Title: Quantifying the future burden of cancers preventable by diet and physical activity in Australia

Baade P, Meng X, Sinclair C, Youl P.

ABSTRACT

Objective: To estimate the number of cancers diagnosed in 2025 that could be prevented solely due to changes in diet and physical activity.

Design: We estimated the total number of cancers that would be diagnosed in 2025 by applying published (Series “A”, “B” and “C”) age- and sex-specific population projections to current incidence rates, and then multiplied the projected numbers of cancers by the estimates of population attributable fractions published by the World Cancer Research Fund (WCRF) and American Institute for Cancer Research (AICR).

Results: Our projections suggest that there will be around 170,000 Australians diagnosed with cancer in 2025. This represents about a 60% increase of the incidence in 2007. Almost 43,000 of these cancers (low 42,295; middle 42,657; high 43,990) could be prevented through improvements in dietary intake and physical activity levels, including its impact on obesity. It is likely this is an underestimate of the true figure. Bowel cancer and female breast cancer were projected to have the most preventable cases in 2025 (10,049 and 7,273 respectively).

Conclusion: Approximately 25% of cancers, or about 43,000 cancers in 2025, can potentially be prevented through improvements in diet and physical activity. It is imperative that governments at all levels, along with clinicians and researchers, act now with vigour if we are going to have any impact on reducing the significant human and financial burden of cancer into the future.

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INTRODUCTION

Chronic diseases, such as cardiovascular disease and cancer, are the most common public health threats in the 21st century. Cancer accounts for approximately 19% of the total disease burden in Australia in 2010 (1) and costs the Australian community about $3.8 billion in direct health system costs per year (2). With the increasing and aging population, the burden caused by cancer and the direct costs to the community are only going to increase. In addition, more and more people are now living with a diagnosis of cancer, and this has additional implications for the indirect costs in terms of support and follow up services.

Fortunately, in spite of their large and increasing impact, these chronic diseases are also the most preventable (3). Only about 5-10% of cancers are due to genetic or inherited disorders, with the remaining cancers being due to external factors, whether they are environmental or related to human behaviour (4). This is best evidenced by migrant studies (5, 6). Clearly not all the external factors are understood, nor quantified.

Recognizing the need to address this lack of knowledge, in 2004 the World Cancer Research Fund (WCRF) and American Institute for Cancer Research (AICR) 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 (3). They then calculated population attributable fractions (PAFs) for the specific cancers included in their review (7). These PAFs represent the proportion of cancer incidence that could be prevented if the exposures of poor nutrition and diet, physical inactivity and obesity were eliminated, while leaving other risk factors unchanged.

While the theoretical impact of primary prevention is substantial, motivating populations to improve their health status is however a difficult task. Therefore, unless a concerted and significant effort is made to invest and implement powerful preventive interventions, the actual impact of primary prevention on reducing total cancer incidence over the coming decades will probably be relatively small (8). These measures, or interventions, are unlikely unless they are viewed as a strong priority by governments and policy makers Australia wide. Typically, this requires quantitative evidence.
Using these published WCRF/AICR PAF estimates, the aim of this current study was to quantify the number of cancers projected to be diagnosed in 2025 that would be preventable solely due to changes in diet and physical activity, and then consider the implications of taking action to reduce the future cancer burden.

**METHODS**

Cancer incidence data between 1982 and 2007 were obtained from the Australia Institute of Health and Welfare (AIHW), with data grouped by cancer site, 5-year age groups (to 85+) and sex. We focused on the cancer types that were included in the WCRF/AIRC report and thus demonstrated to have some proportion of cases preventable by improved nutrition and physical activity. These comprised twelve individual types of cancers: bowel cancer (C18-C20), breast cancer (C50), gallbladder cancer (C23-C24), kidney cancer (C64), liver cancer (C22), lung cancer (C33-C34), mouth and larynx cancer (C00-C02, C32), pancreatic cancer (C25), prostate cancer (C61), oesophageal cancer (C15), stomach cancer (C16) and uterine cancer (C54-C55) along with all cancer types combined (C00-C80). We did not consider male breast cancer cases due to the small number of cases diagnosed each year.

We were unable to match two categories of cancer in this study to the definitions in the WCRF/AIRC report due to the availability of Australian cancer incidence data. Instead of Mouth, Pharynx and Larynx (C00-C009, C10-C14, C32) we have reported on Mouth and Larynx only (C00-C02, C32), which based on unpublished Queensland Cancer Registry data comprised about 54% of the original grouping. Similarly we included all Uterine cancers (C54, C55), whereas the WCRF/AIRC report only included endometrium cancers (C54.1), representing about 82% of all Uterine cancers.

We used a two-stage process to estimate the number of cancers diagnosed in 2025 that could be prevented by diet and physical activity. First we estimated the number of cancers that would be diagnosed in 2025 by applying the current age- and sex-specific incidence rates to the age- and sex-specific population projections. This method assumes that the age- and sex-specific cancer incidence rates averaged over the years 2005-2007 will remain constant through to 2025. The eventual validity of this assumption cannot be determined, however a similar modelling process was used recently for a major US study and the overall Australian
cancer incidence rates since 1998 have increased by less than 2% per year(9). Secondly we multiplied the projected numbers of cancers by the published PAF estimates (percentages) from the WCRF/AIRC report.

The Australian Bureau of Statistics (ABS) has published three main series (“A”, “B” and “C”) of population projections for the Australian population from 2006 to 2101.(12) Series “B” largely reflects current trends in fertility, life expectancy at birth, net overseas migration and net interstate migration, and Series “A” and “C” are based on high and low assumptions of these variables respectively.

The number of projected cancer cases for each cancer type was obtained by applying the middle series of population projections (Series “B”) according to the following formula, where \(i\) represents the calendar year (2008, .., 2025), \(j\) is sex (males, females) and \(k\) is the 5-year age group. To improve stability, we have set the current incidence rate to be the average incidence rate over the combined 2005 to 2007 period.

\[
\text{New Diagnoses}_i = \sum_{j=1}^{2} \sum_{k=1}^{18} \text{projected population}_{ijk} \times \text{current incidence rate}_{jk}
\]

We incorporated a crude measure of quantitative uncertainty about these projected count estimates by calculating corresponding estimates based on the Series “A” and Series “C” population projections. However it is important to note that the greatest uncertainty with projections is not with statistical noise (random error) but the unquantifiable bias that might occur if the age-sex-specific incidence rates in the future are substantially different from those of the present.

To estimate the number of preventable cancer cases for each cancer type, we multiplied the year-specific projected number of cancer cases by the corresponding percentage of preventability (PAF) for that cancer from the WCRF/AICR report(13) (see Table 1). Although separate estimates were published for the USA and the UK, we applied the average of the two estimates to the Australian data since they shared similar socioeconomic, cultural and environmental characteristics.
RESULTS

Based on current trends in cancer incidence and population growth and aging, our projections suggest that there will about 170,000 Australians diagnosed with cancer in 2025. This represents a nearly sixty percent increase on the current incidence of nearly one hundred and ten thousand in 2007 (Table 1 & Figure 1). As shown in Figure 1, the aging of the population means that the gradient for cancer incidence projections is steeper than for population projections. By applying the WCRF/AICR preventability estimates, we suggest that by 2025 that about 42,700 of these cancers could be prevented through improvements in dietary intake and physical activity levels, including its impact on obesity. There was only minimal impact of the different projection series on these projections (Table 1). There were some differences between 2007 and 2025 in the ranking of cancer types according to the number of preventable cancers, reflecting both number of projected cancers and the preventable fraction.

Bowel cancer was estimated to have the most cases in 2025 that would be preventable by changes nutrition and physical activity, with a mid-point estimate of 10,049 cases (Table 1). This was followed by female breast cancer with 7,273 preventable cases. While only a relatively small proportion of prostate cancers are considered preventable (16%), the very high number of projected cases in 2025 meant that 4,882 cases would have been preventable by 2025. Lung cancer (5,736) and mouth & larynx (2,054) rounded out the top five cancers that could be prevented by changes in diet and physical activity.
DISCUSSION

Estimating cancer incidence for future years is always a problematic exercise, and subject to unknown levels of error. It is impossible for anyone to accurately predict what the precise number of new cancers diagnosed in Australia in 2025 will be. Age- and sex-specific incidence rates can change in the future depending on variations in the prevalence of causal agents or other risk factors. Similarly screening patterns can have a strong impact on observed incidence trends, even without there being a change in the underlying incidence. That we have not taken these and other factors into account will presumably impact on the future accuracy of these projections. While more complex and comprehensive methods of calculating projections have been developed,(14, 15) even these are based on current knowledge, much of which is likely to change over the next 15 years. With our focus on the impact of population increases and aging, we have consciously chosen a methodology that is intuitive and transparent.

For these reasons we acknowledge that some projected counts for individual cancers may prove to be incorrect in another 15 years’ time. However a recent major US study (11) also based their cancer incidence projections on the assumption of stable age-sex-specific cancer incidence rates. In separate analyses (not presented) applying statistical methods described elsewhere,(15) we found that approximately 85% of the change in overall cancer incidence counts since 1982 is due solely to population increases and aging. This strong impact of population change is due to the incidence of most cancers being highest amongst older Australians, and there is no suggestion that the current pattern of an aging and increasing population in Australia will change. Therefore our results are consistent with the expectation that cancer will affect the lives of a rapidly increasing number of Australians.

The PAF for all cancers combined makes the assumption that the remaining cancers not considered in this analysis had zero preventability. Although quantitative evidence is lacking, it is probably more likely than not that this assumption will be proven false in the future. Therefore the true PAF for all cancers combined is likely to be higher than the 25% stated here. For this reason our estimate that almost forty-three thousand cancers in 2025 would be preventable by changes in nutrition and physical activity is likely to be an under-estimate, although it is impossible to quantify by how much.
We have interpreted the published PAF estimates as being the proportion of disease risk that could be eliminated if the excess risk associated with exposure were to be eliminated. As has been discussed by others, this interpretation does make some assumptions; including that the elimination of the risk factor has no effect on the distribution of other relevant risk factors (16).

Increasing the need to intervene is that these risk factors of poor nutrition and low physical activity are generally increasing in prevalence, rather than decreasing. Latest trend estimates suggest that the more of the Australian population is sedentary than ever before, with percentages increasing from 31.5% in 2001 (17) to 35.2% in 2007-08. Similarly, the prevalence of overweight and obese in adults (aged 18 years and over) increased from 56.3% in 1995 to 61.4% in 2007-08 (excluded those for whom height and weight were not stated or not known). 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. There is also substantial scope for improvement in diet, with only 8.8% of Australians having the recommended amount of vegetable intake (5 serves per day) and 6.1% having adequate fruit and vegetable consumption in the 2007-08 survey.

Prevention is but one of several methods capable of reducing the burden of cancer in the community, alongside earlier detection and diagnosis of cancers, and improved treatments once diagnosed. Improvements in treatment have been responsible for much of the increases in survival outcomes and accompanying lower mortality rates for many cancers. However, alongside their increasing effectiveness, cancer treatments are still associated with a variety of side effects and are progressively becoming more expensive. Based on the estimated lifetime treatment costs in 2000-01 (which included hospital admissions, out-of-hospital medical services and prescription and pharmaceuticals) for the twelve specific cancers in this study, and ignoring inflation, preventing these 37,776 cancers could save in excess of $674 million in 2025, a not insignificant annual figure given the current pressures on health expenditure.

An emphasis on prevention through improving diet and physical activity should not preclude continuing efforts to develop more effective screening methods to detect cancer earlier, and treatment methods for those people already diagnosed with cancer. However, we suggest that prevention offers substantial hope to reduce
the burden of cancer using a sustainable method, particularly when considering their impact on the prevalence of other chronic diseases such as diabetes, hypertension, heart disease and stroke,

There is an increasing body of evidence highlighting the inequities in cancer outcomes depending on where people living in Australia, whether according to remoteness or area disadvantage. There are also similar inequities in the prevalence of poor diet, lower physical activity and obesity by geographical location. Increasingly the poor are becoming obese faster than the rich. In Australia in 2004-05, the self-reported obesity rate in disadvantaged areas (22%) was nearly double that in advantaged areas (13%). The burden of obesity, poor diets and reduced physical activity is found among the poor more and more.

Adults in rural and remote areas were more likely to have consumed fats and oils, and those living in most disadvantaged areas had the lowest average intake of vegetable products and dishes. It was been suggested that cost is one of the main reasons why Australians with lower incomes were less likely to buy and eat healthy foods, and between 1999 to 2011 the cost of healthy food increased more than the Consumer Price Index (CPI) for All Foods, and higher than for non-healthy food. Thus an increasing focus on prevention and removing existing barriers to that prevention, particularly in these disadvantaged areas, has the potential to reduce these current inequities in cancer outcomes among these population groups.

Designing and implementing interventions in diet, nutrition, physical activity and obesity at a population level are not simple nor are they inexpensive. However just over 2% of Australia’s total health expenditure in 2007-08 was spent on preventive services or health promotion. When compared to the costs of treatment, prevention efforts in the area of nutrition and physical activity can be a very cost effective investment for governments. Another challenge is that the time lag between intervention and outcome is also likely to be substantial. However the example of reducing cigarette smoking and declining lung cancer incidence among males demonstrate that interventions can be successful over the long term when government policies work in conjunction with other efforts.

With 25% of cancers able to be prevented through improvements in diet and physical activity, governments at all levels must act now with vigour if we are going to have any impact on reducing the significant human and financial burden of cancer in to the future.
Table 1: Projected number of cancer cases in 2025\(^a\) and the number of preventable cancers due to poor nutrition and diet, physical inactivity and obesity.

<table>
<thead>
<tr>
<th>Cancer Type (ICD10 code)</th>
<th>No. of cancer cases observed in 2007</th>
<th>(^a) No. of projected cancer cases for 2025</th>
<th>(^b) % preventability</th>
<th>(^b) No. of preventable cancer cases range for 2025</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Middle</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Mouth (C00, C01, C02), larynx (C32)(^c)</td>
<td>2,078</td>
<td>3,130</td>
<td>3,160</td>
<td>3,254</td>
</tr>
<tr>
<td>Oesophagus (C15)</td>
<td>1,264</td>
<td>2,050</td>
<td>2,060</td>
<td>2,130</td>
</tr>
<tr>
<td>Lung (C33-C34)</td>
<td>9,703</td>
<td>16,307</td>
<td>16,388</td>
<td>16,891</td>
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<tr>
<td>Stomach (C16)</td>
<td>1,897</td>
<td>3,233</td>
<td>3,251</td>
<td>3,363</td>
</tr>
<tr>
<td>Pancreas (C25)</td>
<td>2,525</td>
<td>3,982</td>
<td>4,001</td>
<td>4,139</td>
</tr>
<tr>
<td>Gallbladder (C23-C24)</td>
<td>676</td>
<td>1,071</td>
<td>1,076</td>
<td>1,111</td>
</tr>
<tr>
<td>Liver (C22)</td>
<td>1,169</td>
<td>1,866</td>
<td>1,880</td>
<td>1,940</td>
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<tr>
<td>Bowel (C18-C20)</td>
<td>14,234</td>
<td>22,708</td>
<td>22,840</td>
<td>23,548</td>
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<td>Breast (C50)</td>
<td>12,567</td>
<td>17,950</td>
<td>18,183</td>
<td>18,644</td>
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<td>Uterine (C54, C55)(^c)</td>
<td>1,942</td>
<td>2,884</td>
<td>2,908</td>
<td>2,977</td>
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<tr>
<td>Prostate (C61)</td>
<td>19,403</td>
<td>30,372</td>
<td>30,515</td>
<td>31,393</td>
</tr>
</tbody>
</table>

\(^a\) No. of cancer cases observed in 2007
\(^b\) % preventability
\(^c\) Data not available
<table>
<thead>
<tr>
<th>Kidney (C64)</th>
<th>2,580</th>
<th>3,895</th>
<th>3,934</th>
<th>4,055</th>
<th>22</th>
<th>857</th>
<th>866</th>
<th>892</th>
</tr>
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<tr>
<td>Total cancer for these cancers combined (^d)</td>
<td>70,038</td>
<td>109,448</td>
<td>110,196</td>
<td>112,335</td>
<td>37,505</td>
<td>37,776</td>
<td>38,893</td>
<td></td>
</tr>
<tr>
<td>All cancers (C00-C97, D45-D46, D47.1, D47.3)</td>
<td>108,368</td>
<td>169,180</td>
<td>170,629</td>
<td>175,959</td>
<td>42,295</td>
<td>42,657</td>
<td>43,990</td>
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\(^a\): Low, Medium and High projections are based on the three main series ("A", "B" and "C" respectively) of population projections published by the Australian Bureau of Statistics.

\(^b\): The values for % preventability was the mean value of USA and UK value which were obtained from WCRF/AICR report.

\(^c\): See methods for details of approximations used for these cancer types.

\(^d\): The total for the twelve cancers was based on the sum of the cancer-specific estimates of preventable cancers.
Figure 1. Projection of cancer case from 2008 to 2025 for all cancers.

The double line corresponds to the observed (solid) and projected (dashed) population estimates. Observed incidence (all invasive cancers combined) is shown by the solid single line, and the current cancer incidence projections are shown by the straight (dot dash) line. The dotted line connects the 2007 incidence counts with the projected incidence in 2025 after excluding the preventable cancers (Middle series in Table 1).
Figure 1
Projected population growth and cancer incidence, Australia, 1982-2025

[Graph showing projected population growth and cancer incidence from 1982 to 2025 with different lines representing observed, projected, and projected with prevention scenarios.]
References