Impact of prevention on future cancer incidence in Australia

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Abstract

Cancer, along with other chronic diseases such as cardiovascular disease, is recognised as one of the most common public health threats in Australia. This burden and associated financial cost to the community will continue to increase given Australia's increasing and aging population. Projections based on population growth and aging have estimated that there will be about 170,000 new cancers diagnosed in 2025. However, there is some potential for optimism given that only about 5-10% of cancers are caused by genetic or inherited disorders. The World Health Organisation suggests that at least one third of all cancer cases are preventable with a reduction in the prevalence of risk factors such as tobacco smoking, poor nutrition and diet, physical inactivity, alcohol consumption, occupational exposure and sun exposure, offers the most cost-effective long-term strategy for the control of cancer. While we have witnessed significant declines in the prevalence of tobacco smoking, there is little evidence that there have been any significant reductions in the prevalence of other known behavioural risk factors. Clearly, large-scale and long-term preventive strategies are required and if fully implemented, can have the potential to prevent nearly 57,000 new cancers in 2025 alone.

Cancer, along with other chronic diseases such as cardiovascular disease, is recognised as one of the major public health threats in Australia. About one-fifth of the total disease burden in Australia is caused by cancer,[1] costing the Australian community about $3.8 billion in direct health system costs annually.[2] Since 1982 the number of Australians diagnosed with cancer has almost doubled, from 47,350 to 108,368 in 2007, and the incidence rate has increased by 27% over the same period.[3]

This burden and financial cost to the community will further increase given Australia's increasing and aging population. Projections based on population growth and aging have estimated that there will be nearly 170,000 new cancers diagnosed in 2025.[4] Most of the growth is expected to be in prostate cancer, colorectal cancer, lung cancer and breast cancer.[4] Combined with improving survival outcomes for people diagnosed with cancer,[5] the future direct and indirect costs in support and ongoing services are also important considerations.

While these observations are daunting, there is some potential for optimism given these chronic diseases are also the most preventable.[6] Most cancers are caused by external factors, whether environmental or related to human behaviour, leaving only about 5-10% of cancers caused by genetic or inherited disorders.[7] Migrant studies provide the best evidence of this, with cohorts of people migrating from low-incidence countries to high-incidence countries experiencing cancer rates equivalent to their adopted country within two or three generations.[8,9] There is much work to be done to identify, understand and quantify the impact of these external factors.

What is known about risk factors for cancer?

There is, however, much we do know about the risk factors for cancer, and this has important implications for our potential to reduce the burden of cancer in the future. The World Health Organisation suggests that at least one third of all cancer cases are preventable, and that prevention offers the most cost-effective long-term strategy for the control of cancer.[10,11]

Tobacco smoking

Tobacco smoking has long been recognised as the single largest preventable cause of cancer; tobacco smoking alone causes about 71% of lung cancer worldwide.[12] Aside from lung cancer, there is now sufficient evidence for a causal association between cigarette smoking and cancers of the oral cavity, oropharynx, hypopharynx, nasal cavity and paranasal sinuses, larynx, oesophagus, stomach, pancreas, liver, kidney (body and pelvis), ureter, urinary bladder, uterine cervix and bone marrow (myeloid leukaemia).[13] Additionally, exposure to second-hand or 'environmental' tobacco smoke has also been proven to be a cause lung cancer in non-smoking adults.[13]

Diet, physical activity and nutrition

In 2004 The World Cancer Research Fund and the American Institute for Cancer Research assembled an international group of experts in cancer epidemiology, nutrition, public health and cancer biology to systematically examine the association between food, nutrition and physical activity (including body fatness) and the prevention of cancer. They calculated that overall, at least 25% of cancers could be prevented

if the exposures of poor nutrition and diet, physical inactivity and obesity were eliminated, while leaving other risk factors unchanged.[6] Based on the average of percentages for US and UK, they estimated that at least 40% of cancers of the mouth, oesophagus, stomach, pancreas, colon and rectum, breast and uterus were preventable by changes in these risk factors.

Alcohol

Drinking alcohol is a known risk factor for cancer and there is sufficient evidence that alcohol consumption causes cancers of oral cavity, pharynx, larynx, oesophagus, liver, female breast cancer and colorectal cancer.[14] It is estimated that 5% of all cancers diagnosed in Australia are attributable to chronic use of alcohol.[15]

Occupation

The proportion of cancer attributable to occupational exposures has been estimated to range from 2% to 11%.[16] The known occupational carcinogens include certain chemicals (eg. benzene and vinyl chloride), dusts (eg. asbestos and wood dusts), radiation (eg. sunlight and radon) and industrial processes (eg. underground mining with exposure to uranium and/or radon).[1] Certain occupational exposures cause particular types of cancer, for example, asbestos causes mesothelioma.[1]

Sun exposure

The association of early life sun exposure and a prolonged latency period for the development of melanoma is well established.[17] It is estimated that more than 90% of melanoma can be attributed to sun exposure, with a similar population attributable fraction for squamous cell and basal cell carcinoma.[18] There have been ongoing primary prevention campaigns designed to reduce sun exposure and promote sun protection in Australia since the early 1980s.[19] The observed reduction in melanoma incidence in younger age groups and a similar stabilising of rates of non-melanoma skin cancer provides cautious support for the success of these programs.[20-22] These public health campaigns have been shown to have a positive influence on sun-related attitudes, along with some evidence that they have led to improved sun protection behaviours.[23,24]

However recently, issues surrounding the impact of sun protection programs and possible vitamin D deficiency have arisen.[25,26] The majority of vitamin D intake is provided by exposure of the skin to the sun, with only a small proportion obtained through the diet. Vitamin D deficiency has been found to be associated with some diseases such as osteoporosis, multiple sclerosis,[27] and more recently it has been suggested that vitamin D deficiency may be implicated in increasing the risk of some cancers,[28] as well as reduced survival.[29] Aiming to clarify the risks and benefits of sun exposure, professional health bodies released a joint statement in 2005.[30] However, despite this there continues to be increasing media attention,[31] and an increase in the general public's uncertainty about the role of sun protection in particular.[32,33]

Trends in known risk factors

The impact of primary cancer prevention efforts to reduce exposure to known risk factors is reflected in the direction of current trends. Unfortunately, with the exception of smoking prevalence, the picture is not very promising.

The proportion of daily smokers has declined by 40% from 1991 to 2010.[34] In 2010, 15.1% of those aged 14 years or older reported smoking daily.[34] With the time lag between smoking and onset of disease often more than 20-30 years, the full impact of the reduction in smoking prevalence will take considerable time to show in observed trends. However, lung cancer incidence rates have been decreasing for many years,[1] and it has been suggested that the current increasing trends among females will soon plateau and then start to decrease, consistent with the reduction in smoking prevalence.[35]

Other trends are not so encouraging. For example there has been little change in levels of physical activity since 1995,[36] if anything, more of the Australian population is sedentary than ever before, with percentages increasing from 31.5% in 2001,[37] to 35.2% in 2007-08.[36] To a large extent, this is due to changes in methods of transportation, increased television viewing time, increasing use of technologies such as computers and video games, and work practices that are more sedentary. Similarly, the prevalence of overweight and obesity in adults (aged 18 years and over) increased from 56.3% in 1995 to 61.4% in 2007-08 (not including those with unknown height and weight).[36] While the percentage of Australians aged 14 years or older who consumed alcohol daily declined slightly from 8.1% in 2007 to 7.2% in 2010,[36,38] harmful alcohol consumption has increased, from 8.3% in 1995 to 12.6% in 2007-08, although the latest estimate does represent a slight decrease from a peak in 2004-05.[36] There is also substantial scope for improvement in diet, with only 8.8% of Australians having the recommended amount of vegetable intake (five serves per day) and only 6.1% having adequate fruit and vegetable consumption in the 2007-08 survey.[36]

Impact of screening

When considering the possible influence of prevention efforts on cancer incidence, we also need to acknowledge that some incidence trends can reflect the impact of population screening programs and ad hoc testing of asymptomatic people rather than representing an underlying change in incidence. The most obvious example is prostate cancer, the most common cancer among males. While there is no population-based screening for prostate cancer in Australia, the introduction of PSA testing in the early 1990s, and subsequent increasing use, has directly impacted on trends in prostate cancer incidence.[39]

Currently, Australia has two established population health screening programs for breast cancer and cervical cancer, both introduced in 1991. Both influence incidence trends for the respective tumour types in different ways. Population-based mammography screening is designed to detect smaller, less invasive cancers.[40] It has been accompanied by some debate about possible over-diagnosis and overtreatment of breast cancers.[41-43] However, since its

introduction, while the breast cancer incidence rate for women aged 50-69 has increased by 18% in 2007 in Australia, breast cancer mortality has decreased by 32%.[3]

In contrast, the cervical cancer screening program using Pap smears is designed to detect and subsequently treat precancerous lesions, rather than detect cancerous lesions.[44] As such, its impact has been to significantly reduce both incidence and mortality of cervical cancer since 1991 by 45% and 49% respectively in women aged 20-69 years.[3] In addition, the introduction of a vaccine against the human papilloma virus, the most important risk factor for cervical cancer, has the potential to eradicate some variants of cervical cancer in the future.[45]

There has been a limited implementation of the National Bowel Cancer Screening Program, introduced in Australia in 2002,[46,47] incorporating a one-time immunochemical faecal occult blood test (FOBT) for people aged 50, 55 and 65 years. The current timing and breadth of the program is unlikely to have influenced current incidence trends. However, particularly with a full population-based screening program, it has the potential to reduce future colorectal cancer incidence through the detection and removal of colorectal adenomas.[48-50] It has been suggested that annual or biennial FOBT could reduce colorectal cancer mortality by 15-21%.[48,51,52]

In addition to the currently ad hoc Prostate Specific Antigen testing in Australia, there has also been a widespread increase in the number of ad hoc skin examinations conducted in general practice and dedicated skin cancer clinics.[53-55] This may have resulted in the documented increase in in situ and thin melanomas, and possible over-diagnosis.[56,57] A similar possibility has been suggested for thyroid cancer, with asymptomatic cancers identified by neck ultrasound and subsequent fine-needle aspiration biopsy.[58,59]

Combined, these formal screening and ad hoc asymptomatic testing programs have and are likely to continue to influence cancer incidence trends in Australia, and need to be kept in mind when considering any impact, or potential impact, that primary prevention efforts have on observed cancer trends.

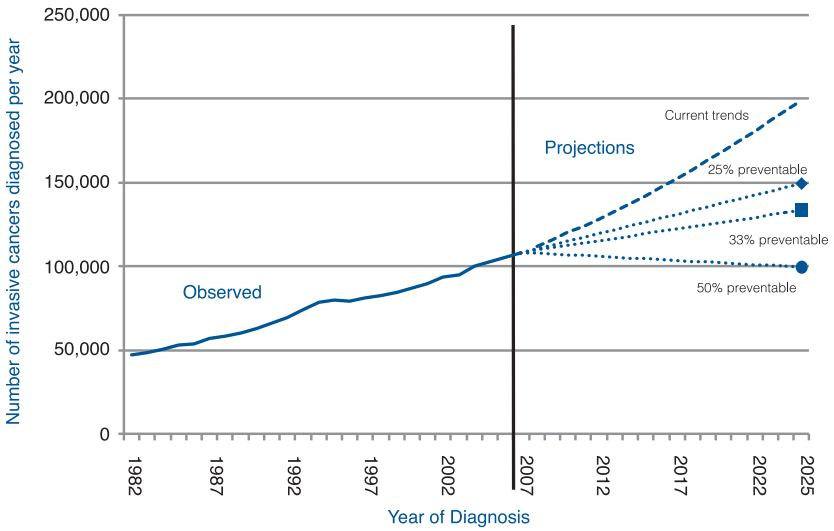
Where to from here?

In this paper we have specifically focused on the association between prevention and new diagnoses of cancer, rather than on cancer mortality. This is simply based on the understanding that in order to die from a cancer you first need to develop the cancer. So preventing the cancer developing in the first place will automatically have an impact, even if a delayed one, on mortality irrespective of advances in treatment and other management strategies. Prevention activities have much potential to impact on the future burden of cancer in Australia.

To examine the potential impact of primary prevention we estimated the number of cancers that would be diagnosed in 2025 by applying age and sex-specific population projections (Series "B"),[60] to current age and sex-specific cancer incidence rates. The series "B" population projections largely reflects current trends in fertility, life expectancy at birth, net overseas migration and net interstate migration This method assumes that the age and sex-specific cancer incidence rates averaged over the years 2005-2007 will be constant through to 2025. The eventual validity of this assumption cannot be determined, particularly in relation to the future directions of the obesity epidemic and the impact of declining smoking rates. However, a similar modelling process was used recently for a major US study,[61] and the overall Australian cancer incidence rates since 1998 have increased by less than 2% per year.[3] To assess the number of cancers that could be prevented we used published figures of one-third preventable cancers.[6] We additionally examined the number of incident cases that could be prevented based on different estimates of preventability.

Based on population growth and aging, it has been estimated that about 170,000 new cancers (excluding non-melanoma skin cancer) will be diagnosed in the year 2025.[4] Figure 1 presents a graph showing the total number of incident cases observed in Australia from 1982 to 2007 and the total number of expected cases from 2008 to 2025, joined with three estimates of the number of cases that could be prevented based on 25%, 33% and 50% preventability.

Figure 1: *Potential impact of prevention programs on projected incidence of invasive cancer in Australia.*



The top line represents the total number of incident cancers in Australia (observed 1982-2007; projected 2008-2025). The three dotted lines (25%, 33%, 50%) are the projected lines joining the observed data with the projections for 2025 based on different estimates of preventable cancers. For example, the line marked '25% preventable' reflects the projected incidence trends in cancer cases if 25% of the projected cancers were able to be prevented by the year 2025.

Thus one third of these cancers could be prevented by implementing appropriate preventive interventions now, potentially preventing nearly 57,000 new cancers in 2025 alone. Even preventing a quarter of cancers would mean that by 2025 around 42,000 fewer cancers would be diagnosed.

Clearly, in terms of reducing the overall burden of cancer in the community, primary prevention efforts are just one of several methods, coming alongside earlier detection and diagnosis of cancers and improved management techniques for diagnosed cancers. Much of the increase in survival outcomes and accompanying lower mortality rates for many cancers has been attributed to improvements in treatment.[62,63] However, despite their increasing utility in treating the diagnosed cancer, in addition to becoming more expensive, cancer treatments are still associated with a variety of side-effects.[64,65]

There is also much we don't know. Complicating any preventive efforts is that the causes of many cancers are currently not known. For example, while there are some established socio-demographic risk factors for prostate cancer,[66] the modifiable causes are still unknown, limiting any effective prevention efforts.[67] This is of concern since if current trends continue, the increase in prostate cancer incidence will mean that prostate cancer will account for about 20% of the total projected cancer counts in 2025.[4] Although the impact is lower, there is a similar lack of knowledge about the preventable risk factors for non-Hodgkin's lymphoma.[68] Further research is critical to better understand and quantify the causes of specific cancer types, and the importance of primary prevention underscores this urgency.

Increasing the relevance of primary prevention is that many of the lifestyle changes required will also impact on the incidence of other chronic diseases such as diabetes, hypertension, heart disease and stroke,[11] thus improving the overall health of the Australian population. There is also the potential for primary prevention efforts to reduce the current inequities in cancer outcomes specifically in relation to where people are living in Australia. There is a consistency between poorer cancer outcomes based on increased remoteness or area disadvantage,[39,69] and evidence of poorer diet, lower physical activity and greater obesity in these areas.[70-74]

There can be no denying that the goal of reducing cancer incidence through primary prevention will be difficult. While the key prevention messages are simple, the design and implementation of large-scale prevention programs or interventions that address diet and nutrition, exercise, healthy weight, smoking cessation and other behaviours are often complex and expensive. Lifestyle behaviours such as exercise are compounded by a trend towards increased sedentary behaviour associated with electronic work-related and recreational pursuits, suburban-orientated lifestyles requiring greater use of motor vehicle transport and greater demands on people's time, meaning that exercise requirements are often placed on a lower priority compared to competing demands or interests.

While the cost of large-scale prevention programs may be significant, when compared with the costs of treatment, prevention efforts have the potential to be a very cost-effective intervention for governments.[75] In the context of expenditure on health care, in 2007-2008 only 2% of Australia's total health expenditure was spent on preventive services or health promotion.[76] It also needs to be recognised that the time lag between a prevention intervention or program and reductions in cancer incidence is likely to be substantial, as has been shown with tobacco control and lung cancer incidence. However, this same example demonstrates that interventions can be successful over the long-term, and the prevention programs and government policies gradually implemented up to 20 or 30 years ago are now reaping their benefits.

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