

16 Discussion

Geographical variations

There are geographical variations in the risk of cancer across Ireland. For some cancers, these patterns are quite striking, while for others they are less marked. Although some similarities were apparent (which are described further below), the observed geographical variations were, in the main, different for different cancers. Generally, for those cancers that affect both sexes, the geographical distribution was similar for males and females. However, it must be kept in mind that these variations in risk do not mean that the spatial location itself causes cancer, but rather they are likely to reflect socio-economic differences in the population, geographical differences in exposure to risk factors and, for some cancer sites, variations in access to, or uptake of, screening or other cancer services. These issues are discussed in more detail below.

Genetic, environmental and lifestyle risk factors

Several strands of evidence suggest that there are genetic differences between different parts of Ireland (Hill et al, 2000, Dolan et al, 2005 and references therein). Although there is a genetic component to the aetiology of many cancers, it is very unlikely that variations in genetic make-up alone could explain the geographical (and socio-economic) variations in cancer incidence seen in this report. Once specific genetic syndromes are discounted, inherited genetic factors make a minor contribution to susceptibility of most types of "sporadic" cancer (Lichtenstein et al, 2000). The seminal work by Doll and Peto almost 30 years ago estimated that four in every five cancers were due to lifestyle or environmental factors (Doll and Peto, 1981). Although more recent estimates suggest that the percentage of the cancer burden due to *well established* behavioural and environmental factors is somewhat lower (Danaei et al, 2005, International Agency for Research on Cancer, 2007d, Boffeta et al, 2009), the overwhelming importance of these factors in cancer aetiology is clear. In addition, while it is recognised nowadays that most diseases, including cancer, are a result of complex gene-environment interactions (Khoury et al, 2005), it is exposure to lifestyle factors which remains of paramount importance - after all, germline mutations or polymorphisms are determined at birth, but lifestyle exposures are potentially modifiable throughout life.

Smoking

The observed higher incidence of lung cancer in cities and in the east of the country must reflect geographical variations in smoking habits, since 90% of lung cancers are caused by smoking (International Agency for Research on Cancer, 2004b). Smoking is also a major risk factor for cancers of the bladder and head and neck and, to a somewhat lesser extent, for cancers of the stomach, oesophagus and cervix. Therefore, some similarities between the geographical distributions of these cancers and lung cancer might have been expected. For bladder cancer, where two-thirds of cases in men and one-third in women are considered to be due to smoking (Brennan et al, 2000, Brennan et al, 2001), the maps showed some similarities to those for lung cancer, but did not fully correspond. For head and neck cancer, where up to 70% of cases may be due to smoking (Hashibe et al, 2009), there were again some similarities with the distribution of lung cancer, but also some differences. These observations suggest that other important risk factors probably play a role in the geographical distribution of bladder and head and neck cancer in Ireland. The distributions of cancers of the stomach,

oesophagus and cervix were much less similar to those of lung cancer, pointing to the importance of other risk factors in these cancers.

Early detection and screening

There were some similarities in the patterns of incidence of breast and prostate cancer and of non-melanoma and melanoma cancer of the skin. The detection of all of these cancers is influenced by better health awareness and access to early-detection or screening. For prostate cancer, there was quite striking spatial variation in risk, with marked areas of higher incidence around the major urban centres, with the exception of Limerick. Within Dublin and Cork, incidence was higher in the more affluent areas of the cities. PSA testing is extensive in Ireland and there is evidence of widespread variations in practice between GPs (Drummond et al, 2009b). It seems likely that these variations are driving incidence of prostate cancer to some extent. Although the geographical variation in breast cancer incidence was not strong, there were some similarities with prostate cancer: those areas with higher incidence of prostate cancer also tended to have higher incidence of breast cancer. The higher breast cancer incidence around Dublin, where the national screening programme began, and similarities with the distribution of levels of private health insurance, suggests attendance for mammography has influenced the geographical distribution of breast cancer.

Skin cancers

As regards melanoma and non-melanoma skin cancers, there were clear similarities in the spatial distributions, with patches of higher incidence around Dublin and Cork, and on the southeast coast. This is not surprising given that exposure to UV radiation is the major risk factor for both lesions (International Agency for Research on Cancer, 1992, International Agency for Research on Cancer, 2001). However, there were quite widespread areas of high incidence of non-melanoma skin cancer in the southwest, which do not seem to be explained by patterns of sun exposure or occupation. This suggests that other factors may play a role in non-melanoma skin cancer - either influencing disease risk *per se*, or influencing likelihood of detection (and registration).

Cervical cancer and HPV

Quite striking geographical variations in incidence of cervical cancer were observed, with a distinct area of higher risk extending westwards from Dublin, and south towards Wexford. The biggest difficulty in interpreting these patterns is the lack of information on HPV prevalence in different parts of Ireland. Preliminary data from the CERVIVA research programme suggest that prevalence of HPV high-risk types among women having smears is slightly higher in the east (Leinster) than the west (Connacht) of the country (McInerney et al, 2008), which would be consistent with the observed distribution of cervical cancer.

Gastro-intestinal cancers

There are some similarities in the factors thought to be involved in cancers of the upper gastro-intestinal tract (e.g. tobacco, alcohol, diet, aspirin and non-steroidal anti-inflammatory drugs, *H pylori*). However, the maps for stomach and oesophageal cancer were quite different, with a clear area of higher risk in the northeast for stomach cancer and higher risk in the south for oesophageal cancer. These differences probably reflect, to some extent, spatial variations of risk factors specific to the individual cancers (e.g. diet rich in salted food for stomach cancer). However, the interpretation of the geographical patterns of these two cancers is actually very difficult, since both

comprise distinct sub-types of cases. In terms of oesophageal cancer, the risk factors for squamous cell carcinoma and adenocarcinoma are not the same. The epidemiology and aetiology of distal, intestinal-type, stomach tumours and proximal, diffuse-type, tumours of the gastric cardia (which are also assigned to the ICD10 code for stomach) also differ (Crew and Neugut, 2006); indeed, the latter group shares some similarities with oesophageal adenocarcinoma. Mapping such distinct sub-types together would tend to diminish spatial differences. Further analyses of specific sub-types might be informative.

The geographical variation in the incidence of colorectal cancer was not as striking as for some other cancers. Having said that, there were areas of higher incidence in and around Cork and Dublin, for both sexes, and in the northwest for women and in the northeast for men. The lack of a strong association with deprivation suggests that other factors must explain the spatial variation. The acknowledged importance of lifestyle factors in the aetiology of colorectal cancer makes it likely that the variations are due to the combined influence of geographical variations in obesity, levels of physical activity, diet, use of aspirin and other non-steroidal anti-inflammatory drugs, etc.

Deprivation and cancer incidence

All of the cancers analysed showed some association with deprivation, either positive (all malignant cancers combined and colorectal, lung, stomach, bladder, head and neck, cervical and oesophageal cancer) or negative (breast, prostate and non-melanoma and melanoma skin cancers). In general, the relative risk estimates for the most, compared to the least, deprived were relatively modest falling in the range 0.8-1.3. Stronger associations were seen for lung cancer in men (RR=1.72) and women (RR=1.56), head and neck cancer in men (RR=1.78), cervical cancer (RR=1.74), and melanoma (RR in men 0.66, in women 0.64).

The patterns are generally consistent with those reported from the UK using area-based measures of deprivation (Quinn et al, 2005). They are also consistent with patterns reported in other countries for a range of other measures of socio-economic status at the level of the individual, including occupation and social class, education, housing tenure and income (Faggiano et al, 1997).

The possible explanations for socio-economic variations in cancer incidence (and mortality) have been extensively discussed elsewhere (see, for example, Kogevinas et al, 1997). The associations are, in the main, likely to be explained by socio-economic variations in exposure to cancer risk factors and cancer preventive behaviours, such as screening. Social class variations in occupational exposures make a (relatively minor) contribution to the socio-economic gradient for some cancers (Boffetta 1997), but for most cancers, the most important explanation is socio-economic variation in lifestyle risk factors such as smoking, alcohol, diet and obesity. These variations are evident both in Ireland (Morgan et al, 2008) and internationally (Bolton-Smith et al, 1991, Møller and Tønnesen, 1997, Erens, 1998, Huisman et al, 2005, Mackenbach et al, 2008, British Heart Foundation, 2009) and generally show that the groups of lowest socio-economic status have higher prevalence of smoking and obesity and lower consumption of fruit and vegetables. In addition, and of relevance to some cancers, there are socio-economic differences in reproductive behaviour and use of exogenous oestrogens (dos Santos Silva and Beral, 1997, Shah et al, 2001, Layte et al, 2006, Løkkegaard et al, 2007, Parazzini et al, 2008). Moreover, socio-economic variations in sexual behaviours have also been described (de Sanjosé et al, 1997), which suggest that there may also be variations in prevalence of HPV. In terms of other infections, prevalence of *H pylori* infection is inversely related to

socio-economic status (Murray et al, 1997). This means that any attempts to address the socio-economic variations in cancer risk in Ireland will require initiatives to tackle socio-economic differentials in these well established cancer risk factors.

Uptake of screening is generally lower among those of lower socio-economic status (Segnan, 1997), even in settings where screening is offered in the form of an organised programme for which the participant does not have to pay (for example, as in the NHS in the UK; Maheswaran et al, 2006, Sabates and Feinstein, 2006, Weller et al, 2007). Avoiding similar patterns in Ireland will be a challenge for the newly established national screening programmes, BreastCheck and CervicalCheck.

It is worth noting that the cancers which were positively associated with deprivation did not all have the same geographical pattern, and the same was true for the cancers which were negatively associated with deprivation. So, while deprivation is related, in a broad sense, to cancer incidence in Ireland, it does not fully explain the geographical variations observed in this report. As a caveat to this, it should be remembered that, since the majority of the most deprived areas are located in the main cities, the associations with deprivation are dominated by areas of high population. In contrast, most of the maps are dominated by incidence patterns in areas of low population, outside of the main cities.

Urban/rural variations in cancer incidence

With the exception of prostate cancer, all of the cancers considered in this report were significantly associated with population density. More densely populated areas (those with a population of >20 persons/ha) consistently had a higher risk of cancer than those that were sparsely populated (<1 persons/ha). Some of the observed associations were reasonably strong: relative risks were 1.4 or higher for cancers of the stomach, bladder, and lung. There are likely to be several reasons for these findings. There is undoubtedly some confounding between "deprivation" in its most general sense and population density, since (as we noted above) many of the areas which would be classified as most deprived are in urban areas (and the deprivation indices provide a less good marker of socio-economic status in rural areas - see below). This means that, in part, the relationships with population density simply reflect "deprivation" and the related associations with cancer risk factors, as discussed above. Interestingly, for some cancers which were positively associated with deprivation, the associations with population density were slightly stronger than those with deprivation (e.g. bladder and stomach cancer, and lung cancer in females).

However, the relationship between deprivation and urban/rural status cannot be the entire explanation for the associations between cancer and population density since, for several cancers that were inversely associated with deprivation (e.g. breast cancer, and melanoma and non-melanoma skin cancer), incidence was higher in more density populated areas. Urban/rural variations in risk factors for these cancers have been suggested by studies in other countries. For example, accessibility of (or access to) air travel correlates strongly with melanoma incidence in the USA and Norway (Agredano et al, 2006) and, in Sweden, more foreign travel was considered to be the explanation for the higher melanoma rates in cities compared to the countryside (Eklund and Malec, 1978). In Denmark, use of HRT (which is aetiologically relevant to breast, uterus and colorectal cancer, and may be

involved in ovarian cancer) was higher amongst women resident in urban areas (Løkkegaard et al, 2007). Whether there are urban/rural variations in cancer risk factors in Ireland is not known.

Research in England and Northern Ireland has demonstrated that access to health services is worse, and rates of health service utilisation are lower, in rural than urban areas (Gilthorpe and Wilson, 2003, O'Reilly et al, 2007). Specifically, uptake of breast cancer screening has been shown to be lower amongst women in more rural areas in both the USA (Doescher and Jackson, 2008) and Europe (Maheswaran et al, 2006, Polasek et al, 2007). Data such as this suggests that our findings could also be due to differences in access to, or utilisation of, cancer screening or early detection services between urban and more rural parts of Ireland.

Other area characteristics and cancer incidence

Elderly living alone

For all cancer sites, with the exception of cervix uteri, risk of the disease was higher in areas with the highest proportion of elderly people living on their own. Although the risk estimates for the highest compared to the lowest quartile were less than 1.3, this factor was significantly related to almost every cancer. These findings are difficult to interpret, and several different explanations are possible. Firstly, the proportion of elderly living alone may simply be another marker of deprivation. However, positive associations with elderly living alone were also seen for cancers which are negatively associated with deprivation. Secondly, the group of elderly living alone may make greater use of health services and be consequently more likely to be diagnosed with cancer. However, recent studies from the UK have found that elderly people living alone have poorer self-reported health than elderly persons who do not live alone, and that those at risk of social isolation (for which the proportion of elderly living alone may be a marker) do not make greater use of medical services (Iliffe et al, 2007, Kharicha et al, 2007). This makes it unlikely that increased medical attention in this group would be the explanation for the findings. Thirdly, there may be something about those who live alone which places them at increased risk of cancer. The same UK studies also showed that elderly persons living alone have poorer diet, lower physical activity, more hazardous alcohol use and are more likely to be smokers, than those who do not live alone (Kharicha et al, 2007). This might either be a result of, or a contributing factor for (via shared lifestyles), the premature death of a spouse/partner. Either way, this suggests that the elderly living alone could be at greater risk of cancer by virtue of their lifestyle, at least in the UK. Whether the same variations in lifestyle are evident among older people in Ireland is not known. Finally, in terms of explanations, it is possible that the proportion of elderly living alone may be a proxy for some other unmeasured cancer risk factor.

Agricultural workers

Areas with a higher percentage of agricultural workers consistently had a lower risk of cancer. This was seen for all cancers, with the exception of prostate cancer. It is most likely that rather than conferring a lower risk of cancer *per se*, agricultural work is simply a marker for some other factor. One likely possibility is population density, since the correlation between these two variables was very strong (correlation coefficient=-0.892; chapter 2).

Other area-based measures of socio-economic status

The observed relationships between the other area-based characteristics and cancer risk - such as percentages of lower social class, unemployed, living in overcrowded housing, and early school leavers - tended to mirror the associations with deprivation. This was not surprising, since some of these are included in the composite deprivation index. What is more interesting, perhaps, is that there were differences between cancers in the individual area-based characteristics which were related to risk.

Strengths and limitations of the analysis

The report presents, for the first time, a detailed analysis of the geographical variation in cancer across Ireland. In order to facilitate interpretation of the geographical patterns, it presents the main available data on diet and other aspects of lifestyle, together with the maps of cancer incidence. A major strength is that it also explores how cancer incidence varies according to various area-based measures of socio-economic status. Although these analyses have limitations (which are discussed below), they extend knowledge about the socio-economic variations in cancer in Ireland. Information on income, employment or other indicators of socio-economic status is not available at an individual level to the Registry, as this information is rarely available from medical records, and linkage to other sources of information on individuals (e.g. census or income tax data) is not permitted.

Ecological analyses

The major limitation of the type of analysis contained in this report is that it is ecological - neither the cancer incidence nor the area characteristics studied necessarily apply to the individuals resident within the areas (Morgenstern, 1995). For example, individuals may live in an area which has a higher proportion of manual workers, without being a manual worker themselves. This means that there is no guarantee that associations at area level translate to associations at the level of the individual. Using small-area data (as was done in this report), as opposed to regional or county-specific data, would be expected to reduce ecological bias but does not exclude it. This should be borne in mind when interpreting the patterns described in the report.

The assessment of deprivation

Many studies, in a variety of different countries, have shown a link between "deprivation", measured at an area level, and cancer incidence or survival (see, for example, Faggiano et al, 1997, Kogevinas and Porta, 1997, Singh et al, 2003, Coleman et al, 2004, Dejardin et al, 2006, Shack et al, 2007, Shack et al, 2008, van der Aa et al, 2008, Yu et al, 2008). Where such studies have been possible, poverty, measured at the level of the individual, has been shown to have the same associations. It is not clear, therefore, if measures of deprivation at an area level are merely proxies for individual deprivation, or whether there are also area-specific factors. In addition, it is well recognised that there may be differences in what deprivation indices measure in urban and rural areas (Haynes and Gale, 2000, Gilthorpe and Wilson, 2003).

Cook and colleagues have illustrated the problems of using compound (e.g. deprivation score) and secondary (e.g. % manual workers, % without a car) indices in Ireland (Cook et al, 2000). Even in areas with high unemployment, the majority of residents in any ED are employed, and in areas where housing is poor, most residents are adequately housed. Therefore, these measures probably indicate no more than a risk of poverty.

Moreover, while various measures of deprivation such as unemployment and low educational attainment are highly correlated in urban areas, where people tend to be segregated by income, these relationships are weak in rural areas, which typically have a more heterogeneous population. Therefore, while measures of “deprivation” have some predictive, if not explanatory, value in urban areas, this is much less so in the country. Therefore, although we describe relationships between socio-economical characteristics and cancer in this report, care must be taken not to over-interpret these.

Exposure to cancer risk factors

A final limitation relates to the available data on exposures to risk factors. Cancer is a complex multi-factorial disease and arises as a result of prolonged exposure to a particular - or more likely several - risk factor(s). Therefore, what is relevant in terms of interpreting current patterns of cancer incidence are patterns of exposure to risk factors 20 or more years ago. However, the available data relate to current (or recent) patterns of exposure, and these may not reflect patterns in past years. This is one reason why the geographical distribution of some cancers does not correlate particularly well with the distribution of the known risk factors.

It is perhaps worth commenting on a more general limitation as regards cancer risk factors. A 2007 study by the International Agency for Research on Cancer estimated that 40% of cancers in France were attributable to known environmental or lifestyle risk factors including smoking, alcohol, obesity, lack of physical activity, exogenous hormones, etc (International Agency for Research on Cancer, 2007d). Since only a relatively small proportion of the remainder are likely to be due solely to known genetic factors, this means that there are still major gaps in knowledge about cancer aetiology. In light of this, it is not surprising that many of the geographical and socio-economic patterns described in this report are unexplained.

Finally, this report did not set out to investigate cancer risk in relation to specific geographical locations, such as industrial sites, landfill sites, etc. As alluded to in chapter 2, different statistical approaches are required for methods for analysing cancer patterns around such “point sources”. Understandably, those who live in proximity to such locations often have concerns about the potential impact on their health. Many of the studies that have been undertaken on cancer risk (and other health outcomes) around such sites have methodological limitations. To date, the evidence does not support a causal relationship between risk of cancer and residence close to landfill sites (Jarup et al, 2002), sites of toxic waste (Russi et al, 2008) or locations of mobile phone transmission masts (Wood, 2006).

Further work

This is the first report on the spatial distribution of cancer in Ireland. The National Cancer Registry intends to build on this, and a range of further analyses are planned. These include:

- exploration of spatial patterns over time, which would provide useful insights on the impact of prevention, screening or other population interventions on the long-term risk of cancer;
- mapping sub-groups of cancers (e.g. basal and squamous cell non-melanoma skin cancers, squamous cell carcinomas and adenocarcinoma of the oesophagus), which might provide further clues as to factors which explain geographical variations;

- joint disease mapping (i.e. mapping several cancers simultaneously), which would allow the impact of shared risk factors to be explored (Downing et al, 2008);
- mapping cancer incidence in small areas across the whole island of Ireland, which may shed more light on possible explanations for geographical variations, particularly in those areas bordering on Northern Ireland;
- exploration of geographical and socio-economic variations in survival and mortality, which would provide a better understanding of cancer disparities in Ireland.

Research and data recommendations

Areas with unexplained high risk

As regards the specifics contained within this report, it seems obvious that the areas with higher than average incidence of particular cancers, which cannot be readily explained in terms of known risk factors, deserve further study to determine what factor(s) may be driving the observed geographical patterns. Examples include the areas of higher incidence of stomach cancer in the northeast and far northwest of the country; the strip of higher incidence of bladder cancer down the east coast and the area of higher incidence in the northwest; the diagonal split across the country into areas of higher (south and east) and lower (north and west) incidence of oesophageal cancer; the increased risk of colorectal cancer around Cork; and the various patches of higher incidence of melanoma and non-melanoma skin cancer around the coastline, particularly in the west of the country.

Further study is needed of areas with unexplained higher than average cancer incidence.

Patterns of exposure to cancer risk factors in Ireland

It is perhaps inevitable that analyses such as these generate more questions than they answer. This is in part due to the limitations of the methodology itself (discussed above) and in part due to a lack of knowledge about cancer aetiology. Having said this, it is worth noting that much is known about which factors are associated with increased risk of cancer and which are related to decreased risk. However, the available data on patterns of exposure to cancer risk factors in Ireland, and how these vary across the country and in different sub-groups of the population, is limited. For example, even in a survey as detailed as SLÁN, which involved interviewing more than 10,000 individuals (Morgan et al, 2008), the number of persons in each area was too small to permit detailed spatial patterns in lifestyle behaviours and other risk factors to be explored. For some important cancer risk factors, such as use of exogenous oestrogens like HRT, or exposure to HPV, there seems to be an almost complete lack of data at the national level, never mind by age, socio-economic status, and geographical area. This lack of data makes it difficult to confirm the extent to which the associations described in this report can be explained by known risk factors, or might be due to other factors.

More data is needed on patterns of exposure to well-known cancer risk factors in the population of Ireland, and how these patterns vary by age, sex, socio-economic status, geographically, and over time.

Health service utilisation, and data availability, access and linkage

The socio-economic and geographical variations described in this report are likely to be partly influenced by issues related to healthcare utilisation, for some cancers at least. For example, variations in non-melanoma skin cancer might be due to differences in referral to dermatology clinics, which in turn would be influenced by availability of dermatology services, and variations in GP referral practice. However, little is known about patterns of utilisation of, or access to, either primary or tertiary care services in Ireland.

Similar comments apply to uptake of mammography and cervical smear testing. Both of these were commonly done before the national screening programmes were established, but little, if anything, is known about which groups of the population were accessing these services and - perhaps more importantly - which groups were not.

In some instances, data which would help interpret the patterns in this report is probably already collected, but simply cannot be, or has not been, accessed or collated on the national level. For prostate cancer, for example, it seems likely that differences in PSA testing practices and uptake underlie the observed variations between deprivation categories and across the country. Over the past few years, the National Cancer Registry has made extensive efforts to collect detailed data on PSA testing, but this has been thwarted by a range of difficulties, including problems with IT systems and data ownership (Drummond et al, 2009a).

A related issue concerns linkage of routinely-collected data. In many countries linkage of, for instance, individual-level census or occupational data with cancer registrations is taken for granted. It provides information of much higher quality than that which is available at the area level, and generates datasets with great power and versatility, which can be used to investigate the role of socio-economic and other factors in cancer risk, health service utilisation by cancer patients, factors influencing treatment, patient outcome, etc (see, for example, Dalton et al, 2008, Dal Maso et al, 2009, Dalton et al, 2009, Hagel et al, 2009, Lindbohm et al, 2009, Thygesen et al, 2009, Reeve et al, 2009, Tetsche et al, 2008). In Ireland, however, due to legal restrictions, this type of analysis cannot be carried out at present.

Developments such as the Health Atlas (Health Service Executive, 2009) - which is bringing together the diverse sources of health data in Ireland and making it publicly available - are to be welcomed, but on their own they are not sufficient.

Greater understanding is needed of patterns of healthcare access and utilisation in Ireland, and how these vary. Data to facilitate such analyses should be collected nationally in a standardised form.

Linkage of routinely collected data should be permitted, with appropriate - but not overly restrictive - provisos regarding confidentiality.

Knowledge and awareness of cancer risk factors in the population

One of the major drivers of utilisation of health services, particularly preventive services such as screening, is likely to be knowledge and awareness of cancer risk factors, and indeed of early signs and symptoms of the disease. There has been very little research into the knowledge, awareness, attitudes and beliefs of the Irish

population about what causes cancer, how it can be prevented, and what the signs of cancer are (McMenamin et al, 2005, FitzGerald et al, 2008, Harewood et al, 2009). How levels of knowledge, for example, vary by socio-class, geography, age, etc, and how they relate to health behaviours (e.g. participation in screening, smoking, etc) and help-seeking practices (e.g. attending the GP if concerned about symptoms), is unknown. Without such knowledge, individuals cannot be expected to take personal responsibility for addressing their own exposures, or indeed to be sufficiently aware of cancer warning signs to present early for investigation. Related to this, it is interesting that public health campaigns to encourage healthy lifestyle behaviours (e.g. physical activity) in Ireland, have tended to focus on benefits in terms of cardiovascular prevention, rather than cancer. An approach which stresses the many and diverse benefits of lifestyle change might be more successful, and might serve to increase awareness of risk factors for cancer.

Research is needed into levels of awareness and knowledge of cancer risk factors in Ireland, and how these vary by age, sex, socio-economic status and geographical area.

To help raise awareness of cancer risk factors among the public, "healthy lifestyle" campaigns and initiatives should make clear the links between lifestyle and cancer.

Cancer aetiology

Having said all of the above, it is worth remembering that for some cancers, relatively little is known about the disease aetiology, and further investigation of risk factors is warranted; prostate cancer is a prime example. There have been very few studies of cancer aetiology in Ireland. Those reported to date are limited to oesophageal adenocarcinoma (Anderson et al, 2008), breast cancer (Colleran et al, 2009) and lymphomas and multiple myeloma (Boffetta et al, 2008b), and a study of pancreatic cancer is underway involving the National Cancer Registry and Queen's University, Belfast (Ireland-Northern Ireland-National Cancer Institute Cancer Consortium, 2009). While it is worth bearing in mind that few cancers would be sufficiently common in a small country like Ireland to make "stand-alone" case-control studies feasible or worthwhile, joining international collaborations is a realistic possibility, assuming funding is available. The oesophageal, pancreatic and lymphoma studies mentioned above are all part of international consortia. This approach offers advantages, both in terms of advancing understanding of the causes of cancer in Ireland and elsewhere, and by providing some local information on exposures to cancer risk factors in the general population. The International Agency for Research on Cancer, which Ireland has recently joined, offers exceptional potential for this type of study.

Studies of aetiological factors for several cancers are warranted. Ireland could best contribute to these by joining international collaborations.

17 Conclusions

This report has revealed geographical and socio-economic variations in cancer risk in Ireland. These are likely to reflect differences in social, economic, cultural and environmental differences between subgroups of the population. Although risk factors for cancer are not all well-defined, nor modifiable (e.g. family history, genetic background), it is likely that many of the differences observed reflect a combination of variations in well-known risk factors (such as tobacco smoking, alcohol drinking, obesity, diet, sexual behaviour, etc), and variations in participation in screening, health awareness and access to cancer services. Since these factors are potentially modifiable, there is considerable potential for reducing cancer incidence in Ireland and eliminating the disparities described in this report.