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Incidence, prevalence, mortality, disability-adjusted life years and risk factors of cancer in Australia and comparison with OECD countries, 1990–2015: findings from the Global Burden of Disease Study 2015

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ABSTRACT

Background: Comparative evidence on the burden, trend, and risk factors of cancer is limited. Using data from the Global Burden of Disease (GBD) study, we aimed to assess cancer burden – incidence, prevalence, mortality, disability-adjusted life years (DALYs) – and attributable risk factors for Australia between 1990 and 2015, and to compare them with those of 34 members of the Organisation for Economic Co-operation and Development (OECD).

Methods: The general GBD cancer estimation methods were used with data input from vital registration systems and cancer registries. A comparative risk assessment approach was used to estimate the population-attributable fractions due to risk factors.

Results: In 2015 there were 198,880 (95% uncertainty interval [UI]: 183,908–217,365) estimated incident cancer cases and 47,562 (95% UI: 46,061–49,004) cancer deaths in Australia. Twenty-nine percent (95% UI: 28.2–29.8) of total deaths and 17.0% (95% UI: 15.0–19.1) of DALYs were caused by cancer in Australia in 2015. Cancers of the trachea, bronchus and lung, colon and rectum, and prostate were the most common causes of cancer deaths. Thirty-six percent (95% UI: 33.1–37.9) of all cancer deaths were attributable to behavioral risks. The age-standardized cancer incidence rate (ASIR) increased between 1990 and 2015, while the age-standardized cancer death rate (ASDR) decreased over the same period. In 2015, compared to 34 other OECD countries Australia ranked first (highest) and 24th based on ASIR and ASDR, respectively.

Conclusion: The incidence of cancer has increased over 25 years, and behavioral risks are responsible for a large proportion of cancer deaths. Scaling up of prevention (using strategies targeting cancer risk factors), early detection, and treatment of cancer is required to effectively address this growing health challenge.

1. Introduction

In 2015, cancer was the second leading cause of death globally, cardiovascular diseases being the first [1,2]. Recognizing non-communicable diseases (NCDs) as one of the global grand health concerns, the United Nations (UN) addressed this threat in the High-Level Meeting on Prevention and Control of Non-Communicable Disease in 2011 [3]. NCDs (including cancer) were also identified as a major health challenge in the Sustainable Development Goals (SDGs), with the target of reducing premature mortality due to NCDs by one third by 2030 [4].

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However, despite stakeholder efforts and the remarkable improvements in diagnosis and treatment of cancer in developed countries, the burden is expected to increase due to growth and aging of the population as well as the increasing prevalence of risk factors [5]. In Australia, the economic and social impact of premature death and disability due to cancer is significant. In addition to healthcare costs, premature deaths from cancer in 2003 were responsible for a total loss of $4.2 billion in private income in the country [6]. Systematic evaluation of cancer burden and risk factors, as well as an assessment of trends over time, are important steps toward mitigating the impact and evaluating interventions. However, comparative evidence on the cancer burden and risk factors is limited. In addition, most studies assessing cancer epidemiology in Australia have been limited to a single year, or focused on a particular component of cancer without comparing Australia to other countries, or had a narrow focus (for instance, looking at survival patterns only) [7–12].

Using data from the Global Burden of Disease (GBD) study 2015 [2,13–15], cancer incidence, prevalence, mortality, disability-adjusted life years (DALYs), and attributable risk factors were reported for Australia between 1990 and 2015. Patterns of cancer incidence and deaths by age and sex were assessed. Cancers were ranked − highest (first) to lowest (29^{th}) − on the basis of their crude and age-standardized incidence and mortality rates. The change between 1990 and 2015 was examined for each cancer. In addition, comparisons of estimates between Australia and 34 other members of the Organisation for Economic Co-operation and Development (OECD) were made.

2. Methods

2.1. Study overview

Published results from the GBD 2015 study were used for this analysis [1]. Detailed methods for the GBD study have been published previously [2,13–19]. Methods specific to the cancer estimation and risk factors have also been described elsewhere [15,20,21]. The GBD study adhered to the newly developed Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER) [22]. In this study, estimates for 29 cancer groups, by sex and age, for Australia from 1990 to 2015 are presented. We also compare cancer estimates with 34 other OECD countries (namely Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Singapore, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States). Countries were ranked from highest (first) to lowest (35th) on the basis of age-standardized cancer incidence rate (ASIR) and death rate (ASDR).

2.2. Data sources

Data used in the GBD cancer mortality estimation for OECD countries came from vital registration-system and cancer-registry incidence data that were converted to mortality estimates by using separately estimated mortality-to-incidence (MI) ratios [20]. A list of sources used for the GBD study cancer estimation for Australia is provided in Supplementary Table 1; for the other OECD countries, sources can be found in the Global Health Data Exchange (http://ghdx.healthdata.org/gbd-2015/data-input-sources).

2.3. Data analysis

Major data processing in the GBD cancer estimation steps included adjustments for undefined causes of death ("garbage codes"), mapping between different coding systems, and noise-reduction algorithms. For the MI ratio estimation, processed incidence and mortality data from cancer registries were matched by cancer, age, sex, year, and location [20]. These MI ratios were used as an input into a three-step modeling approach, which included a mixed effect linear regression followed by a space–time smoothing algorithm and a Gaussian process regression. Final MI ratios were selected from eight different models based on out-of-sample validation [20,21]. Using the combined data on cancer-specific mortality, a Cause of Death Ensemble model (CODEm) approach was used to generate mortality estimates for each cancer [2,23]. CODEm models estimate the individual cause-level mortality without taking into account the all-cause mortality. Covariates were used to improve prediction in data-sparse locations [20]. To ensure that all single causes add up to the all-cause mortality and that all child-causes add up to the parent cause, an algorithm called "CodCorrect" was used [2].

GBD cancer incidence estimates were generated by dividing final mortality estimates (after CodCorrect adjustment) by the MI ratio for the specific cancer. MI ratios were also used to calculate cancer survival and prevalence. Cancer DALYs were calculated by summing up years lived with disability (YLDs; multiplicative result of disability weight and prevalence) and years of life lost (YLLs; age-specific cancer deaths multiplied by standard life expectancy). To propagate uncertainty from the MI ratios and the mortality estimates to incidence and prevalence, dividing final mortality estimates by MI ratios was repeated at the 1000-draw level [20].

2.4. Estimation of risk factors for cancer mortality

For the GBD 2015 study, a comparative risk assessment (CRA) approach was used to estimate the proportion of cancers attributable to different risk factors. Data sources for exposure levels of risk factors in Australia and other OECD countries can be accessed through the Global Health Data Exchange (http://ghdx.healthdata.org/gbd-2015/data-input-sources). GBD classifies risk factors into three major categories: behavioral, environmental/occupational, and metabolic. For each risk factor, the attributable burden was estimated by comparing observed deaths to those that would have been observed if a counterfactual level of exposure had occurred in the past. Theoretical minimum risk exposure level (TMREL), which is the level of risk exposure that minimizes risk of diseases at the population level, was used to compute attributable disease burden. Risk factors and their definitions and TMREL are provided in Supplementary Table 2. Methods (data sources, computation process, and statistical analysis approaches) used in estimating exposure levels and associated disease burden have been published elsewhere [15]. In this study we present the number, rate, and proportion of cancer deaths attributable to risk factors in Australia as published in the GBD 2015 study [15]. We also compare the age-adjusted population-attributable fraction (PAF) of different cancer risk factors across all OECD countries.

The GBD world population standard was used for the computation of age-standardized estimates [17]. Results are presented as means with 95% uncertainty intervals in parentheses. Rates are reported per 100,000 person-years.

3. Results

3.1. Cancer incidence, prevalence, mortality, and DALYs in Australia, 2015

In 2015 there were 198,880 (183,908–217,365) incident cancer cases, 1,196,113 (1,128,550–1,268,050) prevalent cancer cases, and 47,562 (46,061–49,004) cancer deaths in Australia; 29% of all deaths (28.2–29.8) in Australia were caused by cancer. Cancer caused 903,288 (867,130–941,532) DALYs in 2015. This represents 17.0% (15.0–19.1) of all-cause DALYs in the country in 2015. The incidence, mortality, and DALYs of cancer were higher among males than females, with male-to-female ratios of 1.5:1, 1.3:1, and 1.3:1, respectively. In 2015, 119,674 (105,477–136,473) and 79,206 (74,326–84,811) incident cases were estimated for males and females, respectively. In the same year, the number of deaths was 27,204 (25,946–28,369) in males and 20,358 (19,540–21,199) in females (Tables 1 and 2 and Supplementary Tables 3 and 4).