sum=7	N= 9, 14% Sum=9	N= 9, 16% Sum=9
SKIN	N= 5, 7% Sum=5	N= 4, 6% Sum=4	N= 1, 1% Sum=1	N= 5, 7% Sum=5	N= 2, 3% Sum=4	N= 3, 4% Sum=3	N= 7, 10% Sum=13	N= 6, 8% Sum=6	N= 6, 8% Sum=6	N= 3, 5% Sum=3	N= 3, 5% Sum=3	N= 1, 2% Sum=1
ENT	N= 14, 20% Sum=20	N= 10, 14% Sum=18	N= 10, 14% Sum=16	N= 12, 17% Sum=12	N= 12, 17% Sum=13	N= 10, 14% Sum=19	N= 8, 11% Sum=13	N= 9, 13% Sum=11	N= 12, 17% Sum=16	N= 9, 14% Sum=10	N= 12, 19% Sum=12	N= 7, 12% Sum=7
MH	N= 7, 10% Sum=8	N= 8, 11% Sum=9	N= 5, 7% Sum=6	N= 6, 8% Sum=8	N= 4, 6% Sum=5	N= 2, 3% Sum=2	N= 0, 0% Sum=0	N= 3, 4% Sum=3	N= 7, 10% Sum=7	N= 6, 9% Sum=6	N= 9, 14% Sum=9	N= 9, 16% Sum=5
OTHER	N= 8, 11% Sum=8	N= 3, 4% Sum=3	N= 1, 1% Sum=1	N= 2, 3% Sum=2	N= 4, 6% Sum=5	N= 2, 3% Sum=2	N= 0, 0% Sum=0	N= 1, 1% Sum=1	N= 2, 3% Sum=2	N= 1, 2% Sum=1	'N= 1, 2% Sum=1	N= 1, 2% Sum=1
SM	N= 5, 7% Sum=7	N= 5, 7% Sum=7	N= 3, 4% Sum=5	N= 2, 3% Sum=2	N= 6, 8% Sum=7	N=3, 4% Sum=3	N= 0, 0% Sum=0	N= 1, 1% Sum=2	N= 0, 0% Sum=0	N= 1, 2% Sum=1	N= 7, 11% Sum=7	N= 3, 5% Sum=3
GI	N= 7, 10% Sum=7	N= 6, 8% Sum=6	N= 4, 6% Sum=4	N= 5, 7% Sum=6	N= 0, 0% Sum=0	N= 8, 11% Sum=8	N= 4, 6% Sum=4	N= 2, 3% Sum=2	N= 3, 4% Sum=3	N= 2, 3% Sum=2	N= 3, 5% Sum=4	N= 5, 9% Sum=6
FATIG	N= 14, 20% Sum=14	N= 11, 15% Sum=16	N= 11, 15% Sum=11	N= 10, 14% Sum=10	N= 13, 18% Sum=13	N= 5, 7% Sum=5	N= 7, 10% Sum=7	N= 9, 13% Sum=9	N= 12, 17% Sum=12	N= 9, 14% Sum=9	N= 11, 17% Sum=11	N= 11, 19% Sum=11

TABLE 43 The average (SD) and range of days symptoms persisted over the year of investigation with explainable symptoms removed and a group of five removed.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
RESP	Mean 11 3 SD=9 1 Range=4-31 Sum=79 N=7, 10%	Mean 6.5 SD=8 3 Range=1-30 Sum=72 N=11, 16 %	Mean 17 1 SD=12 9 Range=3-31 Sum=205 N=12, 17%	Mean 5 5 SD=4 2 Range=1-12 Sum=93 N=17, 24%	Mean 5 8 SD=2 3 Range=2-10 Sum=69 N=12, 17%	Mean 15 0 SD=6.9 Range=1-20 Sum=135 N=9, 13%	Mean 4.0 SD=2.6 Range=1-9 Sum=32 N=8, 11%	Mean 9.3 SD=4 6 Range=1-13 Sum=102 N=11, 16%	Mean 9.6 SD=8 2 Range=1-18 Sum=106 N=11, 16%	Mean15 9 SD=7 7 Range=2-28 Sum=111 N=7, 11%	Mean 26 0 SD=12 2 Range=1-31 Sum=156 N=6, 9%	Mean 15 5 SD=14 1 Range=1-30 Sum=170 N=11, 19%
EYE	Mean4 5 SD=4 4 Range=1-11 Sum=18 N=4, 6%	Mean 3 8 SD=2 9 Range=2-8 Sum=15 N=4, 6%	Mean1 7 SD=1 6 Range=1-5 Sum=10 N=6, 8%	Mean 4 0 SD=2 8 Range=2-6 Sum=8 N=2, 3%	Mean 2 8 SD=1 7 Range=1-5 Sum=11 N=4, 6%	Mean 6.2 SD=5.7 Range=1-13 Sum=81 N=13, 18%	Mean 8 0 SD=0 0 Range=8-8 Sum=40 N=5, 7%	Mean 11 0 SD=2 4 Range=6-12 Sum=66 N=6, 8%	Mean 8 4 SD=3 7 Range=2-11 Sum=67 N=8, 11%	Mean 6 1 SD=2 3 Range=5-11 Sum=43 N=7, 11%	Mean 6 3 SD=3.0 Range=3-14 Sum=57 N=9, 14%	Mean 6 9 SD=8.8 Range=1-30 Sum=62 N=9, 16%
SKIN	Mean5 2 SD=6 0 Range=1-15 Sum=26 N=5, 7%	Mean5 8 SD=3 6 Range=1-9 Sum=23 N=4, 6%	Mean12 0 SD=0.0 Range=12 Sum=12 N=1, 1%	Mean4 6 SD=7 0 Range=1-17 Sum=23 N=5, 7%	Mean11 0 SD=7 1 Range=6-16 Sum=22 N=2, 3%	Mean1 3 SD=0.6 Range=1-2 Sum=4 N=3, 4%	Mean3 7 SD=3 4 Range=2-11 Sum=26 N=7, 10%	Mean2.2 SD=2 9 Range=1-8 Sum=13 N=6, 8%	Mean5.2 SD=6 7 Range=1-18 Sum=31 N=6, 8%	Mean3 7 SD=2 5 Range=1-6 Sum=11 N=3, 5%	Mean4 3 SD=1 2 Range=3-5 Sum=13 N=3, 5%	Mean8 0 SD=0.0 Range=8-8 Sum=8 N=1, 2%
ENT	Mean5 0 SD=7 7 Range=1-31 Sum=70 N=14, 20%	Mean20 5 SD=13 4 Range=3-31 Sum=205 N=10, 14%	Mean17 2 SD=14 6 Range=2-31 Sum=172 N=10, 14%	Mean3.2 SD=2 7 Range=1-10 Sum=38 N=12, 17%	Mean3 4 SD=1 5 Range=1-5 Sum=41 N=12, 17%	Mean11.8 SD=7 9 Range=1-19 Sum=118 N=10, 14%	Mean2 5 SD=0 8 Range=1-3 Sum=20 N=8, 11%	Mean9.7 SD=4 8 Range=1-16 Sum=87 N=9, 13%	Mean7 3 SD=4 2 Range=1-12 Sum=87 N=12, 17%	Mean2 1 SD=1.8 Range=1-6 Sum=19 N=9, 14%	Mean 5 7 SD=3.9 Range=2-17 Sum=68 N=12, 19%	Mean4 0 SD=1.2 Range=2-6 Sum=28 N=7, 12%
MH	Mean3 0 SD=2 2 Range=1-7 Sum=21 N=7, 10%	Mean5 6 SD=7 7 Range=1-24 Sum=45 N=8, 11%	Mean2 2 SD=1 3 Range=1-4 Sum=11 N=5, 7%	Mean2 8 SD=1 2 Range=1-4 Sum=17 N=6, 8%	Mean2 0 SD=1 4 Range=1-4 Sum=8 N=4, 6%	Mean2 0 SD=1 4 Range=1-3 Sum=4 N=2, 3%	Mean0 SD=0 0 Range=0 Sum=0 N=0, 0%	Mean4 3 SD=2 1 Range=2-6 Sum=13 N=3, 4%	Mean2.1 SD=1.0 Range=1-3 Sum=15 N=7, 10%	Mean3 0 SD=4 0 Range=1-11 Sum=18 N=6, 9%	Mean4.0 SD=4.4 Range=1-14 Sum=36 N=9, 14%	Mean5 8 SD=9 2 Range=1-30 Sum=52 N=9, 16%
OTHER	Mean9 5 SD=13 4 Range=1-31	Mean1 0 SD=0 0 Range=1-1	Mean31 SD=0.0 Range=31	Mean16 0 SD=21 2 Range=1-31	Mean9 5 SD=12.4 Range=2-28	Mean6 0 SD=4 2 Range=3-9	Mean0 SD=0 Range=0	Mean4 0 SD=0.0 Range=4-4	Mean4 0 SD=4 2 Range=1-7	Mean7.0 SD=0 0 Range=7-7	Mean10 0 SD=0 0 Range=10	Mean4 0 SD=0.0 Range=4-4

	Sum=76 N=8, 11%	Sum=3 N=3, 4%	Sum=31 N=1, 1%	Sum=32 N=2, 3%	Sum=38 N=4, 6%	Sum=12 N=2, 3%	Sum=0 N=0, 0%	Sum=4 N=1, 1%	Sum=8 N=2, 3%	Sum=7 N=1, 1%	Sum=10 N=1, 2%	Sum=4 N=1, 2%
SM	Mean9.8 SD=12.5 Range=1-31 Sum=49 N=5, 7%	Mean12 4 SD=13 5 Range=1-30 Sum=62 N=5, 7%	Mean6 7 SD=5 1 Range=1-11 Sum=20 N=3, 4%	Mean10 0 SD=12 7 Range=1-19 Sum=20 N=2, 3%	Mean5 2 SD=5.4 Range=1-13 Sum=31 N=6, 8%	Mean1 7 SD=0.6 Range=1-2 Sum=5 N=3, 4%	Mean0 SD=0 Range=0 Sum=0 N=0, 0%	Mean6 0 SD=0.0 Range=6-6 Sum=6 N=1, 1%	Mean0 SD=0 Range=0 Sum=0 N=0, 0%	Mean3 0 SD=0.0 Range=3-3 Sum=3 N=1, 2%	Mean4 7 SD=4.5 Range=3-15 Sum=33 N=7, 11%	Mean11 3 SD=16 2 Range=2-30 Sum=34 N=3, 5%
GI	Mean2.1 SD=1.0 Range=1-3 Sum=15 N=7, 10%	Mean2.0 SD=1 1 Range=1-3 Sum=12 N=6, 8%	Mean1 3 SD=0 5 Range=1-2 Sum=5 N=4, 6%	Mean2 2 SD=1 6 Range=1-4 Sum=11 N=5, 7%	Mean0 SD=00 Range=0 Sum=0 N=0, 0%	Mean2 4 SD=1.1 Range=1-4 Sum=19 N=8, 11%	Mean1.3 SD=1 5 Range=1-2 Sum=5 N=4, 6%	Mean3 0 SD=0 0 Range=3-3 Sum=6 N=2, 3%	Mean3.7 SD=2 3 Range=1-5 Sum=11 N=3, 4%	Mean3 0 SD=0 0 Range=3-3 Sum=6 N=2, 3%	Mean2 3 SD=0.6 Range=2-3 Sum=7 N=3, 5%	Mean2 2 SD=1 1 Range=1-4 Sum=11 N=5, 9%
FATIG	Mean13 8 SD=13 6 Range=1-31 Sum=193 N=14, 20%	Mean18.6 SD=13.3 Range=2-31 Sum=205 N=11, 15%	Mean17.7 SD=14 1 Range=2-31 Sum=177 N=10, 14%	Mean13 7 SD=14.3 Range=1-31 Sum=178 N=13, 18%	Mean4 2 SD=1 9 Range=1-6 Sum=21 N=5, 7%	Mean2 1 SD=1 5 Range=1-5 Sum=19 N=9, 13%	Mean4 3 SD=3 9 Range=2-13 Sum=30 N=7, 10%	Mean8.0 SD=6 0 Range=1-13 Sum=72 N=9, 13%	Mean15 4 SD=13.2 Range=1-30 Sum=185 N=12,17%	Mean21.4 SD=12.0 Range=3-31 Sum=193 N=9, 14%	Mean16 0 SD=12 4 Range=1-27 Sum=176 N=11, 17%	Mean8 5 SD=5 4 Range=3-23 Sum=94 N=11, 19%

PRESENTATION OF RESULTS

Symptoms reported by adults and children

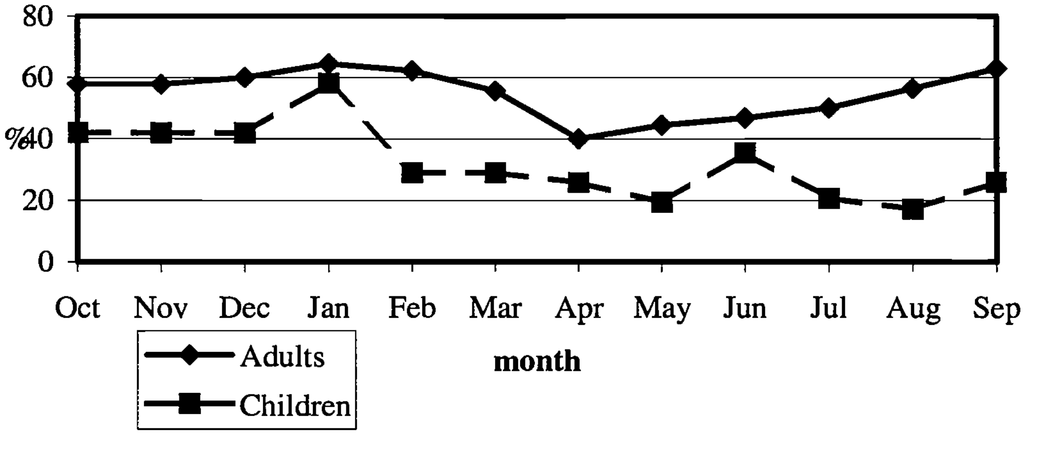
Another aim of the study was to investigate if some family members were more susceptible to health problems than others. In the next section symptoms experienced by adults and symptoms experienced by children are compared. There were 45 respondents over the age of 18 years and 31 respondents under 18 years. As can be seen from the table below adults accounted for 79% of all symptoms reported with children accounting for the remaining 21%. Other findings are presented in the table below.

TABLE 44 The total number of symptoms experienced and the proportion experienced by adults and children.

	Total	Resp	Eye	Skin	ENT	MH	Other	SM	GI	Fatigue
Adult	1070 **79%**	208 **79%**	94 **88%**	140 **80%**	170 **77%**	108 **77%**	28 **57%**	116 **85%**	60 **68%**	146 **86%**
< 18	283 **21%**	56 **21%**	13 **12%**	36 **20%**	52 **23%**	32 **23%**	21 **43%**	21 **15%**	28 **32%**	24 **14%**
Total	**1353**	**264**	**107**	**176**	**222**	**140**	**49**	**137**	**88**	**170**

Adults experienced more symptoms than children for all symptom types. However 'other' symptoms were experienced by approximately half of the adults and half of the children. The following graph reveals the percentage of adults and children experiencing symptoms throughout the year of investigation. Adults experienced more symptoms than children for all 12 months of the study. The percentage of symptoms reported by children peaked in the winter months. However the percentage of symptoms reported by adults remained relatively stable over the year except for a drop in late Spring. The findings for total number of symptoms reported and for each symptom type as reported by adults and children are presented in the following series of graphs.

Figure 26 Percentage of adults and children who reported a health symptom throughout the year of investigation.



A comparison of respiratory symptoms experienced by adults and those experienced by children are graphically represented below. Overall adults experienced more respiratory symptoms than children. For both groups respiratory symptoms peaked during the winter months and began to increase in the final months (autumn) of the study. Adults and children were also compared on the level of eye symptoms experienced. Adults experienced considerably more symptoms than children. In the final six months of the study only one child had an eye complaint. On the contrary the number of eye symptoms experienced by adults began to increase in the final months of the study. The maximum number of adults who experienced eye symptoms was 11 peaking in December, March, August and September. The maximum number of children was 3 (9.7%).
As was the case with respiratory and eye symptoms adults experienced more skin complaints than children. The number of skin complaints peaked in April and May for adults while the most skin complaints experienced by children was in January and June. These findings are presented in the graph below. The maximum number of adults to experience skin complaints was 11 from a total of 45. The maximum number of children to experience skin complaints was 5 from a total of 31 children in the study. Overall the pattern of skin complaints reported were quite random. With regard to ENT symptoms adults experienced more symptoms than children. ENT symptoms were highest for adults in October with a total of 16 persons (35.6%) from the adult population of 45 persons reporting ENT symptoms. ENT symptoms reported by children peaked in June with a total of six children (19.4%) reporting ENT symptoms. The number of mental health symptoms reported by adults and children are presented in the graph below. The overall pattern for adults and children was relatively the same except for the final few months of the study. The maximum number of mental health symptoms reported by adults was in August where 11 persons (28.2%) reported symptoms. Most symptoms were experienced by children in the final month of the study where four children (14.8%) reported mental health symptoms. Few adults and children reported 'other' symptoms. The majority of other symptoms reported by adults was in the first month of the study (N=6, 13.3%) and a similar number of children also experienced 'other' problems in the first month of the study also (N=6, 19.4%). These findings are presented in the following graph. Adults reported more skeletal muscular symptoms than children who experienced few skeletal muscular problems. The pattern over the year of the study is apparent from the graph below.
The maximum number of children to report skeletal muscular problems was 3 (9.7%) and this was in the month of November. A total of 12 adults (30.8%) reported skeletal muscular symptoms and this was in the month of August. The pattern of gastrointestinal symptoms experienced by adults and children over the year of the study are presented in the graph below. Clearly adults reported more symptoms than children. In March the most adults reported gastrointestinal symptoms (N=9, 20%). The maximum number of children to report gastrointestinal symptoms was (N=5, 16%) in the months of October, November and December. In three months of the study there were no gastrointestinal symptoms reported by children.
Clearly, as evident from the graph below, adults experienced fatigue more than children. The pattern was relatively consistent over the year of the study except in February and July where the numbers dropped slightly. However the number began to rise in the last month of the study where the number of adults experiencing fatigue was 13 (37.1%). The highest number of children experiencing fatigue during any one month was four (12.9%).

Figure 27 Percentage of adults and children who reported respiratory symptoms throughout the year of investigation

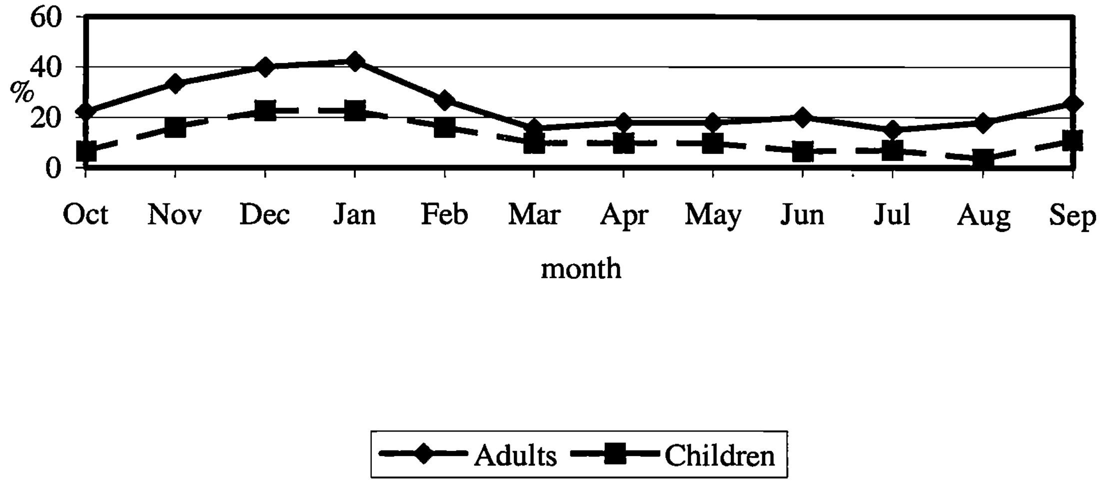


Figure 28 Percentage of adults and children who reported eye symptoms throughout the year of investigation.

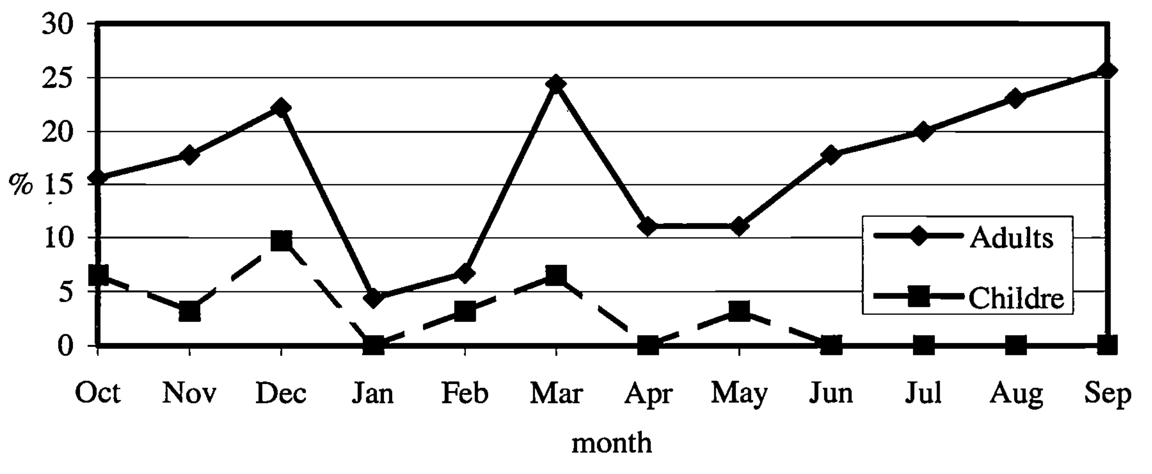


Figure 29 Percentage of adults and children who reported skin symptoms throughout the year of investigation

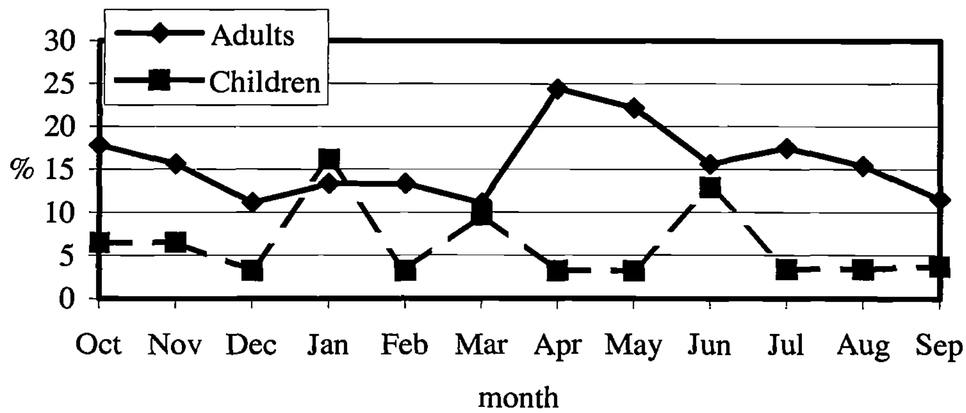


Figure 30 Percentage of adults and children who reported mental health symptoms throughout the year of investigation.

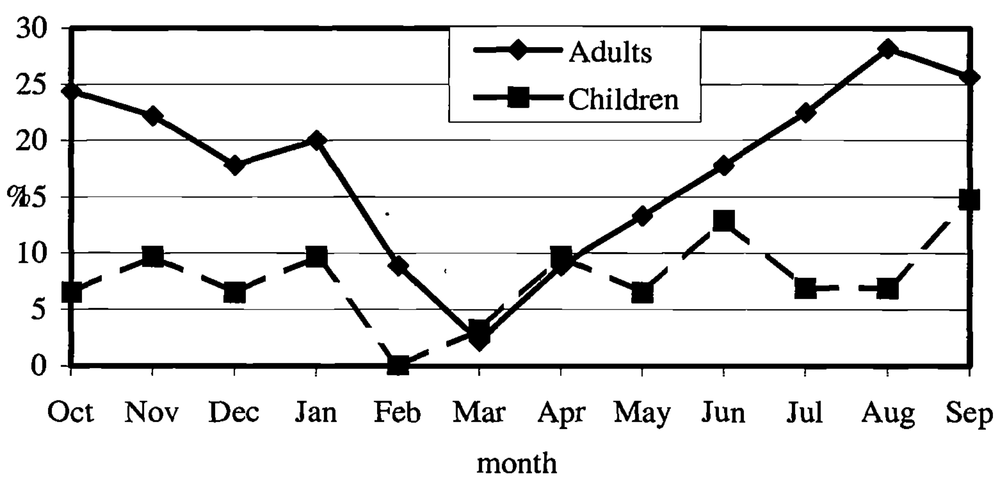


Figure 31 Percentage of adults and children who reported ear nose and throat symptoms throughout the year of investigation.

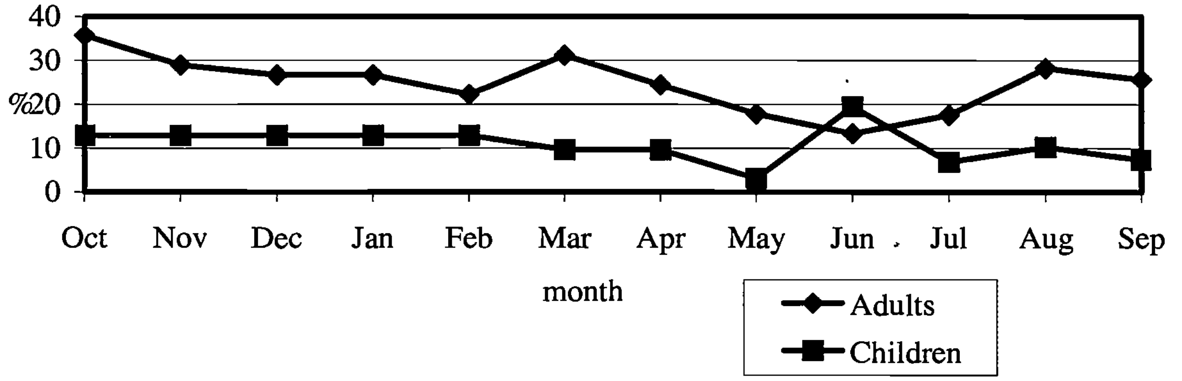


Figure 32 Percentage of adults and children who reported other symptoms throughout the year of investigation.

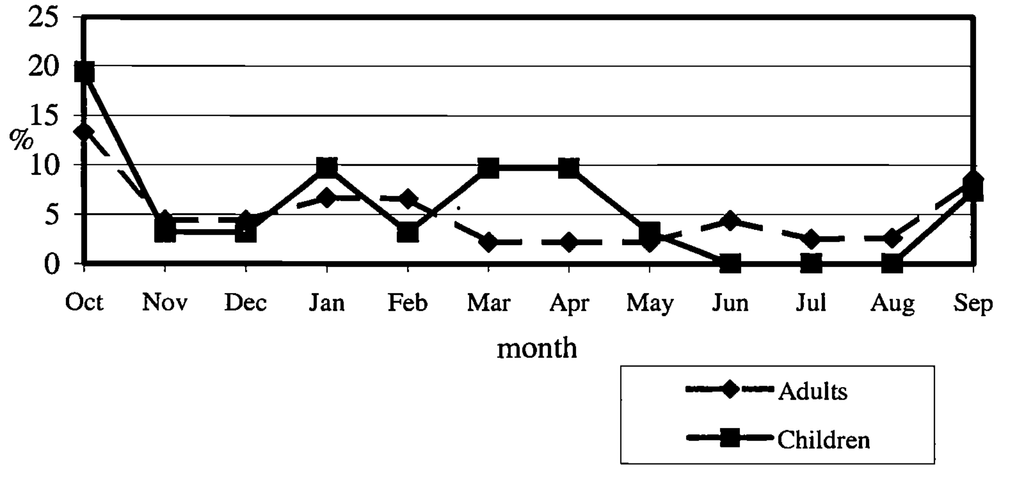


Figure 33 Percentage of adults and children who reported skeletal muscular symptoms throughout the year of investigation

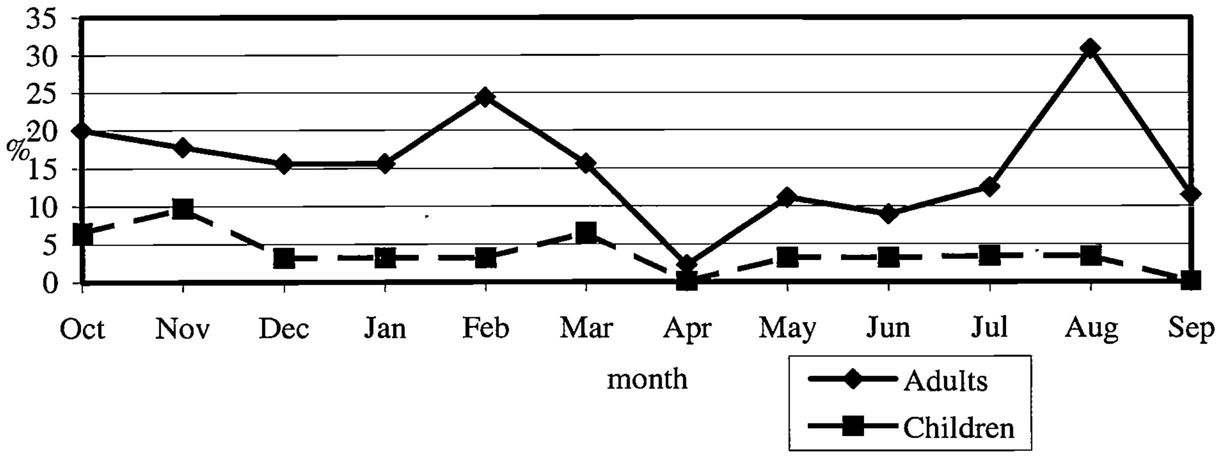


Figure 34 Percentage of adults and children who reported gastro intestinal symptoms throughout the year of investigation.

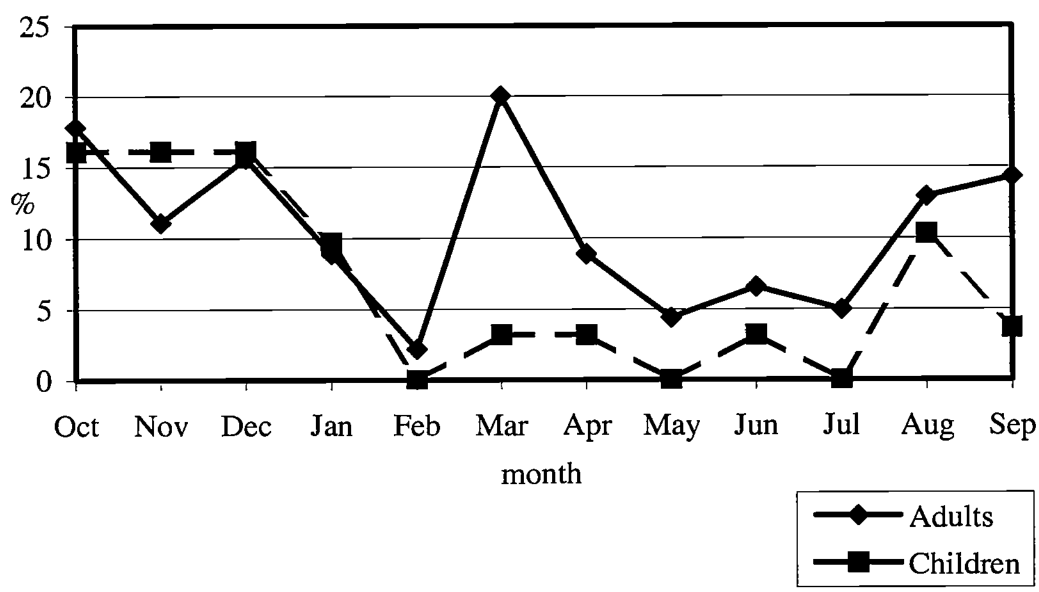
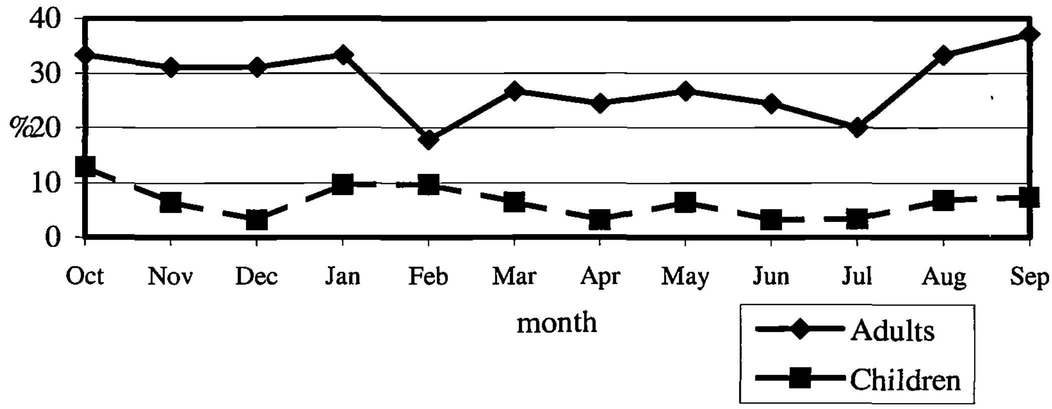


Figure 35 Percentage of adults and children who reported symptoms of fatigue throughout the year of investigation.



Summary of the symptoms reported by adults and children

Clearly adults experienced more symptoms over the year of the study than those under 18 years of age. Adults accounted for 79% of all symptoms reported with children accounting for the remaining 21%. Moreover, adults experienced more symptoms than children for all symptom types. The percentage of symptoms reported by children peaked in the winter months, however the percentage of symptoms reported by adults remained relatively stable over the course of the year except for a decline in late Spring. Respiratory symptoms peaked during the winter months for both adults and children and increased again in the final, autumn months of the study. Adults experienced considerably more eye symptoms than children. In the final six months of the study only one child had an eye complaint. On the contrary the number of eye symptoms experienced by adults at this stage were on the increase. The maximum number of adults who experienced skin complaints was 11 from a total of 45 adults peaking in April and May. While the maximum number of children to experience skin complaints was five from a total of 31, peaking in January and June. Overall, the pattern of skin complaints was quite random. Adults experienced more ENT symptoms than children. The highest number of adults reporting ENT symptoms was 16 (35.6%) from a total of 45 adults during the month of October. The highest number of children reporting symptoms was six (19.4%) in the month of June. Overall the pattern of mental health symptoms for adults and children were relatively the same except during the final months of the study. The maximum number of mental health symptoms reported by adults was in August (N=11, 28.2%) while the most children experiencing mental health symptoms was four (14.8%). There were few reports of 'other' symptoms for both adults and children. The most adults to report 'other' symptoms was six (13.3%) and the most children was also six (19.4%). Adults reported more skeletal-muscular symptoms than children. The maximum number of adults reporting skeletal-muscular problems at any one time was 12 (30.8%) while the greatest number of children was three (9.7%). Adults also reported more gastrointestinal symptoms than children. The greatest number of adults reporting gastrointestinal symptoms at any one time was nine (20%) compared with five children (16%). In three months of the study there were no gastrointestinal symptoms reported by children. Adults experienced more fatigue symptoms and the pattern of symptoms reported was relatively consistent over the year of the study except in February and July where the numbers dropped slightly. The highest number of adults experiencing fatigue at any one time was 13 (37.1%) while the highest number of children during one month was 4 (12.9%).

As before, it was decided to report the findings for adults and children with 'explainable symptoms rSmoved'. These findings are presented in the next series of tables.

TABLE 44 Percentage of adults and children who reported 'all respiratory symptoms' and 'reduced respiratory symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	22.2%	33.3%	40.0%	42.2%	26.7%	15.5%	17.8%	17.8%	20.0%	15.0 %	17.9%	25.7%
	(10)	(15)	(18)	(19)	(12)	(7)	(8)	(8)	(9)	(6)	(7)	(9)
	22.2%	28.9%	28.9%	31.1%	17.8%	13.3%	13.3%	17.8%	20.0%	15.0%	15.4%	22.8%
	(10)	(13)	(13)	(14)	(8)	(6)	(6)	(8)	(9)	(6)	(6)	(8)
CHILD	6.5%	16.1%	22.6%	22.6%	16.1%	9.7%	9.7%	9.7%	6.5%	6.9%	3.4%	11.1%
	(2)	(5)	(7)	(7)	(5)	(3)	(3)	(3)	(2)	(2)	(1)	(3)
	6.5%	9.7%	12.9%	9.7%	12.9%	9.7%	6.5%	9.7%	6.5%	3.4%	0%	11.1%
	(2)	(3)	(4)	(3)	(4)	(3)	(2)	(3)	(2)	(1)	(0)	(3)

TABLE 45 Percentage of adults and children who reported 'all eye symptoms' and 'reduced eye symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	15.6%	17.8% (8)	22.2%	4.4%	6.7%	24.4%	11.1%	11.1%	17.8%	20.0%	23.1%	25.7%
	(7)		(10)	(2)	(3)	(11)	(5)	(5)	(8)	(8)	(9)	(9)
	15.5%	17.8%	22.2%	4.4%	6.7%	24.4%	11.1%	11.1%	17.8%	17.5%	23.1%	25.7%
	(7)	(8)	(10)	(2)	(3)	(11)	(5)	(5)	(8)	(7)	(9)	(9)
CHILD	6.5%	3.2%	9.7%	0%	3.2%	6.5%	0%	3.2%	0%	0%	0%	0%
	(2)	(1)	(3)	(0)	(1)	(2)	(0)	(1)	(0)	(0)	(0)	(0)
	6.5%	3.2%	3.2%	0%	3.2%	6.5%	0%	3.2%	0%	0%	0%	0%
	(2)	(1)	(1)	(0)	(1)	(2)	(0)	(1)	(0)	(0)	(0)	(0)

TABLE 46: Percentage of adults and children who reported 'all skin symptoms' and 'reduced skin symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	17.8%	15.6%	11.1%	13.3%	13.3%	11.1%	24.2%	22.2%	15.6%	17.5%	15.4%	11.5%
	(8)	(7)	(5)	(6)	(6)	(5)	(11)	(10)	(7)	(7)	(6)	(4)
	17.8%	15.6%	11.1%	13.3%	13.3%	11.1%	24.4%	22.2%	15.6%	17.5%	15.4%	11.4%
	(8)	(7)	(5)	(6)	(6)	(5)	(11)	(10)	(7)	(7)	(6)	(4)
CHILD	6.5%	6.5%	3.2%	16.1%	3.2%	9.7%	3.2%	3.2%	12.9%	3.4%	3.4%	3.7%
	(2)	(2)	(1)	(5)	(1)	(3)	(1)	(1)	(4)	(1)	(1)	(1)
	6.5%	6.5%	3.2%	12.9%	3.2%	9.7%	3.2%	3.2%	12.9%	3.4%	3.4%	3.7%
	(2)	(2)	(1)	(4)	(1)	(3)	(1)	(1)	(4)	(1)	(1)	(1)

TABLE 47: Percentage of adults and children who reported 'all ear nose and throat symptoms' and 'reduced ear nose and throat symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	35.6 %	28.9%	26.7%	26.7%	22.2%	31.1%	24.4%	17.8%	13.3%	17.5%	28.2%	25.7%
	(16)	(13)	(12)	(12)	(10)	(14)	(11)	(8)	(6)	(7)	(11)	(9)
	35.5%	26.7%	24.4%	17.8%	22.2%	28.9%	22.2%	17.8%	13.3%	17.5%	25.6%	25.7%
	(16)	(12)	(11)	(8)	(10)	(13)	(10)	(8)	(6)	(7)	(10)	(9)
CHILD	12.9%	12.9%	12.9%	12.9%	12.9%	9.7%	9.7%	3.2%	19.4%	6.9%	10.3%	7.4%
	(4)	(4)	(4)	(4)	(4)	(3)	(3)	(1)	(6)	(2)	(3)	(2)
	9.7%	9.7%	12.9%	12.9%	6.4%	6.4%	9.7%	3.2%	19.4%	6.9%	6.9%	7.4%
	(3)	(3)	(4)	(4)	(2)	(2)	(3)	(1)	(6)	(2)	(2)	(2)

TABLE 48: Percentage of adults and children who reported 'all mental health symptoms' and 'reduced mental health symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	24.4%	22.2%	17.8%	20.0%	8.9%	2.2%	8.9%	13.3%	17.8%	22.5%	28.2%	25.7%
	(11)	(10)	(8)	(9)	(4)	(1)	(4)	(6)	(8)	(9)	(11)	(9)
	22.2%	22.2%	17.8%	20.0%	8.9%	2.2%	8.9%	13.3%	17.8%	22.5%	28.2%	25.7%
	(10)	(10)	(8)	(9)	(4)	(1)	(4)	(6)	(8)	(9)	(11)	(9)
CHILD	6.5%	9.7%	6.5%	9.7%	0%	3.2%	9.7%	6.5%	12.9%	6.9%	6.9%	14.8%
	(2)	(3)	(2)	(3)	(0)	(1)	(3)	(2)	(4)	(2)	(2)	(4)
	6.5%	9.7%	6.5%	6.4%	0%	3.2%	3.2%	6.5%	12.9%	6.9%	6.9%	14.8%
	(2)	(3)	(2)	(2)	(0)	(1)	(1)	(2)	(4)	(2)	(2)	(4)

TABLE 49: Percentage of adults and children who reported 'all other symptoms' and 'reduced other symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	13.3%	4.4%	4.4%	6.7%	6.7%	2.2%	2.2%	2.2%	4.4%	2.5%	2.6%	8.6%
	(6)	(2)	(2)	(3)	(3)	(1)	(1)	(1)	(2)	(1)	(1)	(3)
	8.9%	4.4%	2.2%	4.4%	6.7%	2.2%	0%	2.2%	4.4%	2.5%	2.6%	8.6%
	(4)	(2)	(1)	(2)	(3)	(1)	(0)	(1)	(2)	(1)	(1)	(3)
CHILD	19.4%	3.2%	3.2%	9.7%	3.2%	9.7%	9.7%	3.2%	0%	0%	0%	7.4%
	(6)	(1)	(1)	(3)	(1)	(3)	(3)	(1)	(0)	(0)	(0)	(2)
	12.9%	3.2%	0%	0%	3.2%	3.2%	0%	0%	0%	0%	0%	7.4%
	(4)	(1)	(0)	(0)	(1)	(1)	(0)	(0)	(0)	(0)	(0)	(2)

TABLE 50: Percentage of adults and children who reported 'all skeletal muscular symptoms' and 'reduced skeletal muscular symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	20.0% (9) 17.8% (8)	17.8% (8) 17.8% (8)	15.6% (7) 15.5% (7)	15.6% (7) 13.3% (6)	24.4% (11) 22.2% (10)	15.6% (7) 13.3% (6)	2.2% (1) 0% (0)	11.1% (5) 11.1% (5)	8.9% (4) 8.9% (4)	12.5% (5) 12.5% (5)	30.8% (12) 25.6% (10)	11.4% (4) 8.6% (3)
CHILD	6.5% (2) 6.5% (2)	9.7% (3) 6.5% (2)	3.2% (1) 3.2% (1)	3.2% (1) 3.2% (1)	3.2% (1) 3.2% (1)	6.5% (2) 6.5% (2)	0% (0) 0% (0)	3.2% (1) 3.2% (1)	3.2% (1) 3.2% (1)	3.4% (1) 3.4% (1)	3.4% (1) 3.4% (1)	0% (0) 0% (0)

TABLE 51: Percentage of adults and children who reported 'all gastrointestinal symptoms' and 'reduced gastrointestinal symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	17.8% (8) 15.6% (7)	11.1% (5) 8.9% (4)	15.6% (7) 8.9% (4)	8.9% (4) 6.7% (3)	2.2% (1) 0% (0)	20.0% (9) 17.8% (8)	8.9% (4) 8.9% (4)	4.4% (2) 4.4% (2)	6.6% (3) 4.4% (2)	5.0% (2) 5.0% (2)	12.9% (5) 12.8% (5)	14.3% (5) 11.4% (4)
CHILD	16.1% (5) 16.1% (5)	16.1% (5) 6.5% (2)	16.1% (5) 0% (0)	9.7% (3) 6.5% (2)	0% (0) 0% (0)	3.2% (1) 0% (0)	3.2% (1) 0% (0)	0% (0) 0% (0)	3.2% (1) 3.2% (1)	0% (0) 0% (0)	10.3% (3) 6.9% (2)	3.7% (1) 3.7% (1)

TABLE 52: Percentage of adults and children who reported 'all fatigue symptoms' and 'reduced fatigue symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	33.3% (15) 33.3% (15)	31.1% (14) 31.1% (14)	31.1% (14) 31.1% (14)	33.3% (15) 33.3% (15)	17.8% (8) 17.8% (8)	26.7% (12) 26.7% (12)	24.4% (11) 24.4% (11)	26.7% (12) 26.7% (12)	24.4% (11) 24.4% (11)	20.0% (8) 20.0% (8)	33.3% (13) 33.3% (13)	37.1% (13) 37.1% (13)
CHILD	12.9% (4) 12.9% (4)	6.5% (2) 6.5% (2)	3.2% (1) 3.2% (1)	9.7% (3) 9.7% (3)	9.7% (3) 6.5% (2)	6.5% (2) 6.5% (2)	3.2% (1) 3.2% (1)	6.5% (2) 6.5% (2)	3.2% (1) 3.2% (1)	3.4% (1) 3.4% (1)	6.9% (2) 6.9% (2)	7.4% (2) 7.4% (2)

Summary of the findings reported by adults and children with *explainable symptoms* removed from the analyses

The number of respiratory symptoms reported by adults and children declined when *explainable symptoms* were removed. These changes were mainly evident in the winter months. This pattern was replicated for ENT symptoms which also declined considerably during the winter months. There were very little changes in the pattern of eye symptoms reported when *explainable symptoms* were removed from the analyses. This was also the case with skin symptoms. There were changes in the number of mental health symptoms reported, especially so for children where the number of mental health symptoms reported were greatly reduced when explainable symptoms were removed from the analyses. Reports of 'other' symptoms experienced by children almost disappeared when symptoms with explainable causes were removed. There were few changes in the number of skeletal-muscular symptoms reported while gastrointestinal symptoms declined somewhat when *explainable symptoms* were removed. There were no changes at all in the number of fatigue symptoms reported for both adults and children. As was reported in the method section respondents were asked to indicate the severity of symptoms and any action taken to alleviate symptoms. If no action was taken subjects were asked to report this also. However over the year of investigation there were considerable amounts of missing data for these two variables making it difficult to present the findings in a meaningful and concise manner. In order to give some indication of the general trends regarding the level of discomfort caused by symptoms and action taken to alleviate symptoms some sample findings for each symptom type will be presented.

Conclusion of the findings reported by adults and children

- There were 45 adults (59.2%) and 31 children (40.8%) in the study.
- Adults accounted for 79% of all symptoms reported with children accounting for the remainder.
- The percentage of symptoms reported by adults was relatively stable over the year of the study except for a drop in the spring months.
- The percentage of symptoms reported by children peaked in the winter months.
- The percentage of respiratory symptoms reported peaked in the winter months for both groups.
- There was quite a dramatic difference between adults and children regarding the proportion of eye symptoms reported.
- The maximum number of children to report eye symptoms over the year of the study was three children (9.7%).
- Children experienced more skin than eye complaints however the proportion of children with skin symptoms was five (16.1%) compared to 11 adults (24.4%) who reported skin complaints.
- Adults also reported considerably more ENT symptoms than children did. The maximum number of adults reporting ENT symptoms was 16 (35.6%) while the number of children was six (19.4%).
- Adults reported more mental health symptoms than the children did.
- The pattern of 'other' symptoms reported by adults and children were similar.
- Adults reported more skeletal-muscular symptoms than children did, the greatest number of adults to report such symptoms was twelve (30.8%) while the greatest number of children was three (9.7%).
- The pattern was replicated regarding gastrointestinal symptoms, the maximum number of adults reporting such symptoms was nine (20.0%) while the greatest number of children was five (16.1%). In three months of the study there was no reports of gastrointestinal symptoms by children.
- Adults reported more symptoms of fatigue than the children did however the pattern of symptoms reported by both groups was relatively consistent over the year of the study. The

greatest number of adults to report symptoms of fatigue at any one time was 13 (37.1%) with a maximum of four children (12.9%) reporting such symptoms at any one time.

- When explainable symptoms were removed from the analysis, as before, there was a decline in the number of respiratory and ENT symptoms reported by both groups.
- As before, there was little change in the pattern of eye and skin symptoms reported for both adults and children when explainable symptoms were removed from the analysis.
- There were changes in the number of mental health symptoms reported when explainable symptoms were removed from the analysis, especially for children.
- Reports of 'other' symptoms by children were also greatly reduced when explainable symptoms were removed from the analysis.
- There were few changes in reports of skeletal-muscular symptoms, while gastrointestinal symptoms declined somewhat when explainable symptoms were removed from the analysis for adults and children.
- There was little change in the pattern of fatigue symptoms reported by adults and children.

TABLE 53: The total number of symptoms experienced and the proportion experienced by adults and children.

	Total	Resp	Eye	Skin	ENT	MH	Other	SM	GI	Fatigue
Adult	1070 **79%**	208 **79%**	94 **88%**	140 **80%**	170 **77%**	108 **77%**	28 **57%**	116 **85%**	60 **68%**	146 **86%**
< 18	283 **21%**	56 **21%**	13 **12%**	36 **20%**	52 **23%**	32 **23%**	21 **43%**	21 **15%**	28 **32%**	24 **14%**
Total	**1353**	**264**	**107**	**176**	**222**	**140**	**49**	**137**	**88**	**170**

Figure 36 Percentage of adults and children who reported a health symptom throughout the year of investigation.

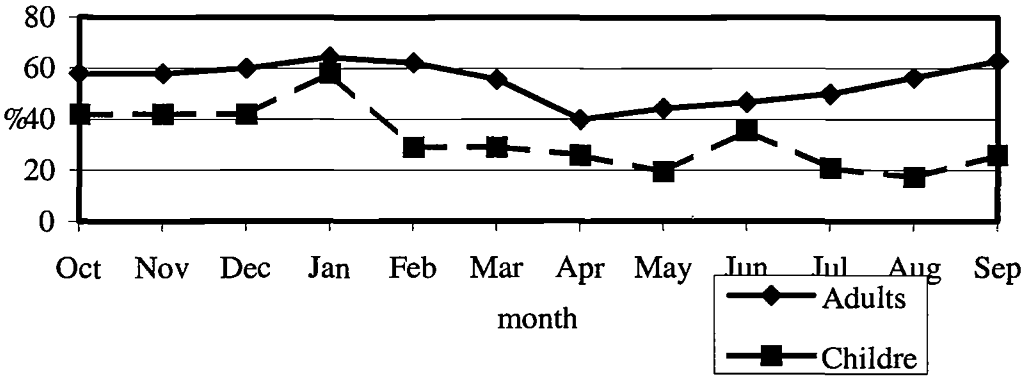


Figure 37 Percentage of adults and children who reported respiratory symptoms throughout the year of investigation

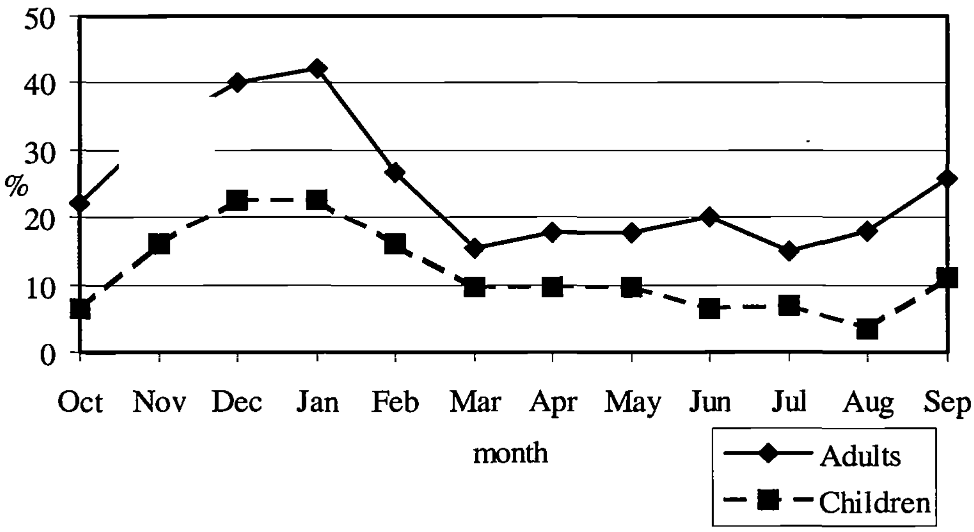


Figure 38 Percentage of adults and children who reported eye symptoms throughout the year of investigation.

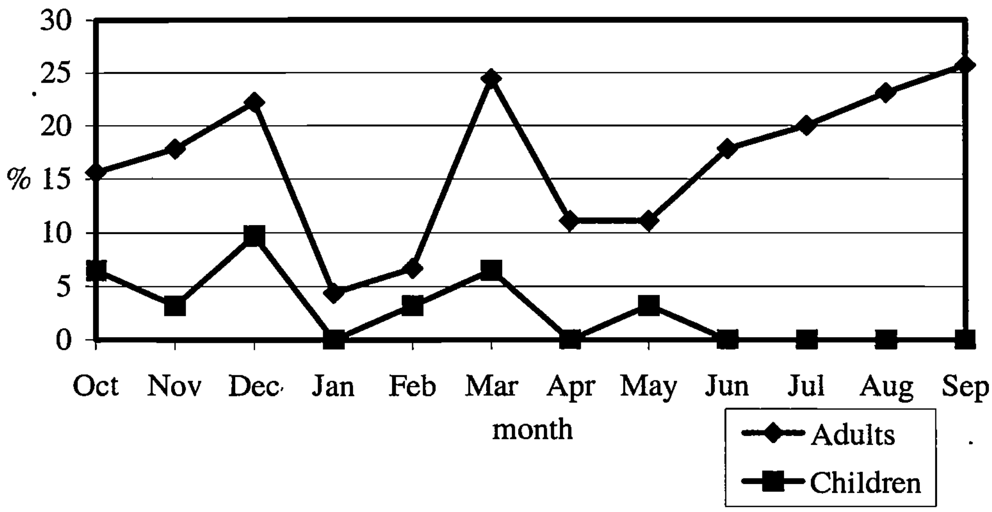


Figure 39 Percentage of adults and children who reported skin symptoms throughout the year of investigation

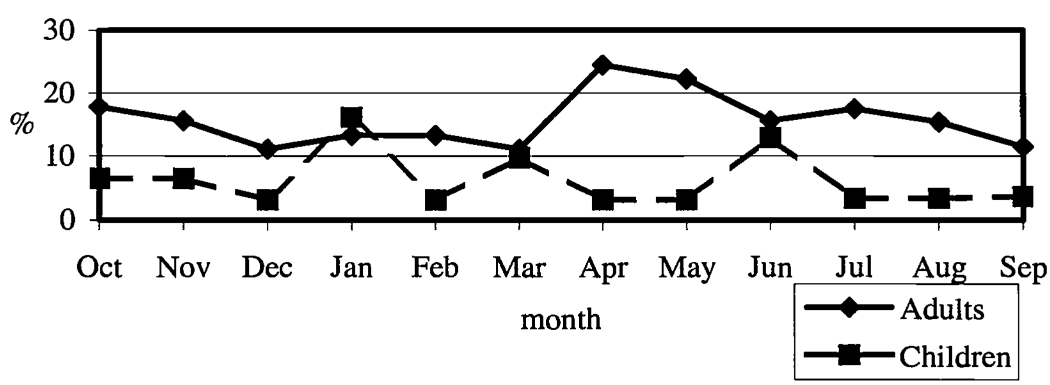


Figure 40 Percentage of adults and children who reported ear nose and throat symptoms throughout the year of investigation.

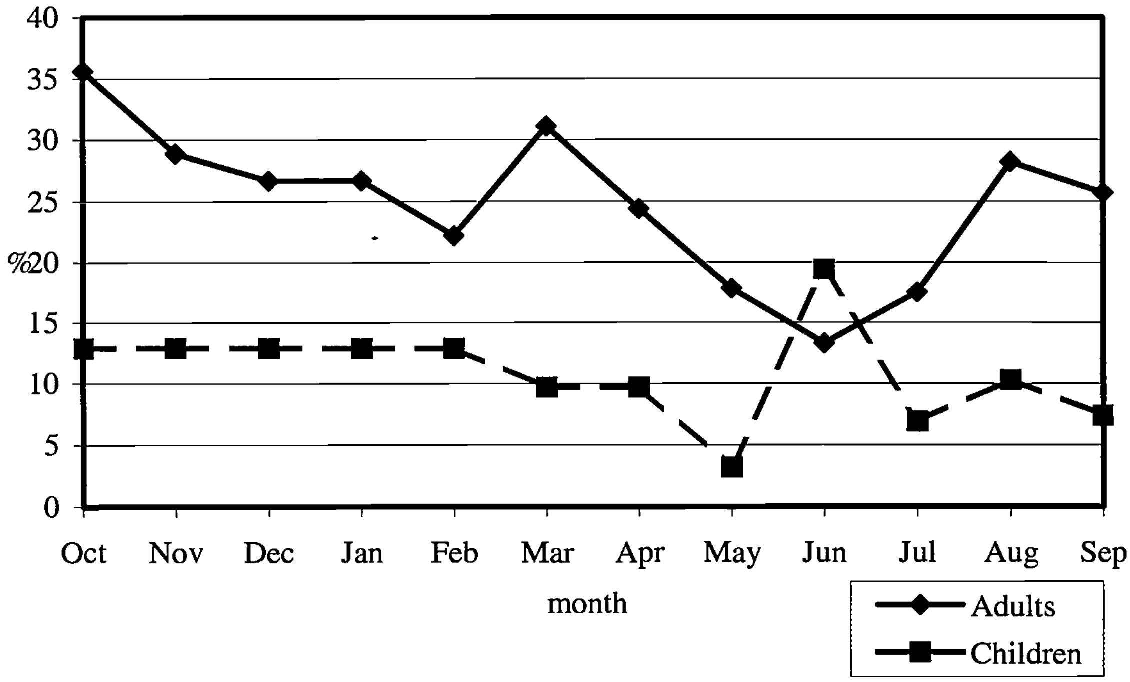


Figure 41 Percentage of adults and children who reported mental health symptoms throughout the year of investigation.

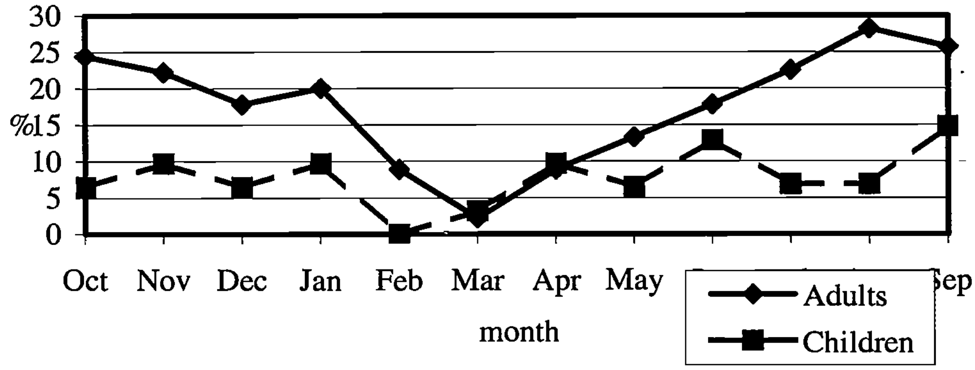


Figure 42 Percentage of adults and children who reported other symptoms throughout the year of investigation.

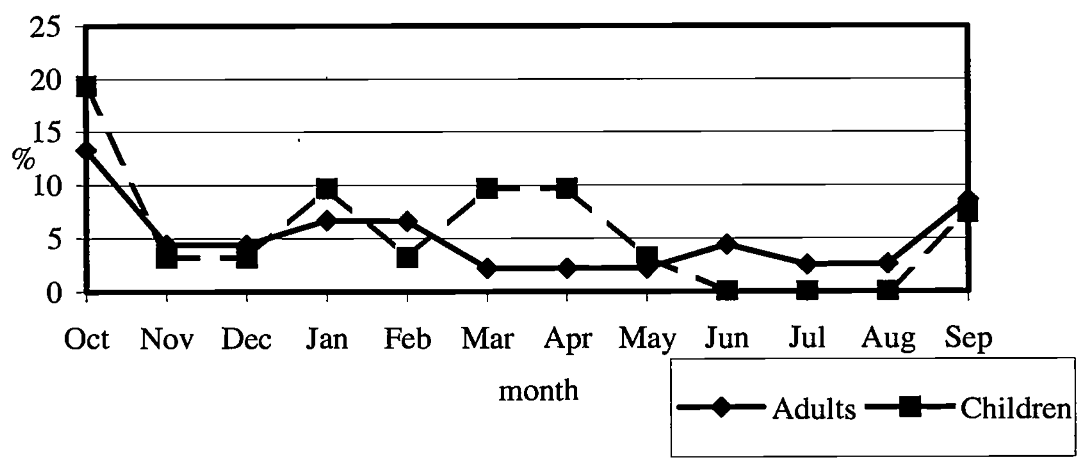


Figure 43 Percentage of adults and children who reported skeletal muscular symptoms throughout the year of investigation

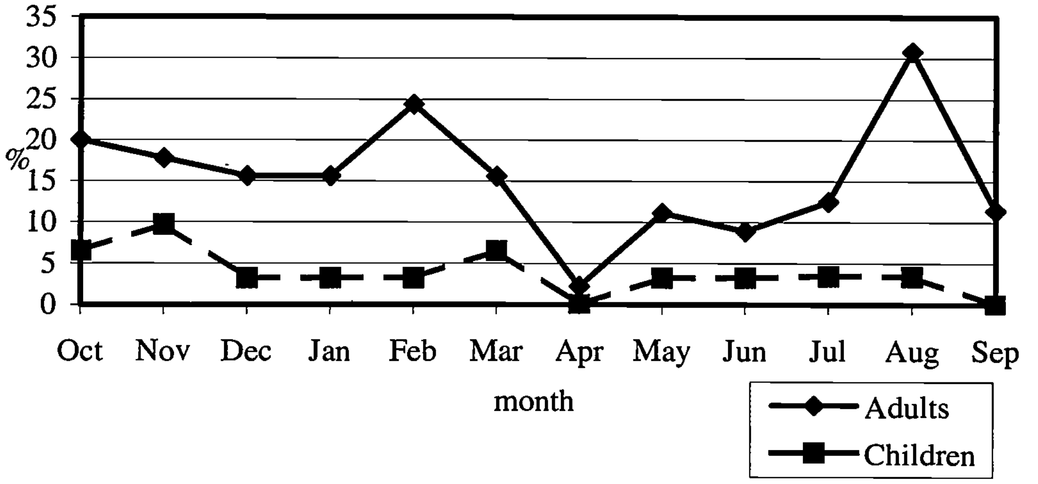


Figure 44 Percentage of adults and children who reported gastro intestinal symptoms throughout the year of investigation.

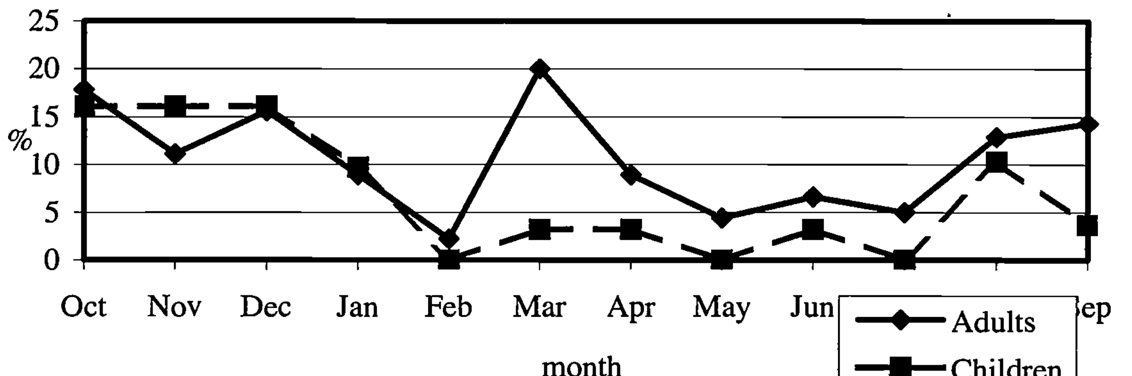


Figure 45 Percentage of adults and children who reported symptoms of fatigue throughout the year of investigation.

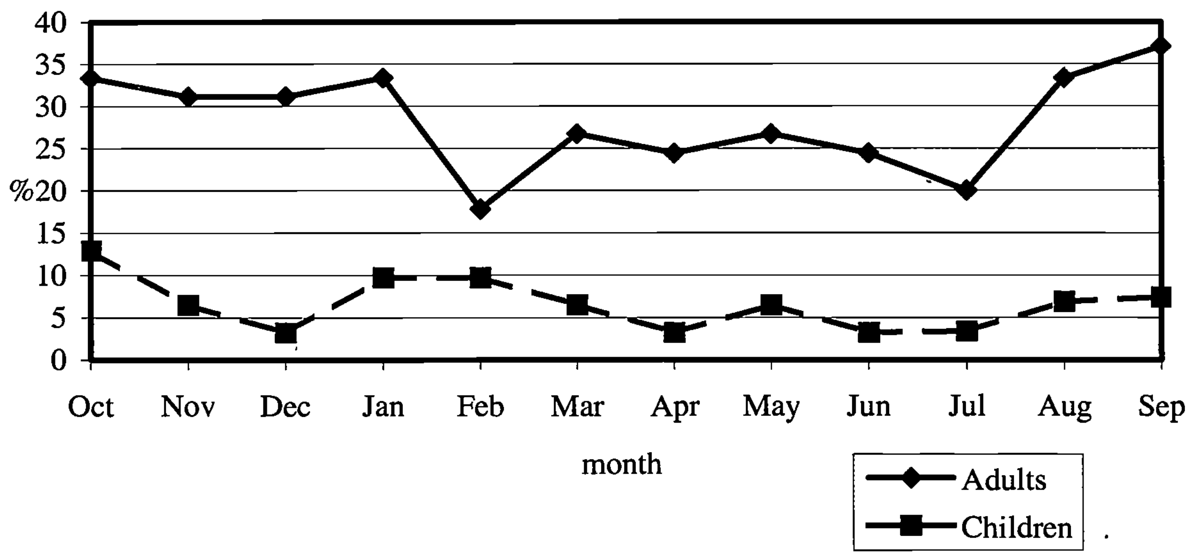


TABLE 54: Percentage of adults and children who reported 'all respiratory symptoms' and 'reduced respiratory symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	22.2%	33.3%	40.0%	42.2%	26.7%	15.5%	17.8%	17.8%	20.0%	15.0 %	17.9%	25.7%
	(10)	(15)	(18)	(19)	(12)	(7)	(8)	(8)	(9)	(6)	(7)	(9)
	22.2%	28.9%	28.9%	31.1%	17.8%	13.3%	13.3%	17.8%	20.0%	15.0%	15.4%	22.8%
	(10)	(13)	(13)	(14)	(8)	(6)	(6)	(8)	(9)	(6)	(6)	(8)
CHILD	6.5%	16.1%	22.6%	22.6%	16.1%	9.7%	9.7%	9.7%	6.5%	6.9%	3.4%	11.1%
	(2)	(5)	(7)	(7)	(5)	(3)	(3)	(3)	(2)	(2)	(1)	(3)
	6.5%	9.7%	12.9%	9.7%	12.9%	9.7%	6.5%	9.7%	6.5%	3.4%	0%	11.1%
	(2)	(3)	(4)	(3)	(4)	(3)	(2)	(3)	(2)	(1)	(0)	(3)

TABLE 55: Percentage of adults and children who reported 'all eye symptoms' and 'reduced eye symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	15.6%	17.8% (8)	22.2%	4.4%	6.7%	24.4%	11.1%	11.1%	17.8%	20.0%	23.1%	25.7%
	(7)		(10)	(2)	(3)	(11)	(5)	(5)	(8)	(8)	(9)	(9)
	15.5%	17.8%	22.2%	4.4%	6.7%	24.4%	11.1%	11.1%	17.8%	17.5%	23.1%	25.7%
	(7)	(8)	(10)	(2)	(3)	(11)	(5)	(5)	(8)	(7)	(9)	(9)
CHILD	6.5%	3.2%	9.7%	0%	3.2%	6.5%	0%	3.2%	0%	0%	0%	0%
	(2)	(1)	(3)	(0)	(1)	(2)	(0)	(1)	(0)	(0)	(0)	(0)
	6.5%	3.2%	3.2%	0%	3.2%	6.5%	0%	3.2%	0%	0%	0%	0%
	(2)	(1)	(1)	(0)	(1)	(2)	(0)	(1)	(0)	(0)	(0)	(0)

TABLE 56 Percentage of adults and children who reported 'all skin symptoms' and 'reduced skin symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	17.8%	15.6%	11.1%	13.3%	13.3%	11.1%	24.2%	22.2%	15.6%	17.5%	15.4%	11.5%
	(8)	(7)	(5)	(6)	(6)	(5)	(11)	(10)	(7)	(7)	(6)	(4)
	17.8%	15.6%	11.1%	13.3%	13.3%	11.1%	24.4%	22.2%	15.6%	17.5%	15.4%	11.4%
	(8)	(7)	(5)	(6)	(6)	(5)	(11)	(10)	(7)	(7)	(6)	(4)
CHILD	6.5%	6.5%	3.2%	16.1%	3.2%	9.7%	3.2%	3.2%	12.9%	3.4%	3.4%	3.7%
	(2)	(2)	(1)	(5)	(1)	(3)	(1)	(1)	(4)	(1)	(1)	(1)
	6.5%	6.5%	3.2%	12.9%	3.2%	9.7%	3.2%	3.2%	12.9%	3.4%	3.4%	3.7%
	(2)	(2)	(1)	(4)	(1)	(3)	(1)	(1)	(4)	(1)	(1)	(1)

TABLE 57: Percentage of adults and children who reported 'all ear nose and throat symptoms' and 'reduced ear nose and throat symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	35.6 %	28.9%	26.7%	26.7%	22.2%	31.1%	24.4%	17.8%	13.3%	17.5%	28.2%	25.7%
	(16)	(13)	(12)	(12)	(10)	(14)	(11)	(8)	(6)	(7)	(11)	(9)
	35.5%	26.7%	24.4%	17.8%	22.2%	28.9%	22.2%	17.8%	13.3%	17.5%	25.6%	25.7%
	(16)	(12)	(11)	(8)	(10)	(13)	(10)	(8)	(6)	(7)	(10)	(9)
CHILD	12.9%	12.9%	12.9%	12.9%	12.9%	9.7%	9.7%	3.2%	19.4%	6.9%	10.3%	7.4%
	(4)	(4)	(4)	(4)	(4)	(3)	(3)	(1)	(6)	(2)	(3)	(2)
	9.7%	9.7%	12.9%	12.9%	6.4%	6.4%	9.7%	3.2%	19.4%	6.9%	6.9%	7.4%
	(3)	(3)	(4)	(4)	(2)	(2)	(3)	(1)	(6)	(2)	(2)	(2)

TABLE 58: Percentage of adults and children who reported 'all mental health symptoms' and 'reduced mental health symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	24.4%	22.2%	17.8%	20.0%	8.9%	2.2%	8.9%	13.3%	17.8%	22.5%	28.2%	25.7%
	(11)	(10)	(8)	(9)	(4)	(1)	(4)	(6)	(8)	(9)	(11)	(9)
	22.2%	22.2%	17.8%	20.0%	8.9%	2.2%	8.9%	13.3%	17.8%	22.5%	28.2%	25.7%
	(10)	(10)	(8)	(9)	(4)	(1)	(4)	(6)	(8)	(9)	(11)	(9)
CHILD	6.5%	9.7%	6.5%	9.7%	0%	3.2%	9.7%	6.5%	12.9%	6.9%	6.9%	14.8%
	(2)	(3)	(2)	(3)	(0)	(1)	(3)	(2)	(4)	(2)	(2)	(4)
	6.5%	9.7%	6.5%	6.4%	0%	3.2%	3.2%	6.5%	12.9%	6.9%	6.9%	14.8%
	(2)	(3)	(2)	(2)	(0)	(1)	(1)	(2)	(4)	(2)	(2)	(4)

TABLE 59: Percentage of adults and children who reported 'all other symptoms' and 'reduced other symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	13.3%	4.4%	4.4%	6.7%	6.7%	2.2%	2.2%	2.2%	4.4%	2.5%	2.6%	8.6%
	(6)	(2)	(2)	(3)	(3)	(1)	(1)	(1)	(2)	(1)	(1)	(3)
	8.9%	4.4%	2.2%	4.4%	6.7%	2.2%	0%	2.2%	4.4%	2.5%	2.6%	8.6%
	(4)	(2)	(1)	(2)	(3)	(1)	(0)	(1)	(2)	(1)	(1)	(3)
CHILD	19.4%	3.2%	3.2%	9.7%	3.2%	9.7%	9.7%	3.2%	0%	0%	0%	7.4%
	(6)	(1)	(1)	(3)	(1)	(3)	(3)	(1)	(0)	(0)	(0)	(2)
	12.9%	3.2%	0%	0%	3.2%	3.2%	0%	0%	0%	0%	0%	7.4%
	(4)	(1)	(0)	(0)	(1)	(1)	(0)	(0)	(0)	(0)	(0)	(2)

TABLE 60: Percentage of adults and children who reported 'all skeletal muscular symptoms' and 'reduced skeletal muscular symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	20.0% (9) 17.8% (8)	17.8% (8) 17.8% (8)	15.6% (7) 15.5% (7)	15.6% (7) 13.3% (6)	24.4% (11) 22.2% (10)	15.6% (7) 13.3% (6)	2.2% (1) 0% (0)	11.1% (5) 11.1% (5)	8.9% (4) 8.9% (4)	12.5% (5) 12.5% (5)	30.8% (12) 25.6% (10)	11.4% (4) 8.6% (3)
CHILD	6.5% (2) 6.5% (2)	9.7% (3) 6.5% (2)	3.2% (1) 3.2% (1)	3.2% (1) 3.2% (1)	3.2% (1) 3.2% (1)	6.5% (2) 6.5% (2)	0% (0) 0% (0)	3.2% (1) 3.2% (1)	3.2% (1) 3.2% (1)	3.4% (1) 3.4% (1)	3.4% (1) 3.4% (1)	0% (0) 0% (0)

TABLE 61: Percentage of adults and children who reported 'all gastrointestinal symptoms' and 'reduced gastrointestinal symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	17.8% (8) 15.6% (7)	11.1% (5) 8.9% (4)	15.6% (7) 8.9% (4)	8.9% (4) 6.7% (3)	2.2% (1) 0% (0)	20.0% (9) 17.8% (8)	8.9% (4) 8.9% (4)	4.4% (2) 4.4% (2)	6.6% (3) 4.4% (2)	5.0% (2) 5.0% (2)	12.9% (5) 12.8% (5)	14.3% (5) 11.4% (4)
CHILD	16.1% (5) 16.1% (5)	16.1% (5) 6.5% (2)	16.1% (5) 0% (0)	9.7% (3) 6.5% (2)	0% (0) 0% (0)	3.2% (1) 0% (0)	3.2% (1) 0% (0)	0% (0) 0% (0)	3.2% (1) 3.2% (1)	0% (0) 0% (0)	10.3% (3) 6.9% (2)	3.7% (1) 3.7% (1)

TABLE 62: Percentage of adults and children who reported 'all fatigue symptoms' and 'reduced fatigue symptoms' throughout the year of investigation.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADULTS	33.3%	31.1%	31.1%	33.3%	17.8%	26.7%	24.4%	26.7%	24.4%	20.0%	33.3%	37.1%
	(15)	(14)	(14)	(15)	(8)	(12)	(11)	(12)	(11)	(8)	(13)	(13)
	33.3%	31.1%	31.1%	33.3%	17.8%	26.7%	24.4%	26.7%	24.4%	20.0%	33.3%	37.1%
	(15)	(14)	(14)	(15)	(8)	(12)	(11)	(12)	(11)	(8)	(13)	(13)
CHILD	12.9%	6.5%	3.2%	9.7%	9.7%	6.5%	3.2%	6.5%	3.2%	3.4%	6.9%	7.4%
	(4)	(2)	(1)	(3)	(3)	(2)	(1)	(2)	(1)	(1)	(2)	(2)
	12.9%	6.5%	3.2%	9.7%	6.5%	6.5%	3.2%	6.5%	3.2%	3.4%	6.9%	7.4%
	(4)	(2)	(1)	(3)	(2)	(2)	(1)	(2)	(1)	(1)	(2)	(2)

Symptom discomfort and action taken by respondents

This section investigates the extent of symptom discomfort associated with symptoms as reported by respondents and the action taken by respondents in order to alleviate symptom discomfort.

Level of discomfort caused by respiratory symptoms and action taken

In October, the first month of the study, 12 persons experienced respiratory symptoms. In this case 10 respondents commented on the severity of the symptoms and 11 commented on the action taken. Six rated symptom discomfort experienced as marked, three rated it as mild and one as severe. With regard to action taken seven of the 11 used a self-administered medication. One respondent took no action while another attended the GP and received a prescription. Two respondents initially self administered medication before attending the GP and having medication prescribed. In November the number experiencing respiratory symptoms was 20, however seven failed to report the severity of symptoms and eight did not report whether or not any action was taken. The majority of those who did answer, nine from 13, rated symptom discomfort as marked while 11 from 12 who reported on action taken said that action was self administered and respondents did not attend the GP. In June eight of the 11 experiencing respiratory symptoms failed to indicate whether any action was taken clearly indicating the amount of missing data.

Level of discomfort caused by eye symptoms and action taken

In October nine people reported eye problems, seven respondents rated their problem as marked while two rated it as moderate. One person failed to report on the action taken however the majority, five from the eight respondents who answered, self administered some treatment while the remainder took no action. This was the general trend of the findings with regard to eye symptoms. In December 13 respondents experienced eye symptoms however only six reported on the action taken, five of whom self administered some treatment while the remaining one took no action. Eleven of the 13 with complaints in March failed to answer. In August five of the nine respondents with complaints rated symptom discomfort as severe but only one took any action and attended the GP.

Level of discomfort caused by skin symptoms and action taken

In October the number reporting skin complaints was 10, six respondents rated symptom discomfort as marked, two respondents rated it as moderate and the remaining two respondents rated discomfort as severe. In relation to action taken six respondents self-administered a treatment while two respondents attended the GP and received a prescription. In December six people reported skin symptoms and for this month there was no missing data. One person rated symptom discomfort as moderate and the remaining five people rated it as marked. Five respondents self-administered some treatment while one took no action. In April 12 people had skin symptoms while only half reported on symptom discomfort and action taken. Of those who answered all rated the level of symptom discomfort as marked and all self- administered some form of treatment.

Level of discomfort caused by ENT symptoms and action taken

In November 17 people experienced ENT symptoms, one person rated symptom discomfort as mild, three rated it as moderate while 13 persons rated it as marked or severe. Five responses were missing with regard to action taken. The majority (N=7) self-administered some treatment, four persons took no action and one person attended the GP. Sixteen people reported ENT symptoms in January while four persons did not answer the question on symptom severity two persons rated it as mild, another two rated it as moderate, seven persons rated it as marked and another as severe. With regard to action taken 15 of the 16 with ENT symptoms answered. The majority (N=8) self-administered some medication or treatment, four persons took no action, three persons attended the GP and had medication prescribed. In February 14 persons had ENT symptoms and half of the respondents did not report the level of discomfort. Five of those who did said that symptom discomfort was marked and another two persons said it was severe. A total of nine persons did not comment on action taken but of those who did (N=5) four persons self-administered some treatment and the other took no action. In May nine persons reported ENT symptoms yet only four persons reported on the level of discomfort. Two persons rated the level of discomfort as moderate and the remaining two rated it as marked. Four persons also commented on the action taken, two persons self administered some treatment, another took no action at all while one attended the GP and had medication prescribed after initially self administering some treatment. This pattern of response was consistent throughout the remainder of the year for ENT symptoms.

Level of discomfort caused by mental health symptoms and action taken
In October 13 people reported mental health symptoms, two persons rated discomfort as moderate, eight persons rated it as marked and another two persons rated it as severe (there was one missing case). The majority of those with mental health symptoms (N=7) self-administered some treatment while two persons took no action (there were four missing cases). In January 12 persons reported mental health symptoms. Two rated the level of discomfort experienced as a result of symptoms as moderate, six persons rated it as marked and two persons rated it as severe (two responses were missing). Four failed to respond with regard to action taken and of the eight persons who did answer this question seven persons self administered some treatment while the other attended the GP and had medication prescribed. In April seven persons reported symptoms but only two commented on action taken which incidentally involved self administering some treatment. May saw eight persons with mental health symptoms, six persons did not comment on the action taken to alleviate symptoms and the two persons who did answer did not attend the GP but instead treated the symptoms themselves. This trend was similar for the rest of the year.

Level of discomfort caused by 'other' symptoms and action taken
In January six persons reported 'other' symptoms. Three persons rated symptom discomfort as moderate, one rated it as marked and another rated it as severe (there was one missing case). With regard to action taken three persons self-administered some medication while another attended the GP and had medication prescribed (there were two missing cases). In March four persons reported other symptoms. The level of discomfort rated by one person was mild, by another as moderate and two persons rated it as marked. All action taken was self administered by the two who answered this question. In April four persons reported other symptoms, one rated symptom discomfort as mild and the remainder rated it as marked. All four self-administered some treatment and nobody attended the GP. The pattern of results just described reflects the findings for the rest of the year.

Level of discomfort caused by skeletal muscular symptoms and action taken
In October, the first month of the study, 11 persons reported skeletal muscular symptoms. The majority of respondents (N=8) rated symptom discomfort as marked while the remaining two persons rated it as moderate (there was one missing case). Six respondents self-administered some treatment another person simply rested while the other person attended the GP and had medication prescribed. A total of eight respondents reported skeletal muscular symptoms in December. The level of symptom discomfort was rated by one person as mild and by the majority of persons (N=5) as marked (there were two missing cases). Five of the eight respondents who answered self-administered some treatment to alleviate discomfort. The data for the remaining three persons was missing. In February 12 persons reported skeletal muscular symptoms. The level of discomfort endorsed by the majority of respondents (N=7) was marked, one person rated symptom discomfort as mild while two persons rated it as moderate. With regard to action taken three responses were missing however the majority of respondents (N=6) self-administered treatment, one person took no action, two persons attended the GP and had medication prescribed. Six persons reported symptoms in May. The level of symptom discomfort rated by one person was mild and the remainder rated it as marked. One person took no action to alleviate symptom discomfort and the remainder treated symptoms themselves.

Level of discomfort caused by gastrointestinal symptoms and action taken

A total of 13 persons reported gastrointestinal symptoms in October. The majority of respondents rated symptom discomfort as marked (N=7), three persons rated it as mild, one person rated it as moderate and another rated it as severe (there was one missing case). In the majority of cases the action taken to alleviate symptom discomfort was self-administered (N=6), three persons took no action and there were four missing cases. Twelve persons reported gastrointestinal symptoms in December. Four persons rated symptom severity as marked and another four persons rated it as moderate, two persons rated it as severe and one rated it as mild (there was one missing case). In the majority of cases seven persons self-administered treatment to alleviate symptoms and three persons took no action. One person attended the GP and had medication prescribed while another went to hospital. Ten persons reported gastrointestinal symptoms in March and the majority of persons (N=5) rated symptom discomfort as severe, a further two people rated it as marked while the remainder rated symptom discomfort as moderate (there were two missing cases). There were seven missing cases with regard to action taken to alleviate symptoms and two of those who did reply self-administered some treatment or medication while one person attended the GP. Two persons reported gastrointestinal symptoms in May and rated symptom discomfort as marked yet no action was taken to alleviate symptoms. This was the general pattern of results with regard to symptom discomfort and action taken for gastrointestinal symptoms throughout the year of investigation

Level of discomfort caused by fatigue symptoms and action taken

A total of 19 persons experienced fatigue in October, eight persons rated the discomfort as marked, four persons rated it as severe, two persons rated it as mild and another as moderate. Action taken to alleviate symptoms was reported by only seven persons, with 12 missing cases. Action taken was in the form of rest for two respondents, four persons took no action while one person attended the GP. Sixteen persons reported fatigue in November however only four persons reported whether any action was taken. The results revealed that in two cases no action was taken while in the other two respondents rested. Similarly in December 15 persons reported fatigue but only two people took any action which was resting. With regard to the level of discomfort eight people of the nine who responded rated it as marked. In February one of the 11 persons reporting fatigue attended the GP. In April 12 persons reported fatigue and 10 persons rated it as marked or severe yet only one person reported any action taken which was resting. This was the general pattern of results throughout the year of investigation.

In conclusion the majority of respondents who reported the level of symptom discomfort experienced rated it as marked or severe. Moreover when respondents were asked to describe the action taken to alleviate symptom discomfort the majority self administered treatment or took no action. Only a small minority of respondents attended the GP.

Summary of findings for symptom discomfort and action taken

Due to the large amount of missing data for questions concerned with the level of discomfort caused by symptoms and the action taken to treat symptoms it is difficult to draw any overall conclusions. Overall, few respondents attended their GP. It is also noteworthy that people from the same family attended different GPs. Discomfort associated with respiratory symptoms was usually rated as 'marked'. The poor response rate however hampers the ability to draw any general conclusions about the severity of respiratory symptoms experienced by the respondents. The majority of respondents self-administered medication to treat respiratory symptoms and generally if symptoms persisted respondents attended their GP. Eye symptoms were usually rated as 'moderate' or 'marked'. Treatments were either self-administered or no action was taken. Only one respondent attended their GP with eye complaints. Skin symptoms were usually rated as 'marked' or 'severe'. As was the case with eye symptoms, in the majority of cases respondents took no action to treat symptoms or self-administered some form of treatment. In two cases respondents attended the GP for a prescription. The majority of ENT symptoms were rated as 'marked' or 'severe'. Treatments were usually self-administered although slightly more respondents attended their GP with severe ENT symptoms. This response pattern was consistent throughout the year of investigation. The pattern was similar for mental health symptoms, which were usually rated by respondents as 'marked' or 'severe'. There was one record of a respondent attending their GP with such symptoms otherwise symptoms were self-treated. The symptom discomfort associated with 'other' symptoms ranged from 'mild' to 'severe' yet few respondents attended the GP with 'other' symptoms. This pattern reflect the findings for the year. Skeletal-muscular symptoms were usually rated as 'moderate' or 'marked' by the majority of respondents. Action taken to alleviate symptom discomfort was in the form of rest or treatment was self-administered, however some respondents attended their GP. Gastrointestinal symptoms were usually self-treated while symptom discomfort was 'marked' or 'severe' with few respondents attending their GP. Overall, few respondents attended their GP with such symptoms. Symptoms of fatigue were generally 'marked' or 'severe' and respondents took no action or simply rested. There is one record of a respondent attending their GP with symptoms of fatigue.

Symptoms reported by adult males and females

It was decided to investigate if there were any differences between adult males and adult females regarding the number of morbidity symptoms reported. Children were not investigated in this manner since adults experienced considerably more morbidity symptoms than children did. The morbidity symptoms reported by adult males and adult females with *explainable* symptoms removed are presented in the following table. For the majority of symptom types females experienced more symptoms than males except for skeletal-muscular symptoms and fatigue, with males experiencing slightly more symptoms overall. However, differences between the number of symptoms experienced by males and females were not *statistically significantly different* except in the cases of skeletal-muscular symptoms where males experienced significantly more symptoms than females ($t=1.96$: $df=43$; $p< 0.05$).

TABLE 63: Percentage of males and females reporting each symptom

	RESP	EYE	SKIN	ENT	MH	OTHER	SM	GI	FATIGUE
Male N=23	N=17 74% Sum=50	N=11 48% Sum=39	N=9 39% Sum=47	N=14 61% Sum=54	N=10 44% Sum=59	N=5 22% Sum=13	N=11 48% Sum=60	N=9 39% Sum=26	N=12 52% Sum=70
Female N=22	N= 18 82% Sum=78	N=12 55% Sum=46	N= 10 45% Sum=35	N= 16 73% Sum=75	N= 10 45% Sum=31	N= 9 41% Sum=13	N= 8 36% Sum=20	N= 15 68% Sum=29	N= 10 45% Sum=66

To conclude, adult females experienced slightly more symptoms than males over the year of the study.3.18 Semi-Structured Interview Conducted With All Farms Involved In The Diary Study.

SEMI-STRUCTURED INTERVIEWS

A semi-structured interview was conducted with 13 of the 18 families taking part in the study. Arrangements were made on two occasions to interview the remaining families but these appointments were missed. The interview used is presented in the appendices.

Initially a general medical history of each family was ascertained at the beginning of each interview. Questions relating to smoking and allergy history, as well as previous serious illness showed that approximately one-third of households had at least one family member who smoked (31%). Family members of 46% of households reported a history of allergies. There was only one reported inhaler-user who suffered from asthma. Four households (31%) had hay-fever sufferers with children representing 75% of those affected. Only one respondent reported a previous serious illness. This was accident related and had occurred many years previous. Only two households (15%) used gas heaters (Super Ser) in the home.

> The continuing lack of energy and burning of the nose and throat is much more pronounced on days when the wind comes from the west...

> The weather conditions are very important in our area. For the period of the (diary) study, the wind has blown from the West on very few occasions, the wet smog conditions have not been evident. Therefore a true picture of the disaster we suffered here in the early 1990s will not be portrayed here
>
> We all get the smell in the air which can almost turn your stomach. If we stay out in this we can be sick

Families were asked the approximate time when health problems were first noted and although only 31% offered a seasonal date (50% Spring : 50%Winter), there was almost total agreement on the time period- around the very late 1980's and early 1990's. Symptoms were usually preceded by rain after a dry spell. Conditions were usually 'still' but many found it difficult to describe specific weather conditions. Additionally the weather was not very cold. Moreover many felt that people became sensitized to these conditions over time. Respondents were asked to indicate the nature of symptoms experienced which ranged from respiratory problems such as coughing, sore throats and sinus trouble to watery eyes, a 'runny' nose and 'migraine-type' headaches. Burning skin was also reported as a presenting symptom.

> Boils and scabs are watery and stay oozing for a long time before healing

People working outdoors were most affected. When children at boarding school returned home at weekends or during holidays they often became ill immediately. Moreover, visitors to the farm experienced symptoms almost immediately as evident from the following quote.

> Relief milker was here from early morning until 1 o'clock and his face and eyes got burned and inflamed
>
> X finds it impossible to live at home. When s/he returns s/he suffers immediate asthma like conditions and skin rashes...symptoms clear up within 24 hours when s/he leaves area

Many families were concerned more recently with the levels of fatigue and lack of energy experienced by family members especially in older children and young adults.

> This tiredness is not natural and especially in young people

More than one-third (38%) of households specified that the symptoms listed in the semi-structured interview were more prominent in their children. The frequency of symptoms ranged from being daily (at the time when problems were first noted) to sporadic but were in all cases persistent when they occurred taking a long time to clear.

> Scabs and rashes are not healing up like they should
> X's cough never goes away

Respondents were asked whether symptoms were disabling and although few of the reported symptoms were rated as being disabling, three respondents (23%) did consider some of their symptoms extremely restrictive. These were 'flu and 'hay fever like' symptoms, appetite loss, nausea and tiredness. Many families did not have symptoms medically attended to by a GP. Two families did seek medical attention which resulted in prescribed medication. A further two families had members who were taking inhalers or eye/nose drops. Symptoms were mainly self treated. Respondents were asked to rate their current health status, their health status six years ago and to indicate whether current health status was better, the same or worse than previous health status. Current health status compared to health status six years previously for 46% (N=6 families) of families was the same. Although 15% of families (N=2) stated that they had experienced a decline in their health status, equally 15% regarded their current health status as improved. The remaining 23% (N=3) of households indicated that health issues were not a major concern except for the usual winter cold and 'flu's. When asked had any family member been so sick (currently) that health problems had got in the way of normal activities, 23% (N=3 families) stated that their health had been affected a little. 38% (N=5 families) said that their health had not been affected. Four households (31%) indicated that this question was not applicable and one respondent was omitted as a result of an accident many years ago. When asked had any family member been so sick (previously), 15% (N=2 families) said that their health had been affected a great deal. A further 23% (N=3 families) regarded their health to have been affected a little, whereas 31% (N=4 families) stated that their health never got in the way of daily activities. The remainder reiterated that health was not a major concern. Only one respondent reported physical health problems which interfered 'a great deal' both at present and previously. Three others reported that health problems had interfered with their daily lives previously but not any longer.

TABLE 65: Common physical complaints experienced by families when problems were first noticed.

Symptom	% Occurrence	N
Sinus congestion/Sneeze	38.5%	5
Irritated/Sore eyes	38.5%	5
Runny/Blocked nose	46%	6
Blister on lip	38.5%	5
Headache	31%	4
Allergies/Asthma	15%	2
Fatigue/Tired	54%	7
Difficulty sleeping	31%	4
Numbness/Tingling limbs	15%	2
Wheeze in chest	38.5%	5
Skin symptoms/Burning	38.5%	5
Muscle aches/Pains	54%	7
Dizzy spells	23%	3
Sore throat	23%	3
Earaches	8%	1
Loss of appetite	8%	1
Nausea/Vomiting	31%	4
Cough/Phlegm	38.5%	5

Respondents were asked to indicate whether health problems interfered with normal activities such as work and social activities. There was a general consensus among respondents that families had to get on with day-to-day activities and farm management in spite of ill health. Only one family reported that poor health still interfered with social activities. When asked to calculate the number of days they were so sick that they were unable to carry out their daily activities, only four indicated that they were affected by sickness previously. However none of these specified the number of days which were lost due to illness. Nobody stated that they currently were unable to carry out their daily activities. Each interview concluded with an itemized list of common physical complaints which respondents were asked to complete by saying which (if any) members of the family had experienced since they first noticed the problem. The numbers (%) of those with health problems are presented in the table below. Over half reported being tired and suffering from fatigue, half of the respondents also reported experiencing muscle aches and pains. Respiratory problems were also reported by a significant number of families as were eye problems and skin problems. Three families also reported difficulties sleeping and stress over the ill health of the animals. Others reported experiencing some financial loss.

Summary of Interview Findings

- Approximately one-third of all households had a family member who smoked
- Family members of 46% of households reported a history of allergies.
- Health problems were first noticed in the Winter/Spring time of the late 1980s/early 1990s
- Health symptoms were usually preceded by rain after a dry spell, moreover the weather was mild
- Respondents working outdoors were more affected
- Few respondents rated the health symptoms as being disabling
- Current health status (compared with previous six years) was rated as the same by six families
- Two families experienced a decline in their health status
- Two families reported health status as improved compared to the previous six years
- Three families indicated that health issues were not a major concern except for the usual winter colds
- Only one respondent reported physical health problems which interfered 'a great deal' in normal daily activities both currently and in the past
- Three others reported that health problems had interfered with their daily lives previously but not any longer.
- The most common physical complaints experienced by families when problems were first noticed included fatigue, muscle aches and pains and a runny or blocked nose.

CONCLUSION

Health diaries are used to measure symptoms, minor illnesses, medication use and medical care. The health diary in this study was used to investigate the morbidity of a group of farmers located near a chemical plant. Respondents were asked to record symptoms experienced, the level of discomfort associated with symptoms, actions taken and possible explanations for symptoms for 13 months in total. The first month was used as a practice period. Compliance rate and respondent co-operation are discussed in the next section.

Compliance Rate and Respondent Co-operation

Few families suspended diary completion prior to the end of data collection. Indeed, few subjects declined to commence the diary study or skipped days since respondents were asked to record 'no symptoms' if that was the case. Vedal *et al.* (1987) reported that an average 79% of respondents completed the diary each month. However, in this study 100% of respondents completed the diary for the first nine months of the study. This may be due to the fact that subjects were able to complete the diary in less than five minutes. In addition the project co-ordinator was in contact with respondents every five-six weeks to collect completed diaries and distribute additional diary record sheets. Moreover, visits were always preceded by a telephone call. It is noteworthy that all respondents were aware of the saliency of the diary study, a factor which often affects compliance rate according to Sudman & Lannon (1980). Verbrugge (1980) suggested that there may be changes in reporting health behaviour as a result of diary keeping. This did not appear to be the case in this study since the pattern of morbidity symptoms fluctuated over the year especially for respiratory symptoms which declined in the Summer months only to increase again in the Autumn. Indeed the pattern of reports for each symptom type differed from month to month. Verbrugge (1980) also suggested that respondents were likely to become fatigued (with the diary) with longer study periods. This was not apparent in this study as morbidity symptoms generally increased in the final, autumn month of the study.

Findings

The morbidity findings are discussed in relation to the aims of the study.

Aim 1: To identify acute health problems recorded prospectively by family members in a one year period

It was found that diaries elicited reports of symptoms, both acute and chronic, that do not cause disability or require medical attention. The fact that symptoms were recorded consecutively made it possible to detail the length of time symptoms persisted. In this study symptoms were initially found to be recorded one day in every two however a more detailed investigation revealed that symptoms were recorded one day in five when a small group of five persons were removed from the analyses. On average respondents reported 1.5 symptoms per month and this deceased to approximately one symptom a month per person as the analysis was refined. However these symptoms often persisted for long periods of time. On average, respondents were ill approximately 13 days per month of the study.

In general few symptoms resulted in GP visits. This finding is akin to Kosa's *et al.* (1967) study where the overwhelming majority of symptoms experienced by patients were not brought before a physician. In this study respiratory symptoms were the most commonly reported symptoms followed by ear, nose & throat (ENT) symptoms, skin symptoms and fatigue which collectively accounted for approximately 60% of all symptoms reported. One third of the group also experienced mental health, 'other', skeletal muscular, and fatigue symptoms.

Aim 2: To determine the prevalence rates of symptoms of the upper respiratory tract, eye and skin irritation.

In total 72% of the sample reported a respiratory symptom at some stage during the year with 28% of the sample never reporting any respiratory symptom. Approximately half of the group reported ENT symptoms. Forty percent of the group reported eye symptoms during the year and approximately one third of the group had skin symptoms. Moreover, children experienced few eye and skin symptoms.

Aim 3: To investigate if some family members were more susceptible to health problems than others.
Approximately 40% of the sample were under 18 years of age and the remainder were over 18 years. The findings revealed that the majority of symptoms were recorded by adults. Indeed certain symptom types were rarely recorded for children namely, eye, skin and skeletal-muscular symptoms. Moreover, there were no major differences between adult males and adult females except in the case of skeletal-muscular symptoms, where males experienced more symptoms than females.

Aim 4: To investigate seasonal differences in the health status of family members.
Respondents were most ill during the autumn and winter months. Only 30% of symptom days were endorsed between February and May. In general, morbidity symptoms increased in the final, autumn month of the study. This pattern was particularly evident for upper respiratory tract symptoms. The trend for other symptoms was somewhat irregular.

Aim 5: To investigate possible causes of health problems.
In many cases respondents did not know the cause of symptoms while other symptoms had explainable causes. As was outlined in the results section these were removed from the analysis and additional analysis was conducted which influenced the seasonal factors described above, especially in the case of respiratory symptoms. In some cases respondents did indicate possible pollutants or environmental causes but in general the response was 'don't know'.

Aim 6 &7
It was difficult to investigate aim 6 and aim 7 which were concerned with health status as measured by standardised health indices as there was a very poor completion rate of the General Health Questionnaire disseminated in the fourth month of the study. Moreover, some respondents indicated that they did not wish to complete any questionnaires. However, a semi-structured interview conducted with the majority of families involved indicated that physical health status had greatly improved for most families and the diary study did not reflect that poor health experienced in the past.

Comparison with other studies
In the next section the findings of this study are compared with similar studies. However results must be interpreted with caution since studies had different aims, for example, Freer (1980) and Morrell & Wale (1976) were concerned with self-care. The category of 'symptom type' was not directly comparable since most of the symptoms in the earlier studies were categorised as 'other'. Indeed the studies spanned four decades.
Eye and skin symptoms were highest in this study, however two studies did not have categories for such symptoms which may be included in the 'other' symptoms category. Reports of gastrointestinal symptoms were lowest in this study as were reports of mental health and 'other' symptoms. Fatigue symptoms were higher than in some studies but the highest was in the Freer (1980) study where fatigue accounted for 17% of all symptoms reported. A higher number of respiratory symptoms were recorded in the 1967 study where 43% of all symptoms reported were respiratory.
In a study conducted by Upton (1999) baseline information was gathered from approximately 2,320 respondents investigating the presence of sore throat, cold/flu, cough/catarrh/phlegm and diarrhoea.

A total of 12.2% reported a sore throat, in this study 16% of respondents reported a sore throat throughout the duration of the study. Approximately 45% reported a cold/flu or a cough. This compares to 20% of respondents in this study who reported a respiratory symptom. However in Uptons' (1999) study the population were from an urban area whereas in this study the population all live in a rural area.

Table 66: Types of medical problems reported showing relative frequency of each expressed as a percentage of all medical problems episodes.

Symptom type	Farmers Study (1998)	Freer (1980) Self-care Study	Morrell & Wale (1976) Self-care Study	Alpert *et al.* (1967) Health care
Respiratory	20%	6%	10%	43%
Ear,nose,throat	16%	-	7%	-
Mental Health	10%	35%	23%	11%
Skin	13%	3%	-	8%
Eye	8%	1%	-	-
Skeletal-muscular	10%	14%	7%	-
Gastrointestinal	6%	17%	9%	9%
Tired/Fatigue	13%	17%	10%	-
Other	4%	7%	34%	29%
TOTAL	**100%**	**100%**	**100%**	**100%**

The primary limitation of this study was that only current exposure could be measured. Bearing this in mind, the findings from the present study provide an accurate representation of the levels of ill health experienced by respondents over the duration of the study.

In conclusion, the findings from this study revealed that, with the exception of a small group of respondents who experienced considerable ill health over the course of the study, the majority of respondents recorded one symptom per month on average which was experienced on a recurring basis approximately 13 days per month per person. In addition, in the majority of cases, symptoms were not presented to a physician.

Unfortunately, the interpretation of this finding is hampered by a lack of baseline morbidity data. The availability of such data would allow for empirical comparisons to be made between the incidence of ill health reported in this study and that experienced by the general population. While such comparisons cannot be made, the overall findings from this study indicate a low incidence of ill health experienced by the majority of respondents.

The low incidence of ill health reported in this study cannot however diminish the experiences of these respondents prior to the commencement of this study. As one respondent commented:

> *"The weather conditions are very important in our area. For the period of the study, the wind has blown from the West on very few occasions, the wet smog conditions have not been evident. Therefore, a true picture of the disaster we suffered here in the early 1990s will not be portrayed here".*

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APPENDICES

APPENDIX A - HOW TO USE THE FAMILY HEALTH DIARY

1. Each day keep a record of your family's health in the diary

Record when:
A.. When someone has symptoms, such as....Sore eyes

B. Identify who had symptoms using the following coding frame

(m)	*Mother*	*(f)*	*Father*
(c1)	First Child	(c2)	Second Child etc.
(gm)	Grandmother	(gf)	Grandfather
(r)	Relative	(f)	Friend

For example *Muscle aches (f) [Father had muscle aches]*

C. What you did about health symptoms, such as... Gave eye drops (c1), no action (f)

2. If no one in the family has any symptoms, write down... "No symptoms"

3. Identify any possible explanations for any symptoms reported

4. If a symptom is present please rate the level of discomfort according to the following scale
Mild - Discomfort may have been present in a minor degree or has not caused significant distress

Moderate - Discomfort has occurred occasionally in a degree sufficient to cause significant distress

Marked - Discomfort as defined for 'moderate' but has been present frequently

Severe - Continuous discomfort on a regular basis

Below is a list of possible health effects

Sinus congestion or sneeze
Irritated or sore eyes
Runny or blocked nose
Blister on lip
Headache
Allergies or asthma
Fatigue or tired
Difficulty sleeping
Numbness or tingling in limbs
Wheeze or whistling noise in your chest
Skin burning
Muscle aches or pains
Dizzy spells
Sore throat
Earaches, loss of hearing or other problems
Loss of appetite
Nausea or vomiting
Cough / phlegm

Your interviewer will be in touch with you regularly and will call to collect the Family Health Diary every month. If you have any questions your interviewer's name is ________________ and her telephone number is ______________________

Askeaton Human Health Investigation - Diary Study

Week 1 Date

	Symptoms	**Action Taken**	**Possible explanation for symptoms**	**Symptom Discomfort** 0 None 1 Mild 2 Moderate 3 Marked 4 Severe
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Saturday				
Sunday				

Please write any other comments below.

APPENDIX B

Date of Birth, occupations

Smoking & allergy history, uses of inhalers(wheeze), suffered from hay fever

Previous serious illnesses

Gas heaters in home

APPENDIX C
SEMI-STRUCTURED INTERVIEW CONDUCTED WITH ALL FARMS INVOLVED IN THE DIARY STUDY

Farm ________________ Date ________________

1. Approximate time problem first noticed ____________________
(month, year, weather conditions)

2. Immediate nature of symptoms

3. People affected / ill

4. Frequency of symptoms (daily, monthly, sporadic)

5. Were symptoms disabling, which one most disabling

6. Medically attended symptoms versus medically non-attended symptoms

7. Health rating (NOW)
-excellent, very good, good, fair, poor

8. Health rating (6 years ago)
-excellent, very good, good, fair, poor

9. Current Health status versus previous Health status
-Better, about the same, worse

10. Have you been so sick (currently) that your health has got in way of normal activities?
-not at all, a little (some), a great deal

11. Have you been so sick (previously) that your health has got in way of normal activities?
-not at all, a little (some), a great deal

12. How much does physical health problems stand in the way of you doing the things you want to do? (currently)
-not at all, a little (some), moderately, a great deal

13. How much does physical health problems stand in the way of you doing the things you want to do? (previously)
-not at all, a little (some), moderately, a great deal

14. How much does physical health interfere with your work (currently)
-not at all, a little (some), moderately, a great deal

15. How much does physical health interfere with your work (previously)
-not at all, a little (some), moderately, a great deal

16. How much does physical health interfere with social activities (currently)
-not at all, a little (some), moderately, a great deal

17. How much does physical health interfere with social activities (previously)
-not at all, a little (some), moderately, a great deal

18. No of days so sick unable to carry out your usual activities (currently) -none/a week or less/more than a week but less than one month/1-3 months/ 4-6 months

19. No of days so sick unable to carry out your usual activities (previously) -none/a week or less/more than a week but less than one month/1-3 months/ 4-6 months

Sinus congestion or sneeze
Irritated or sore eyes
Runny or blocked nose
Blister on lip
Headache
Allergies or asthma
Fatigue or tired
Difficulty sleeping
Numbness or tingling in limbs
Wheeze or whistling noise in your chest
Skin symptoms / burning
Muscle aches or pains
Dizzy spells
Sore throat
Earaches, loss of hearing or other problems
Loss of appetite
Nausea or vomiting
Cough / phlegm
(a few times a week/about every week/a few times a month/about every month/a few times a year/never)

CANCER AND MORTALITY STUDIES

INTRODUCTION

Many studies over the last 50 years have convincingly demonstrated that air pollution is a significant contributor to ill health (particularly respiratory ill health) and to premature death. Many of its constituents have been demonstrated to be carcinogenic[1,2]. The debate today centres on the levels at which noxious substances passed into the atmosphere as a result of man's activities will produce these health effects.
The first section of this chapter describes a study which reviews the incidence of cancer in the Askeaton area compared with a control area. The second section describes a study which reviews the mortality experience of those living in the Askeaton area compared with a control area over a six-year period.

CANCER INCIDENCE STUDY

Introduction

Much of the evidence linking human cancer and air borne noxious substances has come from studies of occupational cancer. Descriptions of cancer arising as a result of contact with environmental carcinogenic pollutants go back to Percival Pott's occupational linking, in 1775 of the risk of scrotal cancer and chimney sweeping[2]. Following this description, organic substances known as polynuclear aromatic hydrocarbons were demonstrated , in the early part of this century, to be carcinogenic. Further studies implicated dye stuffs and subsequently radioactive substances including radium were found to produce tumours in animals and man. By the 1930's lung cancer (unusual at that time) had been observed to be commoner in workers exposed to asbestos fibres[2]. From the 1930's onward a steady rise in lung cancer incidences was noted in the industrialised world and this was initially attributed to fumes, in particular from diesel engines. The definitive work of Doll and Hill in examining the lung cancer experience of British doctors demonstrated that cigarette smoking and lung cancer were closely linked. Studies into the possible carcinogenic effects of atmospheric pollution therefore have been dogged by the confounding effects of cigarette smoking. Any possible role played by atmospheric pollution in the development of lung cancer has been particularly difficult to determine. Epidemiological studies over the past 40 years have suggested rather consistently, that general ambient pollution, chiefly due to incomplete combustion of fossil fuels, may be responsible for increased rates of lung cancer[3]. The prominently increased risk of lung cancer among urban rather than rural dwellers was recognised and higher ambient levels of pollution was one suggested reason accounting for this difference[4,5].
In 1998 Freeman and Cattell estimated that in the Sydney region about 30 lung cancers a year could arise from exposure to polycyclic aromatic hydrocarbons in the ambient air[6]. In 1993, Kappos and Schmitt reported that the Lander Committee for Emission Protection commissioned by the Conference of Ministers for the Environment had developed a series of guidelines for the concentration for the carcinogenic pollutants in the atmosphere in West Germany[7]. Of a large number of substances identified as carcinogenic seven were selected for standardisation. These included arsenic, asbestos, benzene, cadmium, diesel exhaust, polynuclear aromatic hydrocarbons and 2,3,7,8-tetrachlorodibenzo-(P)-dioxin. WHO has categorised compounds into inorganic and organic carcinogens:

- Inorganic carcinogens include arsenic, cadmium, chromium and nickel.
- Volatile organic compounds. These include benzene, 1,3 butadiene PAH and TCE.

Currently more than 2,800 different chemicals have been identified in the air or coming from emission sources. Only about 10% of these has been evaluated in bioassays for genetic or carcinogenic effects[8]. Hydrocarbons, nitrogen containing organics and halogenated organics account for nearly 60% of the air borne chemicals that have been studies in long term animal cancer bioassays or short term genetic bioassays[8]. The highest number of potentially carcinogenic chemicals are emitted by combustion sources (i.e. tobacco smoke, car exhausts and coal combustion). Polycyclic organic materials which are produced by the incomplete combustion from

the above sources make up the largest single contribution to human cancer risk. From these combustion sources motor vehicle emissions account for the greatest cancer risk in outdoor air. Environmental tobacco smoke and radon are the major sources of cancer risk from indoor exposure[8]. Despite the undoubted increase in awareness of the potential dangers posed by airborne carcinogens, recent studies have highlighted potential threat posed to the public health. Woodruff and others, in 1998, demonstrated, using 1990 figures that known carcinogens such as benzene, formaldehyde 1,3-butadiene exceeded cancer bench-mark concentrations in over 90% of the sense of the areas studied. Across the range they found concentrations regularly exceeding what would be considered safe[9].
Given that the effects of such pollutants are dose-dependent, it seems safe to assume that sources of these pollutant are more likely to adversely affect the health of nearby communities[3,10,11]. Lloyd and others in 1986, studied the respiratory cancer mortality experience in Armadale, Scotland which had the highest mortality rates in Scotland for these cancers from 1969 to 1973[12]. Despite controlling for factors such as cigarette smoking and occupational background and a very tight study design they concluded that risk of lung cancer was causally linked to atmospheric pollution. It has been demonstrated that risk of lung cancer is associated with increased air pollution secondary to combustion particularly when associated with high levels of polyaromatic hydrocarbons[13,14]. Other surveys have not shown such a relationship. Bhopal and others found that those living near a coking works in northern England had no greater risk of cancer than control areas[11] and Elliot and others demonstrated no association between laryngeal and bronchogenic carcinoma and living close to oil and solvent incinerators in Britain, major emitters of polyaromatic hydrocarbons[15].
While the evidence may not favour a link between point source emissions and cancers due to airborne pollution, urban/rural differences in cancer experience are well documented. A review of epidemiological studies over the last few decades seems to indicate that urban residents have a smoking-adjusted excess of lung cancer 1.5 times that of rural residents[1].

Cancer Incidence in the Republic of Ireland

In Ireland 1 in 10 hospital admissions and 1 in 4 deaths are due to cancer. Cancer death rates in men and women are relatively low during early life and rise rapidly beyond the age of 60. The overall death rate from cancer has remained unchanged since the early 1970s and our figures are comparable to other western European countries. Variations do occur however. Figures from IARC indicate that men have slightly lower incidence of lung cancer and a higher rate of colo-rectal and prostatic cancer than in the rest of Europe (Fig. 1).

FIG.1 Comparative Incidence of Male Cancers in Ireland, the UK and the EU in 1990

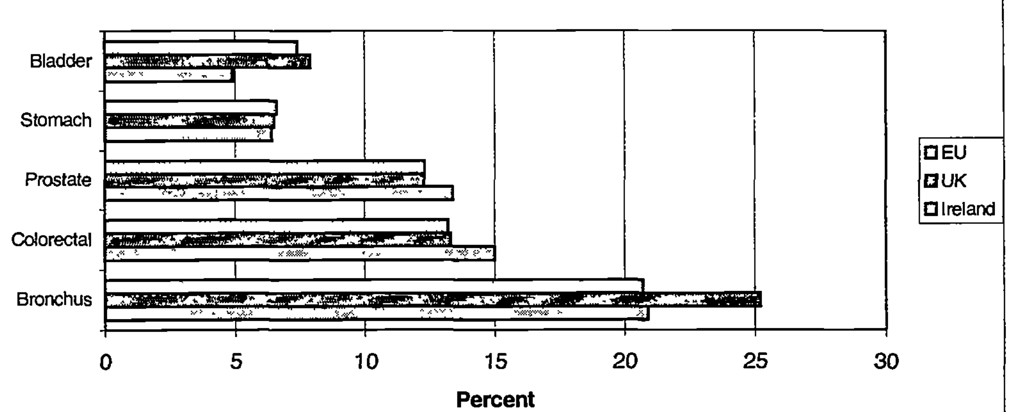
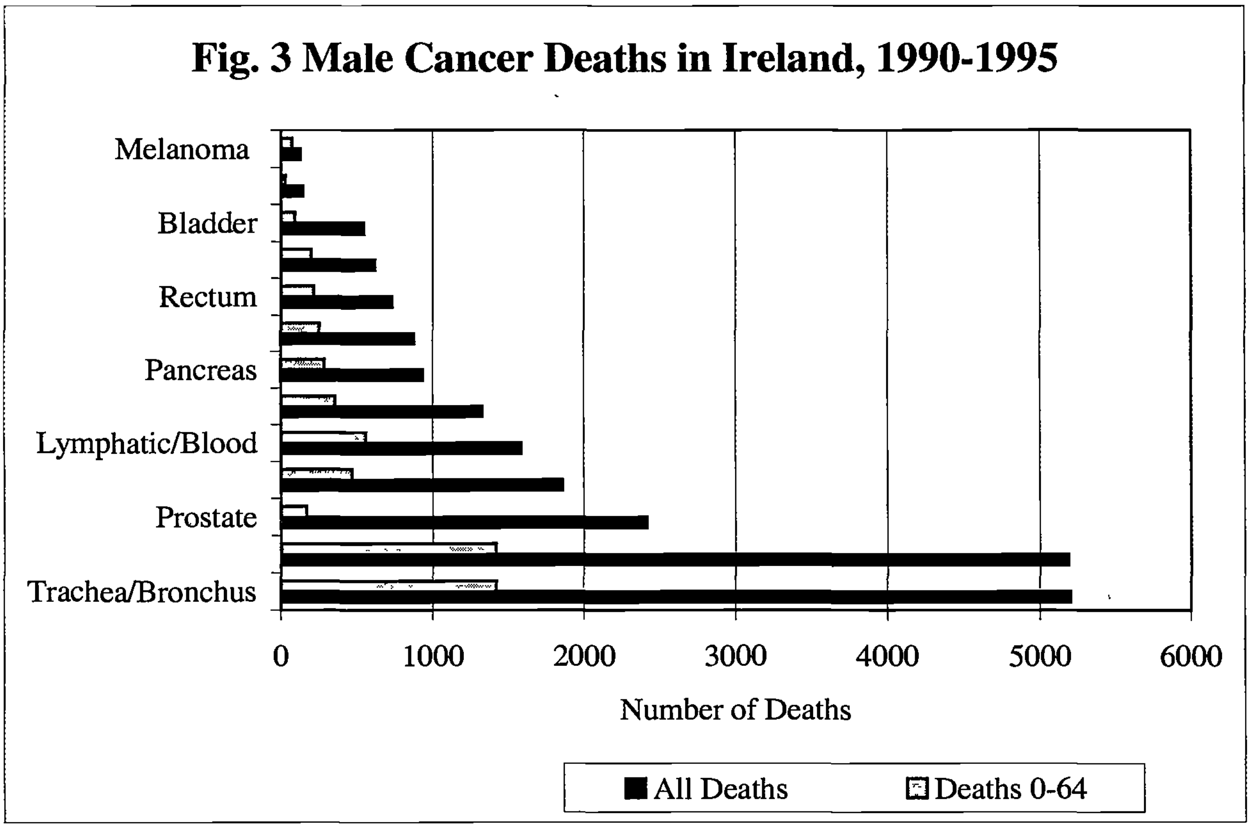


Fig. 2 indicates that in 1990 women had lower rates of breast and colo-rectal cancer than the rest of the EU but recent figures suggest that women are performing worse with regard to colo-rectal and breast cancer than their European counterparts.
The incidence of cancer increases with age but to a greater degree in men than women (Fig. 3).

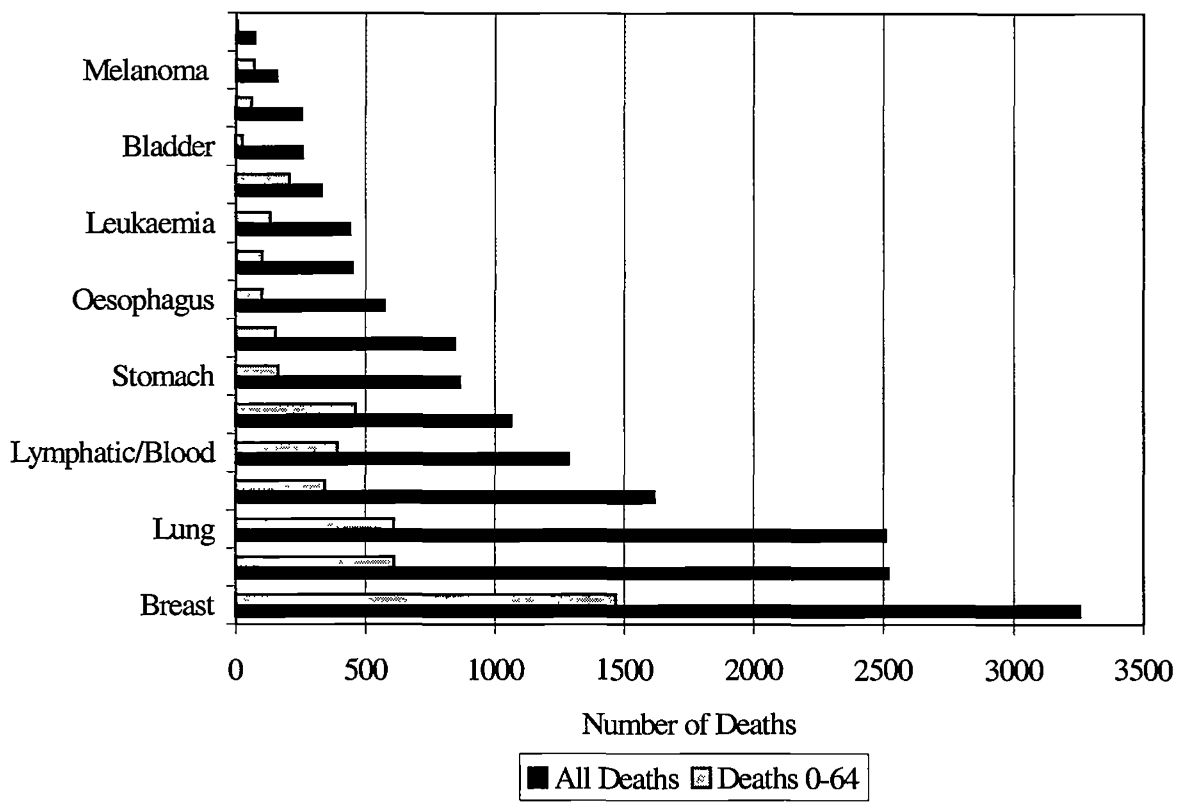
Fig. 2 Age-specific Cancer Mortality Rates for Irish Males and Females per 100,000 Population



Within Ireland death rates and incidence for cancer show geographical variation, for example lung cancer is commoner in the more heavily industrialised parts of eastern Ireland and it is in keeping with the known epidemiology of lung cancer. Reviewing cancer deaths in Ireland between 1990 and 1995, tracheal, lung, prostate and colo-rectal cancers can be seen to be the 4 major causes of death in all men under the age of 64 (Fig. 4). Trachea, bronchus, lung, colon and cancers of the lymphatic and blood-forming systems can be seen to be the commonest.

Looking at the female cancer deaths for the same period breast, lung, trachea. bronchus and colon can be seen to account for the majority of female deaths under the age of 64 breast, broncho lung, ovary and cancers of the lymphatic and blood-forming systems account for most deaths (Fig 5).

Fig. 5 Female Cancer Deaths in Ireland, 1990-1995



Standardisation

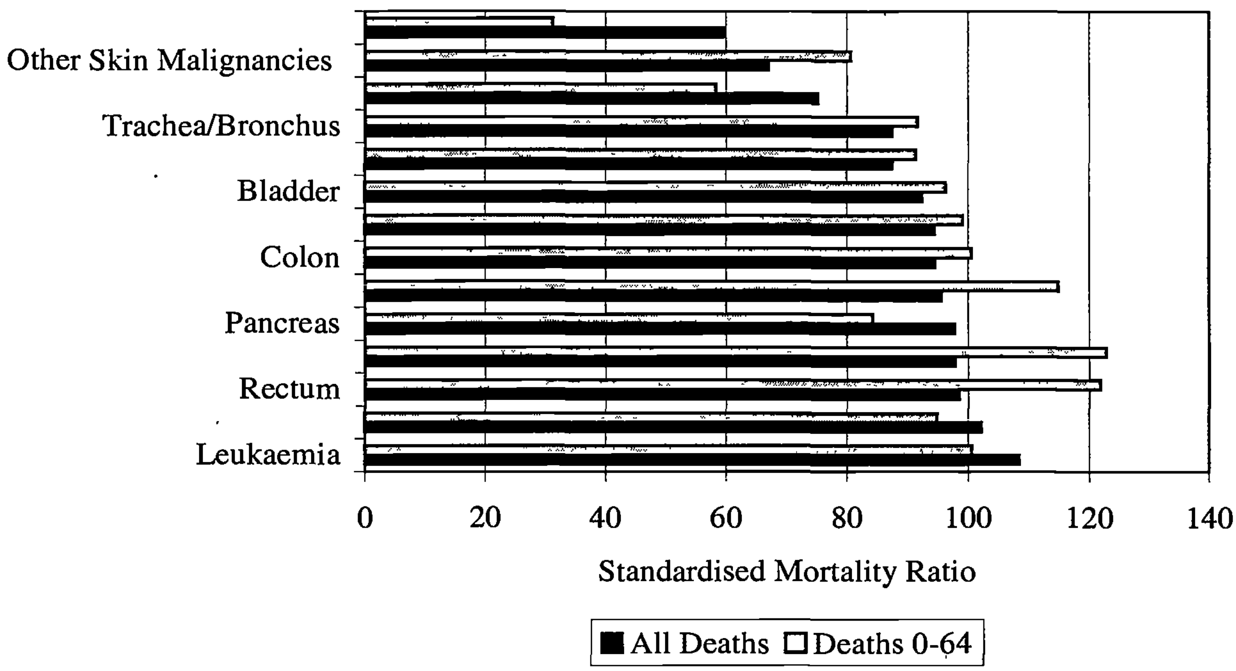
In studying deaths due to a certain condition a standard method is often adopted whereby a region or an area's mortality experience is compared with that of the whole. For example, the following table (Table 1) relates the cancer deaths in the Mid-Western Health Board to that of Irish national figures and is given as a standardised mortality ratio or SMR. The standardised mortality ratio compares the mortality in a particular group, from a particular cause with that of a standard population - in this case the national population. It is given as a ratio and generally expressed as a percentage of the number of deaths which occurred in the designated group to the number that would have been expected if the mortality rates in each age band of the designated groups had been the same as those in the standard population. In other words it is a measure of the mortality experience of a group with calculations and adjustments being made to represent the mortality experience they would have had if the age distribution had been the same as the standard population. It can be seen from Table 1 that male and female death rates in all age groups and in those aged 1-64 are shown. The Mid-Western Health Board region has a better cancer mortality experience than the country as a whole in each of the groups with the exception of females aged 1-64.

Table I

	SMR All	SMR 0-64
Male	94.43	99.08
Female	95.78	104.1

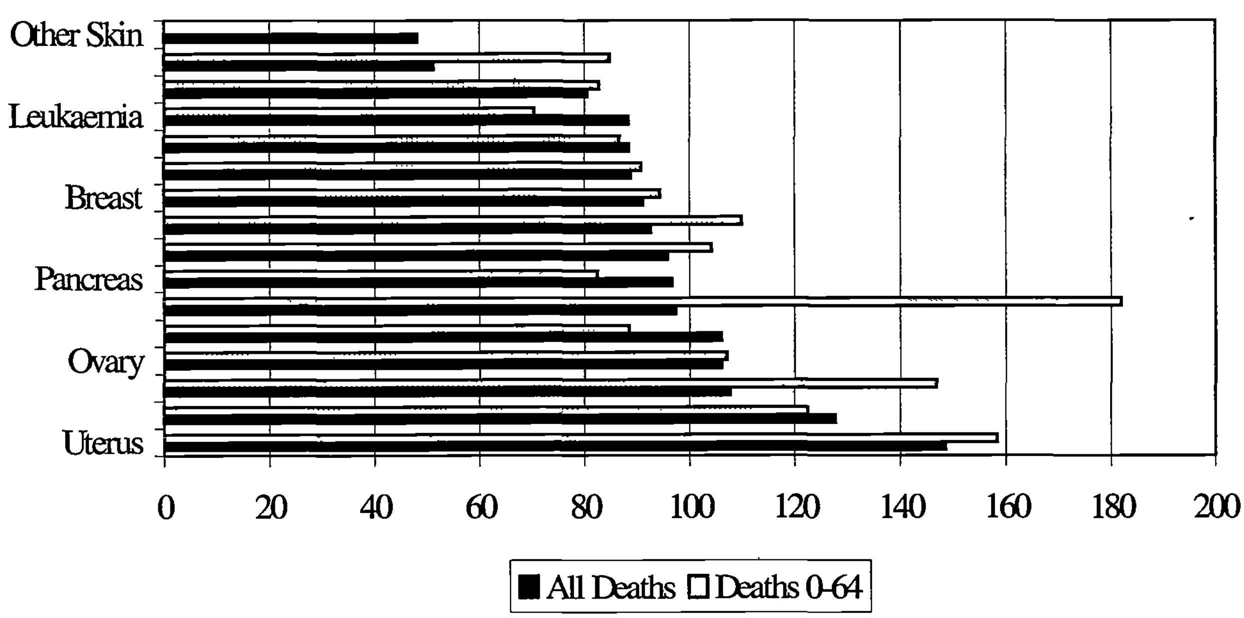
Figure 6 shows the SMRs for male cancer deaths in the Mid-Western Health Board region during the period 1990-1995. Overall, these figures compare favourably with the national picture. For all ages, the highest SMRs are for leukaemia and cancers of lymphatic and blood-forming organs. The SMRS in these cases are slightly over 100 indicating a slightly poorer cancer mortality experience in these cancers than the national picture. All other cancers in this group are less common than would be expected.

Fig. 6 Male Cancer Deaths in the Mid-Western Health Board Region, 1990-1995



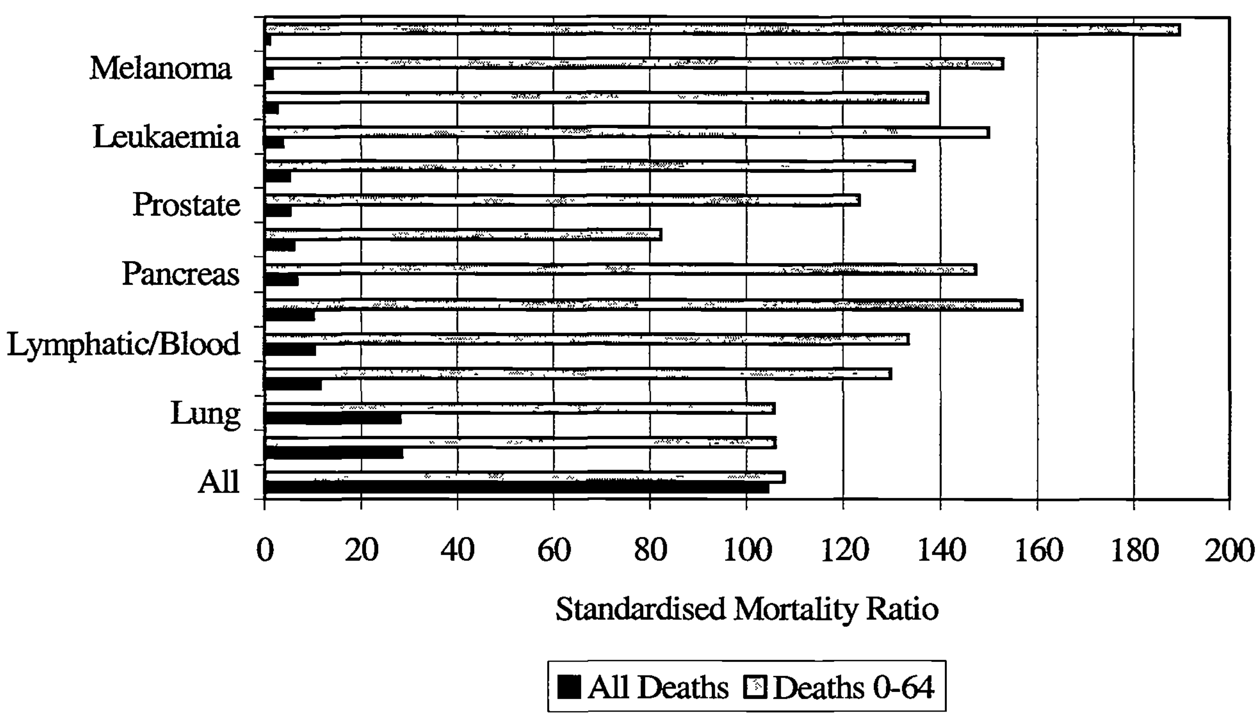
For deaths under the age of 64 in men however the Mid-Western Health Board has a poorer record than nationally for cancers of the rectum, oesophagus and prostate. There is considerably less skin cancer than would be expected nationally. Looking at female cancer deaths in the Mid-Western Health Board region women do not appear to fare as well as men (fig 7)

Fig. 7 Female Cancer Deaths in Mid-Western Health Board Region, 1990-1995



In all age categories, cancers of the uterus, cervix, oesophagus, lung, bladder, pancreas and colon are all commoner than in the general population. Looking at deaths under the age of 64 there is a markedly increased incidence of death for cancers of the uterus, oesophagus, bladder and pancreas. Women fair relatively better than nationally in cancers of the breast, ovary, stomach and rectum. Overall the SMR for all deaths for men in the Mid-Western Health Board region is 94 and for those under 64 is 98. For women the equivalent figures are 108 and 128.

Fig. 8 Male Cancer Deaths in County Limerick, 1990-1995



Looking at the male mortality experience in each of the 3 counties (figs 8, 9 and 10), Limerick county has most noticeable results. Overall, the experience is close to the national average but there is considerably more cancer amongst younger people than would be expected. County Clare has overall SMRs of just over 80, indicating a better than expected mortality experience than the rest of the country. North Tipperary fares better than nationally but not as well as Clare.

Fig. 9 Male Cancer Deaths in County Clare, 1990-1995

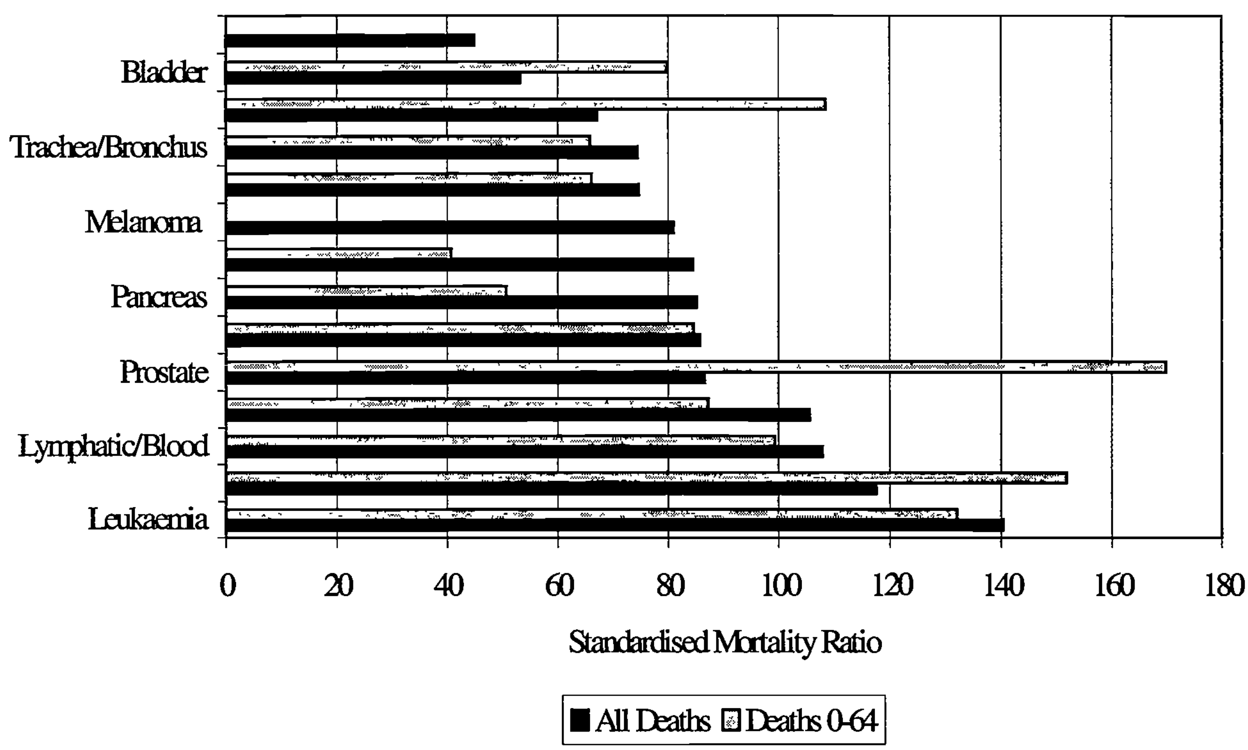


Fig. 10 Male Cancer Deaths in County Tipperary (N. Riding), 1990-1995

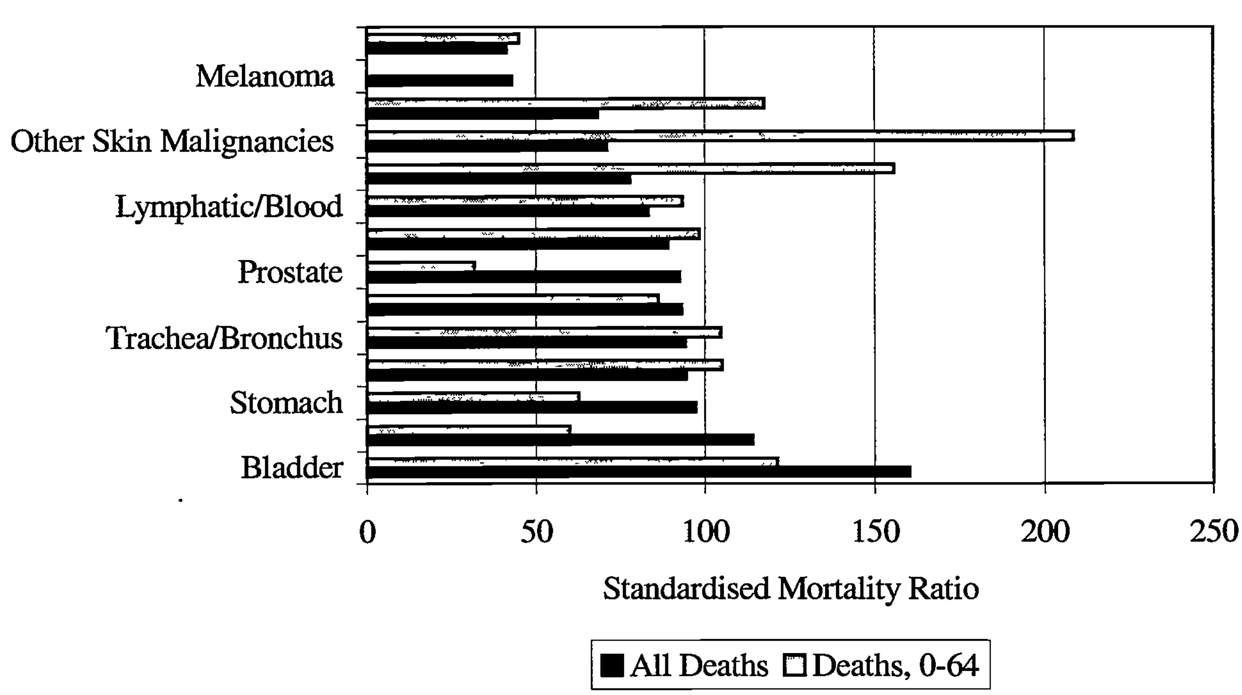


Fig. 11 Female Cancer Deaths in County Limerick 1990-1995

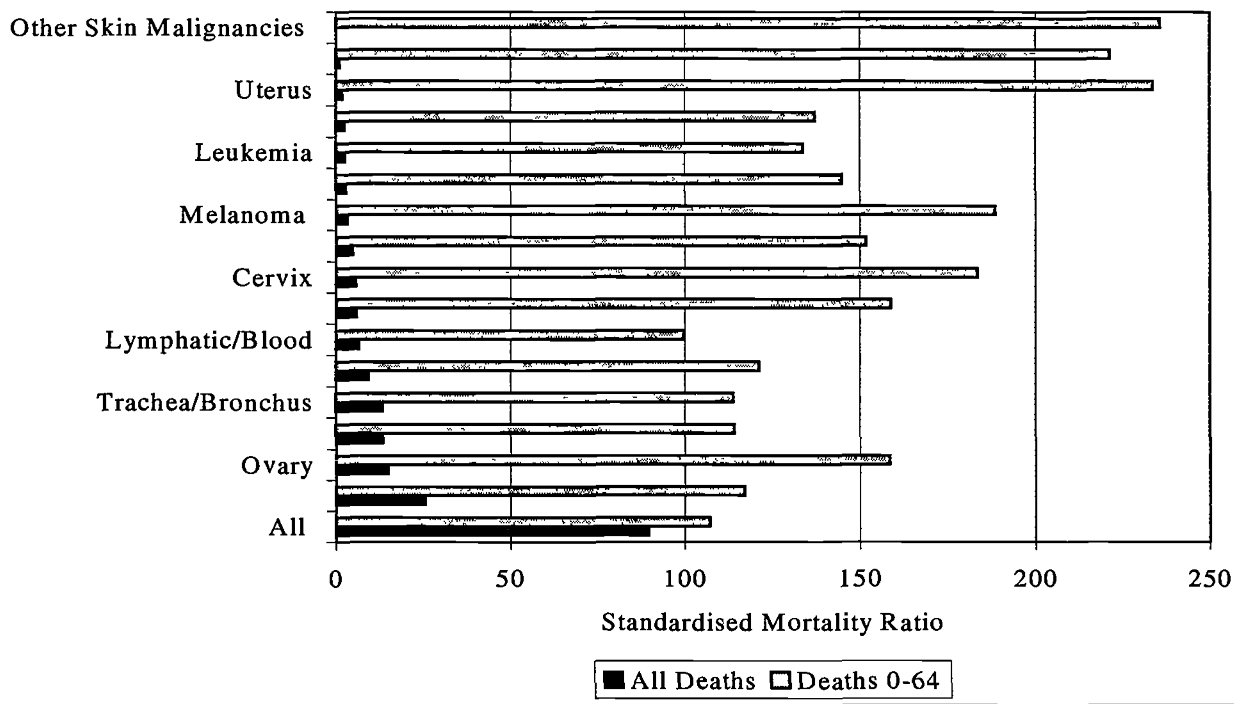


Fig. 12 Female Cancer Deaths in County Clare, 1990-1995

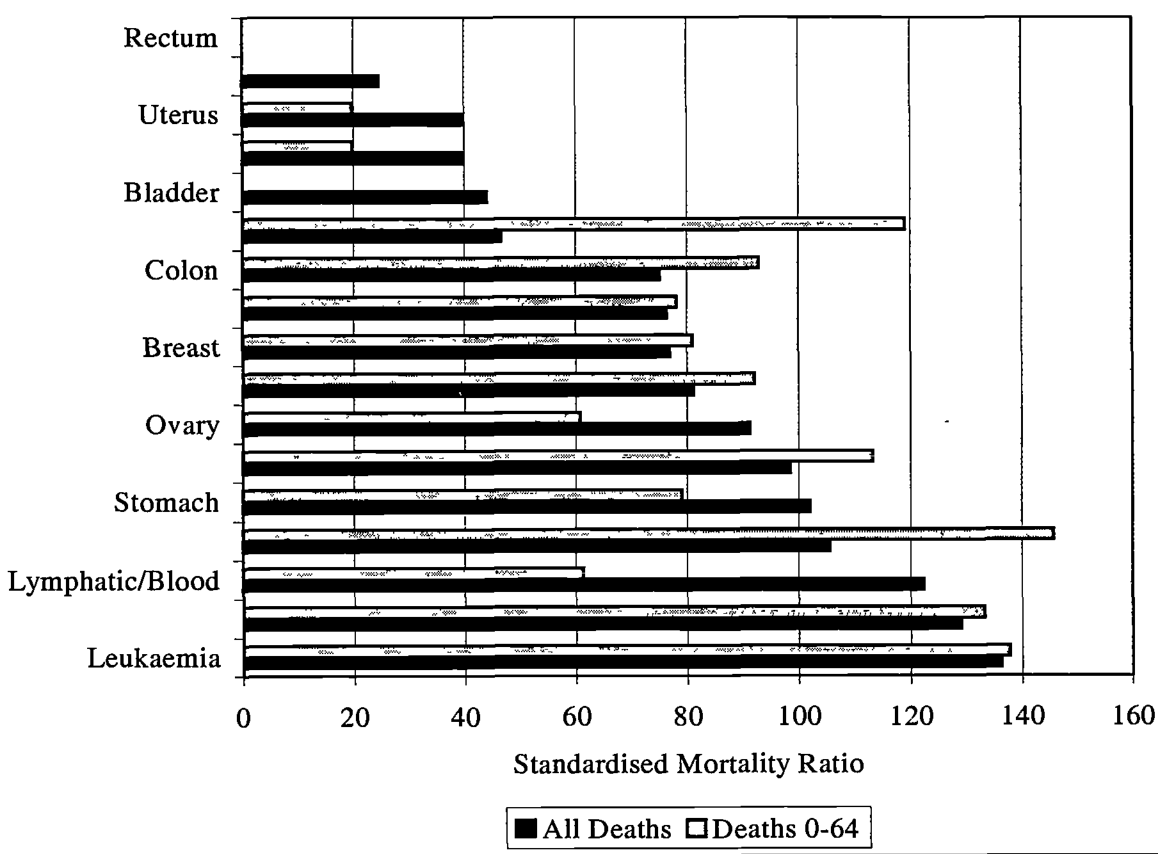
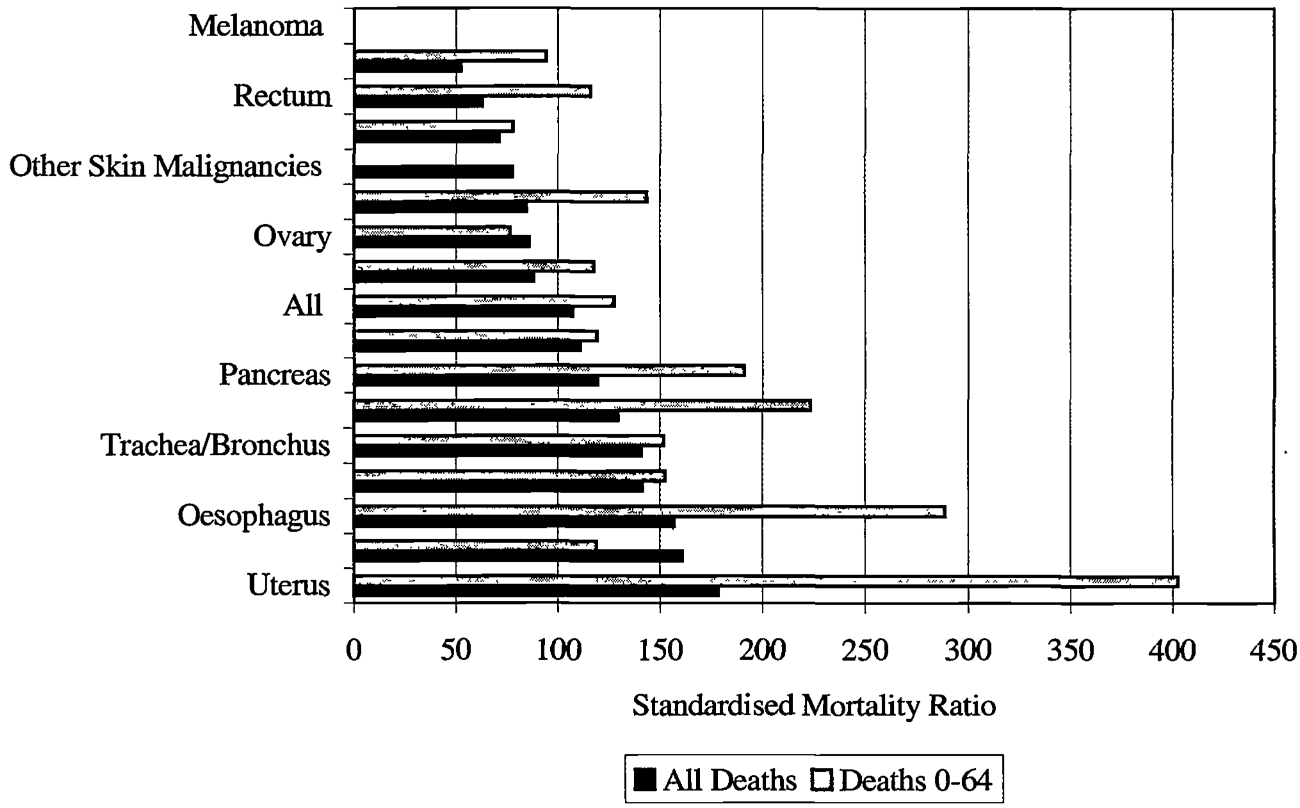


Fig. 13 Female Cancer Deaths in County Tipperary (N. Riding), 1990-1995



Looking at the female mortality experience in each of the 3 counties (figs 11, 12 and 13), Limerick County shows the same prominent pattern of excess mortality in those under 65. Clare has a similarly favourable pattern to the men and North Tipperary is only slightly worse than the national average.

METHODS

The aim of the study was to determine if people living in the Askeaton area had a greater likelihood of developing cancer than those living outside the Askeaton area. The areas chosen for study were:

- **Area 1:** The area within the Rathkeale rural district in County Limerick, encompassing Askeaton East, Askeaton west, Iveruss, Craggs, Aughinish, lismakeery, Nantinan and Riddlestown (population approximately 4,000). This area includes the farms considered to have animal health problems:- the "high-risk" area.
- **Area 2:** The rest of the Rathkeale rural district and Rathkeale urban district in County Limerick (population approximately 10,000); the "medium-risk" area.
- **Area 3:** The Killadysert rural district in County Clare (population approximately 9,000); a control area.
- **Area 4:** The Ennistymon rural district in County Clare (population 9,000); a control area.
- **Area 5:** Moyne and Lyttleton dispensary districts in County Tipperary (DEDs 62, 71, 72, 73, 75, 76, 77, 78 and 80); a control area.

- **Area 6:** The Clarecastle area, County clare, comprising the DEDs of Clareabbey and Doora as well as the southern half of Ennis rural district (made up of the townlands of Coor, Cahircalla More, Cahircalla Beg, Shantulla, Ballymacaula, Keelty, Kilnacally, Ballylinnidy, Shanvogh, Clonroad More, Bunnow, Gaurus, Clonroad More and Drumbiggil - population approximately 3,750); a control area.

Cancer incidence data provided by the National Cancer Registry was geocoded manually from tables of addresses provided by Local Government Computer Services and standardised incident ratios were calculated for each of the study areas compared with the regional Mid-West cancer incidence rates which was used as a reference.

RESULTS

This study sought to determine if there was a difference in the cancer incidence experience between the chosen high and low risk areas. Cases of cancer occurring in these areas in 1994 and 1995 were geocoded to ensure that they could be linked to a risk area. Rates of cancer incidence for those years were then determined for each sex and in every age group in each of the areas. Age specific rates per 100,000 population were calculated and compared with regional Mid-Western Health Board standards and with national standards to give standardised incidence ratios (SIRs) similar in every way to SMRs. The results were further analysed in terms of total rates of disease, including skin cancers and total rates of disease excluding skin cancers in order to allow more detailed evaluation of data without the diluting effects that large numbers of cases of skin cancer produce. The results for each are laid out in Tables 2-5 below.

When cancer incidence in 1994 - 1995 is examined with the Mid-Western Health Board as a standard population (Tables 2 and 3) it can be seen that there is no increased risk of skin cancer in the high risk areas regardless of whether skin cancers are included or not. This is particularly so in the case of women. Looking at Table 2 in which data on skin cancer is included, males in the high risk area have an SIR of 86.02 meaning they have approximately 15% less risk of developing cancer than the average population of the Mid-Western Health Board. The figure is roughly similar for the medium risk area and the control area interestingly shows a slight excess of cases.

In the case of females this pattern is even more pronounced. In the high risk area the SIR for females is 35.59 meaning that their risk of developing cancer is approximately one-third that of the standard Mid-Western Health Board population. The medium risk area has approximately double that risk but is still below what would be expected and again the control area demonstrates an excess of deaths.

In Table 3, with data on skin cancer excluded, this pattern is maintained. In the case of men the reduction in risk in the high risk area is not as marked but in the case of women the reduction is even more marked down to approximately one-quarter of what would be expected in the standard Mid-Western Health Board population.

When compared against the standard Irish population the pattern seen in the three areas are maintained and if anything slightly accentuated. This is not unexpected given the favourable cancer mortality experience of the Mid-Western Health Board population as compared with the national population. Table 4, including all cancer cases, demonstrates that for males in the high risk area the SIR is approximately 70 indicating a decreased risk of cancer in that area by about 30%. The control area shows a slight excess. In the statistical analysis of these figures however these merely indicate trends as the confidence intervals indicate that these results were not statistically significant.

Looking at females the patterns of reduced incidence are maintained and enhanced. Females in the high risk area have an even lower SIR when compared with Ireland as a standard population than with the Mid-West and with a value of 27.13 this indicates that the risk is approximating close to one-quarter the risk of the Irish standard population. The control area shows a significant excess over what would be expected. These results were all statistically significant.

In Table 5, with skin cancer data excluded, the pattern is maintained with diminished risk for males and females in the high risk area, this being particularly marked for females with an SIR of 21.14 but certain of these results do not reach statistical significance.

Table 2 Standardised Incidence Ratios for Males and Females in each of the 3 Study Areas compared to the Mid-Western Health Board Population including skin cancer data.

Males	**Observed Cases**	**Expected Cases**	**SIR**	**95% CI**
High Risk Area	16	18.6	**86.02**	72.69, 99.35
Medium Risk Area	43	49.72	**86.48**	78.31, 94.66
Control Area	166	117.75	**140.98**	134.20, 147.76
Females	**Observed Cases**	**Expected Cases**	**SIR**	**95% CI**
High Risk Area	6	16.86	**35.59**	26.58, 44.59
Medium Risk Area	29	45.27	**64.06**	56.68, 71.43
Control Area	156	84.03	**185.65**	176.44, 194.86

Table 3 Standardised Incidence Ratios for Males and Females in each of the 3 Study Areas compared to the Mid-Western Health Board Population excluding skin cancer data.

Males	**Observed Cases**	**Expected Cases**	**SIR**	**95% CI**
High Risk Area	12	12.06	**99.50**	81.70, 117.31
Medium Risk Area	23	32.24	**71.34**	62.12, 80.56
Control Area	92	76.36	**120.48**	112.70, 128.27
Females	**Observed Cases**	**Expected Cases**	**SIR**	**95% CI**
High Risk Area	3	11.87	**25.27**	16.23, 34,32
Medium Risk Area	20	31.86	**62.77**	54.07, 71.48
Control Area	86	59.15	**145.39**	135.68, 155.11

Table 4 Standardised Incidence Ratios for Males and Females in each of the 3 Study Areas compared to the National Population including skin cancer data.

Males	**Observed Cases**	**Expected Cases**	**SIR**	**95% CI**
High Risk Area	16	22.80	**70.18**	43.79, 112.57
Medium Risk Area	43	56.91	**75.56**	52.98, 98.14
Control Area	166	158.78	**104.55**	88.65, 120.45
Females	**Observed Cases**	**Expected Cases**	**SIR**	**95% CI**
High Risk Area	6	22.11	**27.13**	5.42, 48.84
Medium Risk Area	29	55.07	**52.66**	33.49, 71.83
Control Area	156	109.55	**142.40**	120.05, 164.75

Table 5 Standardised Incidence Ratios for Males and Females in each of the 3 Study Areas compared to the National Population excluding skin cancer data.

Males	**Observed Cases**	**Expected Cases**	**SIR**	**95% CI**
High Risk Area	12	14.21	**84.45**	36.67, 132.23
Medium Risk Area	23	35.56	**64.68**	38.25, 91.11
Control Area	92	98.83	**93.03**	74.07, 112.11
Females	**Observed Cases**	**Expected Cases**	**SIR**	**95% CI**
High Risk Area	3	14.19	**21.14**	-2.78, 45.06
Medium Risk Area	20	35.78	**55.90**	31.40, 80.40
Control Area	86	70.16	**122.5 8**	96.67, 148.49

In summary these figures indicate that there is no increased incidence of cancers in the high risk Askeaton area in 1994 and 1995. If anything, these figures indicate that there are fewer cancers in the Askeaton area in that period than would otherwise be expected. This pattern is maintained whether or not Askeaton is compared with the Mid-West in general, or with the Irish population as a whole. This pattern is also maintained whenever skin cancers are excluded from the picture, as these large numbers of cancers will tend to have a dilutional effect on the less common and more serious cancers.

The above analyses strongly suggest that the areas around Askeaton have a similar and possibly favourable cancer experience when compared with the Mid-West region and with the country as a whole. However, because the numbers of cancers in each study area were so small, additional analysis of the data, using Bayesian modelling was undertaken, to ensure maximal validity. Bayesian modelling is a technique designed to help account for the uncertainty inherent in choosing which type of statistical analysis should be used.

When Bayesian modelling was applied to the cancer incidence data, no additional differences were seen in the results, and it can be concluded that the areas around Askeaton had no worse cancer experience than the control areas.

MORTALITY STUDY

As part of the investigation an analysis of all cause and respiratory mortality between 1991 and 1996 in the Mid-Western Health Board region was undertaken looking at small area mortality statistics. The areas studied were those laid out in the Methods section of the Cancer Incidence Study above.

This investigation set out to answer the following questions:

- Did people living in the Askeaton area have a higher incidence of mortality than people living in the lower risk or control areas?
- If they did was this increase to be found in any particular sub-groups of the population?
- Was there an association between mortality and distance from the site plant? *(?Moneypoint or Aughinish Alumina)*

Methods

All deaths in the Mid-Western Health Board region between 1991 and 1996 inclusive were studied. Deaths which could not be considered due to the effects of environmental pollution were excluded namely those due to accidents and suicide. Death rates for each of the district electoral divisions (DEDs) in the Mid-West region were calculated as standardised mortality ratios using the Mid-Western region as a standard. A form of analysis known as Bayesian analysis was used to smooth the data, to ensure greater validity.

Results

The results are laid out in Tables 6 and 7. The entire analysis is laid out in appendix 3.
The subsequent tables are broken down into the following columns:

- *Outcome:* refers to that group of the population which is being examined.
- *With/without deprivation*: indicates whether or not adjustment has been made for the effect of deprivation on the mortality experience of that group.
- *Number (%) of DEDs with SMRs significantly a) greater than 100 and b) greater than 150:* refers to the numbers or percentage of District Electorate Divisions where the standardised mortality ratios are statistically significantly greater than a) 100 and b) 150.
- *Evidence of association with distance:* summarises whether or not this group had a mortality experience that was influenced by the distance from the point source.
- *Evidence of difference by area:* indicates whether there is a statistically significant difference in the median SMRs between the 6 selected comparison areas.
- *Area SMRs:* refers to the median SMR for each of the 6 pre-selected study areas.

The individual outcomes will be considered separately below. The following categories refer to results of total mortality in Table 6:

All cause all age mortality male and female

When the SMRs for this category are considered without adjustment for deprivation the results show that there is no evidence of difference between any of the areas. There is a non-significant rise from a SMR in area 1 of 83 to a SMR of 102 in area 6 indicating that areas 1 and 2 have a more favourable mortality experience than areas 5 and 6. When adjustment is made for deprivation there is very little change in the outcome.

All cause, all age female

When the SMRs in the 6 areas are considered under this heading there is a rise from area 1 with an SMR of 57 to an SMR of 99 in area 6. These levels are at or below the expected levels of mortality for the region and again indicate a favourable mortality experience for those living in the Askeaton area. Whenever adjustment is made for deprivation there is a slightly significant rise in the SMR between areas 1, and 4 and 5; and 2 and 4 and 5. Again the Askeaton area having a more favourable mortality experience than the control area.

All cause, all age male

Again there is a rise in the SMRs between areas 1 and 6 indicating a more favourable mortality experience than areas 1 and 2 and there is no evidence of statistical differences between the areas. This picture does not change whenever adjustment is made for deprivation. Looking at all cause aged 1 to 64 both males and females area 1 has an SMR of 101 indicating that the population in Askeaton in this category have a mortality experience which is approximately that of the rest of the Mid-West. However SMRs are lower for areas 2, 3, 4 and 6 and there is evidence of statistical difference between areas 1 and 3 and 4. This picture is maintained whenever deprivation is taken into account and the first time a relationship is seen with distance in that the risk of mortality increases the farther away you move from the point source.

All cause, age 1-64, (Male and Female)

In this category, Area 1 has the second highest SMR after Area 6. This picture is maintained but softened following adjustment for deprivation.

All cause, aged 0-14 (Male and Female)

Analysis of the SMRs between different areas show a gradation from area 1 to area 6 with the highest SMR being found in area 5. The differences between area 1 and areas 3, 4, 5 and 6 are statistically significant and indicate that those aged 0 to 14 in the Askeaton area and in one of the control areas have a higher mortality experience than would be expected for the rest of the region. This relationship remains but is weakened whenever deprivation is taken into account. The actual numbers of children involved however are very small. The total number of deaths of children in the Askeaton area, during the study period, is 3. Although the difference between the number of deaths that would be expected and the number seen is statistically significant, the actual difference is very small.

All cause, aged 15-64 (Male and Female)

The low SMRs for areas 1 and 2 indicate that Askeaton has a favourable mortality experience in relation to area 5 and a lower rate of mortality in this group in comparison with the Mid-Western Health Board region. After adjustment for deprivation this pattern is maintained.

All cause, aged 65-84 (Male and Female)

Askeaton has a favourable mortality experience in relation to the control areas and the Mid-Western region and this relationship is maintained following adjustment for deprivation.

Table 6 - All Cause Mortality

Outcome	With/without Depreviation	No. (%) DEDs with SMRs significantly a)>100 b)>150	Evidence of association with distance	Evidence of difference by Area	Area SMRs (median)
1A. All Cause all age (Male & Female)	without	75 (18) 58 (14)	No	No	1. 83 2. 91 3. 54 4. 85 5. 105 6. 102
1B. All Cause all age (Male & Female)	with	76 (18) 53 (14)	No	No	1. 84 2. 90 3. 54 4. 85 5. 106 6. 91
2A. All Cause all age (Female)	without	51 (12) 48 (11)	No	No	1. 57 2. 54 3. 61 4. 100 5. 89 6. 99
2B. All Cause all age (Female)	with	52 (12) 48 (11)	No	Yes 1 vs 4,5 2 vs 4,5	1. 56 2. 54 3. 61 4. 100 5. 87 6. 91
3A. All Cause all age (Male)	without	48 (11) 41 (10)	No	No	1. 87 2. 85 3. 64 4. 73 5. 99 6. 91
3B. All Cause all age (Male)	with	50 (12) 42 (10)	No	No	1. 88 2. 83 3. 64 4. 73 5. 104 6. 78
4A. All Cause age 1-64 (Male & Female)	without	8 (2) 6 (1)	No	Yes 1 vs 3,4 2 vs 3,4,5	1. 101 2. 89 3. 58 4. 79 5. 110 6. 85

Outcome	With/without Depreviation	No. (%) DEDs with SMRs significantly a)>100 b)>150	Evidence of association with distance	Evidence of difference by Area	Area SMRs (median)
4B. All Cause age 1-64 (Male & Female)	with	18 (4) 14 (3)	Yes RR increases with distance.	Yes 1 vs 3,4,6 2 vs 3,4,6	1. 97 2. 91 3. 65 4. 81 5. 108 6. 74
5A. All Cause age 0-14 (Male & Female)	without	none	No	Yes 1 vs 3,4,5,6 2 vs 3,4,5,6	1. 125 2. 112 3. 55 4. 80 5. 172 6. 85
5B. All Cause age 0-14 (Male & Female)	with	1 (< 1) 1 (<1)	Not determine d	Yes 1 vs 3,4,5,6 2 vs 3,4,5,6	1. 109 2. 100 3. 44 4. 66 5. 135 6. 73
6A. All Cause age 15-64 (Male & Female)	without	28 (7) 27 (6)	Yes RR increases with distance.	Yes 1 vs 3,4 2 vs 3	1. 93 2. 71 3. 50 4. 78 5. 104 6. 75
6B. All Cause age 15-64 (Male & Female)	with	32 (8) 31 (7)	Yes RR increases with distance.	Yes 1 vs 3,4 2 vs 3,4,5	1. 88 2. 72 3. 53 4. 72 5. 104 6. 72
7A. All Cause age 65-84 (Male & Female)	without	55 (13) 46 (11)	No	No	1. 77 2. 90 3. 60 4. 93 5. 103 6. 108.
7B. All Cause age 65-84 (Male & Female)	with	55 (13) 46 (11)	No	No	1. 77 2. 90 3. 61 4. 93 5. 103 6. 108

The following categories refer to results of <u>respiratory</u> mortality in Table 7:

Respiratory, all age, (Male and Female)
There is no statistically significant difference within the areas and the SMRs show a gradual fall from areas 1 and 2; down to area 6 after adjustment for deprivation the difference between areas 2 and 5 becomes statistically significant.

Respiratory, all age (Female)
In this category, there is a gradual rise across the areas from 58 in Askeaton to 109 in area 6. The differences between areas 1, 3, 4, and 6 are statistically significant and this relationship is maintained following adjustment for deprivation.

Respiratory, all age, (Male)
This group shows a statistically significant drop in SMRs from the Askeaton area to the control areas and this relationship is maintained following correction for deprivation.

Respiratory, aged 1-64, (Male and Female)
Results here indicate statistically significant differences between groups 1 and groups 3, 4 and 6. There is an overall downward trend in SMRs from areas 1 to areas 6 indicating that areas 1 and 2 have a slightly worse mortality experience in this age group than in the control areas. This pattern is maintained following correction for deprivation.

Respiratory, aged 0-14 (Male and Female)
The numbers here were too small to analyse successfully.

Respiratory, aged 15-64 (Male and Female)
Results here indicate a drop in SMRs from Askeaton to the control areas and this trend is maintained following correction for deprivation.

Respiratory, aged 65-84 (Male and Female)
SMRs here show a slight fall in value from Askeaton to some of the control areas indicating that Askeaton has a slightly worse mortality experience than 3 of the 4 control areas. This relationship is largely maintained following correction for deprivation.

Table 7 - *Respiratory Mortality*

Outcome	With/without Depreviation	No. (%) DEDs with SMRs significantly a)>100 b)>150	Evidence of association with distance	Evidence of difference by Area	Area SMRs (median)
8A. Respiratory all age (Male & Female)	without	26 (6) 26 (6)	No	No	1. 98 2. 108 3. 73 4. 88 5. 71 6. 77
8B. Respiratory all age (Male & Female)	with	29 (7) 29 (7)	No	Yes 2 vs 5	1. 94 2. 106 3. 76 4. 88 5. 68 6. 62
9A. Respiratory all age (Female)	without	13 (3) 13 (3)	No	Yes 1 vs 3,4,6 2 vs 3,4,6	1. 58 2. 58 3. 78 4. 100 5. 55 6. 109
9B. Respiratory all age (Female)	with	13 (3) 13 (3)	No	Yes 1 vs 3,4,6 2 vs 3,4,6	1. 58 2. 57 3. 85 4. 100 5. 57 6. 95
10A. Respiratory all age (Male)	without	7 (1) 7 (1)	No	Yes 1 vs 3,4,5,6 2 vs 3,4,5,6	1. 129 2. 111 3. 78 4. 82 5. 74 6. 67
10B. Respiratory all age (Male)	with	11 (2) 11 (2)	No - marginally	Yes 1 vs 3,4,5,6 2 vs 3,4,5,6	1. 128 2. 104 3. 83 4. 81 5. 78 6. 52
11A. Respiratory age 1-64 (Male & Female)	without	none	No	Yes 1 vs 3,4,6 2 vs 3,4,6	1. 96 2. 92 3. 86 4. 101 5. 94 6. 71

Outcome	With/without Depreviation	No. (%) DEDs with SMRs significantly a)>100 b)>150	Evidence of association with distance	Evidence of difference by Area	Area SMRs (median)
11B. Respiratory age 1-64 (Male & Female)	with	12 (3) 12 (3)	No - marginally	Yes 1 vs 6 2 vs 6	1. 83 2. 79 3. 79 4. 93 5. 86 6. 56
12A. Respiratory age 0-14 (Male & Female)	without	Nos. too small	-	-	-
12B. Respiratory age 0-14 (Male & Female)	with	Nos. too small	-	-	-
13A. Respiratory age 15-64 (Male & Female)	without	2 (< 1)) 2 (< 1)	-	Yes 1 vs 4,5 2 vs 4,5,6	1. 81 2. 78 3. 81 4. 105 5. 94 6. 68
13B. Respiratory age 15-64 (Male & Female)	with	18 (4) 18 (4)	Yes RR increases with distance.	Yes 1 vs 4 2 vs 4	1. 74 2. 67 3. 77 4. 95 5. 83 6. 55
14A. Respiratory age 65-84 (Male & Female)	without	14 (3) 14 (3)	No - marginally	Yes 2 vs 5	1. 103 2. 105 3. 75 4. 87 5. 74 6. 102
14B. Respiratory age 65-84 (Male & Female)	with	12 (3) 12 (3)	No - marginally	Yes 1 vs 6 2 vs 6	1. 83 2. 79 3. 79 4. 93 5. 86 6. 56

Conclusions
On the basis of this analysis of deaths from all cause and respiratory mortality, there is no consistent pattern of elevated risk associated with Areas 1 or 2 in contrast to Areas 3 through 6. Nor, based on a distance from site model, is there any consistent evidence for an increased risk closer to the plant

– if anything, the risk increases as distance increases away the plant (this will be more evident on inspection of the maps). The exceptions with respect to Area contrasts are as already noted above: 5A. All Cause age 0-14 (Male & Female) and 5B. – but this is weak evidence - and 10A. Respiratory all age (Male) - again weak evidence - and 10B. – evidence very slightly stronger but this follows after adjustment for deprivation and is questionable.

Appendix 1

Appendix 1A Industrial processes causally associated with human cancer[a].

Exposure	**Human Target Organ**
Aluminium production	Lung, bladder, (lymphoma, oesophagus, stomach)
Auramine manufacture	Bladder
Boot and shoe manufacture/repair	Leukaemia, nasal sinuses (bladder, digestive tract)
Coal gasification	Skin, lung, bladder
Coke production	Skin, lung, kidney
Furniture and cabinet making	Nasal sinus
Haematite mining (with radon exposure)	Lung
Iron and steel founding	Lung (digestive tract, genitourinary tract, leukaemia)
Isopropyl alcohol manufacture, strong acid process	Nasal sinus (larynx)
Magenta manufacture	Bladder
Painters (occupational exposure)	Lung (oesophagus, stomach, bladder)
Rubber industry	Bladder, leukaemia (lymphoma, lung, renal tract, digestive tract, skin, liver, larynx, brain, stomach)

(Suspected target organs in parenthesis)
[a] Source: Harrington, J. M. Occupational Cancer in *Oxford Textbook of Medicine.* 3rd edn. (eds. Wetherall, D. J., Ledingham, J. G. G. and Warrell, D. A.) Oxford, Oxford University Press, 1996.

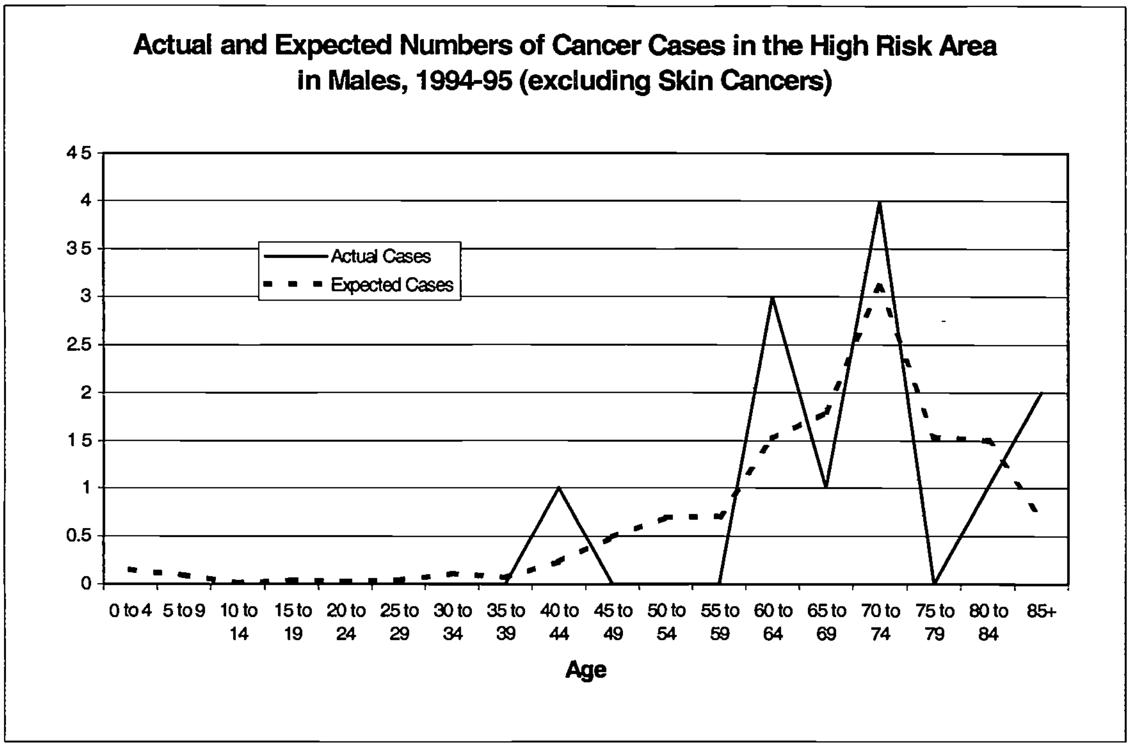
Appendix 1B Chemicals and groups of chemicals causally associated with human cancer for which exposure has been mostly occupational[a]

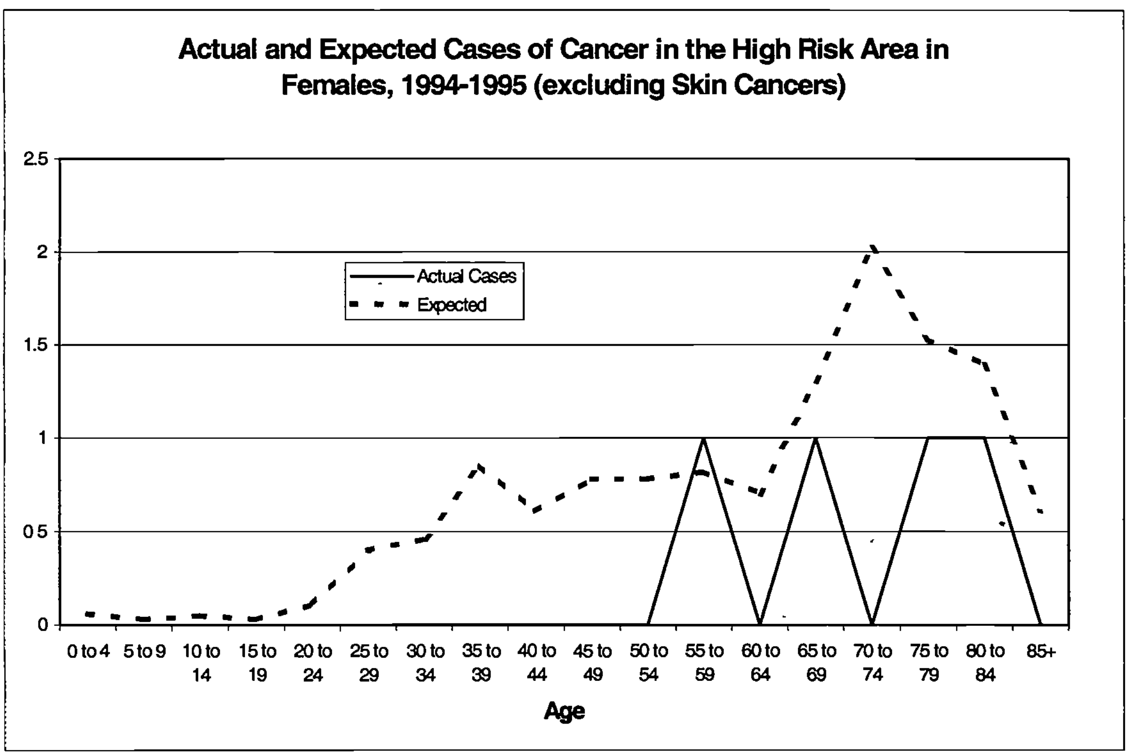
Exposure	**Human Target Organ**
4-Aminobiphenyl	Bladder
Arsenic and arsenical compounds*	Skin, lung (liver, haemopoietic system, gastrointestinal tract, kidney)
Asbestos	Lung, pleura, peritoneum, gastrointestinal tract, larynx
Benzene	Leukaemia
Benzidine	Bladder
Bis(chloromethyl) ether and chloromethyl methyl ether (technical grade)	Lung
Chromium compounds, hexavalent*	Lung (gastrointestinal tract)
Coal tars	Skin, lung (bladder)
Coal tar pitches	Skin, lung, bladder (gastrointestinal tract, leukaemia)
Inorganic acid mists (strong) containing sulphuric acid	Larynx
Ionizing radiation	Leukaemia, bone, skin, and other organs

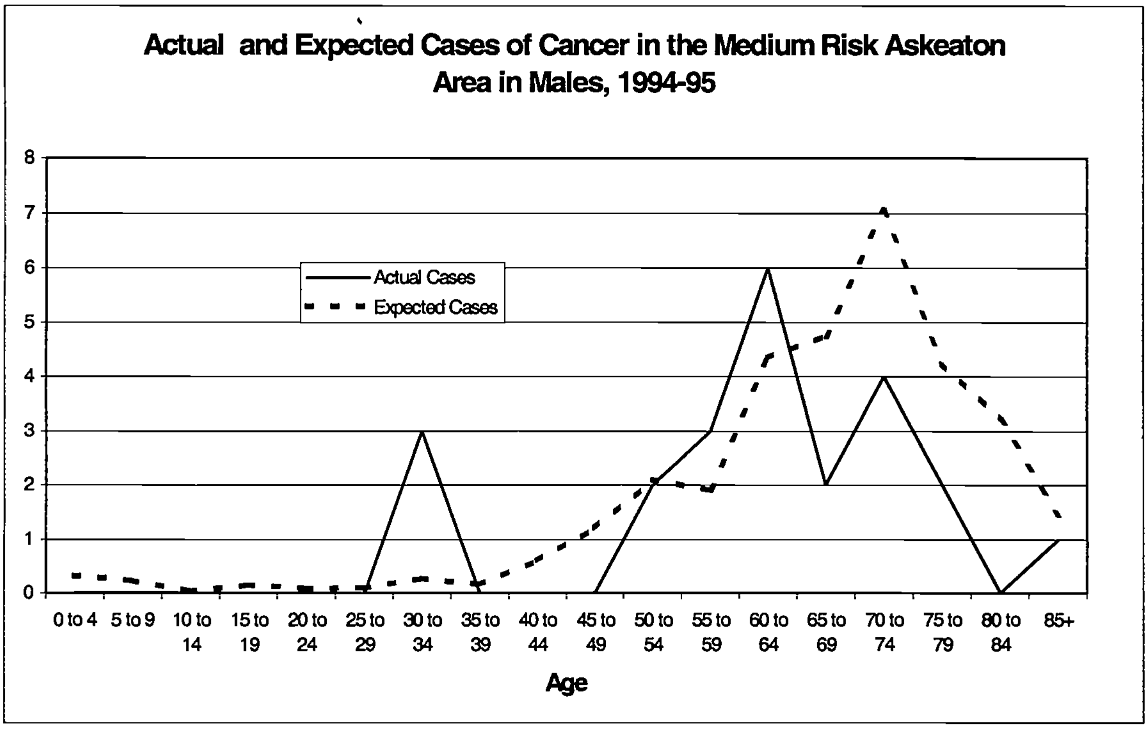
	depending on exposure and type of radiation
Mineral oils, untreated and mildly treated	Skin (respiratory tract, bladder, gastrointestinal tract)
Mustard gas (sulphur mustard)	Lung, larynx, pharynx
2-Naphthylamine	Bladder (liver)
Nickel and nickel compounds*	Nasal sinus, lung (larynx)
Radon	Lung
Shale oils	Skin (colon)
Soots	Skin, lung
Talc containing asbestiform fibre	Lung (pleura)
Vinyl chloride	Liver, lung, brain, lymphatic and haemopoietic system (gastrointestinal tract)

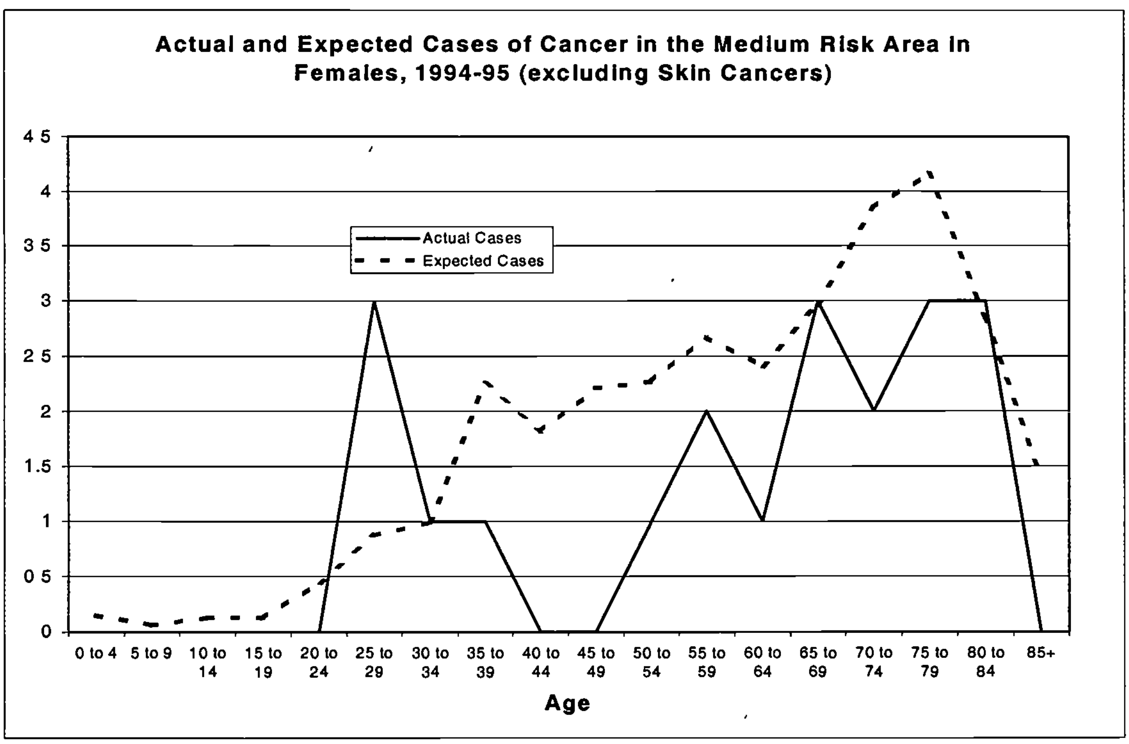
(Suspected target organs in parenthesis)
[a] Source: Harrington, J. M. Occupational Cancer in *Oxford Textbook of Medicine.* 3rd edn. (eds. Wetherall, D. J., Ledingham, J. G. G. and Warrell, D. A.) Oxford, Oxford University Press, 1996.
* The evaluation of carcinogenicity to humans applies to the group of chemicals as a whole and not necessarily to all individual chemicals within the group.

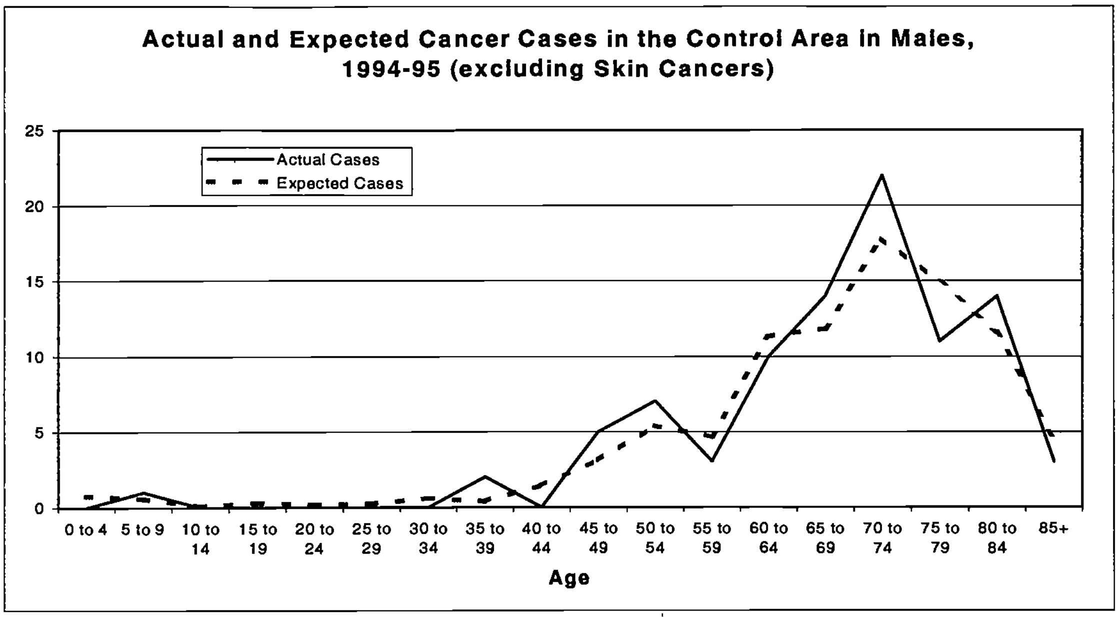
Appendix 2 Actual and Expected Numbers of Cancers in each of the 3 Study Areas

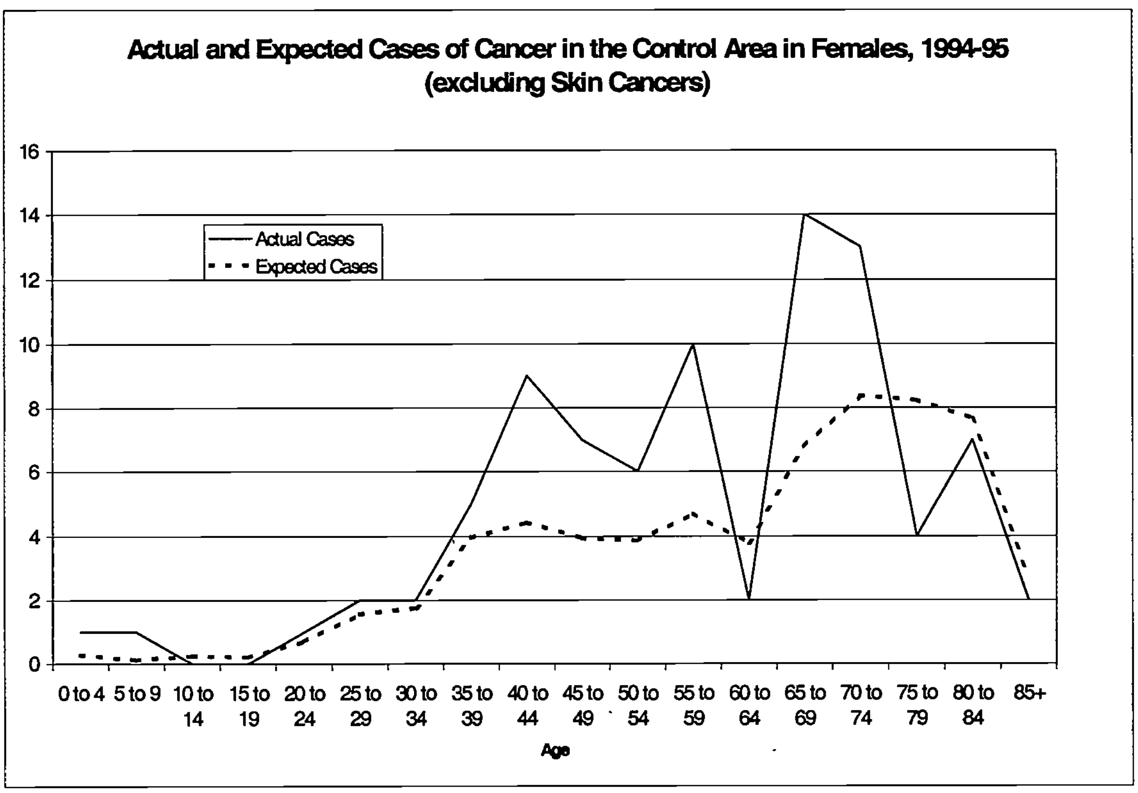


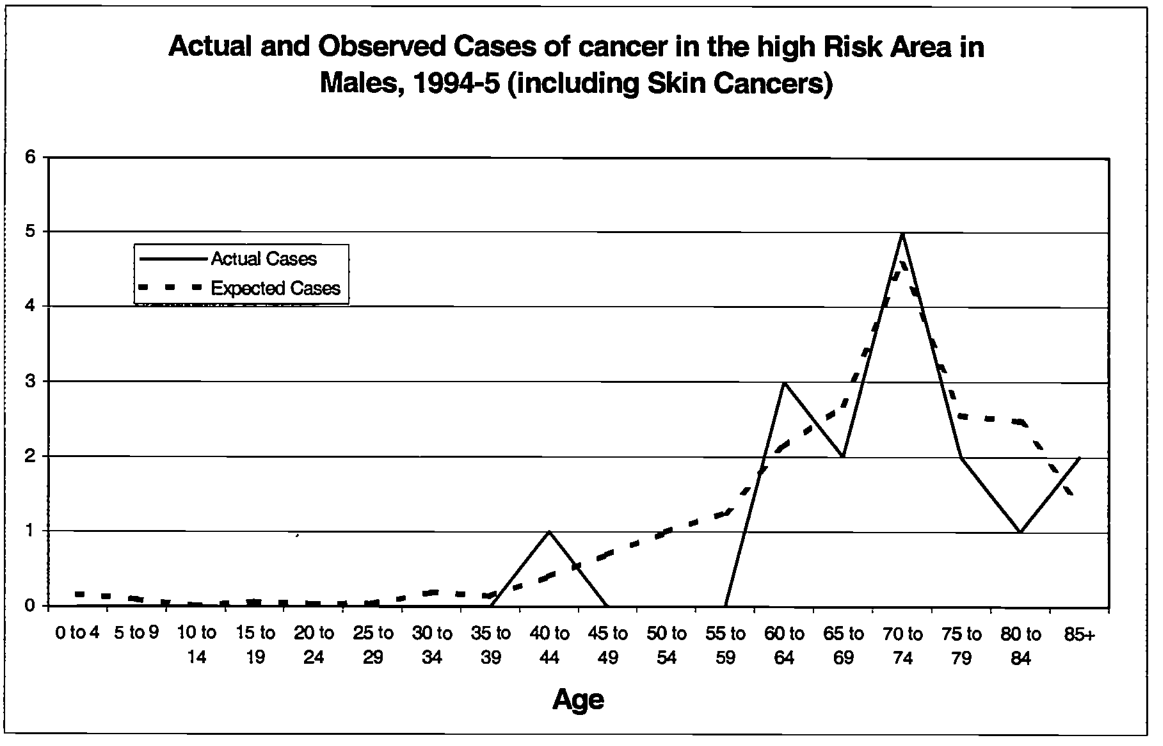


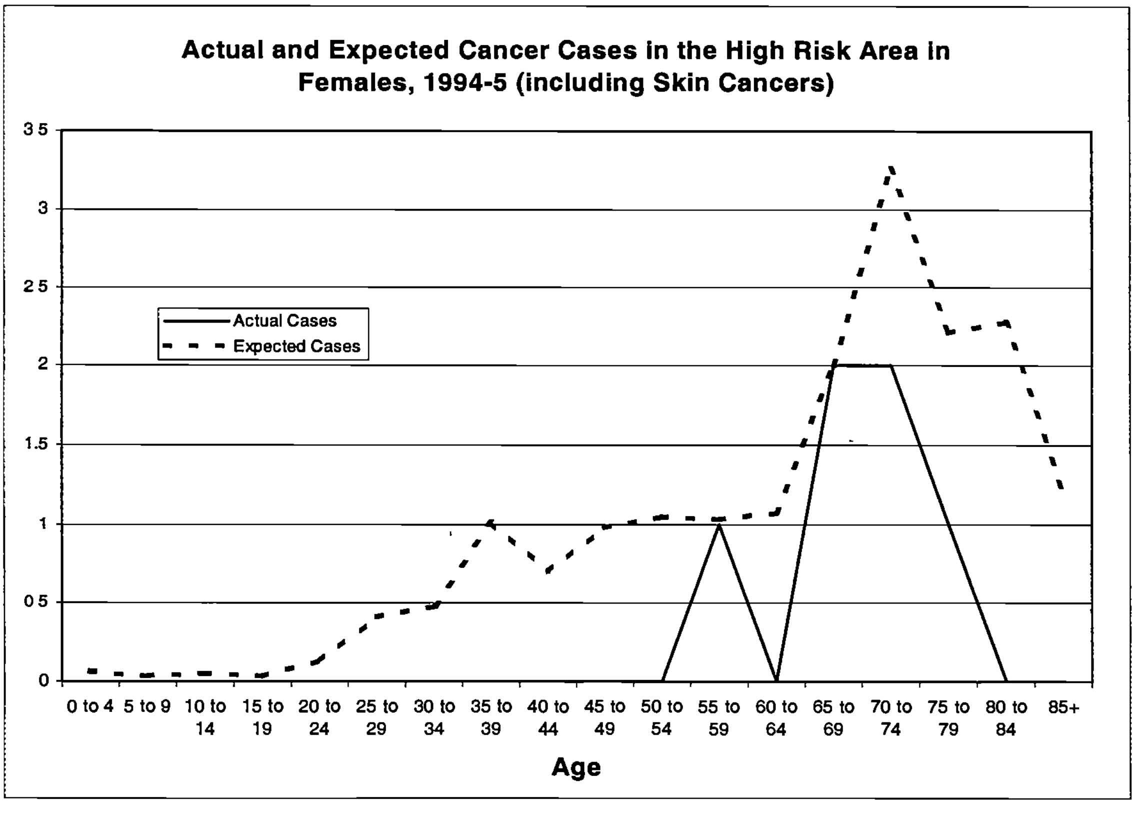

Actual and Expected Cases of Cancer in the Medium Risk Askeaton Area in Males, 1994-95
Actual Cases
Expected Cases
0
1
2
3
4
5
6
7
8
0 to 4
5 to 9
10 to 14
15 to 19
20 to 24
25 to 29
30 to 34
35 to 39
40 to 44
45 to 49
50 to 54
55 to 59
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85+
Age

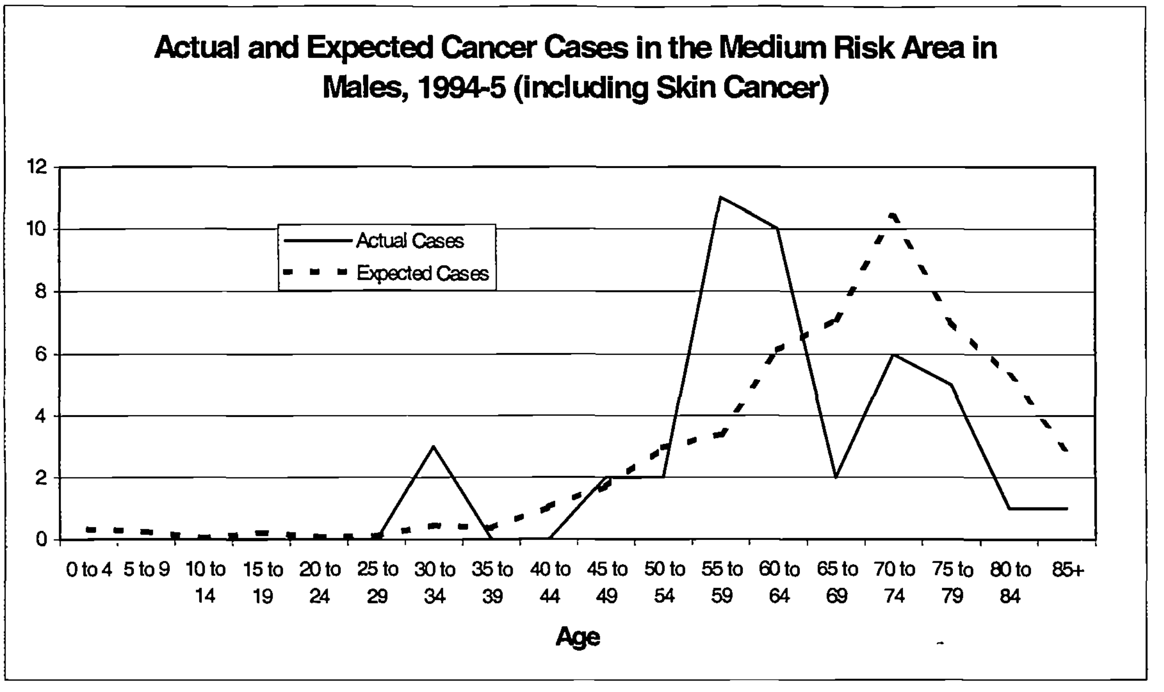

Actual and Expected Cases of Cancer in the Medium Risk Area in Females, 1994-95 (excluding Skin Cancers)
Actual Cases
Expected Cases
0
0 5
1
1.5
2
2 5
3
3 5
4
4 5
0 to 4
5 to 9
10 to 14
15 to 19
20 to 24
25 to 29
30 to 34
35 to 39
40 to 44
45 to 49
50 to 54
55 to 59
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85+
Age


Actual and Expected Cancer Cases in the Control Area in Males, 1994-95 (excluding Skin Cancers)
25
20
15
10
5
0
Actual Cases
Expected Cases
0 to 4
5 to 9
10 to 14
15 to 19
20 to 24
25 to 29
30 to 34
35 to 39
40 to 44
45 to 49
50 to 54
55 to 59
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85+
Age

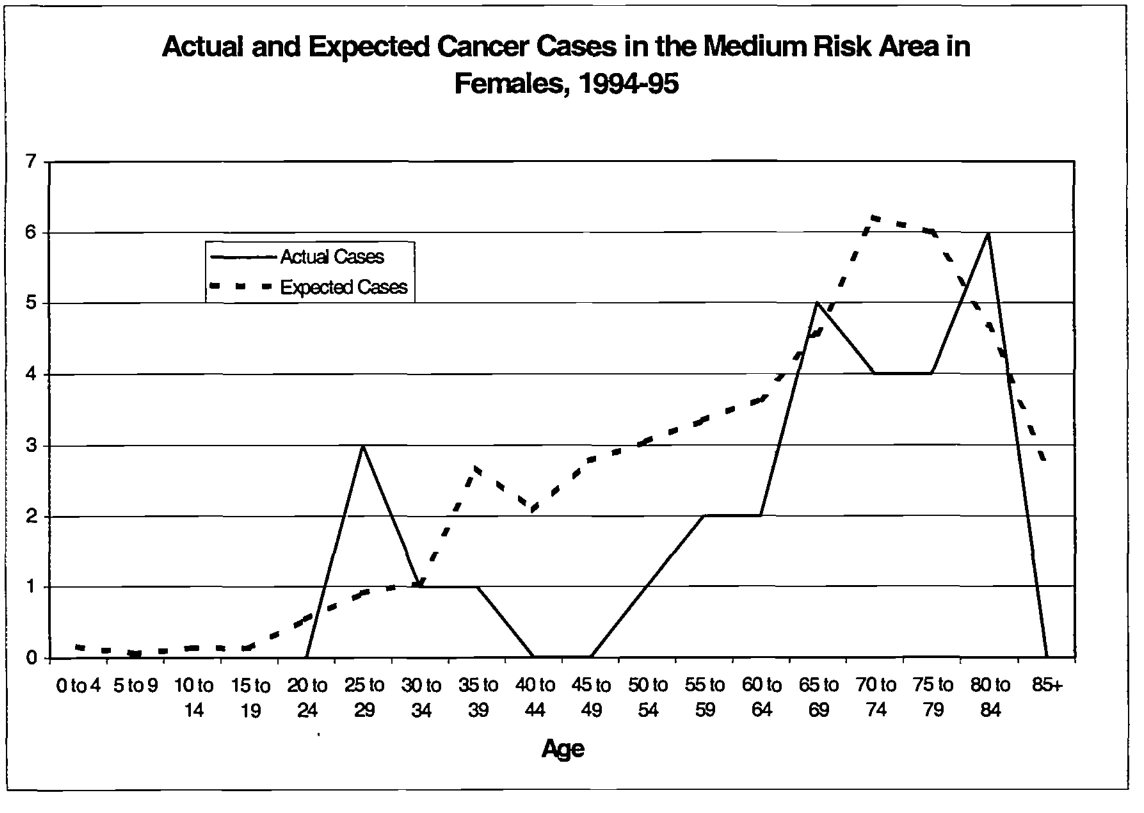

Actual and Expected Cases of Cancer in the Control Area in Females, 1994-95 (excluding Skin Cancers)
16
14
12
10
8
6
4
2
0
Actual Cases
Expected Cases
0 to 4
5 to 9
10 to 14
15 to 19
20 to 24
25 to 29
30 to 34
35 to 39
40 to 44
45 to 49
50 to 54
55 to 59
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85+
Age


Actual and Observed Cases of cancer in the high Risk Area in Males, 1994-5 (including Skin Cancers)
Actual Cases
Expected Cases
0
1
2
3
4
5
6
0 to 4
5 to 9
10 to 14
15 to 19
20 to 24
25 to 29
30 to 34
35 to 39
40 to 44
45 to 49
50 to 54
55 to 59
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85+
Age

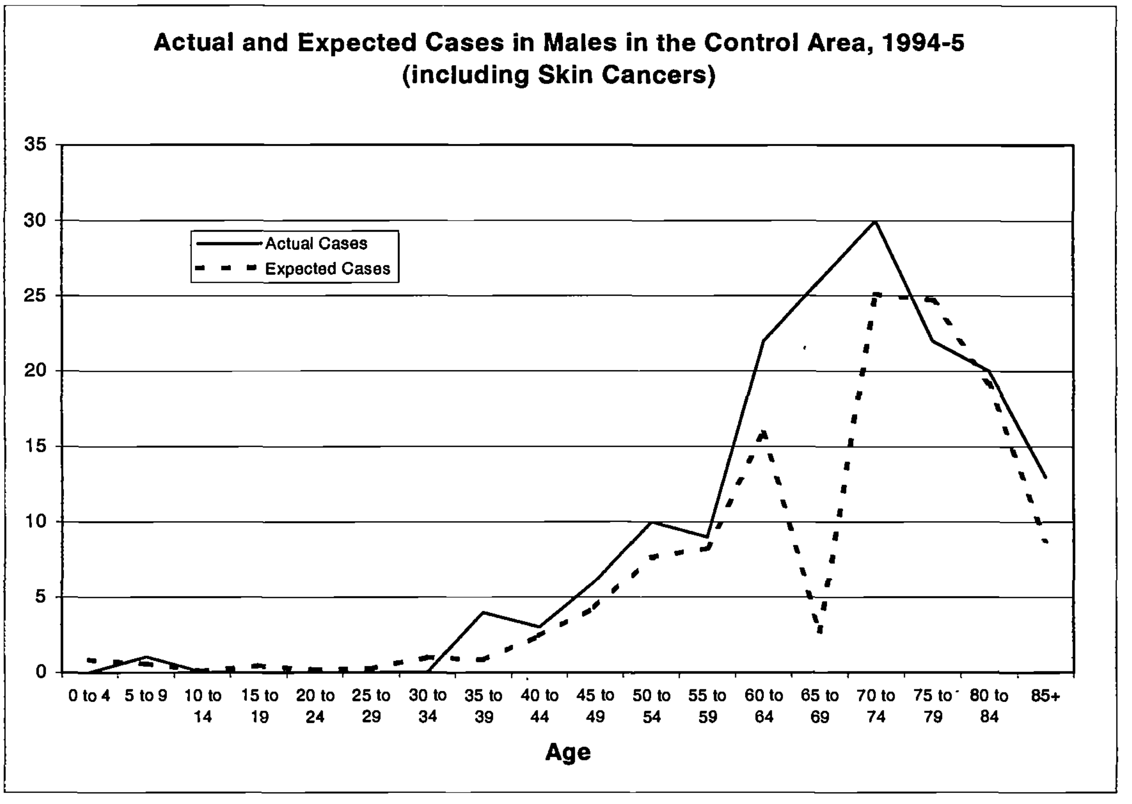

Actual and Expected Cancer Cases in the High Risk Area in Females, 1994-5 (including Skin Cancers)
Actual Cases
Expected Cases
0
0 5
1
1.5
2
2 5
3
3 5
0 to 4
5 to 9
10 to 14
15 to 19
20 to 24
25 to 29
30 to 34
35 to 39
40 to 44
45 to 49
50 to 54
55 to 59
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85+
Age

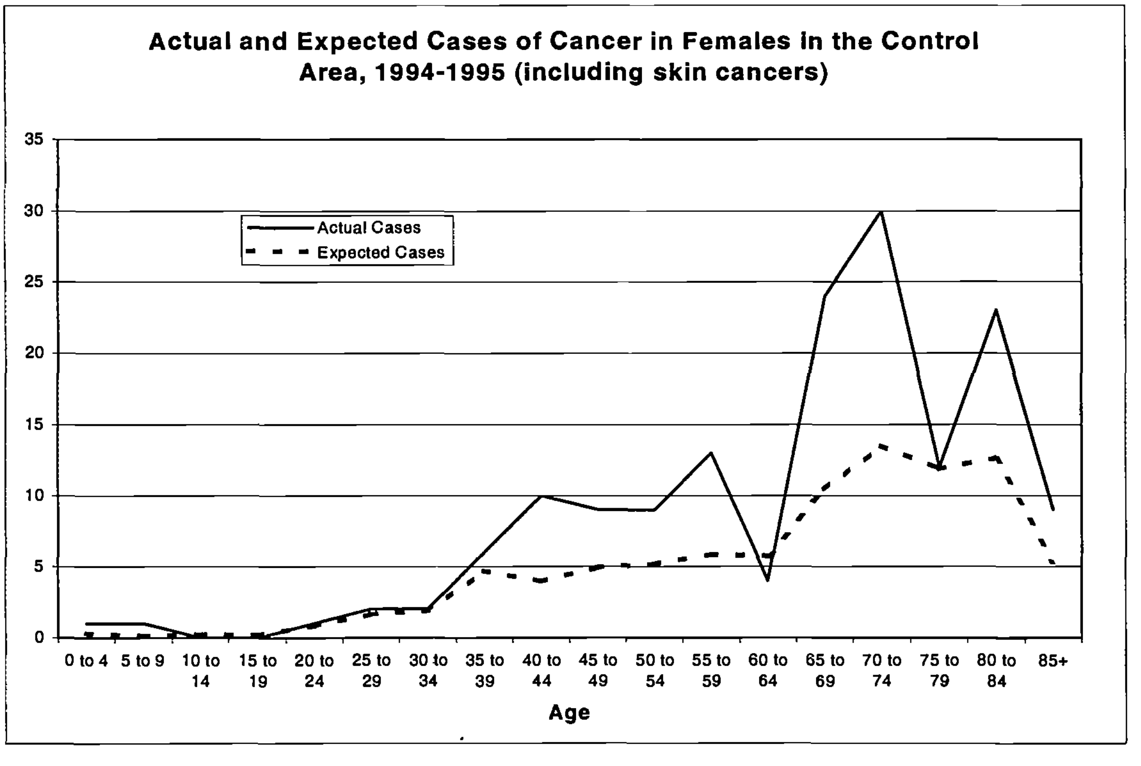


Actual and Expected Cancer Cases in the Medium Risk Area in Males, 1994-5 (including Skin Cancer)
Actual Cases
Expected Cases
0
2
4
6
8
10
12
0 to 4
5 to 9
10 to 14
15 to 19
20 to 24
25 to 29
30 to 34
35 to 39
40 to 44
45 to 49
50 to 54
55 to 59
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85+
Age



Actual and Expected Cancer Cases in the Medium Risk Area in Females, 1994-95
Actual Cases
Expected Cases
0
1
2
3
4
5
6
7
0 to 4
5 to 9
10 to 14
15 to 19
20 to 24
25 to 29
30 to 34
35 to 39
40 to 44
45 to 49
50 to 54
55 to 59
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85+
Age

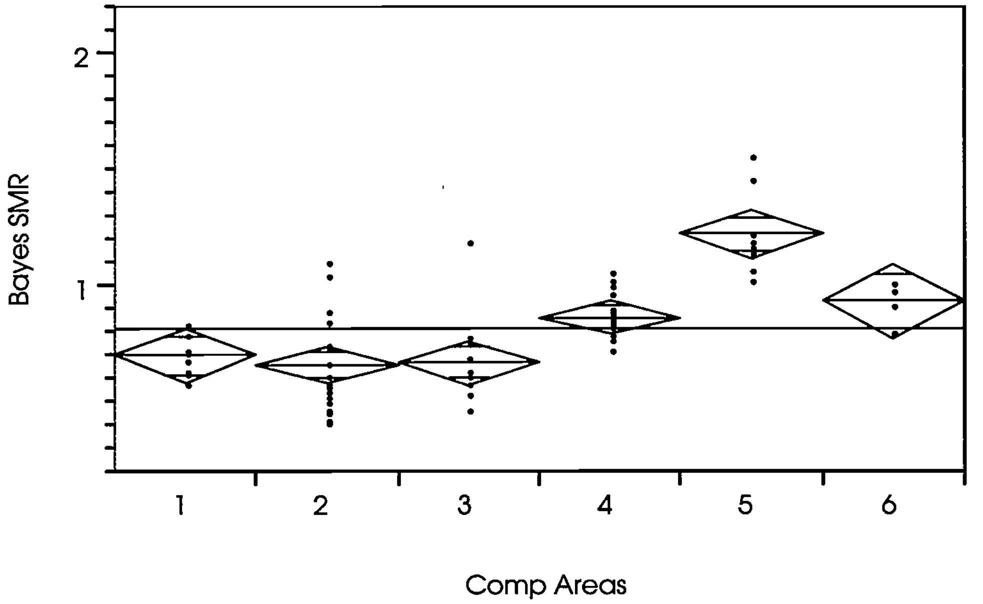

Actual and Expected Cases in Males in the Control Area, 1994-5 (including Skin Cancers)
35
30
25
20
15
10
5
0
Actual Cases
Expected Cases
0 to 4
5 to 9
10 to 14
15 to 19
20 to 24
25 to 29
30 to 34
35 to 39
40 to 44
45 to 49
50 to 54
55 to 59
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85+
Age


Actual and Expected Cases of Cancer in Females in the Control Area, 1994-1995 (including skin cancers)
35
30
25
20
15
10
5
0
Actual Cases
Expected Cases
0 to 4
5 to 9
10 to 14
15 to 19
20 to 24
25 to 29
30 to 34
35 to 39
40 to 44
45 to 49
50 to 54
55 to 59
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85+
Age

Appendix 3. *Results of Bayesian Analysis of Small Area Cancer Incidence Data*

CANCER FEMALE 15-64

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.696	0.087	0.031	0.634	0.757
2	17	0.653	0.210	0.051	0.551	0.755
3	11	0.665	0.199	0.060	0.544	0.785
4	20	0.859	0.095	0.021	0.817	0.901
5	9	1.217	0.178	0.059	1.098	1.336
6	4	0.929	0.094	0.047	0.836	1.023

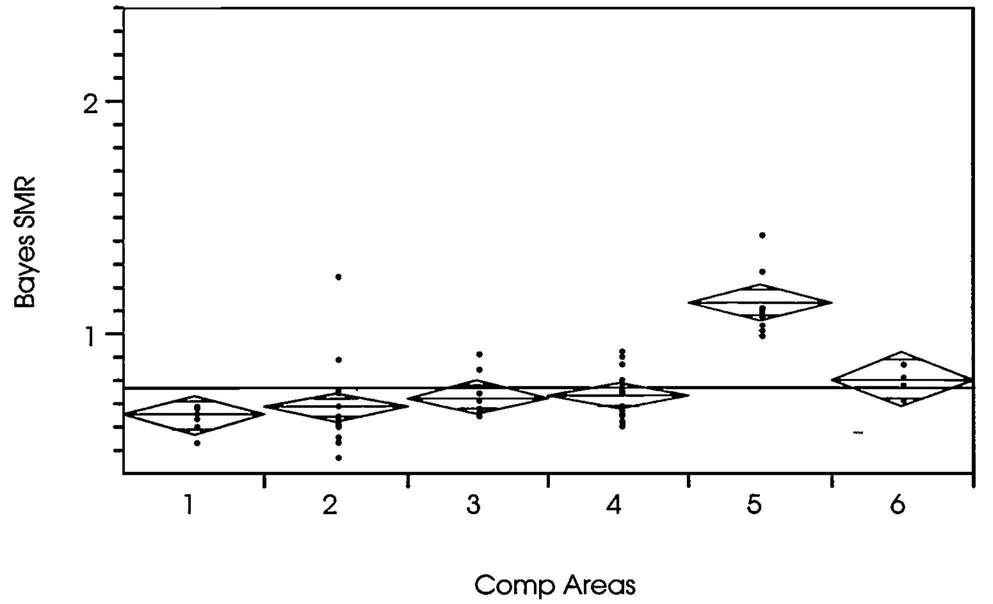
Means Comparisons

Abs(Dif)-LSD	**5**	**6**	**4**	**1**	**3**	**2**
5	-0	0	0	0	0	0
6	0	-0	-0	-0	-0	0
4	0	-0	-0	-0	0	0
1	0	-0	-0	-0	-0	-0
3	0	-0	0	-0	-0	-0
2	0	0	0	-0	-0	-0

Positive values show pairs of means that are significantly different.

CANCER FEMALE 65+

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.653	0.053	0.019	0.615	0.690
2	17	0.685	0.175	0.042	0.600	0.769
3	11	0.726	0.087	0.026	0.674	0.779
4	20	0.731	0.095	0.021	0.688	0.773
5	9	1.133	0.138	0.046	1.040	1.225
6	4	0.804	0.065	0.032	0.740	0.869

Means Comparisons

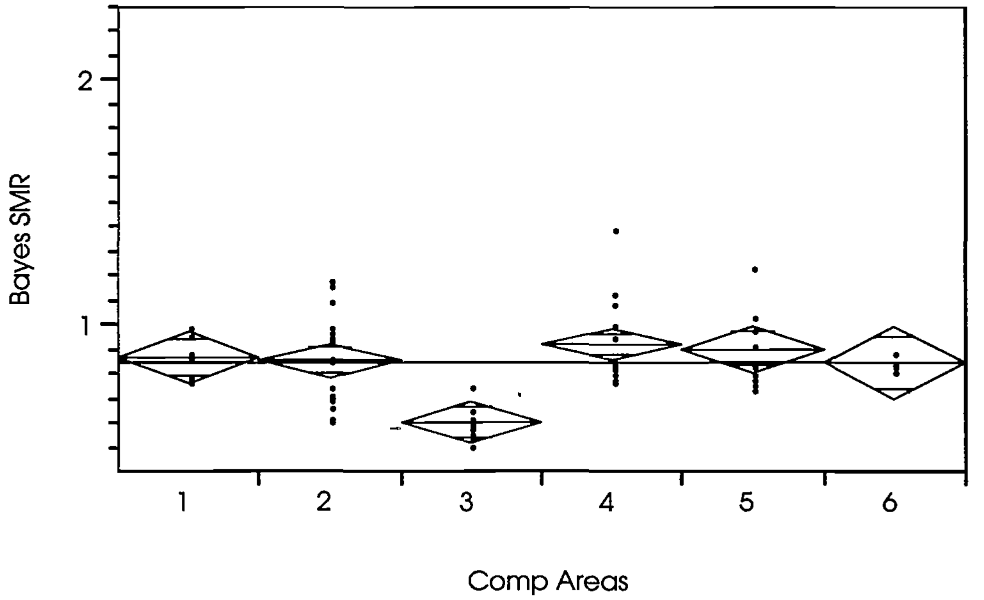
Abs(Dif)-LSD	5	6	4	3	2	1
5	-0	0	0	0	0	0
6	0	-0	-0	-0	-0	-0
4	0	-0	-0	-0	-0	-0
3	0	-0	-0	-0	-0	-0
2	0	-0	-0	-0	-0	-0
1	0	-0	-0	-0	-0	-0

Positive values show pairs of means that are significantly different.

Oneway Analysis of Bayes SMR By Pred 96 Local

Cancer Male 15-64

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.865	0.081	0.029	0.808	0.922
2	17	0.852	0.184	0.045	0.763	0.941
3	11	0.601	0.064	0.019	0.563	0.639
4	20	0.919	0.158	0.035	0.848	0.989
5	9	0.897	0.163	0.054	0.788	1.005
6	4	0.844	0.033	0.016	0.812	0.877

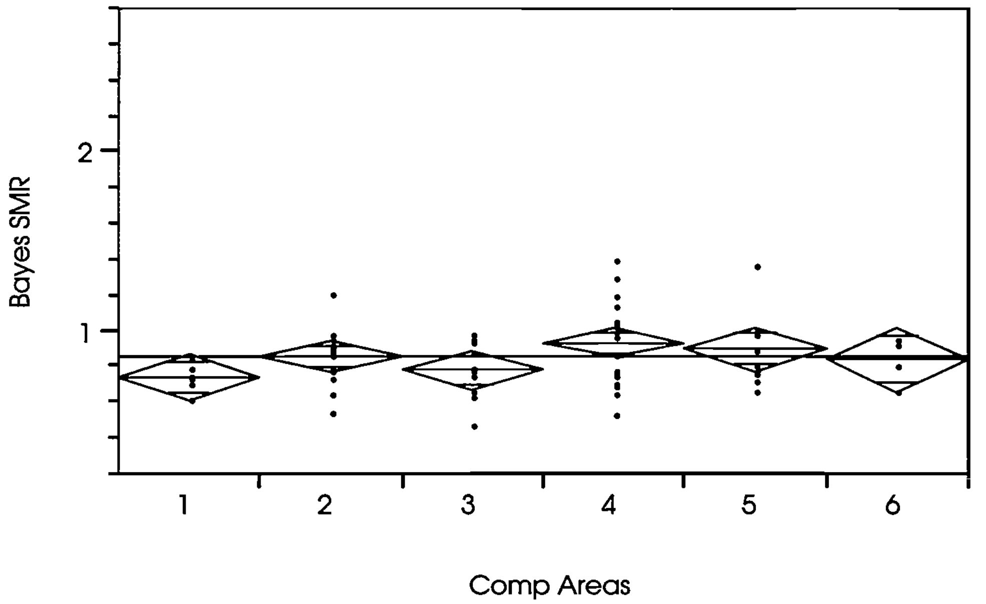
Means Comparisons

Abs(Dif)-LSD	4	5	1	2	6	3
4	-0	-0	-0	-0	-0	0
5	-0	-0	-0	-0	-0	0
1	-0	-0	-0	-0	-0	0
2	-0	-0	-0	-0	-0	0
6	-0	-0	-0	-0	-0	-0
3	0	0	0	0	-0	-0

Positive values show pairs of means that are significantly different.

Cancer Male 65+

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.732	0.070	0.025	0.683	0.782
2	17	0.852	0.148	0.036	0.781	0.924
3	11	0.771	0.157	0.047	0.676	0.866
4	20	0.924	0.231	0.052	0.821	1.028
5	9	0.888	0.211	0.070	0.747	1.029
6	4	0.835	0.135	0.068	0.700	0.970

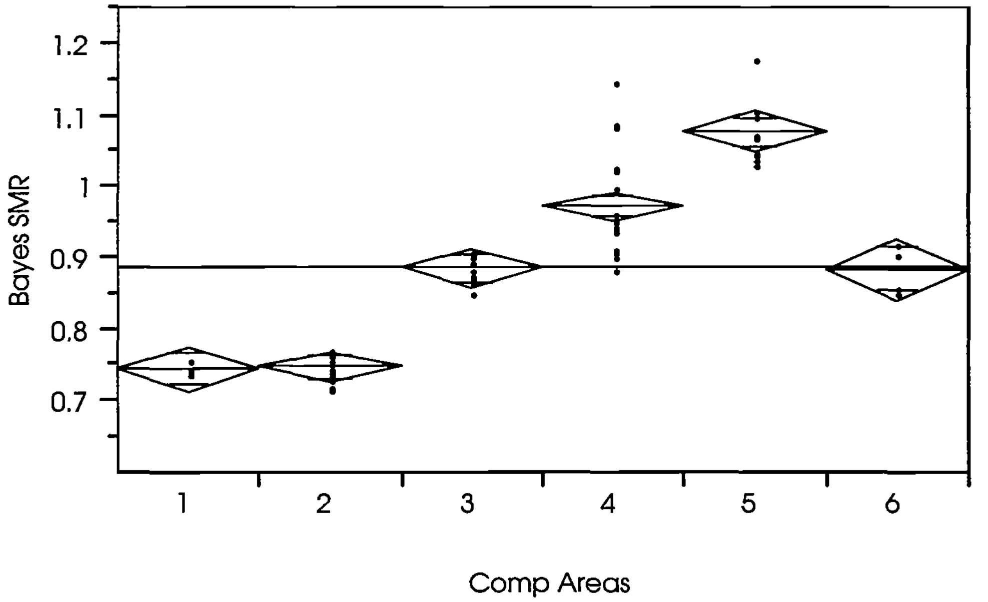
Means Comparisons

Abs(Dif)-LSD	4	5	2	6	3	1
4	-0	-0	-0	-0	-0	-0
5	-0	-0	-0	-0	-0	-0
2	-0	-0	-0	-0	-0	-0
6	-0	-0	-0	-0	-0	-0
3	-0	-0	-0	-0	-0	-0
1	-0	-0	-0	-0	-0	-0

Positive values show pairs of means that are significantly different.

CANCER TOTAL 0-14

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.743	0.005	0.002	0.739	0.747
2	17	0.747	0.019	0.005	0.738	0.756
3	11	0.884	0.018	0.005	0.873	0.895
4	20	0.971	0.069	0.016	0.940	1.002
5	9	1.076	0.047	0.016	1.045	1.107
6	4	0.882	0.034	0.017	0.848	0.917

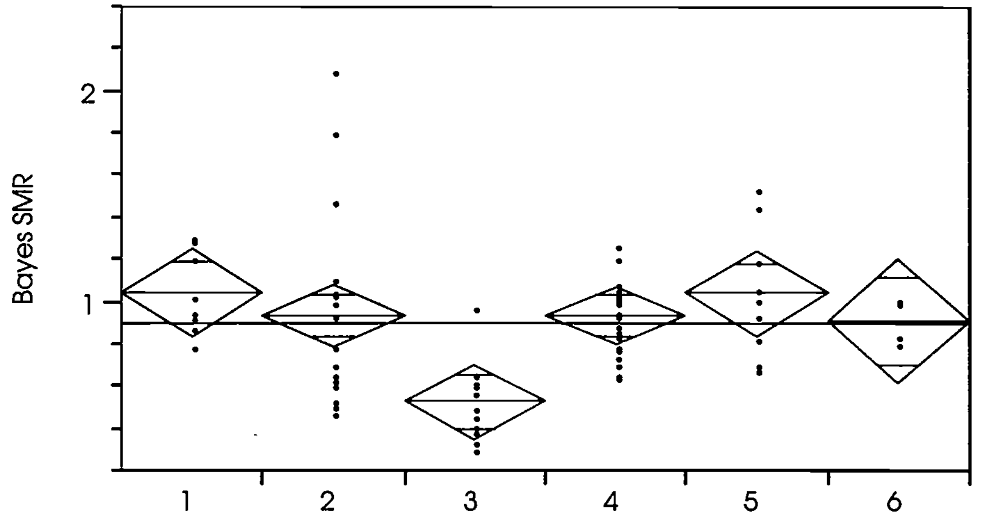
Means Comparisons

Abs(Dif)-LSD	5	4	3	6	2	1
5	-0	0	0	0	0	0
4	0	-0	0	0	0	0
3	0	0	-0	-0	0	0
6	0	0	-0	-0	0	0
2	0	0	0	0	-0	-0
1	0	0	0	0	-0	-0

Positive values show pairs of means that are significantly different.

CANCER TOTAL 15-64

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	1.043	0.197	0.069	0.904	1.181
2	17	0.932	0.470	0.114	0.705	1.160
3	11	0.526	0.190	0.057	0.412	0.640
4	20	0.933	0.187	0.042	0.850	1.016
5	9	1.038	0.305	0.102	0.835	1.241
6	4	0.909	0.108	0.054	0.802	1.017

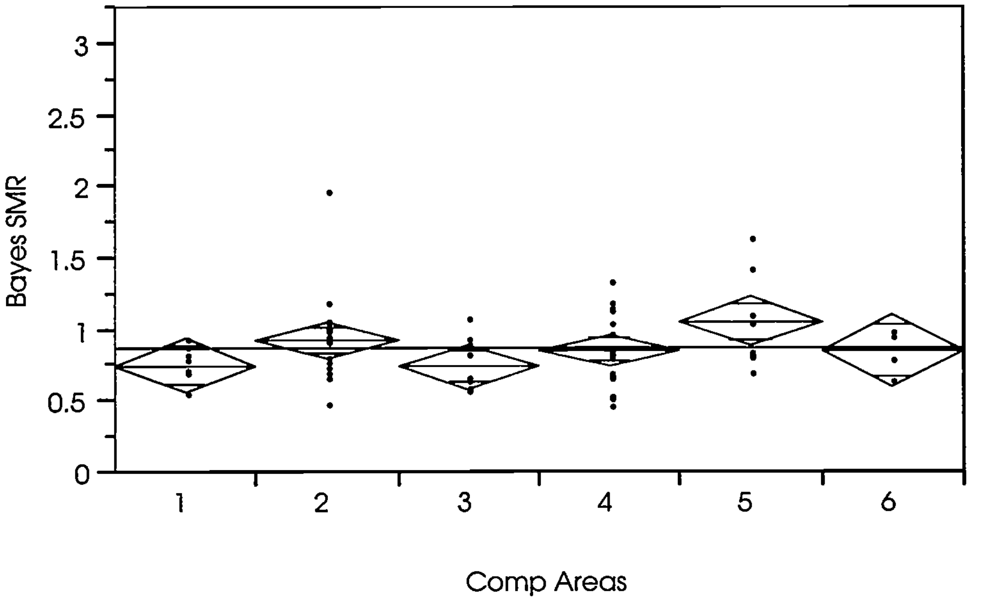
Means Comparisons

Abs(Dif)-LSD	1	5	4	2	6	3
1	-0	-0	-0	-0	-0	0
5	-0	-0	-0	-0	-0	0
4	-0	-0	-0	-0	-0	0
2	-0	-0	-0	-0	-0	0
6	-0	-0	-0	-0	-0	-0
3	0	0	0	0	-0	-0

Positive values show pairs of means that are significantly different.

CANCER TOTAL 65+

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.747	0.140	0.050	0.648	0.846
2	17	0.927	0.321	0.078	0.772	1.083
3	11	0.734	0.171	0.052	0.631	0.837
4	20	0.850	0.263	0.059	0.732	0.968
5	9	1.049	0.309	0.103	0.843	1.255
6	4	0.848	0.160	0.080	0.688	1.008

Means Comparisons

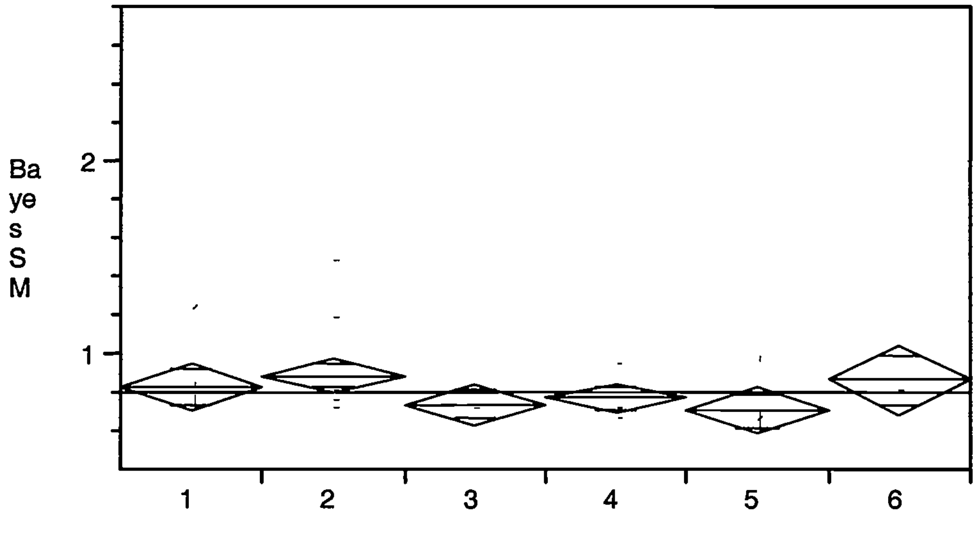
Abs(Dif)-LSD	5	2	4	6	1	3
5	-0	-0	-0	-0	-0	-0
2	-0	-0	-0	-0	-0	-0
4	-0	-0	-0	-0	-0	-0
6	-0	-0	-0	-0	-0	-0
1	-0	-0	-0	-0	-0	-0
3	-0	-0	-0	-0	-0	-0

Positive values show pairs of means that are significantly different.

Appendix 4 *Results of Mortality Analysis on a Small Area Basis*

ALL CAUSE FEMALE 0-14 DISTRIBUTIONS

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.827	0.175	0.062	0.703	0.950
2	17	0.885	0.248	0.060	0.765	1.005
3	11	0.738	0.118	0.035	0.667	0.809
4	20	0.767	0.136	0.030	0.706	0.828
5	9	0.703	0.109	0.036	0.631	0.776
6	4	0.862	0.252	0.126	0.611	1.114

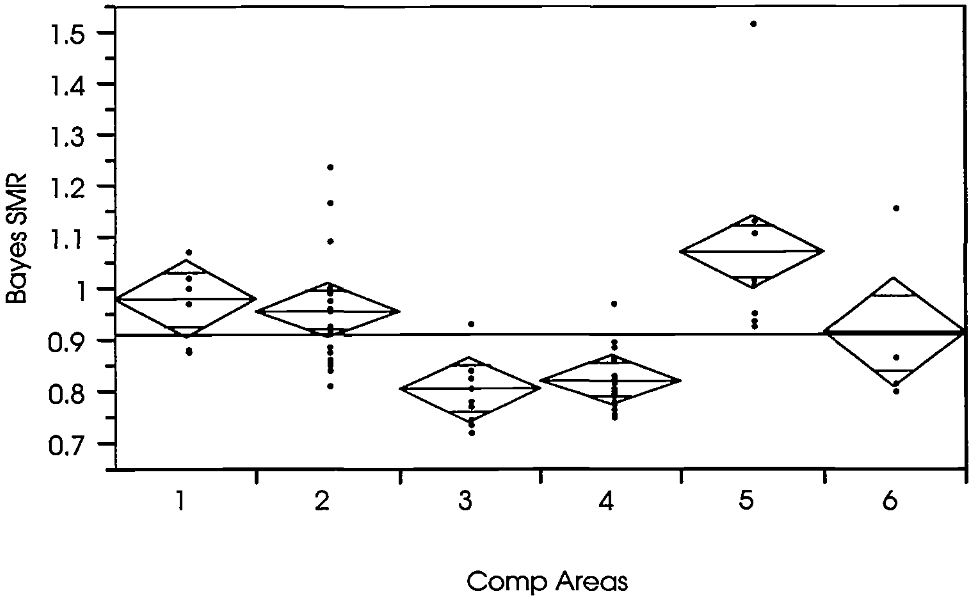
Means Comparisons

Abs(Dif)-LSD	2	6	1	4	3	5
2	-0	-0	-0	-0	-0	-0
6	-0	-0	-0	-0	-0	-0
1	-0	-0	-0	-0	-0	-0
4	-0	-0	-0	-0	-0	-0
3	-0	-0	-0	-0	-0	-0
5	-0	-0	-0	-0	-0	-0

Positive values show pairs of means that are significantly different.

ALL CAUSE FEMALE 15-64 DISTRIBUTIONS

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.979	0.067	0.024	0.932	1.026
2	17	0.957	0.118	0.029	0.900	1.014
3	11	0.803	0.059	0.018	0.767	0.839
4	20	0.821	0.056	0.012	0.796	0.846
5	9	1.070	0.183	0.061	0.948	1.192
6	4	0.913	0.167	0.084	0.746	1.080

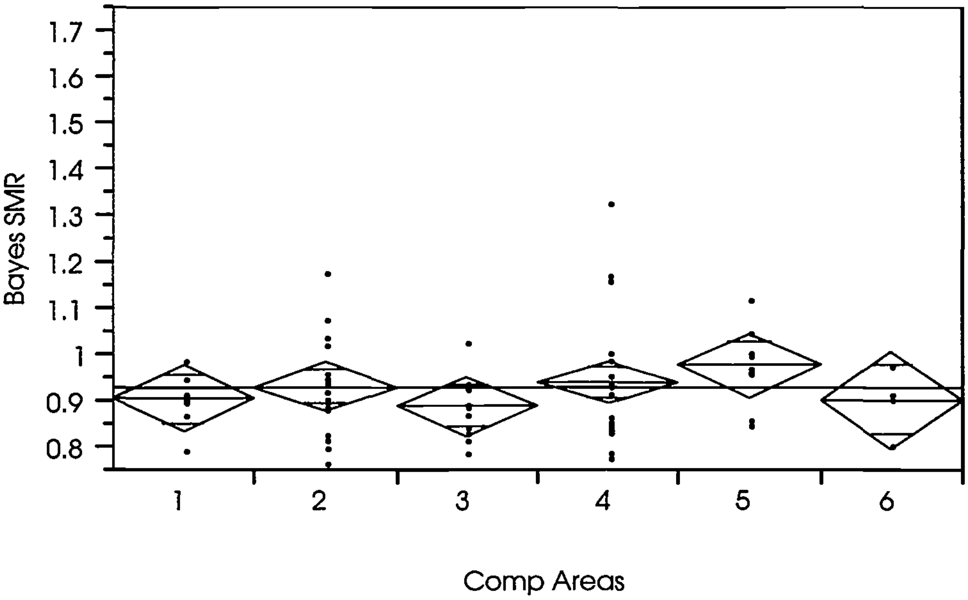
Means Comparisons

Abs(Dif)-LSD	5	1	2	6	4	3
5	-0	-0	-0	-0	0	0
1	-0	-0	-0	-0	0	0
2	-0	-0	-0	-0	0	0
6	-0	-0	-0	-0	-0	-0
4	0	0	0	-0	-0	-0
3	0	0	0	-0	-0	-0

Positive values show pairs of means that are significantly different.

ALL CAUSE FEMALE 65-74 DISTRIBUTIONS

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.905	0.057	0.020	0.864	0.945
2	17	0.931	0.105	0.025	0.880	0.981
3	11	0.888	0.068	0.021	0.847	0.929
4	20	0.939	0.140	0.031	0.877	1.001
5	9	0.977	0.084	0.028	0.921	1.033
6	4	0.901	0.072	0.036	0.829	0.973

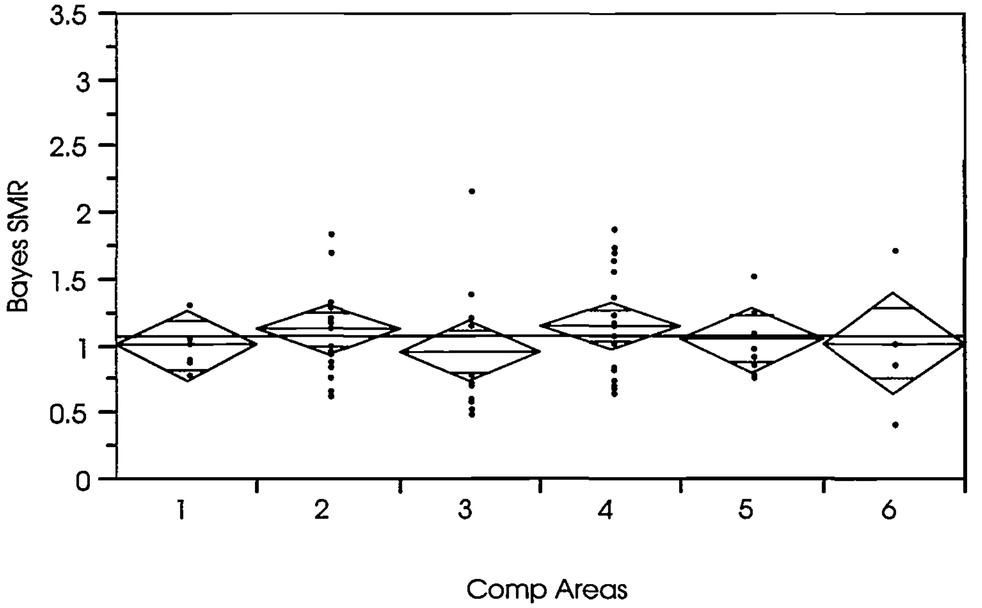
Means Comparisons

Abs(Dif)-LSD	5	4	2	1	6	3
5	-0	-0	-0	-0	-0	-0
4	-0	-0	-0	-0	-0	-0
2	-0	-0	-0	-0	-0	-0
1	-0	-0	-0	-0	-0	-0
6	-0	-0	-0	-0	-0	-0
3	-0	-0	-0	-0	-0	-0

Positive values show pairs of means that are significantly different.

ALL CAUSE FEMALE 75+ DISTRIBUTIONS

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	1.002	0.162	0.057	0.887	1.116
2	17	1.119	0.331	0.080	0.959	1.280
3	11	0.953	0.504	0.152	0.650	1.257
4	20	1,148	0.391	0.087	0.973	1.323
5	9	1.043	0.244	0.081	0.880	1.206
6	4	1.020	0.535	0.267	0.486	1.555

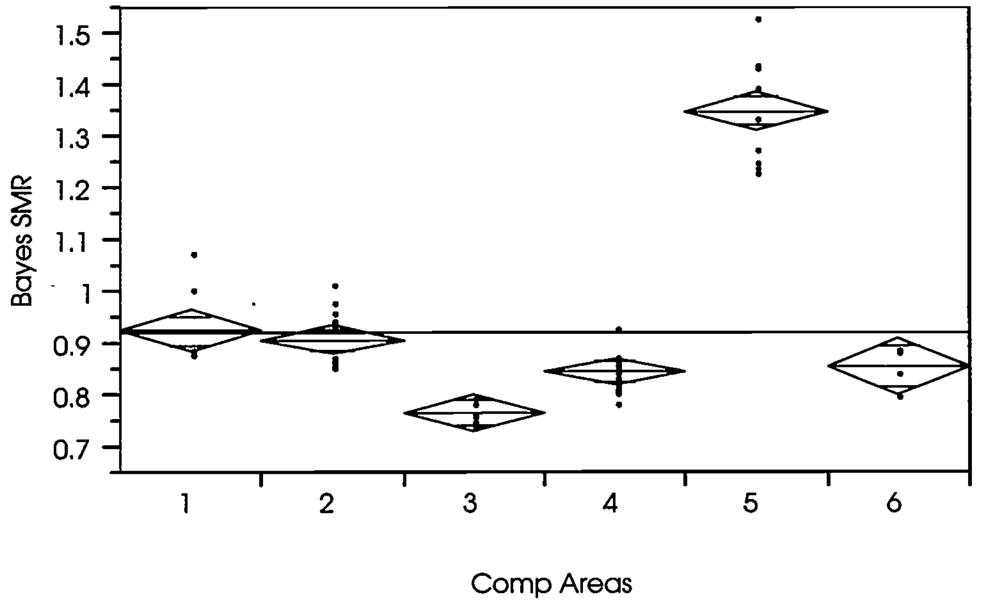
Means Comparisons

Abs(Dif)-LSD	4	2	5	6	1	3
4	-0	-0	-0	-0	-0	-0
2	-0	-0	-0	-0	-0	-0
5	-0	-0	-0	-0	-0	-0
6	-0	-0	-0	-0	-0	-0
1	-0	-0	-0	-0	-0	-0
3	-0	-0	-0	-0	-0	-0

Positive values show pairs of means that are significantly different.

ALL CAUSE MALE 0-14 DISTRIBUTIONS

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.923	0.074	0.026	0.871	0.976
2	17	0.907	0.053	0.013	0.881	0.933
3	11	0.765	0.017	0.005	0.755	0.775
4	20	0.845	0.033	0.007	0.830	0.859
5	9	1.347	0.107	0.036	1.276	1.418
6	4	0.855	0.043	0.021	0.812	0.898

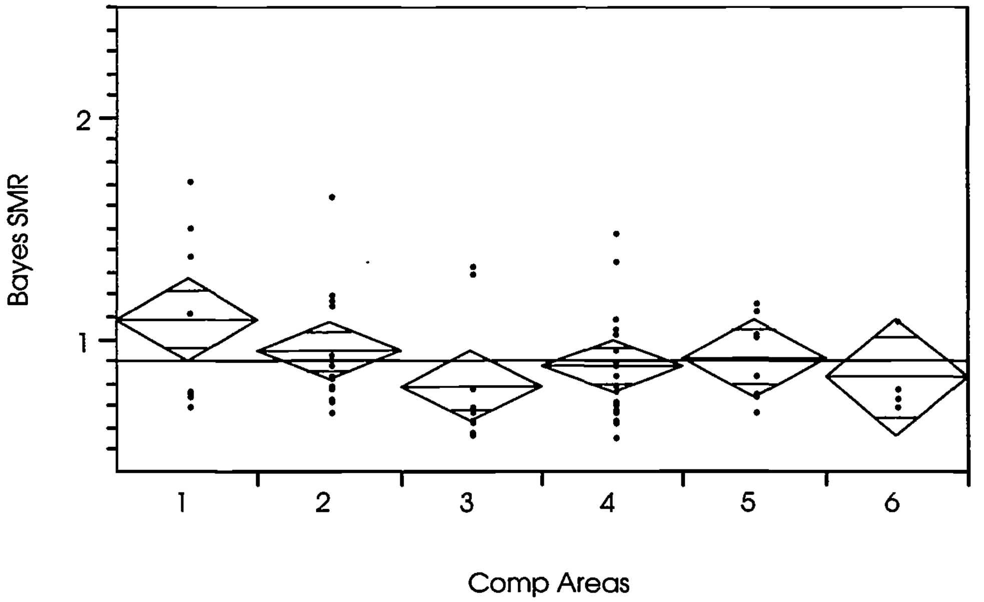
Means Comparisons

Abs(Dif)-LSD	5	1	2	6	4	3
5	-0	0	0	0	0	0
1	0	-0	-0	-0	0	0
2	0	-0	-0	-0	0	0
6	0	-0	-0	-0	-0	-0
4	0	0	0	-0	-0	0
3	0	0	0	-0	0	-0

Positive values show pairs of means that are significantly different.

ALL CAUSE MALE 15-64 DISTRIBUTIONS

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	1.089	0.402	0.142	0.805	1.373
2	17	0.946	0.254	0.062	0.823	1.069
3	11	0.789	0.270	0.081	0.626	0.951
4	20	0.878	0.236	0.053	0.772	0.984
5	9	0.914	0.177	0.059	0.796	1.032
6	4	0.827	0.175	0.088	0.652	1.002

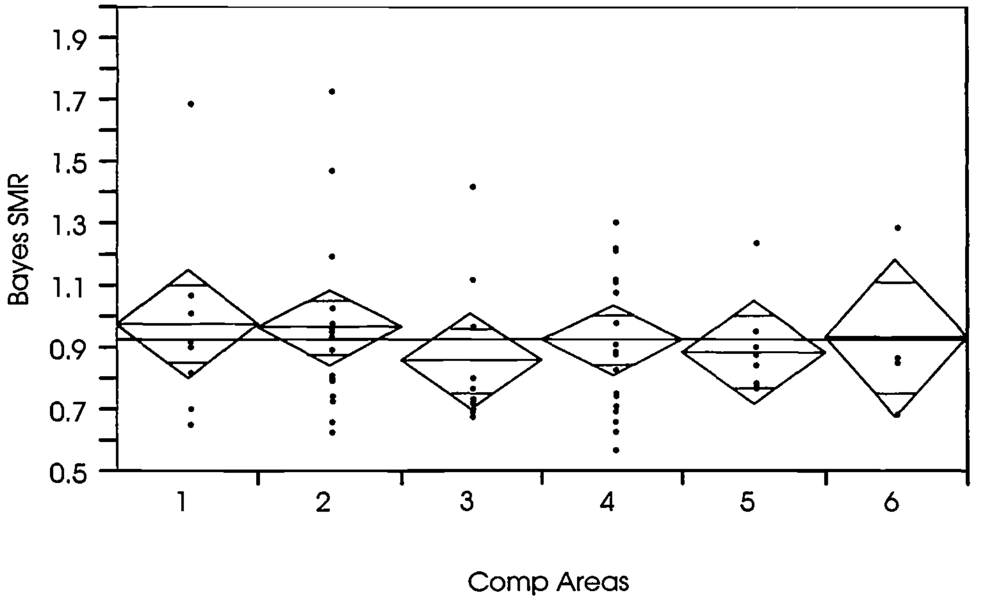
Means Comparisons

Abs(Dif)-LSD	1	2	5	4	6	3
1	-0	-0	-0	-0	-0	-0
2	-0	-0	-0	-0	-0	-0
5	-0	-0	-0	-0	-0	-0
4	-0	-0	-0	-0	-0	-0
6	-0	-0	-0	-0	-0	-0
3	-0	-0	-0	-0	-0	-0

Positive values show pairs of means that are significantly different.

ALL CAUSE MALE 65-74 DISTRIBUTIONS

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.975	0.322	0.114	0.748	1.203
2	17	0.963	0.284	0.069	0.826	1.101
3	11	0.855	0.233	0.070	0.714	0.995
4	20	0.922	0.234	0.052	0.817	1.027
5	9	0.886	0.147	0.049	0.788	0.984
6	4	0.930	0.256	0.128	0.674	1.186

Means Comparisons

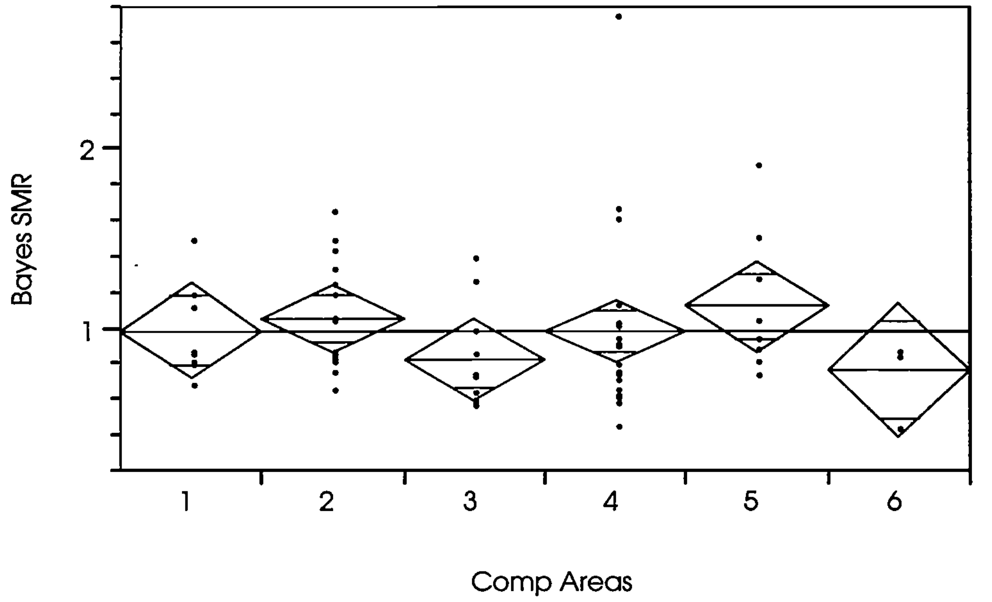
Abs(Dif)-LSD	1	2	6	4	5	3
1	-0	-0	-0	-0	-0	-0
2	-0	-0	-0	-0	-0	-0
6	-0	-0	-0	-0	-0	-0
4	-0	-0	-0	-0	-0	-0
5	-0	-0	-0	-0	-0	-0
3	-0	-0	-0	-0	-0	-0

Positive values show pairs of means that are significantly different.

MALE ALL CAUSE 75+

Distributions

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.986	0.265	0.094	0.799	1.173
2	17	1.052	0.296	0.072	0.909	1.196
3	11	0.821	0.287	0.087	0.648	0.994
4	20	0.979	0.521	0.117	0.746	1.212
5	9	1.122	0.386	0.129	0.865	1.379
6	4	0.763	0.215	0.108	0.549	0.978

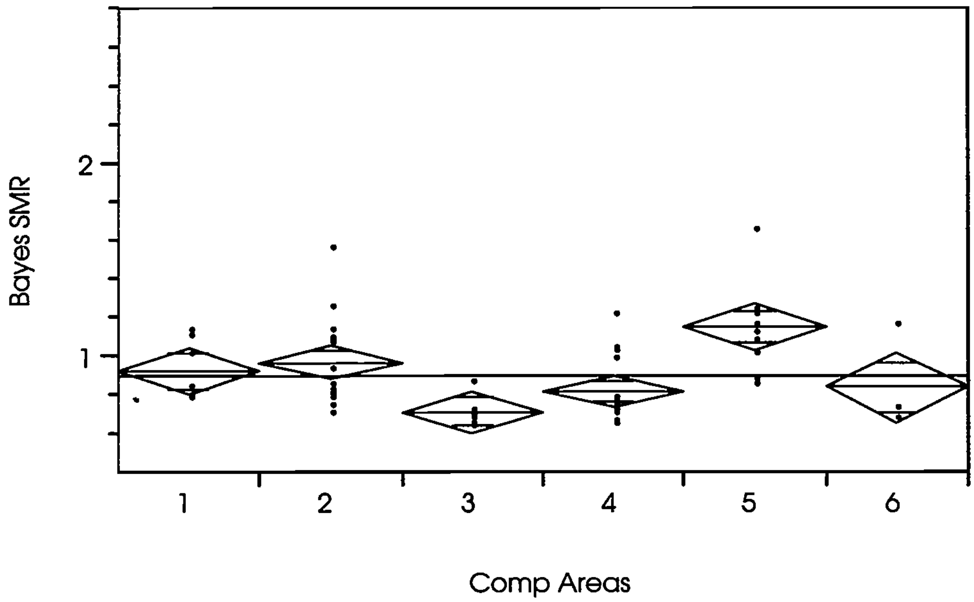
Means Comparisons

Abs(Dif)-LSD	**5**	**2**	**1**	**4**	**3**	**6**
5	-0	-0	-0	-0	-0	-0
2	-0	-0	-0	-0	-0	-0
1	-0	-0	-0	-0	-0	-0
4	-0	-0	-0	-0	-0	-0
3	-0	-0	-0	-0	-0	-0
6	-0	-0	-0	-0	-0	-0

Positive values show pairs of means that are significantly different.

TOTAL ALL CAUSE 0-14

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.920	0.151	0.053	0.813	1.026
2	17	0.960	0.223	0.054	0.852	1.068
3	11	0.712	0.063	0.019	0.674	0.750
4	20	0.810	0.148	0.033	0.744	0.876
5	9	1.149	0.239	0.080	0.990	1.308
6	4	0.838	0.223	0.111	0.615	1.060

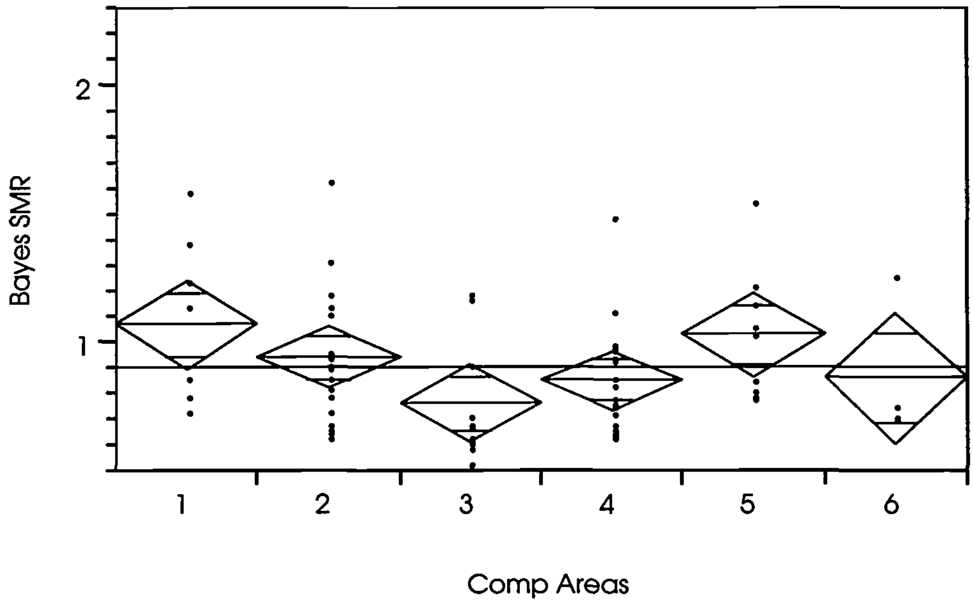
Means Comparisons

Abs(Dif)-LSD	5	2	1	6	4	3
5	-0	-0	-0	-0	0	0
2	-0	-0	-0	-0	-0	0
1	-0	-0	-0	-0	-0	-0
6	-0	-0	-0	-0	-0	-0
4	0	-0	-0	-0	-0	-0
3	0	0	-0	-0	-0	-0

Positive values show pairs of means that are significantly different.

TOTAL ALL CAUSE 15-64

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	1.066	0.324	0.115	0.837	1.295
2	17	0.937	0.270	0.065	0.806	1.068
3	11	0.757	0.232	0.070	0.618	0.897
4	20	0.846	0.205	0.046	0.755	0.938
5	9	1.026	0.256	0.085	0.856	1.197
6	4	0.855	0.270	0.135	0.586	1.125

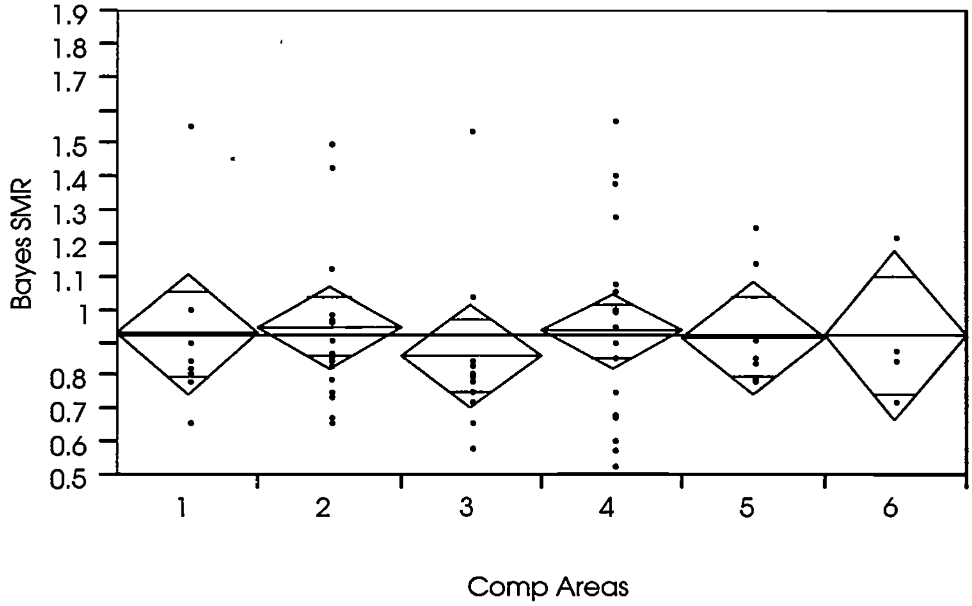
Means Comparisons

Abs(Dif)-LSD	1	5	2	6	4	3
1	-0	-0	-0	-0	-0	-0
5	-0	-0	-0	-0	-0	-0
2	-0	-0	-0	-0	-0	-0
6	-0	-0	-0	-0	-0	-0
4	-0	-0	-0	-0	-0	-0
3	-0	-0	-0	-0	-0	-0

Positive values show pairs of means that are significantly different.

TOTAL ALL CAUSE 65-74

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.926	0.273	0.096	0.733	1.119
2	17	0.947	0.238	0.058	0.831	1.062
3	11	0.856	0.256	0.077	0.701	1.010
4	20	0.933	0.302	0.068	0.798	1.068
5	9	0.915	0.167	0.056	0.804	1.026
6	4	0.920	0.211	0.106	0.708	1.131

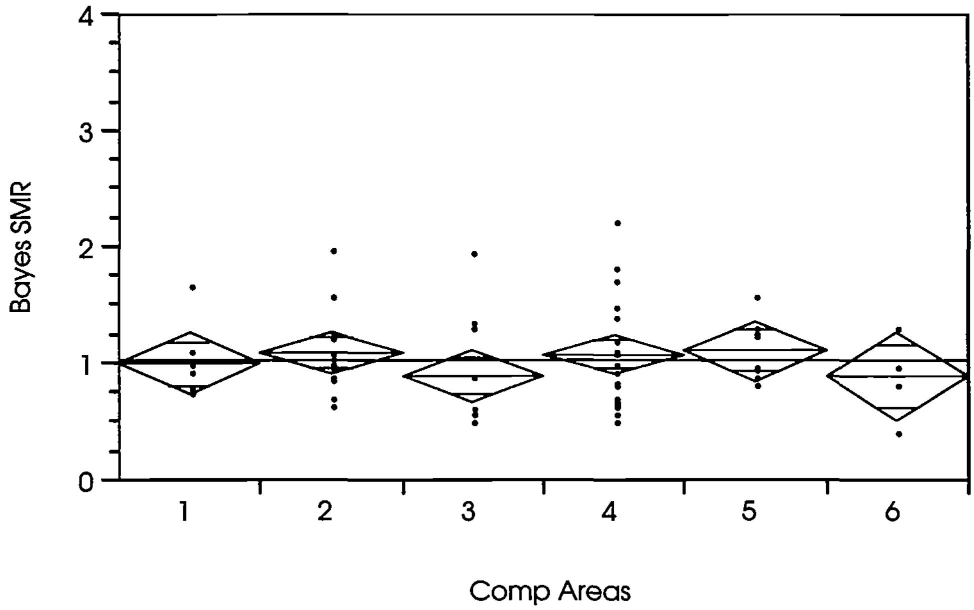
Means Comparisons

Abs(Dif)-LSD	2	4	1	6	5	3
2	-0	-0	-0	-0	-0	-0
4	-0	-0	-0	-0	-0	-0
1	-0	-0	-0	-0	-0	-0
6	-0	-0	-0	-0	-0	-0
5	-0	-0	-0	-0	-0	-0
3	-0	-0	-0	-0	-0	-0

Positive values show pairs of means that are significantly different.

TOTAL ALL CAUSE 75+

Oneway Analysis of Bayes SMR By Comp Areas



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	8	0.996	0.296	0.105	0.787	1.205
2	17	1.088	0.330	0.080	0.929	1.248
3	11	0.890	0.468	0.141	0.607	1.172
4	20	1.073	0.455	0.102	0.870	1.276
5	9	1.107	0.249	0.083	0.941	1.273
6	4	0.886	0.370	0.185	0.516	1.256

Means Comparisons

Abs(Dif)-LSD	5	2	4	1	3	6
5	-0	-0	-0	-0	-0	-0
2	-0	-0	-0	-0	-0	-0
4	-0	-0	-0	-0	-0	-0
1	-0	-0	-0	-0	-0	-0
3	-0	-0	-0	-0	-0	-0
6	-0	-0	-0	-0	-0	-0

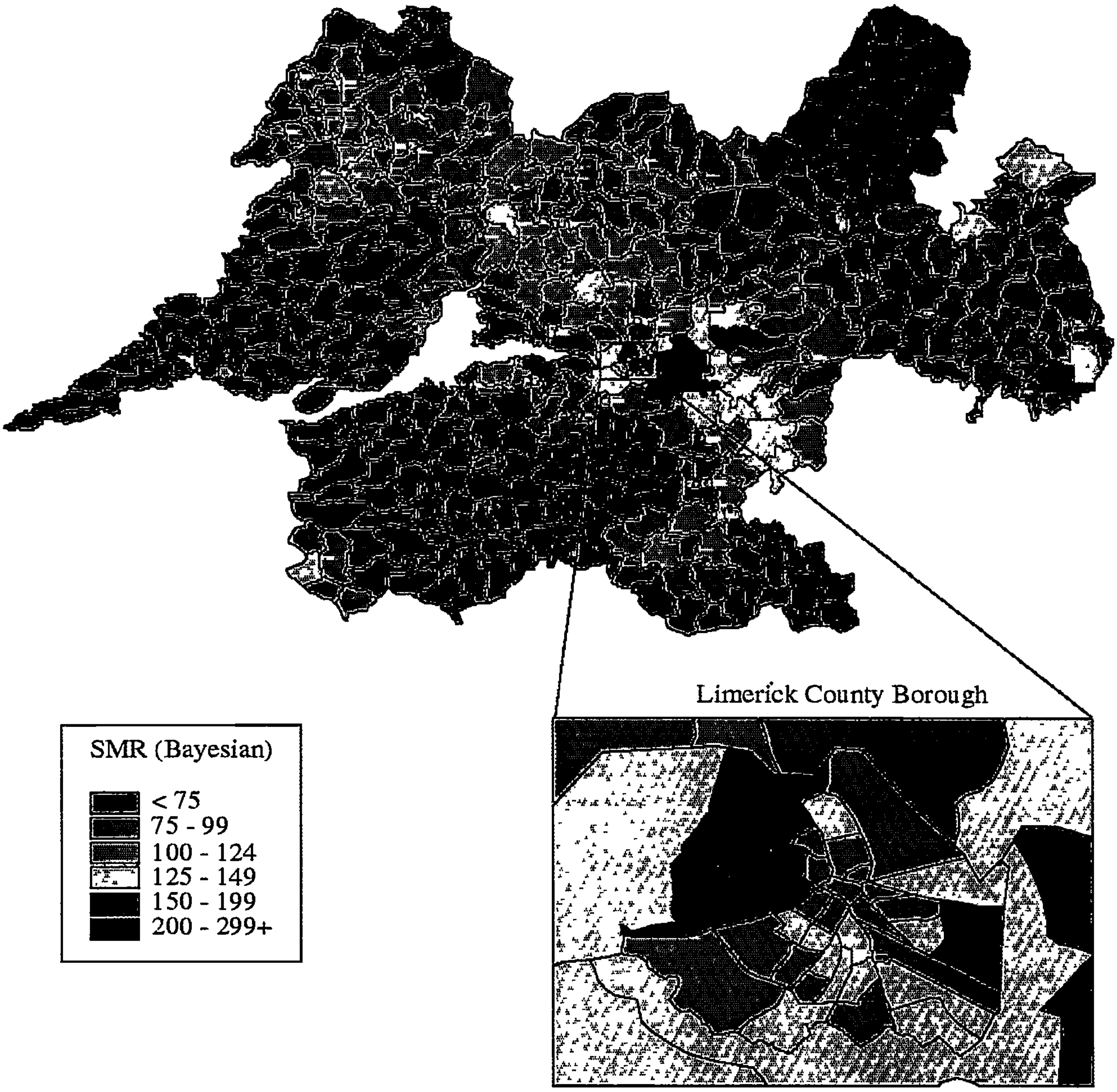
Positive values show pairs of means that are significantly different.

Appendix 5 *Actual Numbers of Deaths from All Causes during the Study Period*

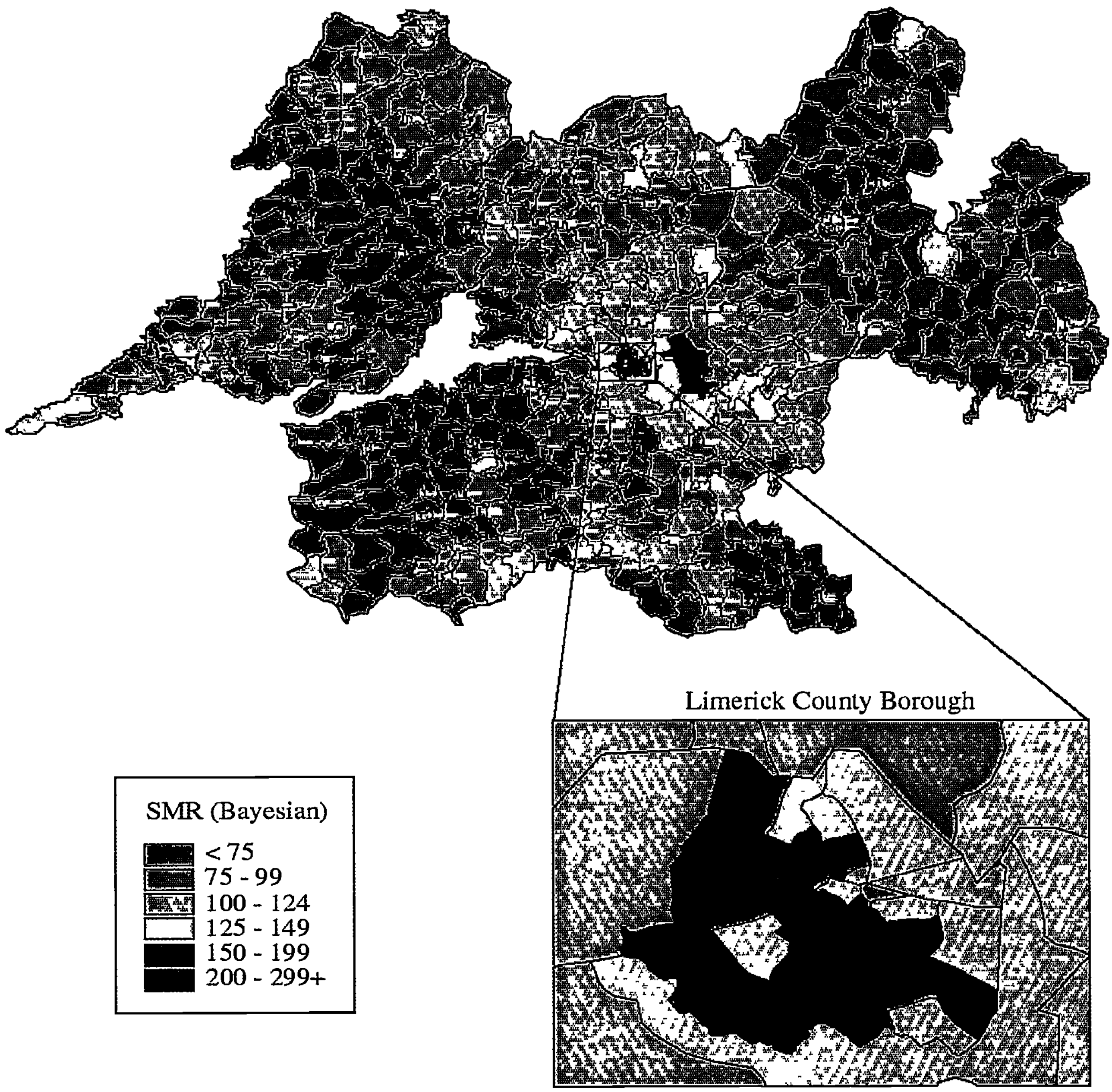
Age Group	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Other	Total
0-4	3	8	0	5	7	8	139	**170**
5-9	0	0	0	1	1	1	16	**19**
10-14	0	2	1	1	2	1	21	**28**
15-19	2	4	0	2	3	3	57	**71**
20-24	1	2	1	2	1	0	89	**96**
25-29	2	0	0	2	1	5	64	**74**
30-34	1	4	2	5	1	5	80	**98**
35-39	4	1	1	3	4	3	96	**112**
40-44	1	9	2	2	4	5	132	**155**
45-49	3	6	6	5	5	9	202	**236**
50-54	4	10	4	10	4	19	345	**396**
55-59	5	20	3	16	11	13	508	**576**
60-64	18	36	7	30	20	20	791	**922**
65-69	18	43	18	48	23	44	1315	**1509**
70-74	30	77	34	114	41	51	1898	**2245**
75-79	35	98	45	136	57	65	2186	**2622**
80-84	30	104	40	144	34	58	2311	**2721**
85+	33	90	48	161	55	66	2535	**2988**
	190	**514**	**212**	**687**	**274**	**376**	**12785**	**15038**

Appendix 6 *Maps of Cancer data*

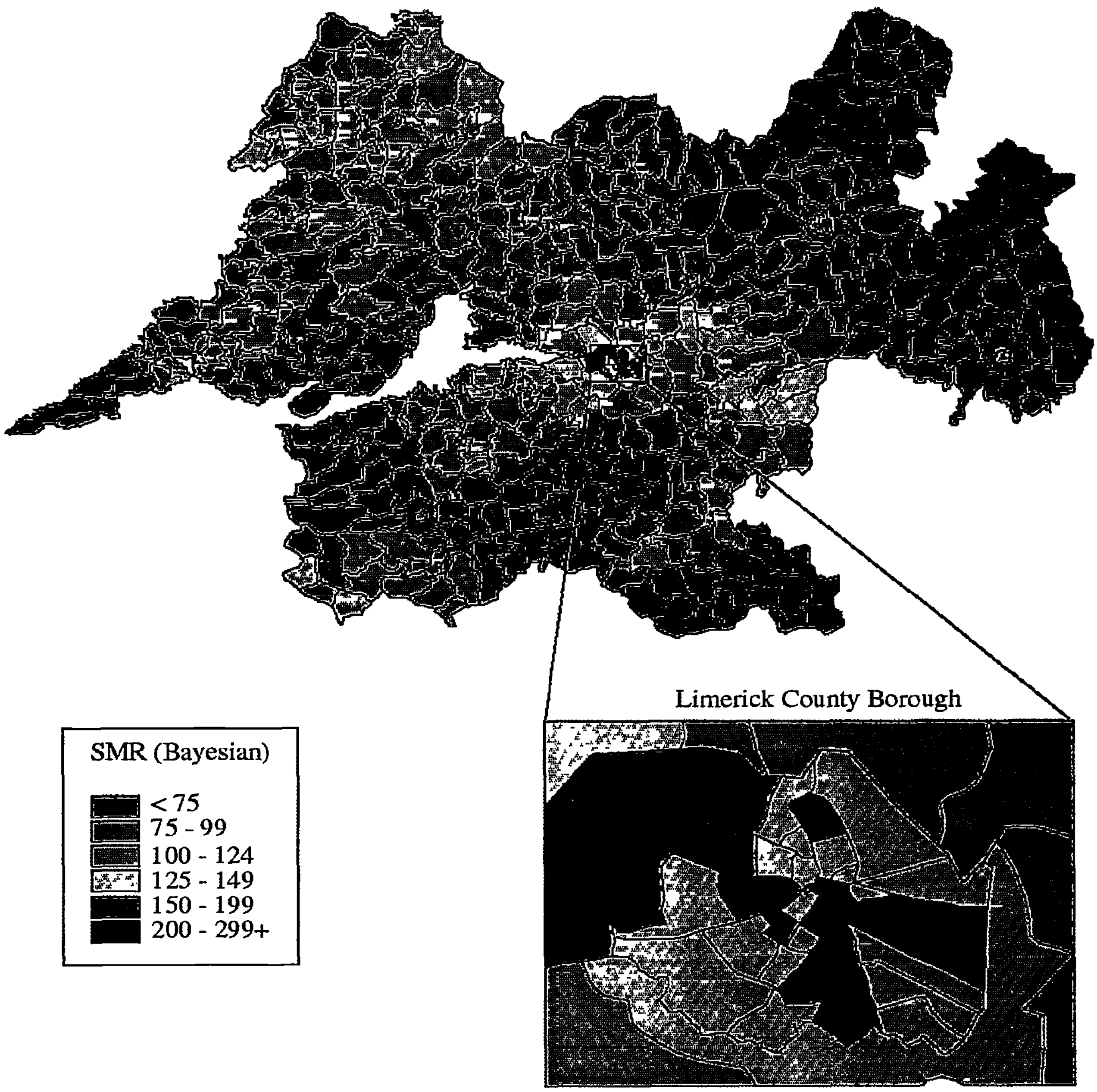
Mid Western Health Board - SMRs (Bayesian) for Females (15-64 years) for All Cancers



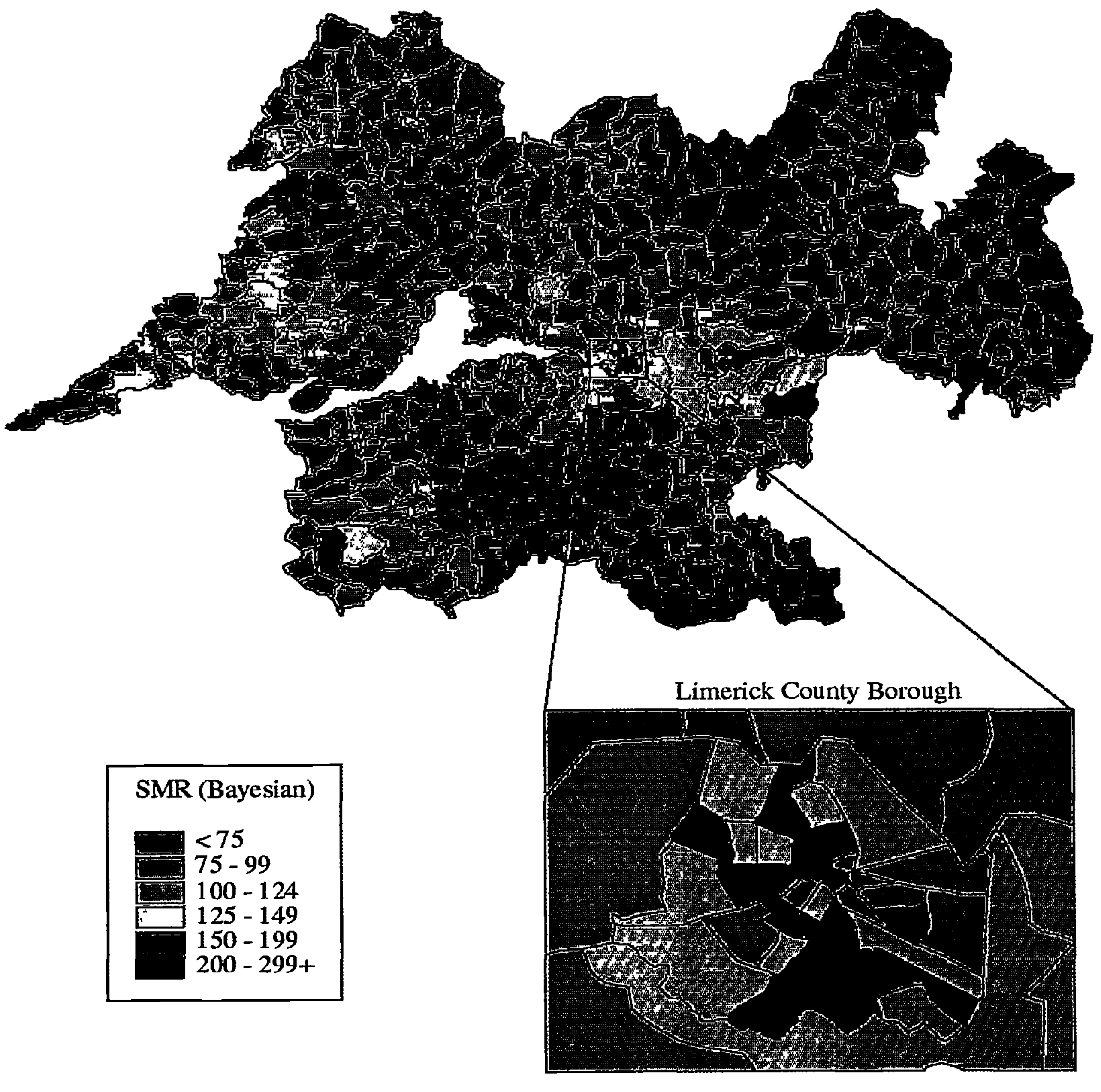
Mid Western Health Board - SMRs (Bayesian) for
Females (65+ years) for All Cancers



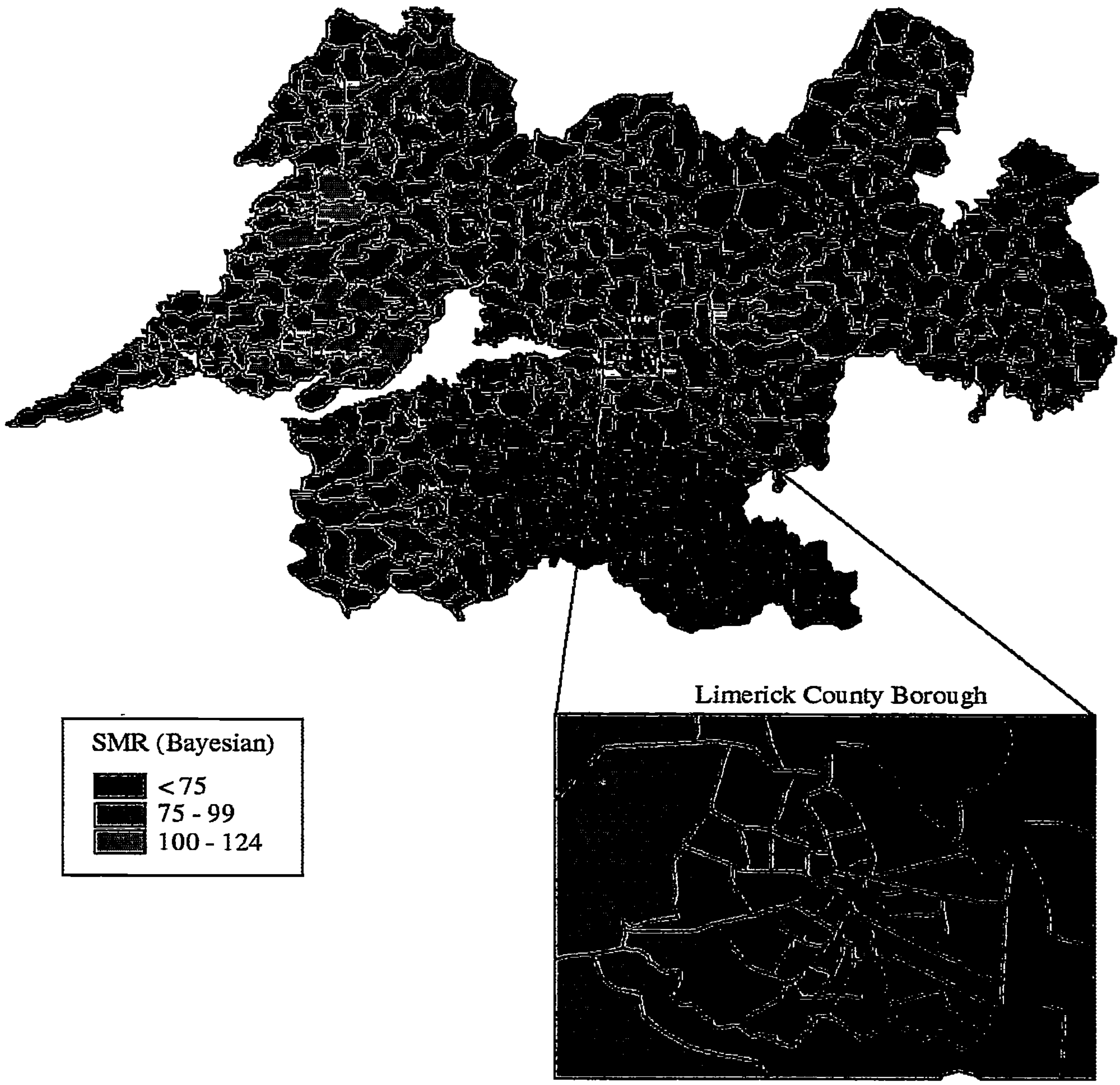
Mid Western Health Board - SMRs (Bayesian) for
Males (15-64 years) for All Cancers



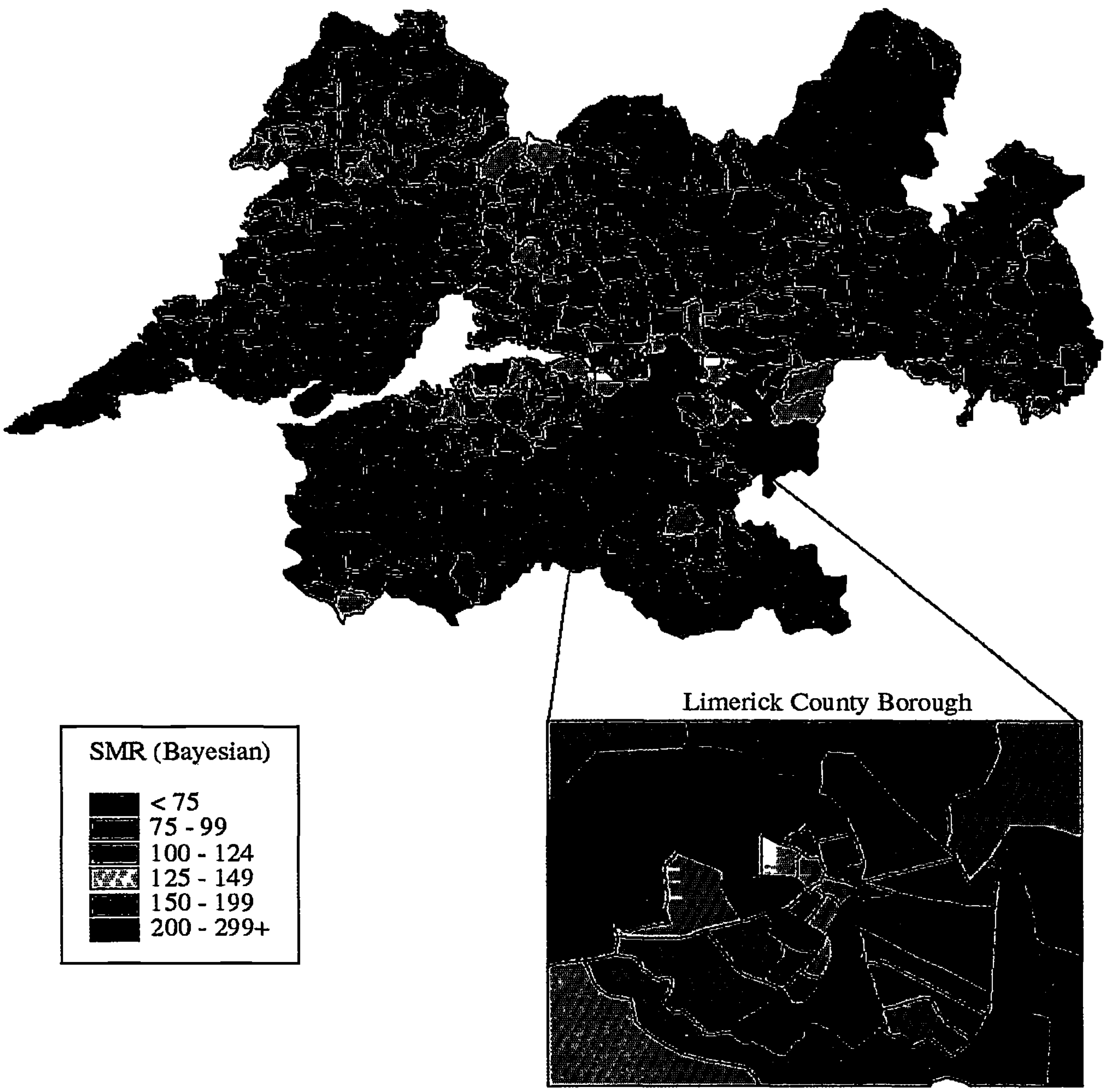
Mid Western Health Board - SMRs (Bayesian) for
Males (65+ years) for All Cancers



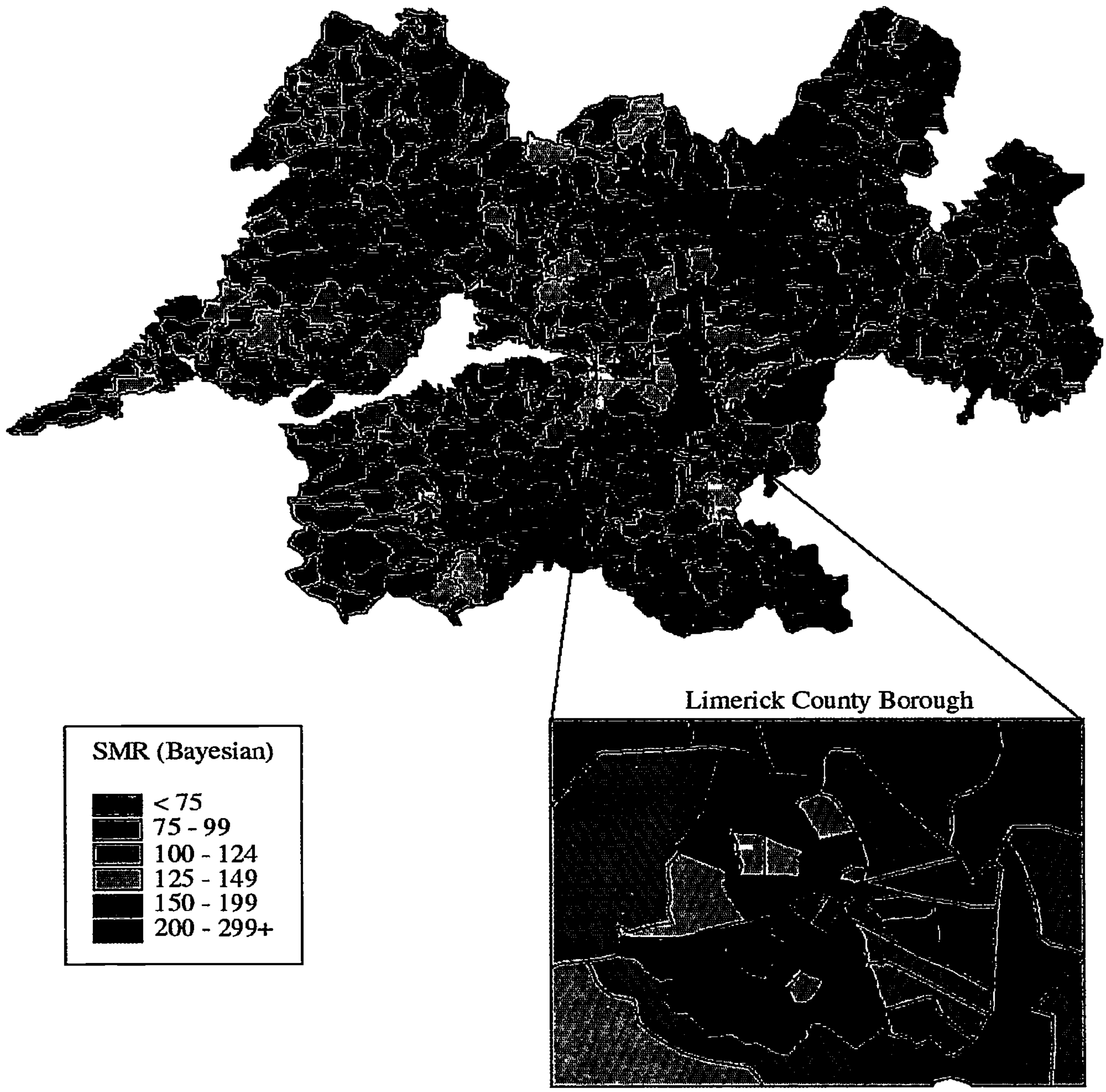
Mid Western Health Board - SMRs (Bayesian) for
Males and Females (0-14 years) for All Cancers



Mid Western Health Board - SMRs (Bayesian) for Males and Females (15-64 years) for All Cancers



Mid Western Health Board - SMRs (Bayesian) for
Males and Females (65+ years) for All Cancers



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THE

HEALTH STATUS

OF

TEENAGERS

INTRODUCTION

Anecdotal concerns
There have been many anecdotal concerns regarding children's health in the Askeaton area of Co. Limerick over the last number of years. These concerns have included an impression that there is a greater incidence of asthma and respiratory problems among younger age groups. These problems have been attributed locally to alleged air pollution from industry around the Shannon estuary.

Air pollution and children's health
Ambient air pollution, including exposure to high levels of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and particulate matter, has been shown to cause adverse effects on health, especially in terms of respiratory illness.[1] It is difficult to extrapolate from findings for adult groups to potentially sensitive groups such as children and the elderly. The association between passive smoking and childhood respiratory disease suggested that children may be unusually susceptible to airborne pollutants.[2] The impact of ambient air pollution on children's respiratory health, pulmonary function and existing morbidity has been the focus of much research.[3]

Many studies have examined the relationship between exposure to pollutants such as sulphur dioxide, nitrogen dioxide, ozone and particulate matter and respiratory symptoms in children. In a diary study of 625 Swiss schoolchildren, Braun-Fahrlander *et al.*[4] found an association between short- and medium-term particulate exposure and the incidence and duration of respiratory symptoms. In a later study, Braun-Fahrlander *et al.*[5] assessed the impact of long-term exposure to PM_{10} (particulate matter less than ten microns), NO_2, SO_2, and O_3 on rates of respiratory symptoms. PM_{10}, NO_2 and SO_2 were positively associated with prevalence rates of chronic cough, nocturnal dry cough, bronchitis and conjunctivitis symptoms. PM_{10} showed that strongest association of the three pollutants. Buchdahl *et al.*[6] found fluctuations in concentrations of atmospheric ozone and SO_2 to be significantly associated with attendance at accident and emergency departments for acute childhood wheezy episodes. Pinter *et al.*[7] reported a statistically significant correlation between SO_2 levels and acute daily respiratory morbidity in children living in a small town in Hungary. Ware *et al.*[8] found an increase in the incidence of respiratory illnesses in children exposed to SO_2 but no decrease in their pulmonary function.

Effects of particulate pollution on respiratory health and pulmonary function have been consistently demonstrated in both healthy children[9,10,11,12,13] and asthmatic or sensitive children.[14,15,16] Neas *et al.*[10] reported that summer occurrences of particulate pollution were acutely associated with declines in peak expiratory flow rates and increased incidence of cough episodes. Using a daily diary methodology, Schwartz *et al.*[9] found significant associations between incidence of coughing symptoms and incidence of lower respiratory symptoms and PM_{10}, and a marginally significant association between upper respiratory symptoms and PM_{10}. Earlier studies have reported that short-term exposure to particulates is associated with acute decrements in pulmonary function.[17,18,19,20]

Halliday *et al.*[21] used a control area in the methodology of their cross-sectional study of children's respiratory health. Lung function was lower and reported symptoms of asthma were higher in children in a town near two power stations compared with children in a town with no nearby industrial emissions. The authors of this study highlight the possibility that there may have been overreporting of symptoms in the risk area that would exaggerate prevalence rates. However, objective measurements of pulmonary function provided valid indices of pollution effects. Brabin *et al.*[21] also compared respiratory symptoms and lung function of children in a locality exposed to pollution with children in two control areas. These investigators used a parent-completed questionnaire as well as measurements of peak expiratory flow. Respiratory symptoms (wheeze, cough, and school absences for respiratory symptoms) were significantly more common in the exposed area.

Other studies have failed to demonstrate adverse effects of air pollutants on children's respiratory health. Mukala *et al.*[23] used passive samplers attached to outer garments of children to monitor exposure levels during everyday activity while diaries of respiratory symptoms were kept by parents. These investigators found no association between low-level exposure to NO_2 and respiratory symptoms. Other studies have similarly failed to find associations between NO_2 exposure and respiratory ill-health.[4,24] Symington *et al.*[25], using control areas in their methodology, found that the prevalence of respiratory symptoms in children at school within one mile of a foundry were actually lower than in schools furthest from industrial facilities. Wilkie *et* al.[26] and Nystad *et al.*[27] found no evidence for increased respiratory morbidity in children in industrialised versus non-industrialised areas.

Koltai[28] in a review of reported effects of air pollution on children concludes that "detriments in air quality cause adverse changes in the lower respiratory tracts of susceptible individuals" and "children with reactive airway disease and asthma appear much more susceptible to diminished lung function with routine SO_2 air pollution". A number of other investigators who have studied children with chronic respiratory illnesses have found that pollutants exacerbate existing morbidity.[4,19,29,30,31] In a review of the literature Bates[29] states that "there is convincing evidence that current levels of fine particulate pollution are responsible for aggravating asthma". In a previous review, Barnes[32] propounds that "...results to date indicate that the *normally* encountered levels of air pollution are unlikely to contribute to a worsening of asthma..." but "...suspended particles may act as an inciter of asthma symptoms when concentrations are *high...*" and "...when levels of SO_2 are exceptionally high it is possible that asthmatic patients may have increased symptoms after exertion...". This author highlights the possibility that combinations of air pollutants may have greater effects on airway function than exposure to a single pollutant.

Methodological problems

Assessing the impact of air pollutants on children is complicated by the fact that there are a number of types of air pollution and a variety of measures of health effects. Studies have adopted different methodologies ranging from self-report questionnaires with risk and control areas to passive sampling of actual exposure and objective measurements of lung function. Cross-sectional and longitudinal studies of the effects of air pollution are generally not designed to detect daily changes in respiratory symptoms or pulmonary function that might be related to daily changes in air pollution concentrations.[24] Ambient air pollution concentrations may not adequately reflect exposures of individual subjects; passive sampling as was used by Mukala *et al.*[23] provides more valid estimates of exposure levels than stationary monitors. Passive sampling also controls for the effect of differing lengths of exposure between children depending on time spent outdoors. Other methodological concerns in studies of child health and air pollution include bias in recall in questionnaires and time interval between experience and recall of symptoms.

The present study was introduced as a result of the pilot stage of the Human Health Status Survey which highlighted the fact that certain questionnaires, for example, the SF-36, held little relevance for children and younger people. While all respondents, regardless of age, would have completed the respiratory, skin and general health sections, children under 15 years did not complete the health status measure. A specific child health status measure was deemed more appropriate for teenagers, a measure that would look at physical, psychological and social functioning.

RESEARCH QUESTION

Is the physical health experience of teenagers living in the Askeaton/Rathkeale area of County Limerick worse than that of teenagers in comparison areas in County Clare?

METHODOLOGY

Design

Independent variables in the present study included Area of Origin, Age, Gender and Social Class while the dependent variable was response to the CHQ-CF87. The sub-scales of the CHQ-CF87 that can be considered especially relevant to the present investigation are physical functioning, role/social limitations-physical, general health, bodily pain/discomfort, and change in health. Opportunistic sampling of secondary schoolchildren in two risk areas and three comparison areas was carried out. Secondary schools were located within the study areas with the assistance of the local School Inspectorate.

Participants

A sample of 750 2nd and 5th (pre-Leaving Cert) year students from 9 secondary schools (1 in Askeaton (high risk) area, 1 in Rathkeale (medium risk) area, 2 in Killadysert (comparison) area, 4 in Ennistymon (comparison) area, and 1 in Clarecastle (comparison) area) completed the CHQ-CF87. For the purposes of analysis, the Askeaton and Rathkeale areas combined ("risk") were compared with the other four areas combined ("comparison"). The secondary school surveyed in the Rathkeale area represented an amalgamation of two schools. A further school in the Rathkeale area could not be surveyed for logistical reasons. There are no secondary schools located in the geographically defined area of Moyne/Littleton in County Tipperary. 2nd and pre-Leaving Cert. years' students were chosen as most accessible because they were not at school entry level or in an examination year.

Questionnaire

Up to the 1990's, health-related outcomes in children and adolescents were still being defined in predominantly clinical terms of morbidity and mortality. The field lacked a well-validated and comprehensive self-report tool measuring perceived health and well being of children. The Child Health Questionnaire (CHQ) was constructed to measure the physical and psychosocial well-being of children five years of age and older.[33] Initially, full-length parent and child completed versions were constructed and tested in 1990. Concepts measured in the CHQ-CF87 (Child Form, 87 items) include physical functioning, role/social limitations - physical, general health perceptions, bodily pain, role/social limitations - emotional and behavioural, self-esteem, mental health, general behaviour, family activities, family cohesion, and change in health. Unlike the parent-completed forms, the CHQ-CF87 does not include items that measure parental impact. The "Facts about You" section sought demographic information such as age, gender and school-year and was extended for the present study to include parental occupations and number of siblings. Landgraf & Abetz[34] examined tests of item scaling assumptions and differences in health status as reported by children representing three predominant cultural groups in the United States (African-American, Spanish-American and Caucasian). Perfect success rates (100%) were observed in tests of item internal consistency for seven of the ten CHQ-CF87 scales for the school-based sample. Item-discriminant validity was reported as ranging from 92 to 100%. Internal consistency reliability coefficients ranged from 0.63 to 0.89. Results to date demonstrate that the CHQ-CF87 is a reliable and valid tool for child health status measurement.

Administration

The CHQ-CF87 is designed to be self-completed by children of at least ten years of age without the use of a trained interviewer. The questionnaire was formatted to be read by an optical mark reader and as such was preceded by special instructions for marking responses. Researchers were available in the classroom situation to answer questions during questionnaire completion.

A series of Mann -Whitney U tests were carried out on the CHQ-CF87 data in an effort to detect differences by area.

RESULTS

A total of 750 pupils took part in this study, 257 from the risk area (Askeaton & Rathkeale) and 493 from the comparison area (Killadysert, Ennistymon & Clarecastle) (see Table 1 for details of age and gender).

Table 1

	Area	
	Risk	**Comparison**
Total	257	493
Males	109	237
Females	149	241
Average Age	15.09	15.43

No summary scales have as yet been produced for the Child Health Questionnaire - Child Form 87. In view of this it is necessary to examine each of the relevant 14 subscales. The subscales have been grouped together by the authors under broad subject areas to aid presentation. The first subject area examined here is what may broadly be termed physical health and is of most relevance to the Askeaton human health investigation. This area includes the CHQ-CF87 subscales 'bodily pain', 'role/social limitations-physical' and 'physical functioning'. Figure One clearly demonstrates the similarity in results between students in the risk and comparison areas.

Figure One

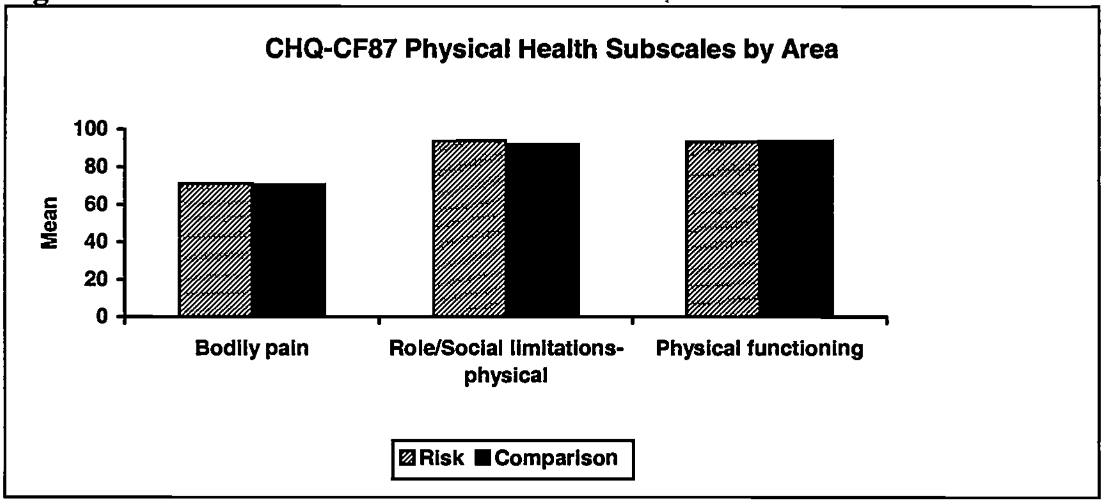

Table 2
CHQ-CF87 Physical Health Sub-Scales (All students)

	Area	
Sub-scales	**Risk**	**Comparison**
Bodily Pain	71.19 (252)	70.65 (479)
Role / Social Limitations - Physical	93.67 (244)	91.89 (471)
Physical Functioning	93.29 (169)	93.51 (442)

No statistically significant differences were found between the risk and comparison groups on any of the physical health subscales (bodily pain, $z=-0.7821$, $p>0.05$; role/social limitations-physical, $z=-1.0093$, $p>0.05$; physical functioning, $z=-0.3067$, $p>0.05$). Students from the risk area did not report significantly different physical health to students from the comparison area.

The next two sub-scales to be examined have been amalgamated under the heading of 'general health'.

Figure Two

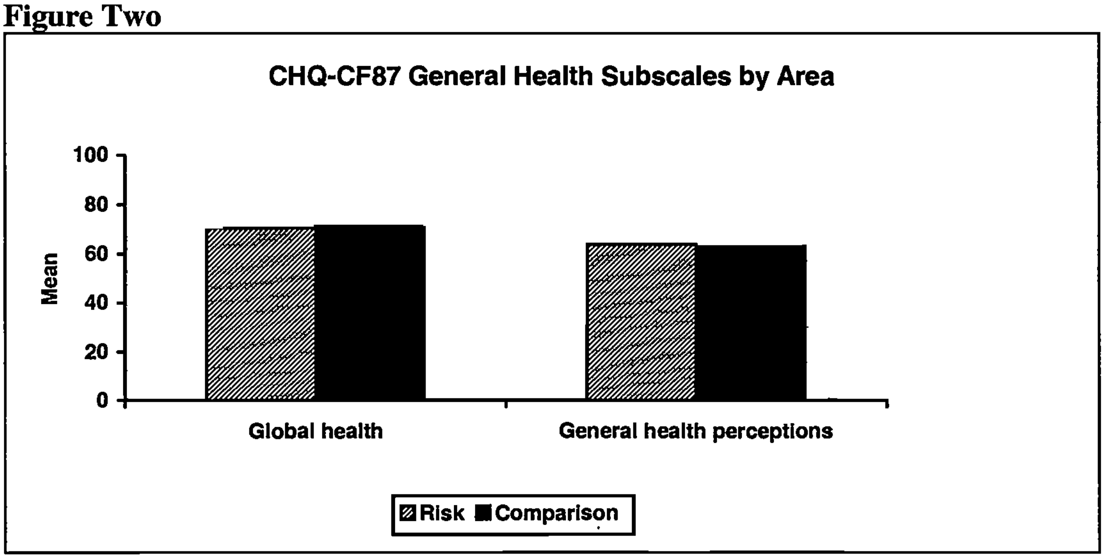

Table 3
CHQ-CF87 General Health Sub-Scales

	Area	
Sub-scales	**Risk**	**Comparison**
Global Health	70.47 (181)	71.56 (473)
General Health Perceptions	63.80 (148)	62.98 (412)

No statistically significant differences were found between the risk and comparison groups on either of the general health subscales (global health, z=-0.9032, p>0.05; general health, z=-0.7491, p>0.05). Students from the risk area did not report significantly different general health to students from the comparison area.

Figure Three

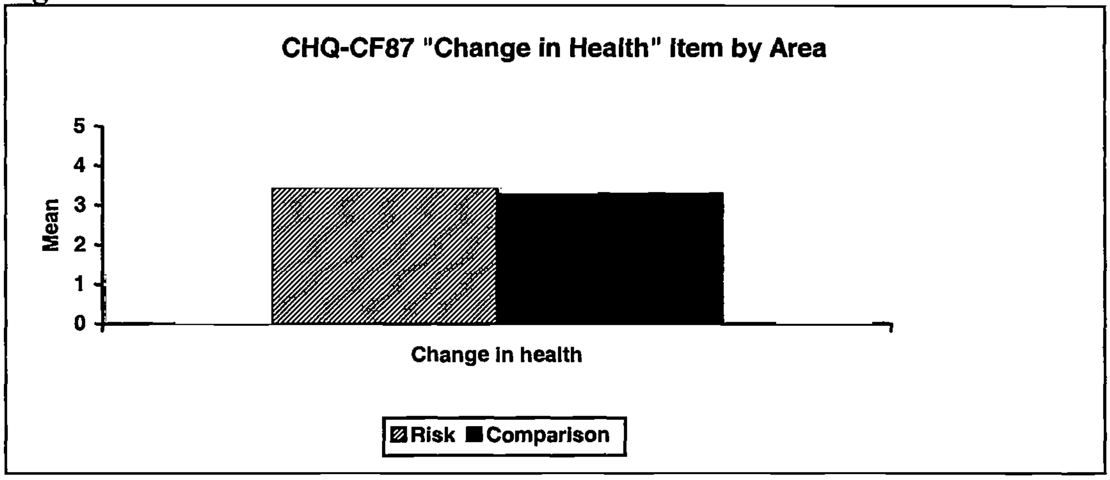

Table 4
CHQ-CF87 'Change In Health' Item (All students)

	Area	
Sub-scales	**Risk**	**Comparison**
Change In Health*	3.46 (250)	3.28 (475)

* p<0.05

A significant difference emerged between the risk and comparison area for the "change in health" item (z=-2.3412; p<0.05). Students in the risk area scored significantly higher on this variable than students in the comparison area.

Figure Four

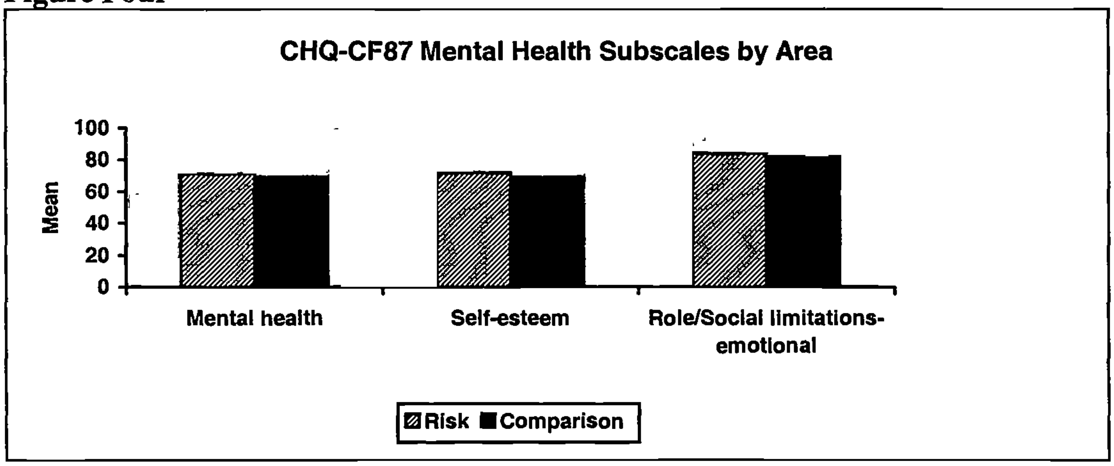

Table 5
CHQ-CF87 Mental Health Sub-Scales (All students)

	Area	
Sub-scales	**Risk**	**Comparison**
Mental Health*	71.05 (215)	70.19 (427)
Self-Esteem*	71.65 (221)	69.78 (445)
Role / Social Limitations - Emotional	83.82 (252)	83.05 (476)

*p<0.05

Significant differences emerged between the risk and comparison areas for two of the mental health subscales, mental health and self-esteem (mental health, z=-2.2715; p<0.05; self-esteem, z=-2.0170; p<0.05). Risk area students reported significantly better mental health and self-esteem than comparison area students. No statistically significant difference was found between the risk and comparison groups for the role/social limitations - emotional subscale (z=-1.8678; p>0.05).

Figure Five

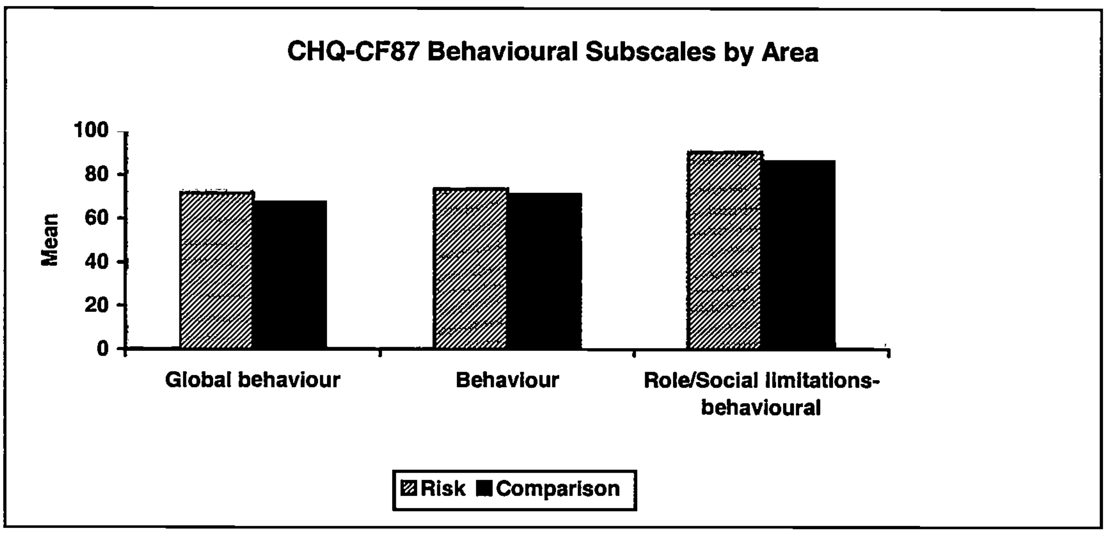

Table 6
CHQ-CF87 Behaviour Sub-Scales

	Area	
Sub-scales	**Risk**	**Comparison**
Global Behaviour*	71.57 (255)	67.48 (475)
Behaviour*	73.35 (235)	71.11 (431)
Role / Social Limitations - Behavioural*	90.22 (250)	86.46 (476)

* p<0.05

Significant differences were found between the risk and comparison areas on the three behavioural subscales (global behaviour, z=-2.4531, p<0.05; behaviour, z=-2.1825, p<0.05; role/social limitations - behavioural, z=-2.3033, p<0.05). Students in the risk area scored significantly higher than students from the comparison area on all the behavioural subscales.

Figure Six

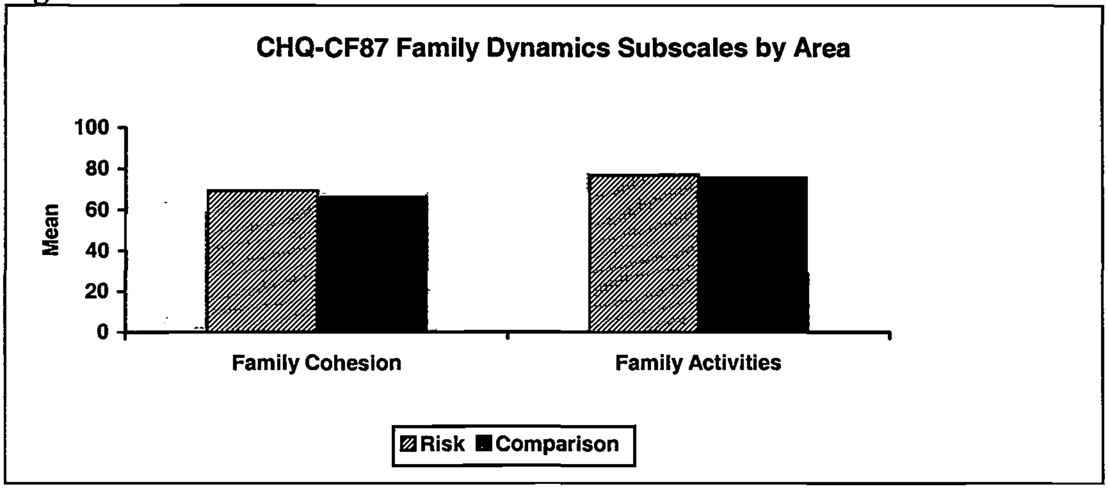

Table 7
CHQ-CF87 Family Dynamics Sub-Scales (All students)

	Area	
Sub-scales	**Risk**	**Comparison**
Family Cohesion	69.16 (244)	66.18 (467)
Family Activities	76.76 (235)	75.46 (456)

No statistically significant differences emerged between students in the risk and comparison areas on either of the subscales relating to family dynamics (family cohesion, z=-1.6705, p>0.05; family activities, z=-0.1621, p>0.05).

Re-analysis using Area 1 (Askeaton) only as the Risk Area

The results presented in Table 8 compare the high risk area of Askeaton with all of the other five areas, including Rathkeale (Area 2). In this analysis, the risk and comparison areas differed significantly on one subscale of the CHQ-CF87, the family activities subscale.

The results presented in Table 9 compare the high risk area of Askeaton with the comparison areas in Co. Clare. The designated medium risk area around Rathkeale has been excluded from the following analysis. In this analysis, no significant differences were found between the risk and comparison areas on any of the CHQ-CF87 subscales.

Table 8

	Area	
Subscales	Risk	Comparison
Bodily Pain**	69.32 (103)	71.08 (628)
Role/Social Limitations - Physical**	91.27 (98)	92.69 (617)
Physical Functioning**	92.94 (96)	93.54 (515)
Global Health**	69.71 (103)	71.55 (551)
General Health Perceptions**	62.08 (89)	63.40 (471)
Change in Health**	3.39 (101)	3.33 (624)
Mental Health**	70.02 (86)	69.83 (556)
Self-Esteem**	69.66 (85)	69.99 (581)
Role/Social Limitations - Emotional**	83.88 (102)	82.46 (626)
Global Behaviour**	68.89 (104)	68.91 (626)
Behaviour**	72.14 (95)	71.86 (571)
Role/Social Limitations - Behavioural**	90.12 (99)	87.38 (627)
Family Cohesion**	69.31 (101)	66.85 (610)
Family Activities*	72.96 (98)	76.38 (593)

*p<0.05; **NS

Table 9

	Area	
Subscales	Risk	Comparison
Bodily Pain**	69.32 (103)	70.65 (479)
Role/Social Limitations - Physical**	91.27 (98)	91.89 (471)
Physical Functioning**	92.94 (96)	93.51 (442)
Global Health**	69.71 (103)	71.56 (473)
General Health Perceptions**	62.08 (89)	62.98 (412)
Change in Health**	3.39 (101)	3.28 (475)
Mental Health**	70.02 (86)	69.25 (427)
Self-Esteem**	69.66 (85)	69.10 (445)
Role/Social Limitations - Emotional**	83.88 (102)	82.05 (476)
Global Behaviour**	68.89 (104)	67.48 (475)
Behaviour**	72.14 (95)	71.11 (431)
Role/Social Limitations - Behavioural**	90.12 (99)	86.46 (476)
Family Cohesion**	69.31 (101)	66.18 (467)
Family Activities**	72.96 (98)	75.46 (456)

*p<0.05; **NS

DISCUSSION

From the present study, it is evident that the physical health experience (as measured by physical and general health subscales of the CHQ-CF87) of teenagers living in the Askeaton/Rathkeale area is not significantly different to that of teenagers living in comparison areas in Co. Clare. Risk area students did not experience more problems doing physical activities due to health problems, they did not experience more bodily pain or discomfort, they did not have role or social limitations due to physical health problems and they perceived their general health in the same way as comparison area students.

The "change in health" item which asks respondents to rate their health now compared to one year ago did produce a significant difference between areas. Respondents in the risk area scored significantly higher on this item than respondents in the comparison area. On average, however, both risk and comparison area students rated their health as between "about the same now as one year ago" and "somewhat better than one year ago". Care must be taken when evaluating data from single global items, especially in the absence of other significant effects. Students from the risk area had significantly higher mental health, self-esteem and behaviour scores than students in the risk area. Re-analysis of the CHQ-CF87 data with the high risk area separated out produced only one significant difference between areas, namely, on the family activities subscale.

Retrospective health assessment can be problematic. In view of this fact, health status measures generally adopt recent time frames within which respondents report their health experience. For example, in the CHQ-CF87 used in the present study, the physical health questions refer to the "past four weeks". Self-reports of physical health would be unreliable beyond this time frame. While anecdotal concerns in the risk area over young people's health may have spanned the last number of years, it is not possible using s self-report measure to examine physical health for that time period.

In conclusion, at the time of this study (mid-1997) the physical health of teenagers living in the risk area of Askeaton/Rathkeale was not significantly different to the physical health of teenagers living in three comparison areas in Co. Clare.

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THE
LEVEL of ABSENTEEISM
AMONGST
SCHOOL-AGED
CHILDREN

INTRODUCTION

This study has emerged from a number of difficulties encountered in attempting the wider Askeaton Human Health Investigation. It was undertaken following consultation with and recommendations from the local residents group (Askeaton/Ballysteen Animal Health Committee) and Dr Pat Wall, Consultant Environmental Epidemiologist. The study emerged primarily as a response to the absence of child health information systems and secondly, to address the problems encountered in examining child health through questionnaire-based methodologies. Specific problems encountered here included the inappropriateness of the short form 36 (SF-36) health questionnaire for children and the difficulty in finding an adequate health questionnaire for children.
It was proposed that administering health questionnaires in schools was open to two serious limitations. The first concern was that questionnaires administered in schools might miss children absent through sickness. Such children are obviously the very subjects of most interest in such an investigation. Secondly, the misreporting of health events has been widely documented and the subsequent need to investigate only a very limited health history is a serious drawback. People notoriously misreport medical histories and therefore health questionnaires tend to ask only about recent defined time periods, for example one week, one month, or three months.[1] It was proposed that children were likely to be even more unreliable in recounting a health history, so there was little point in retrospectively examining anything except the most recent time span. The widespread belief among the local population in the Askeaton area that the pollution problem and therefore the health situation improved as the investigation developed meant that the value of investigating such a short time span was questioned.

The study is intended to be a proxy measure of the morbidity in the national school population in Askeaton. It is an imprecise measure but was intended like the majority of the other elements of the Human Health study to 'scope', to see if there was a health problem. A major issue to bear in mind with this study is the effect of confounding.[2] Air pollution may not be the only reason for absenteeism from school, other factors can also cause a child to be absent. If an excess of absenteeism is observed in Askeaton it may not alone, or even at all, be due to air pollution but due to other equally valid causes of absenteeism.

This study was also intended to complement the two General Practitioner studies conducted as part of the Askeaton investigation. Visiting a GP inevitably involves a certain degree of time investment and unless a medical card holder may well incur a cost of between £15 - £20. As well as these disincentives it was felt that the low level of illness most likely to result from pollution, as indicated in the literature, would probably result in a child having a day in bed, rather than necessitating a visit to a GP.

SCHOOL ABSENTEEISM AND POLLUTION - A REVIEW

The use of routinely collected data to try and assess the impact on health of pollution is not a new phenomenon. Fairbairn & Reid used routinely available archival data on sickness absence among civil servants and postmen to try and evaluate the negative health effects of fog pollution.[3] Their pioneering study found a significant link between pollution and sickness absence in different parts of Great Britain. A significant volume of research has linked pollution with negative health effects among both children and adults. Many of these effects would logically seem to be of a nature whereby they could impact adversely on school attendance among children. Landgraf *et al.* (pp 34) notes that '*...historically, restricted school attendance (i.e., disability days) has been the most frequently used proxy item for assessing* *role limitations in children'*.[4] However only a small number of studies have specifically examined the relationship between pollution and absenteeism.

Pönkä carried out research in Helsinki examining absenteeism and respiratory disease in relation to low-level air pollution (SO_2 & NO_2) and temperature.[5] This study examined both adults and children over a one year period. Absenteeism was examined in day care centres, schools, and workplaces. Only absences specifically due to febrile illness were included in this study. Although a number of interesting findings are reported in this study, once temperature had been standardised only one significant finding remained linking ill-health to pollution. This was the link between high SO_2 concentrations and an increase in the number of upper respiratory tract infections diagnosed at health centres. No significant relationship between school absenteeism and pollution was found once temperature had been standardised.

There have been a number of studies linking PM_{10} pollution with negative health effects. Studies have linked PM_{10} pollution to mortality[6], hospital admissions,[7,8] and reported respiratory symptoms and lung function as measured by peak expiratory flow.[9] This research was followed by a study examining PM_{10} pollution and elementary school absences in Utah Valley, USA.[10] In this study attendance records were examined in two elementary schools for the period covering the school years 1985- 1986 to 1990-1991. There was a large amount of missing data in the early years covered by this study and a continuing query over data quality. Daily records of pupil attendance were available in one school, while weekly averages were the only record in another. In addition to PM_{10} levels other factors examined included the weather, temperature, public and local holidays and days of the week. In view of the cumulative lagged effect of PM_{10} on health and subsequent absenteeism, regression models using lagged moving averages of PM_{10} over 7,14, 21 28 and 35 days were used. Ransom & Pope found a significant relationship between air pollution, as measured by PM_{10} levels, and school absenteeism. This effect, though visible in all school grade levels, was most noticeable in grades 1-3 rather than 4-6. This study is significant because the association between school absenteeism and PM_{10} levels was found in the absence of high SO_2, NO_2, O_3 levels.

Romieu *et al.*[11] examined school absenteeism to examine the effects of raised ozone levels in Mexico City. This prospective study examined school absenteeism only in the context of episodes of respiratory illness resulting in absenteeism. Although there were methodological concerns about the relatively small size of the study (involving approximately 100 children), it found a significant relationship between increased O_3 and school absenteeism. This study also reported an interactive effect between ozone and low temperature on respiratory illness.

RESEARCH AIM

To determine if school absenteeism in the risk areas is significantly different from that in the comparison areas.

METHODOLOGY

The Department of Education was contacted to determine if it held any centralised records of pupil absenteeism in a format amenable to this investigation. However, it soon emerged that they did not possess such information. Two Research Officers were therefore assigned to collect the necessary data. Maps detailing the study areas were forwarded to a local Inspector of Education who provided a list of National Schools in these areas. Fifty-two National Schools were identified in the six study areas. All fifty-two schools agreed to take part and data was collected from fifty of these.

National schools examined fell within the following areas:

Risk Areas

1. Area within Rathkeale rural district encompassing Askeaton East, Askeaton West, Iveruss, Craggs, Aughinish, Lisnakeery, Nantinan and Riddlestown.
2. The rest of Rathkeale rural district and Rathkeale Urban district.

Comparison Areas

3. Killadysert rural district, County Clare.
4. Ennistimon rural district, County Clare.
5. Area encompassing Moyne and Littleton dispensary districts.
6. Clarecastle area, consisting of the district electoral divisions of Clareabbey and Doora, as well as the southern half of Ennis Rural DED (made up of the townlands of Coor, Cahircalla More, Cahicalla Beg, Shantulla, Ballymacaulla, Keelty, Kilnacally, Ballylinnidy, Shanvogh, Clonroad More, Bunnow, Gaurus, Drumbiggil).

Participants

Data was collected on 10,723 pupils in total. 4,531 of these came from the risk areas, while 6,192 came from the comparison areas.

Data collection

The data was generally collected from the *clárleabhar*, which provides a summary of total days attended for pupils over their stay in a school. As well as attendance data, date of birth and details on gender were also collected. However, the *clárleabhar* register was incomplete in approximately one-half of schools and data was collected in part or entirely from the day to day roll-book. It proved much harder to track pupils over subsequent years using the roll-books. Other concerns over data quality also emerged. Pupils who arrived late into a school year or left early were excluded from that year's analysis. One effect of this was no doubt to exclude many members of the travelling community from this analysis. Pupils were also excluded from the relevant year's analysis if in that year they had been taken off the roll books at any point. This was necessary to exclude pupils who had been formally expelled and readmitted later. According to Department of Education guidelines pupils should be taken-off the school roll-book if they fail to attend for two consecutive weeks. However, it soon became clear that although some schools were consistent in complying with this ruling, others were not. In light of this inconsistency the top ten percent and the bottom ten percent of scores were excluded from each year's analysis. According to Department of Education guidelines schools should be open for approximately 183 days a year. However, adverse weather conditions, renovations, training days, elections as well as a number of other factors can all reduce this figure. Information on the number of days the school was open for each of the ten study years was also collected and a percentage attendance rate for each pupil for each was calculated. In light of age differences reported in the research literature on school absenteeism and pollution, results were also analysed by age group.[9] In each year those aged nine and under constituted one group, while older children formed the other group. A series of non-parametric ANOVAs were carried out on the attendance data in an effort to detect significant differences by area and age group.

RESULTS

As Figure One demonstrates attendance in the risk and comparison areas over the ten years studied showed very similar patterns. Results from both of these areas show the same peaks and troughs. However with the exception of 1986, a pattern emerges of the risk areas having generally higher attendance in the first half of the study, while after 1991 it is the comparison areas which have the highest attendance.

Figure One

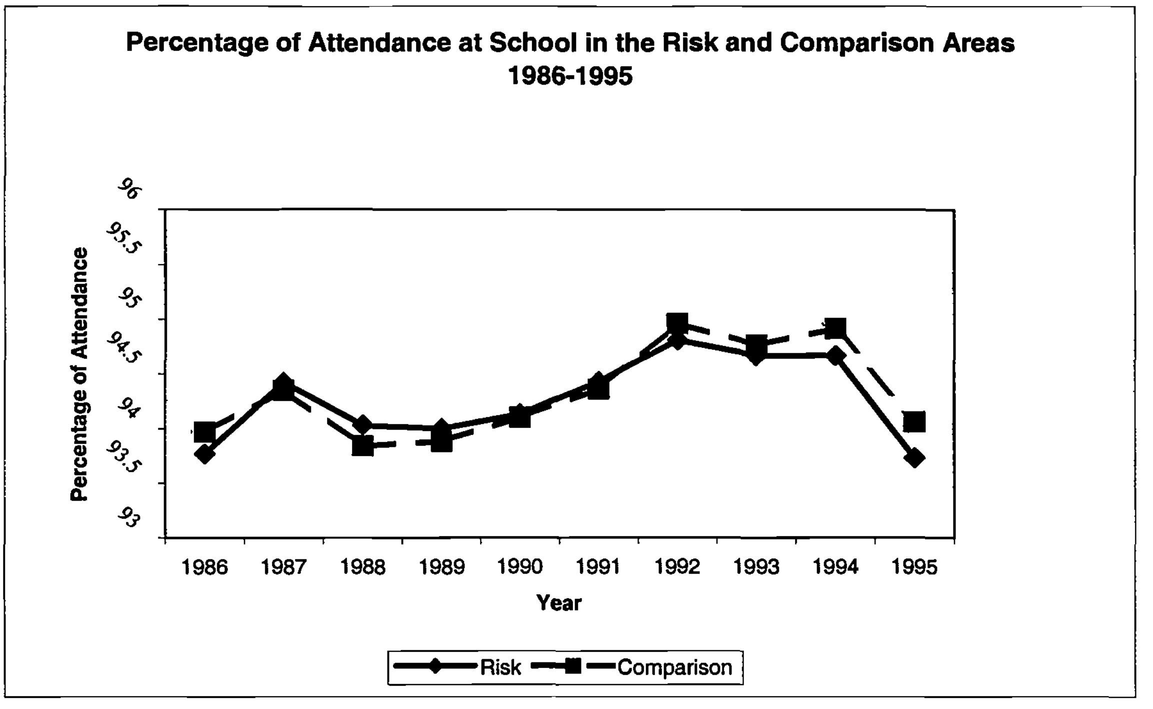
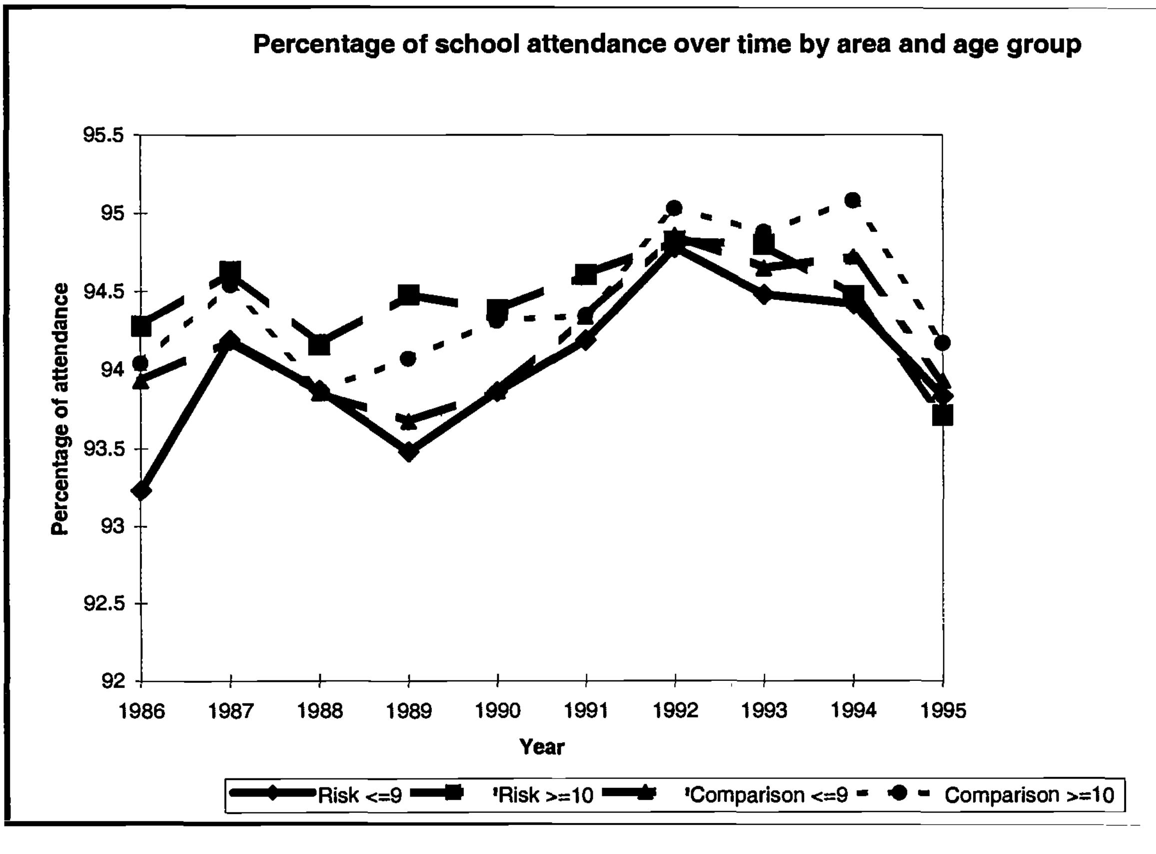


Figure Two spans this same ten-year period, but breaks the risk and comparison groups into two age groups, those aged nine and under and the rest. As one might expect with the smaller numbers involved the results when broken down by age group show more variation within each year than seen in Figure One.

Figure Two



The results displayed graphically above are now presented on a year by year basis by area and by age group.

1986

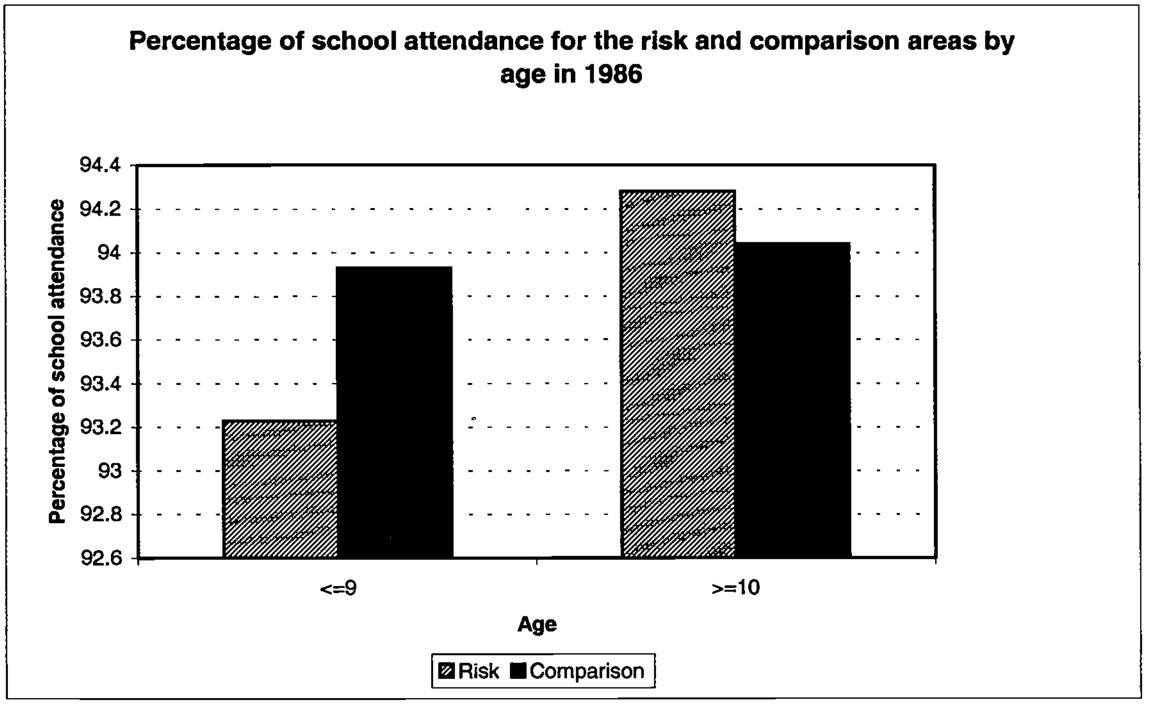
The mean attendance rate of the risk group in 1986 was 93.77%. The figure for the comparison areas was slightly higher at 93.97% (see Table 1). No significant difference were found between these two groups.

Table 1

Area	Percentage of Attendance
Risk	93.77 (n=1370)
Comparison	93.97 (n=1994)

Analysis of the same information broken down by age group is presented graphically in Figure Three.

Figure Three



When the groups were broken down by age (see Table 2), findings showed the younger age group in the risk area (X=93.23%) scored significantly lower than the same age group in the comparison area (X=93.93%), p<.001. Looking at the older age group, the mean attendance rate in the risk area was 94.28%, while in the comparison area it was 94.04%. This difference was not significant.

Table 2

AGE GROUP	Percentage of Attendance	
	Risk Area	Comparison Area
<=9	93.23 (n=668)***	93.93 (n=1003)
>=10	94.28 (n=686)	94.04 (n=950)

*** P< .001

1987

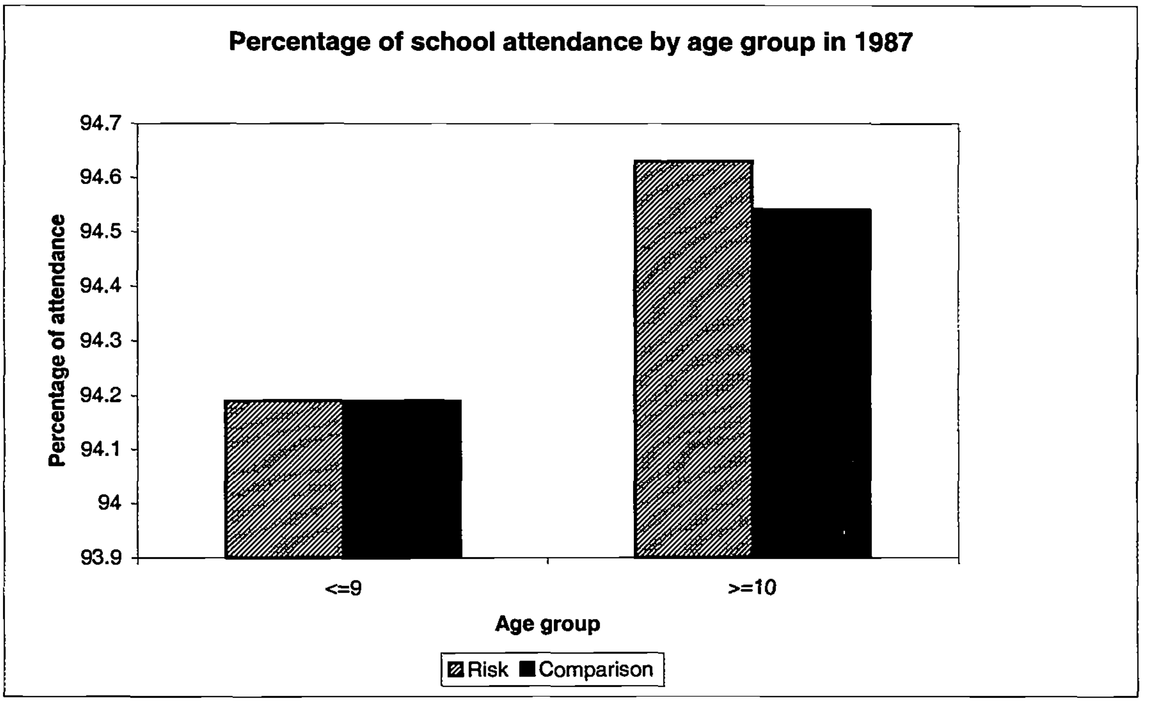
The mean attendance rate of the risk group in 1987 was 94.42%. The figure for the comparison areas was lower at 94.35% (see Table 3). No significant difference was found between these two groups.

Table 3

Area	Percentage of Attendance
Risk	94.42 (n=1334)
Comparison	94.35 (n=2079)

Analysis of the same information broken down by age group is presented graphically in Figure Four.

Figure Four



As can be seen from Table 4, the younger age group in the risk area and the comparison area both had a mean attendance rate of 94.19%. Looking at the older age group, the mean attendance rate in the risk area was 94.63%, while in the comparison area it was 94.54%. No significant differences were found between the risk and comparison groups.

Table 4

AGE GROUP	Percentage of Attendance	
	Risk Area	**Comparison Area**
<=9	94.19 (n=649)	94.19 (n=1039)
>=10	94.63 (n=672)	94.54 (n=992)

1988

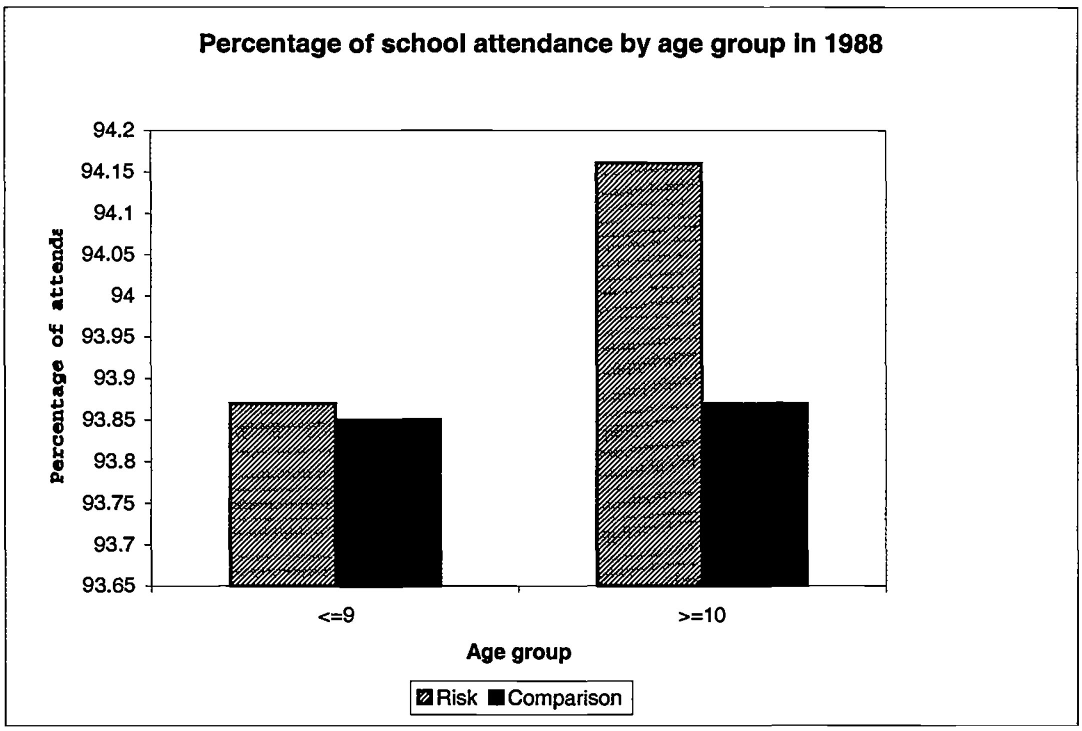
The mean attendance rate of the risk group in 1988 was 94.03%. The figure for the comparison areas was 93.84% (see Table 5). No significant difference was found between these two groups.

Table 5

Area	Percentage of Attendance
Risk	94.03 (n=1365)
Comparison	93.84 (n=1979)

Analysis of the same information broken down by age group is presented graphically in Figure Five.

Figure Five



As can be seen from Table 6, the younger age group in the risk area had a mean attendance rate of 93.87%. The same figure for the comparison area was similar at 93.85%. Looking at the older age group, the mean attendance rate in the risk area was 94.16%, while in the comparison area it was lower at 93.87%. No significant differences were found between the risk and comparison groups.

Table 6

AGE GROUP	Percentage of Attendance	
	Risk Area	**Comparison Area**
<=9	93.87 (n=664)	93.85 (n=997)
>=10	94.16 (n=690)	93.87 (n=927)

1989

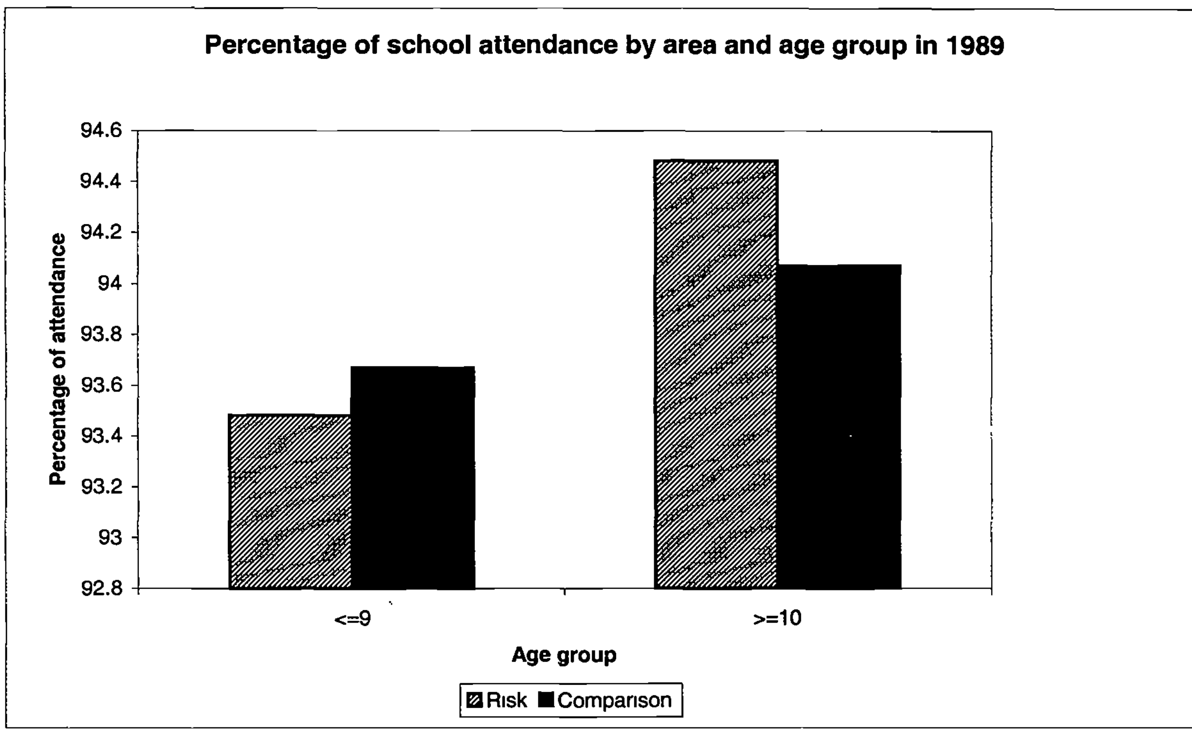
The mean attendance rate of the risk group in 1989 was 94.0%. The figure for the comparison areas was 93.88% (see Table 7). No significant difference was found between these two groups.

Table 7

Area	Percentage of Attendance
Risk	94.00 (n=1421)
Comparison	93.88 (n=1840)

Analysis of the same information broken down by age group is presented graphically in Figure Six.

Figure Six



When the groups were broken down by age (see Table 8), findings showed the older age group in the risk area (X=94.48%) scored significantly higher than the same age group in the comparison area (X=94.07%), p<.05. Looking at the younger age group the mean attendance rate in the risk area was 93.48%, while in the comparison area it was 93.67%. This difference was not significant.

Table 8

AGE GROUP	Percentage of Attendance	
	Risk Area	Comparison Area
<=9	93.48 (n=669)	93.67 (n=874)
>=10	94.48 (n=741)*	94.07 (n=909)

* P<.05

1990

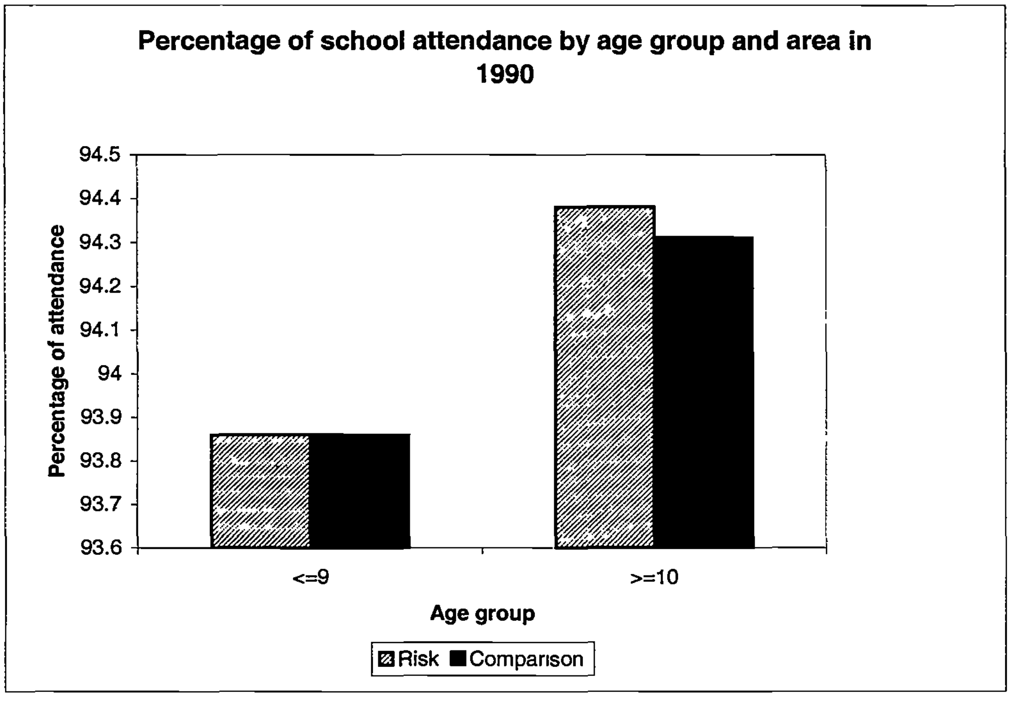
The mean attendance rate of the risk group in 1990 was 94.13%. The figure for the comparison areas was 94.10% (see Table 9). No significant difference was found between these two groups.

Table 9

Area	Percentage of Attendance
Risk	94.13 (n=1474)
Comparison	94.10 (n=1731)

Analysis of the same information broken down by age group is presented graphically in Figure Seven.

Figure Seven



As can be seen from Table 10, the younger age group in the risk area and the comparison area had a mean attendance rate of 93.86%. Looking at the older age group, the mean attendance rate in the risk area was 94.38%, while in the comparison area it was slightly lower at 94.31%. No significant differences were found between the risk and control groups.

Table 10

AGE GROUP	Percentage of Attendance	
	Risk Area	Comparison Area
<=9	93.86 (n=673)	93.86 (n=825)
>=10	94.38 (n=790)	94.31 (n=862)

1991

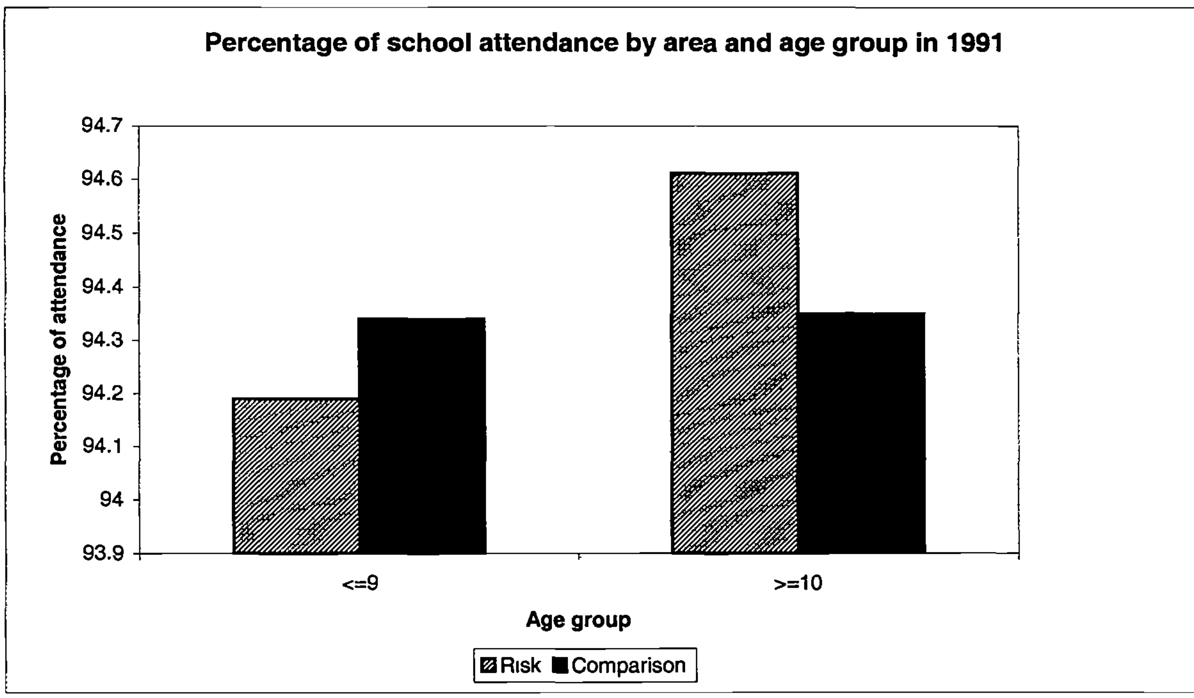
The mean attendance rate of the risk group in 1991 was 94.43%. The figure for the comparison areas was 94.36% (see Table 11). No significant difference was found between these two groups.

Table 11

Area	Percentage of Attendance
Risk	94.43(n=1412)
Comparison	94.36 (n=1692)

Analysis of the same information broken down by age group is presented graphically in Figure Eight.

Figure Eight



As can be seen from Table 12, the younger age group in the risk area had a mean attendance rate of 94.19%. The same figure for the comparison area was higher at 94.34%. Looking at the older age group, the mean attendance rate in the risk area was 94.61%, while in the comparison area it was 94.35%. No significant differences were found between the risk and control groups.

Table 12

AGE GROUP	Percentage of Attendance	
	Risk Area	**Comparison Area**
<=9	94.19 (n=619)	94.34 (n=755)
>=10	94.61 (n=780)	94.35 (n=898)

1992

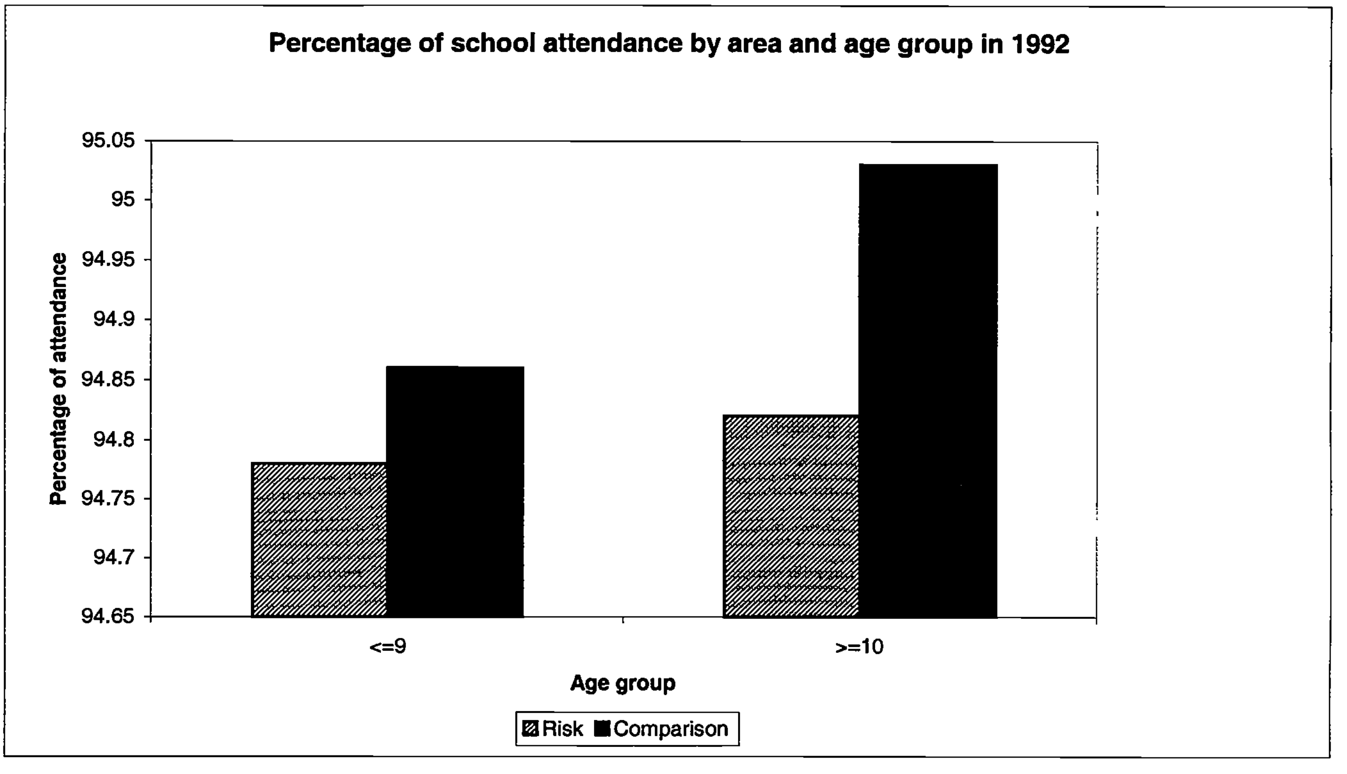
The mean attendance rate of the risk group in 1992 was 94.81%. The figure for the comparison areas was 94.96% (see Table 13). No significant difference was found between these two groups.

Table 13

Area	Percentage of Attendance
Risk	94.81 (n=1378)
Comparison	94.96 (n=1700)

Analysis of the same information broken down by age group is presented graphically in Figure Nine.

Figure Nine



As can be seen from Table 14, the younger age group in the risk area had a mean attendance rate of 94.78%. The same figure for the comparison area was similar at 94.86%. Looking at the older age group, the mean attendance rate in the risk area was 94.82%, while in the comparison area it was higher at 95.03%. No significant differences were found between the risk and control groups.

Table 14

AGE GROUP	Percentage of Attendance	
	Risk Area	Comparison Area
<=9	94.78 (n=556)	94.86 (n=690)
>=10	94.82 (n=809)	95.03 (n=959)

1993

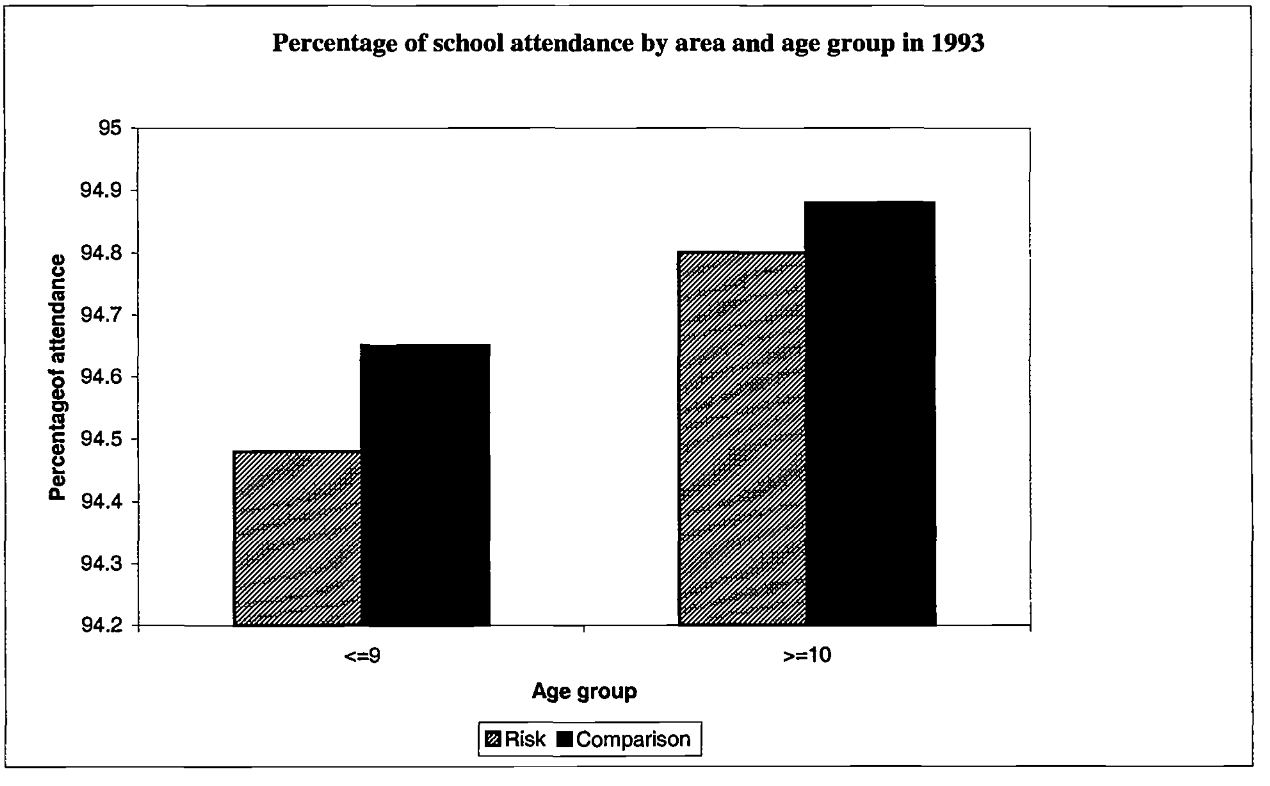
The mean attendance rate of the risk group in 1993 was 94.67%. The figure for the comparison areas was 94.77% (see Table 15). No significant difference was found between these two groups.

Table 15

Area	Percentage of Attendance
Risk	94.67 (n=1318)
Comparison	94.77 (n=1716)

Analysis of the same information broken down by age group is presented graphically in Figure Ten.

Figure Ten



As can be seen from Table 16, the younger age group in the risk area had a mean attendance rate of 94.48%. The same figure for the comparison area was higher at 94.65%. Looking at the older age group, the mean attendance rate in the risk area was 94.80%, while in the comparison area it was 94.88%. No significant differences were found between the risk and control groups.

Table 16

AGE GROUP	Percentage of Attendance	
	Risk Area	Comparison Area
<=9	94.48 (n=513)	94.65 (n=706)
>=10	94.80 (n=791)	94.88 (n=976)

1994

There was a significant difference between the risk (X= 94.67%) and comparison (X= 94.92%) areas attendance figures for 1994, p<.001 (see Table 17).

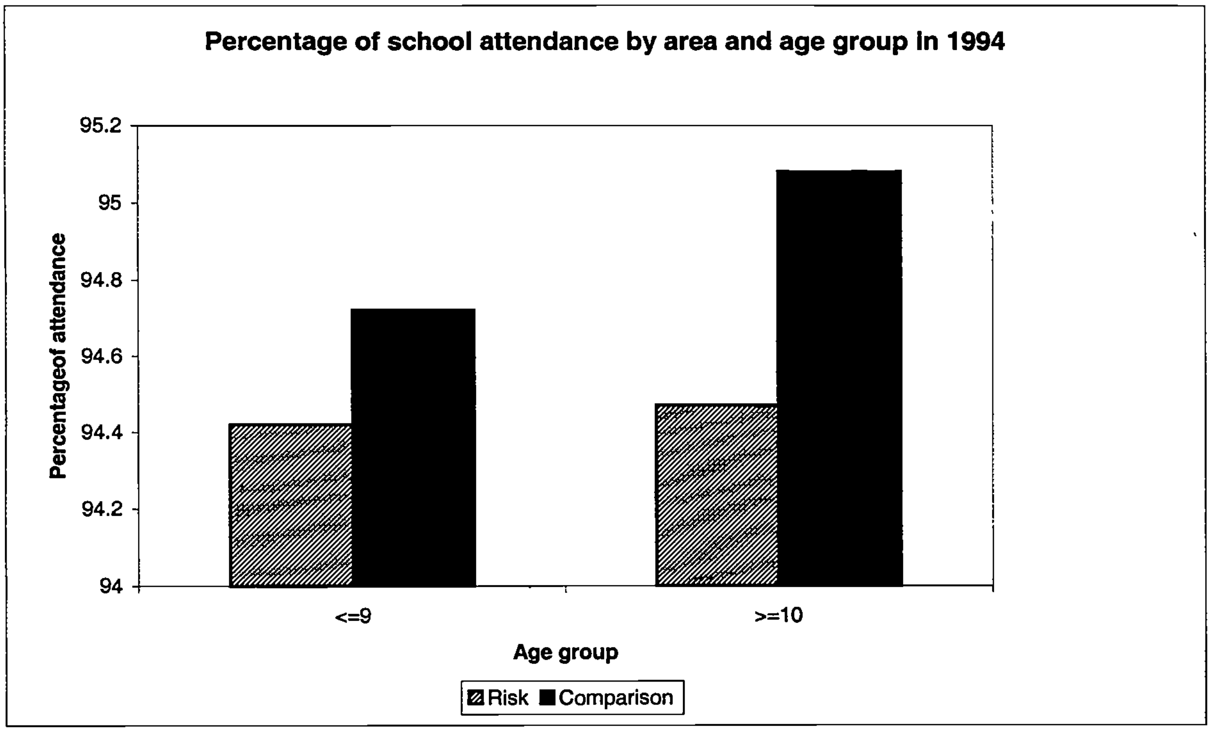
Table 17

Area	Percentage of Attendance
Risk	94.67 (n=1170)***
Comparison	94.92 (n=1668)

*** P< .001

Analysis of the same information broken down by age group is presented graphically in Figure Eleven.

Figure Eleven



When the groups were broken down by age (see Table 18), findings showed the older age group in the risk area (X=94.47%) scored significantly lower than the same age group in the comparison area (X=95.08%), p<.001. Looking at the younger age group, the mean attendance rate in the risk area was 94.42%, while in the comparison area it was 94.72%. This difference was not significant.

Table 18

AGE GROUP	Percentage of Attendance	
	Risk Area	**Comparison Area**
<=9	94.42 (n=439)	94.72 (n=679)
>=10	94.47 (n=704)***	95.08 (n=931)

*** P< .001

1995

There was a significant difference between the risk (X= 93.73%) and comparison (X= 94.06%) areas attendance figures for 1995, $p<.05$ (see Table 19).

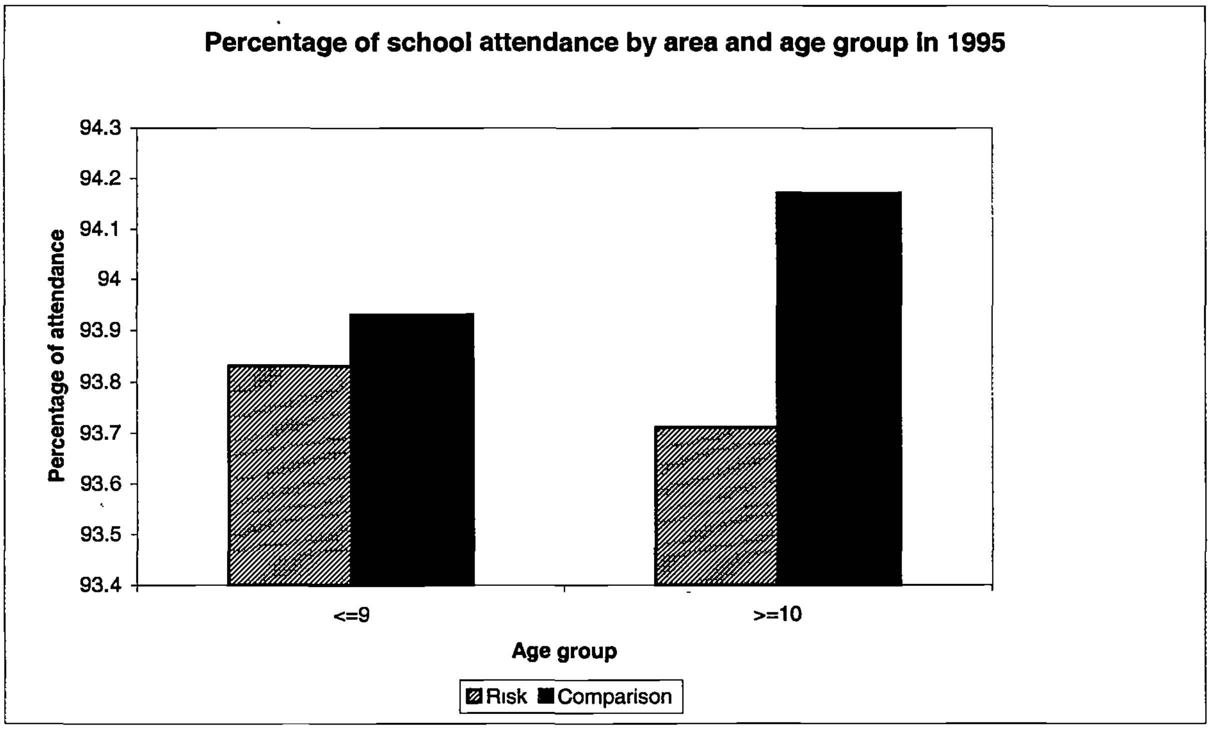
Table 19

Area	Percentage of Attendance
Risk	93.73 (n=1168)*
Comparison	94.06 (n=1512)

* P< .05

Analysis of the same information broken down by age group is presented graphically in Figure Twelve.

Figure Twelve



When the groups were broken down by age (see Table 20), findings showed the older age group in the risk area (X=93.71%) scored significantly lower than the same age group in the comparison area (X=94.17%), $p<.01$. Looking at the younger age group, the mean attendance rate in the risk area was 93.83%, while in the comparison area it was 93.93%. This difference was not significant.

Table 20

AGE GROUP	Percentage of Attendance	
	Risk Area	**Comparison Area**
<=9	93.83 (n=420)	93.93 (n=640)
>=10	93.71 (n=713)**	94.17 (n=830)

P< .01

Re-analysis using Area 1 (Askeaton) only as the Risk Area

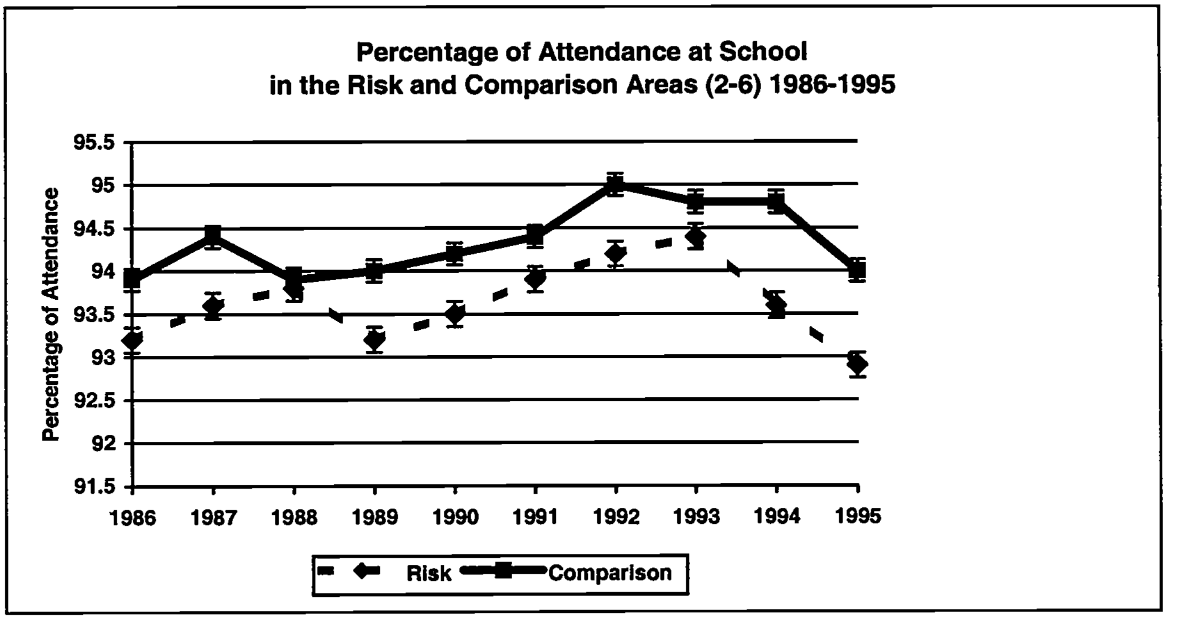
The results presented in Table One compare the high-risk area of Askeaton with all of the other five areas, including Rathkeale (Area 2). The high-risk area (Area 1) had lower attendance in each of the ten years examined. In nine of the ten years examined this difference was statistically significant. The year in which no statistical difference was found was 1988.

Table 21

Year ending (June of ...)	Risk Area- Percentage attendance	Comparison Areas (2-6) Percentage attendance	Significance level
1986	93.20% (n=229)	93.94% (n=3135)	**
1987	93.57% (n=251)	94.44% (n=3162)	***
1988	93.80% (n=274)	93.93% (n=3070)	NS
1989	93.23% (n=280)	94.00% (n=2981)	**
1990	93.53% (n=277)	94.17% (n=2928)	***
1991	93.90% (n=280)	94.44% (n=2824)	**
1992	94.15% (n=274)	94.97% (n=2804)	***
1993	94.42% (n=271)	94.76% (n=2763)	*
1994	93.64% (n=235)	94.83% (n=2603)	***
1995	92.88% (n=243)	94.02% (n=2437)	***

* $p<.05$; ** $p<.01$; *** $p<.001$; NS = not significant

Figure Thirteen



The results presented in Table Two compare the high-risk area of Askeaton with the comparison areas in Co. Clare and Tipperary N.R. (areas 3-6). The designated medium risk area around Rathkeale has been excluded from the following analysis. As can be seen from Table two the results are very similar to those presented in Table one. The high-risk area (area 1) had lower attendance in each of the ten years examined. In nine of the ten years examined this difference was statistically significant. The year in which no statistical difference was found was 1988.

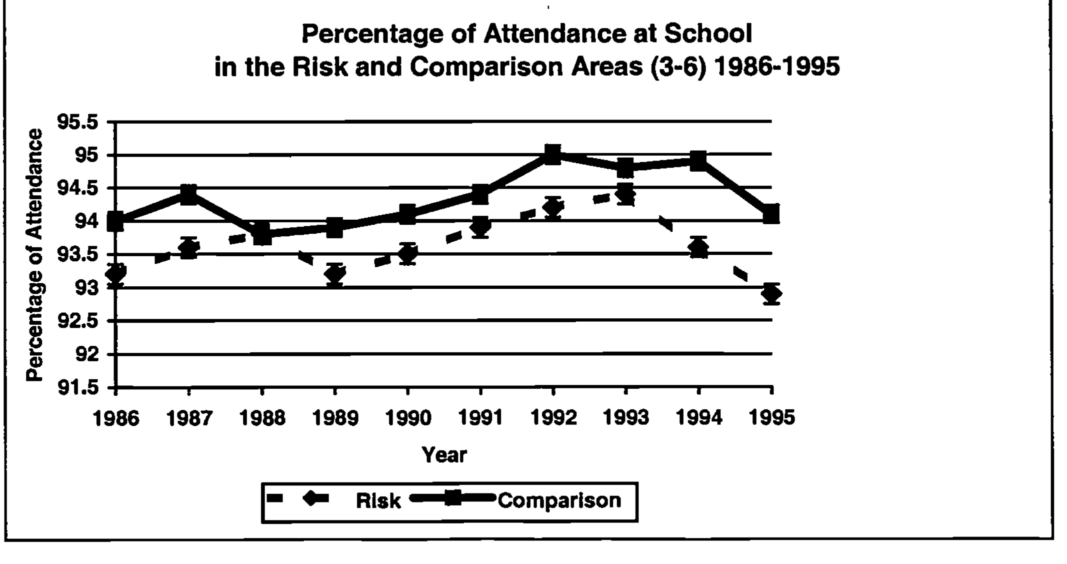
Table 22

Year ending (June of ...)	Risk Area- Percentage attendance	Comparison Areas (3-6) Percentage attendance	Significance level
1986	93.20% (n=229)	93.97% (n=1994)	***
1987	93.57% (n=251)	94.35% (n=2079)	***
1988	93.80% (n=274)	93.84% (n=1979)	NS
1989	93.23% (n=280)	93.88% (n=1840)	*
1990	93.53% (n=277)	94.10% (n=1731)	**
1991	93.90% (n=280)	94.36% (n=1692)	**
1992	94.15% (n=274)	94.96% (n=1700)	***
1993	94.42% (n=271)	94.77% (n=1716)	*
1994	93.64% (n=235)	94.92% (n=1668)	***
1995	92.88% (n=243)	94.06% (n=1512)	***

* p<.05; ** p< .01; *** p< .001; NS = not significant

(In view of the skewed nature of the results and the differing sample sizes involved, non-parametric statistical tests (the Mann-Whitney U) were used.)

Figure Fourteen



DISCUSSION

Children from the Askeaton area had significantly higher rates of absenteeism in nine of the ten years examined (1986-1995) than children from the comparison areas. The difference in rates was not statistically significant for 1988.

It is important to put the present study's findings in context. The statistically significant differences in school absenteeism reported above equate to a difference, on average, of between 0.5 days and 1.25 days a year. To help put this difference in context, McCowan *et al.* report that asthma sufferers have on average three more days absent from school per year than non-sufferers.[12]

It should be noted that this retrospective study has limitations and care should be taken when evaluating the results. School absenteeism is only a proxy measure of ill health. The studies reviewed earlier tended to include only sickness-related absenteeism, or were more particular again, focusing on only respiratory-related absenteeism. This study had no such detailed information, only a crude absenteeism score. Additionally, the study does not include information on the social class of the children involved. This factor has been shown to influence school attendance.

Perhaps the greatest limitation of this study is an absence of pollution exposure information. Only a small number of studies have examined school absenteeism in relation to pollution. Whatever the methodological drawbacks of these studies, they at least have some form of pollution data with which to link their results.

It would also have been preferable to examine patterns of infectious diseases in the risk and comparison areas to try and investigate further the differences found. However the infectious disease notification system is known to be at best unreliable and therefore of no use in this study.

In conclusion, statistically significant differences in absenteeism rates were found between risk and comparison area pupils. These differences may not be clinically significant. The absenteeism rates cited are only a proxy measure of ill health and it is not possible to state that they are respiratory-related absences, or even sickness-related absences. Finally, there is no way of linking absenteeism in the present study to pollution indices. This study was exploratory in nature and no causal implications can be drawn from the results.

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HORTICULTURAL PRODUCE

Introduction

The Environmental Health Department of the Mid-Western Health Board undertook a sampling programme for horticultural products from the Ballysteen area. The programme was instigated on foot of fears expressed by some market gardens in the area that their livelihoods would be adversely affected by a public perception of a health problem in the area (Ballysteen) in which their vegetables were sourced. As this concerned a public health matter, it was considered appropriate that the Mid-Western Health Board address it.

Objective of Survey

The objective of the survey was to establish whether vegetables grown in the Ballysteen area showed evidence of being contaminated or unfit for human consumption and to this end establish:

(a) Whether certain elements were present in the vegetables.

(b) Whether these elements, if present, were present in levels which might be considered above normal.

Scope of Survey

Following consultation with the Public Analysts Laboratory, University College Hospital, Galway, it was decided that over the sampling period samples would be analyzed for Aluminium, Fluoride, Lead, Cadmium and depending on results of analysis and trends indicated perhaps extended to include other parameters.

Methodology

A total of 40 samples were submitted for analysis to the Public Analysts Laboratory. This figure included samples of vegetables produced in the Ballysteen area as well as control samples from outside the area. The vegetables sampled were predominantly loose-leaf vegetables such as cabbage and spring greens with a very limited number of cauliflower, turnips, leak and potatoes also included. The sampling programme extended from March to December 1996, with the majority of the samples being submitted on a fortnightly basis between March and May of that year. Samples were transported to the Public Analysts Laboratory on the day on which they were procured. Samples were identified by reference number only.

Limitations

Certain problems were encountered with the programme. Because of the time of year during which the survey took place the variety of loose-leaf vegetables available for sampling was limited. In addition one of the growers who had initially appeared to be quite enthusiastic and co-operative did not in fact take part in the programme.

Results of Analysis

Lead (Pb)

A total of eighteen samples were analysed for lead content. Results of analysis are shown in Table 1.

Statutory admissible levels for lead in food are set out in the Health (Arsenic and Lead in Food) Regulations 1972 (S.I. No. 44 of 1972). These Regulations prohibit the sale of food which contains lead in a proportion exceeding two parts per million. All samples submitted were found to be well within acceptable range.

Table 1 – Lead in Vegetables

Food	No.of Samples	Levels mg/kg
Cabbage	**6**	**< 0.5**
Spring Greens/Cabbage	**5**	**< 0.5**
Cauliflower	**3**	**< 0.5**
Potatoes	**1**	**< 0.5**
Turnips	**2**	**< 0.5**
Leeks	**1**	**< 0.5**

Detection Limit 0.5mg/kg

Cadmium (Cd)
Of the eighteen samples analysed for Cadmium, twelve contained levels of Cadmium below that which can be detected in the laboratory (<0.05mg/kg). Results of analysis on remaining six samples are set out in Table 2.

Table 2 – Cadmium in Vegetables

Food	No. of Samples Taken	Samples with Detectable Levels	Levels mg/kg
Cabbage	6	2	0.14
Spring Green/Cabbage	5	2	0.06-0.08
Cauliflower	3	1	0.06
Potatoes	1	1	0.19
Turnip	2	0	-
Leeks	1	0	-

Detection Limit 0.05mg/Kg

The highest reading for vegetables sourced in the Ballysteen area was 0.08mg/kg. There is no national legislation in respect of admissible levels of Cadmium in food in this country. Daily intakes of Cadmium in food in Europe, New Zealand and the U.S.A. are usually about 10-25μg. Estimating average green vegetable consumption to be 0.043kg/person per day (M.A.F.F. Report on Aluminum in Food 1993) intake of Cadmium from this source based on highest Cadmium reading would amount to 3μg/day.

Aluminium (Al)
Since aluminum is the third most abundant element in the earth's crust, as expected aluminum levels in samples submitted were higher than other monitored elements. A total of twenty-two samples were analysed for aluminum. Aluminum levels of less than 10mg/kg were detected in sixteen (89%) of the samples analysed. The remaining two samples had Aluminium levels of 11.6mg/kg and 14.7mg/kg respectively. Detailed results of analysis are shown in table 3 and table 4, and in graph form in Appendix 2. A total of twenty-two samples were analysed for Aluminium. In analysing four samples submitted on 04.12.96 particular care was taken to exclude "soil" Aluminium. Quantifiable levels of Aluminium were not found in any of these samples. In the case of the remaining eighteen samples Aluminium levels of less than

10mg/kg were detected in16 (89%). The remaining two samples had Aluminium levels of 11.6mg/kg and 14.7mg/kg respectively. Detailed results of analysis are shown in Table 3 and Table4.

Table 3 – Aluminium in Vegetables

Food	No. of Samples Taken	Mean mg/kg	Range mg/kg
Cabbage	6	8.24	< 5.00 – 14.70
Spring Green/Cabbage	5	5.00	< 4.00-8.54
Cauliflower	3	< 4.66	< 4.00-<5.00
Potatoes	1	< 5.00	-
Turnip	2	< 5.00	< 5.00
Leeks	1	6.4	-

*Means were calculated by assuming that values less than the limit of detection were equal to the limit of detection.

Table 4 – Vegetables from which "soil" Aluminium has been removed.

Food	No. of Samples	Levels mg/kg
Cabbage	4	< 1.0

The average aluminum content of vegetables sourced in the Ballysteen area from which "soil" Aluminium had not been excluded was 6.20mg/kg, while the average aluminum content of control samples was 5.97mg/kg. Allowing an average aluminum dietary intake of 3.9mg/day (M.A.F.F. Report on Aluminium in Food 1993) consumption of vegetables from the Ballysteen area would represent 6.8% of the daily dietary intake of aluminum in the U.K. The median of Aluminium values for Ballysteen grown vegetables was 5.0mg/kg. This figure would represent 5.5% of the average daily intake. Studies have demonstrated that in normal healthy adults subjected to moderate doses of Aluminium absorption is low and the metal is not retained in significant amounts.

Chromium (Cr)

Thirteen samples were analysed for Chromium, and all thirteen were shown on analysis to contain < 0.25mg/kg. Table 4 details the foods sampled.

Table 4 – Chromium in Food

Food	No. of Samples	Levels mg/kg
Spring Greens	11	< 0.25
Cabbage	2	< 0.25

Detection Limit 0.25mg/kg.

Vanadium (V)

Five of the samples submitted were analysed for Vanadium. The method of analysis used in the laboratory will not detect levels of vanadium below 1.0mg/kg. All samples analysed were found to contain non-detectable levels. Table 5 details the food sampled.

Table 5 – Vanadium in Food

Food	No. of Samples	Levels mg/kg
Spring Greens	3	< 1.0
Cabbage	2	< 1.0

Detection Limit 1.0mg/kg.

Arsenic (As)
Five of the samples submitted were analysed for Arsenic and all were found to have levels of less than 1mg/kg. Table 6 hereunder details the nature of the foods sampled.

Table 6 – Arsenic in Food

Food	No. of Samples	Levels mg/kg
Spring Greens	3	< 1.0
Cabbage	2	< 1.0

Detection Limit 1.0mg/kg.

The Health (Arsenic and Lead in Food) Regulations, 1972 (S.I. No. 44 of 1972) prohibits the sale of any food which contains arsenic in a proportion exceeding one part per million. None of samples analyzed were found to have arsenic in excess of the permitted amount.

Fluoride (F)
Five samples were analyzed for Fluoride, and all were found to contain levels less then 1mg/kg. Table 7 below details the nature of the foods sampled.

Table 7 – Fluoride in Food

Food	No. of Samples	Levels mg/kg
Cabbage	2	< 1.0
Lettuce	2	< 1.0
Carrots (with foliage)	1	< 1.0

Detection Limit 1.0 mg/kg

Comparison with Control Samples
Out of a total of forty samples submitted seventeen were control samples. In the case of Lead, Chromium, Vanadium, Arsenic and Fluoride no difference was detected in levels between control samples and samples from the Ballysteen area. A very slight difference in Aluminum and Cadmium levels were noted between the vegetables from the two locations, as shown in table 8 below.

Table 8 – Aluminum/Cadium Comparisons

Source	Aluminum Mean mg/kg	Cadmium Mean mg/kg
Ballysteen	6.2	.056
Control Samples	5.9	.090

* Means were calculated by assuming that values less than the limit of detection were equal to the limit of detection.

Conclusion

The survey shows no significant difference between the vegetables grown in the Ballysteen area and those grown outside. The survey shows no indication that any of the elements measured in the Ballysteen sourced vegetables are present in such levels as might be considered above normal when compared with levels measured in the control samples.

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WHO 1984 – Environmental Health Criteria 36 – Fluorine and Fluorides.

QUESTIONNAIRE FOR HUMAN HEALTH STATUS STUDY

Mid-Western Health Board Health Status Survey

CONFIDENTIAL

INSTRUCTIONS FOR INTERVIEWER GIVEN IN (ITALICS)

RECORD ONE

Ø1 1-2

6

Survey No. ____________________ 12

Respondent Name: ____________________

Respondent Sex: __________ 13

Age : __________ 15

Area: __________ 16

Interviewer No: ______ 18

District Electoral Division (DED): __________ 21

Date: ____________________ 27

END OF
RECORD ONE

Section 1

TO BE ADMINISTERED TO ALL RESPONDENTS AGED 15 AND OVER

SF-36 HEALTH SURVEY

The first part of the Questionnaire asks for your views about your health. This information will help us understand how you feel and how well you are able to do your usual activities. The following questions are about your health now and your current daily activities. Please try to answer very question as accurately as you can.

RECORD TWO

Ø 2 1-2

6

1. In general, would you say your health is:

(Read out categories and circle one)

Excellent.	1
Very Good.	2
Good.	3
Fair.	4
Poor.	5

7

2. <u>Compared to one year ago,</u> how would you rate your health in general. Read out answers that best suits your situation.

(Give Card Question 2 and circle one).

Much better than one year ago.	1
Somewhat better now than one year ago.	2
About the same as one year ago.	3
Somewhat worse now than one year ago.	4
Much worse now than one year ago.	5

8

3. The following questions are about activities you might do during a typical day. Does <u>your health limit you</u> in these activities?. If so, how much?

(Read out activities and give Card Question 3

Circle 1 ,2 ,3 on each line).

<u>ACTIVITIES</u> **Does your health limit you in :**	Yes, Limited A Lot	Yes, Limited A Little	No, Not Limited At All	
a. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports.	1	2	3	☐ 9
b. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf.	1	2	3	☐ 10
c. Lifting or carrying groceries.	1	2	3	☐ 11
d. Climbing several flights of stairs.	1	2	3	☐ 12
e. Climbing one flight of stairs.	1	2	3	☐ 13
f. Bending, kneeling, or stooping.	1	2	3	☐ 14
g. Walking more than a mile.	1	2	3	☐ 15
h. Walking half a mile.	1	2	3	☐ 16
i. Walking one hundred yards.	1	2	3	☐ 17
j. Bathing or dressing yourself.	1	2	3	☐ 18

4. **During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?**

(Circle one number on each line)

	YES	NO	
a. Cut down on the amount of time you spent on work or other activities.	1	2	☐ 19
b. Accomplished less than you would like.	1	2	☐ 20
c. Were limited in the kind of work or other activities.	1	2	☐ 21
d. Had difficulty performing the work or other activities (for example, it took extra effort).	1	2	☐ 22

5. **During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems such as feeling depressed or anxious?.**

(Circle one)

	Yes	No	
a. Cut down on the amount of time you spent on work or other activities.	1	2	☐ 23
b. Accomplished less than you would like.	1	2	☐ 24
c. Didn't do work or other activities as carefully as usual.	1	2	☐ 25

6. **During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours, or groups?.**

(Give Card Question 6 and circle one)

Not at all.	1	
Slightly.	2	☐ 26
Moderately.	3	
Quite a bit.	4	
Extremely.	5	

How much bodily pain have you had during the past 4 weeks?.
(Give Card Question 7 and Circle One)

None.	1		
Very mild.	2		
Mild.	3	☐	27
Moderate.	4		
Severe.	5		
Very severe.	6		

During the past 4 weeks, how much did pain interfere with your normal work including both work outside the home and housework? Has it interfered:-

(Give Card Question 8 and circle one)

Not at all.	1		
A little bit.	2		
Moderately.	3	☐	28
Quite a Bit.	4		
Extremely.	5		

These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling.
(Give Card Question 9 and read out the questions from "a to i" - Circle one number on each line).

How much of the time during the past 4 weeks -	All of the Time	Most of the Time	A Good Bit of the Time	Some of the Time	A Little of the Time	None of the Time		
a. Did you feel full of life?	1	2	3	4	5	6	☐	29
b. Have you been a very nervous person?	1	2	3	4	5	6	☐	30
c. Have you felt so down in the dumps that nothing could cheer you up?	1	2	3	4	5	6	☐	31
d. Have you felt calm and peaceful?	1	2	3	4	5	6	☐	32
e. Did you have a lot of energy?	1	2	3	4	5	6	☐	33
f. Have you felt downhearted and low?	1	2	3	4	5	6	☐	34
g. Did you feel worn out?	1	2	3	4	5	6	☐	35
h. Have you been a happy person?	1	2	3	4	5	6	☐	36
i. Do you feel tired?	1	2	3	4	5	6	☐	37

10. During the <u>past 4 weeks,</u> how much of the time has your <u>physical health or emotional problems</u> interfered with your social activities (like visiting with friends, relatives, etc.)?

(Give Card Question 10 and Circle one).

All of the time.	1	
Most of the time.	2	
Some of the time.	3	☐ 38
A little of the time.	4	
None of the time.	5	

11.How TRUE or FALSE is <u>each</u> of the following statements for you?.

(Give Card Question 11 with categories - Read out the statements and circle one number on each line).

	Definitely True	Mostly True	Not Sure	Mostly False	Definitely False	
a. I seem to get ill more easily than other people.	1	2	3	4	5	☐ 39
b. I am as healthy as anybody I know	1	2	3	4	5	☐ 40
c. I expect my health to get worse.	1	2	3	4	5	☐ 41
d. My health is excellent.	1	2	3	4	5	☐ 42

END OF RECORD TWO

RECORD THREE

Ø3 1-2

6

Section 2
TO BE ADMINISTERED TO ALL RESPONDENTS

RESPIRATORY

These questions are to do with your chest.

(Circle 1 for Yes - 2 for No)

	Yes	No	
12.Have you ever had wheezing or whistling in the chest at any time in the past? **IF "NO" PLEASE SKIP TO QUESTION 14**	1	2	7
13.Have you had wheezing or whistling in your chest at any time in the last 12 months?	1	2	8
IF "NO" PLEASE GO STRAIGHT TO QUESTION 14			
a. Have you been at all breathless when the wheezing noise was present?	1	2	9
b. Have you had this wheezing or whistling when you did not have a cold?	1	2	10
c. Has your chest sounded wheezy during or after exercise?	1	2	11
d. Have you had a dry cough at night, apart from a cough associated with a cold or chest infection?	1	2	12
14.Have you woken up with a feeling of tightness in your chest at any time in the last 12 months?	1	2	13
15.Have you been woken by an attack of shortness of breath at any time in the last 12 months?	1	2	14
16.Have you been woken by an attack of coughing at any time in the last 12 months?	1	2	15
17.Have you ever had asthma?	1	2	16
18. Has any doctor prescribed any inhalers or aerosols for asthma or a wheeze?	1	2	17
19.In the past 12 months has any doctor prescribed any other medication for asthma or a wheeze?	1	2	18
20. Do you suffer from hay fever?	1	2	19

END OF RECORD THREE

Ø 6 1-2

6

SECTION 5

TO BE ADMINISTERED ONLY TO WOMEN AGED BETWEEN 15 - 44

39.While you have been living here, have you consistently tried to get pregnant for period of at least 1 year and failed to do so during that time?

Yes	No
1	2

7

40. Have you ever been pregnant?

Yes	No
1	2

8

If NO please skip to question 42.

If Yes, fill in table on following page.

41. *Record all pregnancies and start with the first and continue to present with details of pregnancy outcome whether living here or not at the time. Interviewer to obtain details and fill in form below. For Multiple births allocate same pregnancy number. Congenital Anomalies refers to Structural defects including congenital malformation, inborn errors of metabolism and hereditary diseases.*

Preg. No.	Residence here during pregnancy 1= Yes 2= No	Outcome Codes 1 = live birth 2 = stillbirth 3 = miscarriage 4 = other 8 = don't know 9 = refuse	Day/Mth/Year End of Pregnancy	Sex 1 = M 2 = F	Gestation	Defect 1= Yes 2= No	If yes, please give details		
					____wks			☐☐☐☐☐☐☐☐☐☐☐☐☐☐	22
					____wks			☐☐☐☐☐☐☐☐☐☐☐☐☐☐	36
					____wks			☐☐☐☐☐☐☐☐☐☐☐☐☐☐	50
					____wks			☐☐☐☐☐☐☐☐☐☐☐☐☐☐	64
					____wks			☐☐☐☐☐☐☐☐☐☐☐☐☐☐	78

END OF RECORD SIX - RECORD SEVEN Ø7 1-2 ☐☐☐☐ 6

					____wks			☐☐☐☐☐☐☐☐☐☐☐☐☐☐	20
					____wks			☐☐☐☐☐☐☐☐☐☐☐☐☐☐	34
					____wks			☐☐☐☐☐☐☐☐☐☐☐☐☐☐	48
					____wks			☐☐☐☐☐☐☐☐☐☐☐☐☐☐	62
					____wks			☐☐☐☐☐☐☐☐☐☐☐☐☐☐	76

END OF RECORD SEVEN

Ø8 1-2

6

Section 6

TO BE ADMINISTERED TO ALL RESPONDENTS AGED 15 AND OVER

Lifestyle

Now, I would like to ask you some questions regarding your lifestyle including diet and exercise.

DIET

42. **In the last years did you make any dietary changes in the following?**
(Show Card Question 42 and circle one per section).

	Tried and changed a lot.	Tried and changed a little.	Tried but did not really change.	Did not try or wish to change.	
Eating less salt ?	1.	2.	3.	4.	7
Eating more fibre ?	1.	2.	3.	4.	8
Eating less fat ?	1.	2.	3.	4.	9
Eating less sugar ?	1.	2.	3.	4.	10
Eating more fruit/vegetables?	1.	2.	3.	4.	11
Losing weight ?	1.	2.	3.	4.	12

ALCOHOL

43. **Do you or did you ever drink alcohol?**
(Circle one)

Now drink alcohol.	1	13
Never drank alcohol.	2	
Used to but not now.	3	

(If never drank alcohol skip to Question 47.

44. **How often in the past year did you have alcoholic drinks?**
(Fill in number of times. Circle week, month or year).

____ per wk/ month / year 16

45. **How many standard drinks would you have at a sitting?** ____ standard drinks 18

Standard Drinks = 1/2 pint Beer
or 1/2 pint Lager
or 1/2 pint Guinness
or 1 glass Wine
or one bar measure spirit (half one - Whiskey, Gin, etc.).
or schooner of Sherry.

46. **During the past year, did you try to change your drinking habits?**

Stopped drinking during the past year.	1	
Tried and cut down a little on amount drunk.	2	
Tried but did not really reduce alcohol.	3	☐ 19
Did not try or did not wish to change drinking habits.	4	
Started or increased drinking during past year	5	
Was a non-drinker one year ago and stayed a non-drinker.	6	
Missing / Unknown	7	

SMOKING

(Circle one category for each question, and fill in further information as appropriate).

47. **(a) Did you ever smoke tobacco regularly?**

Yes	No
1	2

☐ 20

If No go to Question 50.

48. **(a) Which of the following do you smoke nowadays?**

(b) How much do you/did you smoke now?

(Circle)	Amount smoke now.	
Cigarettes....................	__no./day	☐☐☐ 23
Pipe/hand-rolled cigs.........	__oz/week	☐☐ 25
Cheroots.......................	__no./day	☐☐ 27
Large cigars	__no./day	☐☐ 29

49. **During the past year did you try to change your smoking habits?**

In what way ? *(Circle one)*

Stopped smoking during the year.	1	
Tried and cut down a little on amount smoked.	2	
Tried but did not change amount smoked.	3	
Stopped smoking cigarettes but changed to pipe/ cigar.	4	☐ 30
Did not try or wish to change.	5	
Started or increased smoking during the past year	6	
Was not a regular smoker one year ago.	7	

EXERCISE

50. How much physical activity do you have at work during an average day?
(Show Card Question 50 and circle one).

Work mainly sitting, (e.g., computer programmer, office work at a desk, sitting at a production line).	1	
Quite a lot at work, but do not have to lift or carry heavy things, (e.g., shop assistant, light industrial work, office work where one has to move, domestic duties, etc.).	2	
Walk at work and carry a lot, or climb staircases or go uphill, (e.g., carpenter, farmhand, engine-shop, heavy industrial work, etc).	3	☐ 31
Heavy physical work, carry or lift things, digging, shoveling, cutting, (e.g., forestry, heavy farm work, heavy construction and industrial work, etc).	4	
Not employed.	5	
Unable to exercise.	6	
Don't know.	7	

51. How much exercise have you had during leisure time in the past month?
(Show Card Question 51 and circle one).

Reading, watching TV, and hobbies which do not require physical activity.	1	
Walking, cycling, fishing, light gardening for at least four hours per week.	2	
Running, aerobics, swimming, ball games, heavy gardening for at least three hours per week.	3	☐ 32
Training for competitive sports several days per week, running, orienteering, ball games or other physical heavy sports.	4	
Unable to exercise.	5	
Don't know.	6	

52. How many hours per day do you usually watch TV, video or play computer games?

(Record to the nearest 1/2 hour : 0 for less than or about 15 mins)

____________________ hours ☐☐☐ 35

53. Did you try to take more exercise during the past year? *(Circle one).*

Take a lot more exercise now.	1
Tried and take a little more exercise now.	2
Tried but do not take more exercise now.	3
Take less exercise now	4
Did not try or did not wish to change exercise habits.	5

☐ 36

END OF RECORD EIGHT

	Yes	No	
77 (a) Were you involved in organising community meetings about environmental problems.	1	2	40
(b) Did you contact other community members by phone, mail or in person) about the environmental problems .	1	2	41
(c) Did you attend community meetings about the environmental problems.	1	2	42
(d) Were you contacted by other community members by phone, mail or in person about the environmental problems?	1	2	43
(e) Did you contact your public representatives/TDs/Health Board members/staff?	1	2	44
(f) Others - describe	1	2	45
			47

78. On a scale from zero to ten, where zero means least upsetting and ten means most upsetting.
Please rate how upsetting each of these things would be to you:

(Show card with scales Question 78 and Circle one)

Least ______________________________ Most

Hospitalisation to have your appendix removed.	0	1	2	3	4	5	6	7	8	9	10	49
A death in the family.	0	1	2	3	4	5	6	7	8	9	10	51
Redundancy.	0	1	2	3	4	5	6	7	8	9	10	53
Being late for an appointment.	0	1	2	3	4	5	6	7	8	9	10	55
Bad weather spoiling sporting fixtures or an outing.	0	1	2	3	4	5	6	7	8	9	10	57
Living in an area with environmental problems.	0	1	2	3	4	5	6	7	8	9	10	59

END OF
RECORD TEN

Section 9

RECORD ELEVEN

ANIMAL HEALTH - *to be completed by all adults and parents of children 1-14 years. Those 15 - 18 years parent / head of household to answer.*

Thank you very much for your help in completing this much of the Questionnaire. We would be most grateful if you could answer some questions we have concerning animal health.

1 1 1-2

6

a. Do you live on a farm that contains cattle?

If no, skip rest of section

YES	NO
1	2

7

b. If yes, are you the person responsible for managing the farm?

YES	NO
1	2

8

If yes, please complete this section

If no, can you give details of the activities of the farm?

YES	NO
1	2

9

If no, omit this section

If yes, please complete this section.

1. Farm animal deaths

Approximate number of farm animals that died in 1995 and in 1996 to the end of May

	Deaths in 1995	Average no. during 1995	Deaths from 1 Jan. to end May 1996	Approx. no. on farm at present	
Dairy Cows					19
Suckler Cows					29
Heifers					39
Bullocks					49
Calves					59
Sheep					69
Horses					79

Definition

Dairy cow: an animal that has produced at least one calf and whose milk is supplied to the creamery.
Suckler cow: an animal that has produced at least one calf and which is suckled during its entire lactation.
Heifer: A female animal, aged more than six months, that has not calved.
Bullock: A castrated male animal, aged more than 6 months.
Calf: A male or female animal aged 6 months or less.

END OF RECORD ELEVEN

HERD FERTILITY

RECORD TWELVE

1 2 1-2

6

7

What is the routine calving pattern in your herd? Is it

1 Spring Calving Only (January - April) 2 Autumn Calving Only (September - December) 3 Other _____

If the answer to the previous question was 1 or 2, please complete the remainder of this section.
If the answer was 3, then please proceed to the next section (Question 3)

How many cows or heifers were inseminated by AI or a bull on your farm in 1995? _____ 10

How many of the above aborted their calves at least one month before the expected calving date? _____ 12

How many of the above were not-in-calf at the end of the 1995 breeding season? (Exclude animals that aborted)_____ 14

How many have calved late i.e. after January 1st 1996 for an autumn calving herd or after May 1st 1996 for a spring calving herd _____ 16

Calving Information For 1996 Calvings.

What is the total number of cows that have calved in 1996 to date? _____ 19

Total number of cows that delivered twins. _____ 21

Number of cows that needed assistance to calve. _____ 23

Number of cows that went down within one month of calving. _____ 25

Number of cows that died within one month of calving. _____ 27

Number of calves that were deformed at birth. _____ 29

Number of calves that were born dead or died within 2 days of being born. _____ 31

Number of calves that died between 3 days and 3 months of birth _____ 33

Cattle diseases

We are interested in how many animals were treated by veterinary and non-veterinary personnel(yourself, relations, neighbours, farm relief personnel) between January 1st and May 31st, 1996 for the following conditions (exclude preventive treatments, e.g. routine dosing)?

Disease	Dairy Cows		Suckler Cows		Heifers		Bullocks		Calves		
	Vet	Non-Vet	Vet	Non-Vet	Vet	Non-Vet	Vet	Non-Vet	Vet	Non-Vet	
Diarrhea											53
Pneumonia											73 END OF RECORD TWELVE 1 3 1-2 6
Skin Condition											26
Eye Condition											46
Mastitis					N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	54
Retained placenta/womb infections					N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	62 END OF RECORD THIRTEEN 1 4 1-2 6
Milk Fever					N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	14
Lameness											34
Fluke											54
Mineral deficiency											74 END OF RECORD FOURTEEN

ƚas pining (i.e. animals becoming thin) or ill-thrift (i.e. animal/s failing to thrive) been a problem in your herd in 1995 or 996?

RECORD FIFTEEN

0 = no problem 1 = minor problem (‹ 5 cattle affected)

2 = major problem (5 or more cattle affected)

1 5 1-2

6

Dairy Cows ______ 7

Suckler Cow ______ 8

Heifers ______ 9

Bullocks ______ 10

Calve ______ 11

General information

ʼhat is the total acreage of your farm? (Include outfarms and rented land) _____ 14

you keep a dairy herd, what was the average milk production per cow in 1995?

= less than 1,000 gals. 2 = 1,000 - 1,200 gals 3=› 1,200 gals _____ 15

n average, how much concentrate did you feed to each of your cows in 1995?

= less than 500 kgs. 2 = 500 - 750 kgs. 3 = › 750 kgs. _____ 16

ʼhat proportion of your cattle were outwintered during the 1995/96 winter period?

= none 2 = 1-50% 3 = ›50% _____ 17

n average, how much nitrogen did you apply to your land in 1995?

= less than 100 units/acre 2 = 100-200 units/acre 3 = › 200 units/acres _____ 18

ɔw many times have you had your silage analysed in the last three years? _____ 19

END

THANK YOU FOR TAKING PART IN THIS SURVEY

ertify that I have interviewed the above named respondent in accordance with survey instructions.

ƷNED ____________________ DATED ____________________

NOTES

NOTES

An Ghníomhaireacht um Chaomhnú Comhshaoil

Bunú

Achtaíodh an tAcht fán nGníomhaireacht um Chaomhnú Comhshaoil ar an 23ú lá d'Aibreán, 1992 agus faoin reachtaíocht seo bunaíodh an Ghníomhaireacht go hoifigiúil ar an 26ú lá d'Iúil, 1993

Cúraimí

Tá réimse leathan de dhualgais reachtúla ar an nGníomhaireacht agus de chumhachtaí reachtúla aici faoin Acht. Tá na nithe seo a leanas san áireamh i bpríomhfhreagrachtaí na Gníomhaireachta:

- ceadúnú agus rialáil próiseas mór/ilchasta tionsclaíoch agus próiseas eile a d'fhéadfadh a bheith an-truaillitheach, ar bhonn rialú comhtháite ar thruailliú (Integrated Pollution Control-IPC) agus cur chun feidhme na dteicneolaíochtaí is fearr atá ar fáil chun na críche sin,
- faireachán a dhéanamh ar cháilíocht comhshaoil, lena n-áirítear bunachair sonraí a chur ar bun a mbeidh rochtain ag an bpobal orthu, agus foilsiú tuarascálacha treimhsiúla ar staid an chomhshaoil;
- comhairle a chur ar údaráis phoiblí maidir le feidhmeanna comhshaoil agus cuidiú le húdaráis áitiúla a bhfeidhmeannas caomhnaithe a chomhlíonadh;
- cleachtais atá fónta ó thaobh an chomhshaoil de a chur chun cinn, mar shampla, trí úsáid iniúchtaí comhshaoil a spreagadh, cuspóirí cáilíochta comhshaoil a leagan síos agus cóid chleachtais a eisiúint maidir le nithe a théann i bhfeidhm ar an gcomhshaol;
- taighde comhshaoil a chur chun cinn agus a chomhordú,
- gach gníomhaíocht thábhachtach diúscartha agus aisghabhála dramhaíola, lena n-áirítear líontaí talún, a cheadúnú agus a rialáil agus plean náisiúnta bainistíochta um dhramháil ghuaiseach, a bheidh le cur i ngníomh ag comhlachtaí eile, a ullmhú agus a thabhairt cothrom le dáta go tréimhsiúil,
- córas a fheidhmiú a chuirfidh ar ár gcumas astúcháin COS (Comhdhúiligh Orgánacha Sho-ghalaithe) a rialú de bharr cainníochtaí suntasacha peitril a bheith á stóráil i dteirminéil;
- na rialúcháin OMG (Orgánaigh a Mionathraíodh go Géiniteach) a fheidhmiú agus a ghníomhú maidir le húsáid shrianta a leithéad seo d'orgánaigh agus iad a scaoileadh d'aon turas isteach sa timpeallacht;
- clár hidriméadach náisiúnta a ullmhú agus a chur i ngníomh chun faisnéis maidir le leibhéil, toirteanna agus sruthanna uisce in aibhneacha, i lochanna agus i screamhuiscí a bhailiú, a anailísiú agus a fhoilsiú, agus
- maoirseacht i gcoitinne a dhéanamh ar chomhlíonadh a bhfeidhmeanna reachtúla caomhnaithe comhshaoil ag údarás áitiúla.

Stádas

Is eagras poiblí neamhspleách í an Ghníomhaireacht Is í an Roinn Comhshaoil agus Rialtais Áitiúil an coimirceoir rialtais atá aici. Cinntítear a neamhspleáchas trí na modhanna a úsaidtear chun an tArd-Stiúrthóir agus na Stiúrthóirí a roghnú, agus tríd an tsaoirse a dhearbhaíonn an reachtaíocht di gníomhú ar a conlán féin Tá freagracht dhíreach faoin reachtaíocht aici as réimse leathan feidhmeannas agus cuireann sé seo taca breise lena neamhspleáchas Faoin reachtaíocht, is coir é iarracht a dhéanamh dul i gcion go míchuí ar an nGníomhaireacht nó ar aon duine atá ag gníomhú thar a ceann.

Eagrú

Tá ceanncheathrú na Gníomhaireachta lonnaithe i Loch Garman agus tá cúig fhoireann chigireachta aici, atá lonnaithe i mBaile Átha Cliath, Corcaigh, Cill Chainnigh, Caisleán an Bharraigh agus Muineachán

Bainistíocht

Riarann Bord Feidhmiúcháin lánaimseartha an Ghníomhaireacht Tá Ard-Stiúrthóir agus ceathrar Stiúrthóirí ar an mBord Ceapann an Rialtas an Bord Feidhmiúcháin de réir mionrialacha atá leagtha síos san Acht

Coiste Comhairleach

Tugann Coiste Comhairleach ar a bhfuil dáréag ball cúnamh don Ghníomhaireacht. Ceapann an tAire Comhshaoil agus Rialtais Áitiúil na baill agus roghnaítear iad, den chuid is mó, ó dhaoine a ainmníonn eagraíochtaí a bhfuil suim acu i gcúrsaí comhshaoil nó forbartha Tá réimse fairsing feidhmeannas comhairleach ag an gCoiste faoin Acht, i leith na Gníomhaireachta agus i leith an Aire araon.

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