

### **Supplementary appendix**

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**Supplementary material accompanying the article:**

**Cancer incidence and mortality in Australia from 2020 to 2044 and an exploratory analysis of the potential effect of treatment delays during the COVID-19 pandemic: a statistical modelling study**

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## **1. Baseline projections for cancer incidence and mortality**

### **1.1. Overview of previous research**

A number of different statistical models have been developed and used to project future cancer incidence and mortality rates, ranging from a simple assumption of a constant cancer mortality rate to more complex models such as age-period-cohort (APC) models, other generalised linear models (GLMs) and extended methods that account for changes in exposure to risk factors.<sup>1,2</sup> A systematic review by Yu and colleagues provided a comprehensive summary of a variety of different statistical methods used in the published literature to project lung cancer incidence or mortality rates which can be applied to the projection of rates for other cancer types.<sup>3</sup> While APC models provide effective projections in many situations, a model that explicitly includes changes in screening patterns or exposure to major risk factors may be required for some cancer types. For the projection of lung cancer rates we have previously developed and validated a GLM which included cigarette smoking exposure as one of the covariates.<sup>1</sup> This method may also be appropriate for the projection of rates for other cancers types incorporating data for important risk factors or diagnostic factors, such as prostate-specific antigen (PSA) testing rates for prostate cancer. More detailed descriptions of these methods have been published elsewhere.<sup>2,3</sup>

A number of previous studies have used APC models to project incidence or mortality rates for all cancers in a population, generally using an approach that sums the projections for the individual cancer types for which there are sufficient numbers of cases or deaths and the projection for the remaining cancer types as a single group.<sup>4-12</sup> Only two international studies have reported long-term projections (20 or more years) of the national incidence and mortality rates for all cancers in the United Kingdom (UK)<sup>4</sup> and United States (US).<sup>5</sup> The UK study published in 2016 used APC models to project cancer incidence and mortality from

2015 to 2035 for all cancers combined and for 27 individual cancer types.<sup>4</sup> A US study published in 2021 reported projections of incidence for all cancers combined and for the 17 most common cancers in terms of numbers of cases or deaths by applying the average annual percentage change estimated using the last five years of observed data through to 2040.<sup>5</sup> However, neither of these two studies directly integrated crucial cancer-specific factors. The only national projections for both cancer incidence and mortality for Australia are short-term projections produced by the Australian Institute of Health and Welfare (AIHW). The AIHW used simple linear and log-linear regression models to project the incidence of all cancers, based on separate projections for prostate cancer and all other cancers from 2011 to 2020,<sup>13</sup> and projections for mortality from all cancers combined from 2014 to 2025.<sup>14</sup> Currently, no population-based projections for 20 or more years of both cancer incidence and mortality in Australia have been published, although a global study (Foreman et al., 2018) reported mortality rate projections for 2017-2040 for 195 countries including Australia.<sup>15</sup> Projections from this study were based on the Global Burden of Diseases Study (GBD) 2016 estimates, with the data for Australia for 2015-2016 being model estimates.<sup>16</sup>

## **1.2. Data sources for this study**

### ***1.2.1. Cancer incidence and mortality data***

We obtained national tabulated data from the AIHW<sup>17</sup> and the World Health Organization's (WHO) Mortality Database (MDB)<sup>18</sup> on the numbers of new cancer cases and the numbers of deaths for all cancers combined (ICD-10 codes C00–C97, D45, D46, D47.1, D47.3–D47.5) and for 21 individual cancer types (Table A1.1) in Australia by sex, age and calendar year. These 21 major cancer types are those with sufficient numbers of cases and deaths to reliably model past rates, and to provide robust and valid projections. For colorectal cancer mortality, “malignant neoplasms of the intestinal tract unspecified (C26.0)” were included, as most

deaths certified as ‘bowel cancer’ and coded as C26.0 are colorectal cancer.<sup>19</sup> In Australia, all states and territories have legislation that makes cancer a notifiable disease, so that various institutions or health service facilities must report cancer cases and deaths to their jurisdictional cancer registry.<sup>17</sup> In addition, it is mandatory for each state and territory to record all deaths in registries administered by the states’ and territories’ Registries of Births, Deaths and Marriages, and either a medical practitioner or a coroner is required to certify the cause of death.<sup>19</sup> Australia has near complete population coverage in the WHO’s MDB.<sup>18</sup> Cancer incidence data for all ages from 1982 to 2017 and mortality data from 1955 to 2019 were available for this study. To minimise the inconsistency due to changes in the ICD codes over time, for the projections we used the incidence data for 1982-2017 and mortality data for 1970-2019 except for lung cancer mortality projections which included data for 1955-2019. For our analyses the cancer incidence and mortality data were aggregated into 5-year age groups and 5-year calendar periods. For the incidence data, we used the average number of cases for 2016 and 2017 as a proxy for the average number of cases in the last 5-year period (2015-2019). We validated this approach using data for cancer incidence in 1982-2017 and cancer mortality data for 1972-2019, by comparing the observed average rate for each 5-year period with the two-year moving average rate for the middle year of the 5-year period. The results showed good agreement with low absolute differences between rates by 5-year period and the average rate for the middle year (median [range] of differences 0.005 [0.0-7.3] cases per 100 000 population for incidence and 0.001 [0.0-0.2] deaths per 100 000 population for mortality). All age-standardised rates presented in the main results of this paper were standardised to the World Segi standard population.<sup>20</sup>

**Table A1.1. ICD-10 codes for selected cancer types and all cancers combined included in this study**

| Cancer groups                                                    | ICD 10-code                                    |
|------------------------------------------------------------------|------------------------------------------------|
| All cancers combined                                             | C00-97, D45-46, D47.1, D47.3-5                 |
| Bladder                                                          | C67                                            |
| Brain                                                            | C71                                            |
| Breast                                                           | C50                                            |
| Colon and rectum                                                 | Incidence (C18-C20); mortality (C18-20, C26.0) |
| Gallbladder and bile duct                                        | C23-C24                                        |
| Kidney                                                           | C64                                            |
| Larynx                                                           | C32                                            |
| Leukaemia                                                        | C91-C95                                        |
| Lip, oral cavity and pharynx                                     | C00-C14, C30-C31                               |
| Liver                                                            | C22                                            |
| Lung                                                             | C33-C34                                        |
| Melanoma                                                         | C43                                            |
| Non-Hodgkin lymphoma                                             | C82-C85                                        |
| Oesophagus                                                       | C15                                            |
| Ovary                                                            | C56-C57                                        |
| Pancreas                                                         | C25                                            |
| Prostate                                                         | C61                                            |
| Stomach                                                          | C16                                            |
| Testis                                                           | C62                                            |
| Thyroid                                                          | C73                                            |
| Uterus                                                           | C54-C55                                        |
| Other cancer (excluding the 21 selected individual cancer types) |                                                |

### ***1.2.2. Data on smoking patterns in Australia***

Data on cigarette smoking exposure were obtained from the International Smoking Statistics (ISS) Web Edition, which provides data from several different surveys and information on annual tobacco sales,<sup>21</sup> and the National Drug Strategy Household Survey (NDSHS) for 2007-2019.<sup>22-26</sup> Detailed descriptions of the data sources for cigarette smoking exposure are provided in our recent study of lung cancer mortality in Australia.<sup>1</sup> In brief, sex-age-period-specific smoking prevalence and cigarette tar exposure per capita in Australia were re-constructed backwards to 1920 and forwards to 2020 to accommodate a lag of 20-30 years.<sup>1</sup>

### ***1.2.3. Data on cancer screening***

Australia currently has national cancer screening programmes for breast (female), cervical and colorectal cancers. The BreastScreen Australia services for breast cancer screening and the National Cervical Screening Program (NCSP) for cervical cancer were introduced in the early 1990s, and the Australian National Bowel Cancer Screening Program (NBCSP) was introduced in 2006.<sup>27</sup> National tabulated data on participation rates by age group in the breast cancer screening programme between 1996 and 2019 were obtained from the AIHW,<sup>27</sup> and the participation rate over the projection period (2020-2044) was assumed to be the same as that in 2019. Screening data from BreastScreen Australia are considered to be high quality, with the majority of screening mammograms performed in Australia occurring through BreastScreen Australia.<sup>27</sup> Unfortunately the short period for which colorectal screening data are available for selected ages and the low rate of participation in the programme meant that screening rates could not be incorporated into the projection models for colorectal cancer. For cervical cancer, as a result of the recognition of the association between cervical cancer and persistent infection with the human papillomavirus (HPV), Australia introduced the National HPV Vaccination Program in April 2007 to further reduce cervical cancer incidence.<sup>28</sup> A recent simulation study has shown that cervical cancer could be eliminated as a public health concern if high coverage in both the HPV vaccination programme and the concurrent national cervical screening programme is maintained.<sup>29</sup> Also, while a cervical cancer screening programme was first introduced in Australia in the early 1990s, a new protocol using new screening technology was introduced in 2017.<sup>29</sup> As there are only limited data on HPV vaccination coverage available, and no available data on the updated screening programme, we do not provide individual projections for cervical cancer incidence or mortality, instead we have included cervical cancer in the ‘other cancers’ group.

#### ***1.2.4. Data on PSA testing***

Australia has universal health-care coverage, with the whole population being eligible to receive high quality, free health-care through the Medicare public health system. The Medicare Benefits Schedule (MBS) administrative datasets contain records of health services, diagnostic procedures and tests provided.<sup>30</sup> National tabulated data on the PSA testing rates by age group between 1994 and 2020 were obtained from the MBS data (MBS item number 66655),<sup>31</sup> and log-linear regression was applied to data for 1994-2020 by age and year to estimate the PSA testing rates for 2021-2044.

#### ***1.2.5. Australian population data***

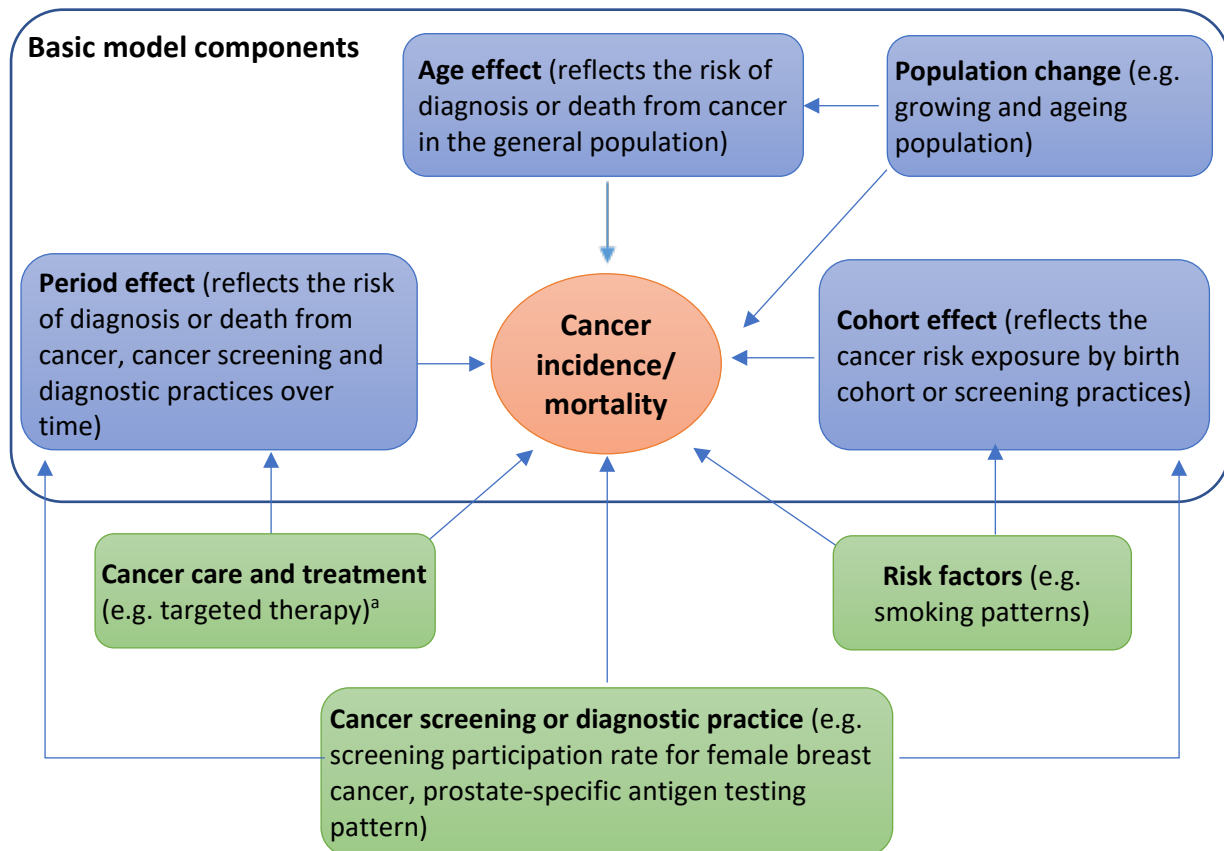
Australian population data by sex, 5-year age group and calendar year from 1955 to 2044 were obtained from the Australian Historical Population Statistics and Population Projections (Series B, based on medium population growth) produced by the Australian Bureau of Statistics (ABS).<sup>32,33</sup>

### **1.3. Statistical projection methods for baseline projections**

#### ***1.3.1. Conceptual framework for baseline projections***

We developed a conceptual framework for the projection of cancer incidence and mortality rates (Figure A1.1). However, limitations in data availability restricted the statistical models that could be practicably implemented.

**Figure A1.1. Conceptual model for the baseline projections of cancer incidence and mortality rates**



a. Data were not available for this study.

### **1.3.2. Baseline projection model selection**

As each individual cancer type has unique disease characteristics, we modelled incidence and mortality rates for each of 21 cancer types separately, where sample sizes allowed, so that the best model for each type could be designed and selected. In brief, for each cancer type, standard APC models were fitted by the `apcspline` command in Stata 17 with natural cubic splines for smoothing.<sup>34</sup> APC models may effectively capture some of the factors which contribute to cancer incidence, as age, period and cohort effects can be considered to be surrogates for exposure to a range of risk factors, and cancer diagnostic and treatment factors (Fig. A1.1).<sup>35</sup> For example, period effects can reflect diagnostic and treatment factors which lead to changes in disease incidence and survival across all age groups,<sup>35</sup> while the cohort effect may represent risk factors, such as smoking behaviours, that change from generation to

generation.<sup>35-37</sup> For those cancer types where it is known that incidence or mortality rates could be strongly impacted by changes in a specific factor, and the relevant data for that factor were available with the required level of detail, a modelling method which could account for that factor was used, including GLMs<sup>1</sup> and APC models incorporating a covariate.<sup>38</sup> The selection of the most appropriate statistical projection model for each cancer type was based on the model fit statistics and the model validation using observed data, as described in the next section. To project rates for all cancers combined, the total numbers of cases and deaths were obtained by summing the estimated numbers of new cases and deaths for 21 individual major cancer types and the remaining cancer types as an ‘other cancers’ group.

### ***1.3.3. Final statistical projection models for individual cancer types***

#### ***Projecting cancer incidence rates***

APC models incorporating cigarette smoking exposure<sup>38</sup> were used to project the incidence rates for lung cancer. The cohort effect is considered to be a reflection of many cohort-specific smoking characteristics and the period effect may reflect other relevant factors such as environmental and occupational factors, and ad hoc lung cancer screening with low dose computerised tomography. An APC model incorporating the participation rate in the breast cancer screening programme was used to project the incidence rate for female breast cancer. For the projection of the prostate cancer incidence rate we used a GLM with a Poisson distribution including age, period and age-specific PSA testing rates. For colorectal cancer incidence we used separate age-stratified APC models for ages <50 years and ages 50 or more years to account for the possible impact of opportunistic and organised screening. Standard APC models were used to project incidence rates for all remaining 17 cancer types. For some cancers, if the period effect or cohort effect was not statistically significant (i.e.

$p > 0.05$ ) in the full APC model, an age-cohort (AC) or age-period (AP) model was selected as the final projection model (Table A1.2).

### ***Projecting cancer mortality rates***

To project colorectal cancer mortality we used an approach similar to the method used for the colorectal cancer incidence projections, with separate age-stratified APC models for ages <50 years and ages 50 or more years to account for the possible impact of opportunistic and organised screening. To project the mortality rates for lung cancer we used previously validated GLMs based on age, cohort and cigarette smoking exposure.<sup>1</sup> For other cancer types which have been shown to have a strong established relationship with cigarette smoking (with >30% of cases caused by smoking), including laryngeal, bladder, oral, and oesophageal cancers,<sup>1</sup> the term for cigarette smoking exposure was not statistically significant in the full APC models. In contrast to the models for incidence rates, the terms for the PSA testing rate and the breast cancer screening participation rate were not statistically significant ( $p\text{-value} > 0.05$ ) in the full APC models for prostate and breast cancer mortality, respectively. Thus, standard APC models were used to project mortality rates for each of all remaining cancer types except lung cancer and colorectal cancer. For some cancers, if the period effect or cohort effect was not statistically significant (i.e.  $p > 0.05$ ) in the full APC model, an age-cohort (AC) or age-period (AP) model was selected as the final projection model. Final statistical projection methods used for each of the selected cancer types are listed in Table A1.2.

**Table A1.2. Final statistical projection methods used for incidence and mortality projections for selected cancer types and all cancers combined**

| Cancer group (ICD 10-code)                                        | Projection method                                                                                                                                  |                                                                                                                                              |
|-------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                   | Incidence                                                                                                                                          | Mortality                                                                                                                                    |
| All cancers combined                                              | Number of new cases estimated by summing the number of new cases for 21 individual cancer types and the remaining cancer types as an 'other' group | Number of deaths estimated by summing the number of deaths for 21 individual cancer types and the remaining cancer types as an 'other' group |
| Bladder                                                           | APC model                                                                                                                                          | APC model                                                                                                                                    |
| Brain                                                             | AC model                                                                                                                                           | APC model                                                                                                                                    |
| Breast                                                            | APC model with screening participation rate as a covariate                                                                                         | APC model                                                                                                                                    |
| Colon and rectum                                                  | Age-stratified APC model for age <50 years and age 50 or more                                                                                      | Age-stratified APC model for age <50 years and age 50 or more                                                                                |
| Gallbladder and bile duct                                         | APC model                                                                                                                                          | APC model                                                                                                                                    |
| Kidney                                                            | APC model                                                                                                                                          | APC model                                                                                                                                    |
| Larynx                                                            | APC model                                                                                                                                          | APC model                                                                                                                                    |
| Leukaemia                                                         | APC model                                                                                                                                          | APC model for males, AC model for females.                                                                                                   |
| Lip, oral cavity and pharynx                                      | APC model                                                                                                                                          | APC model                                                                                                                                    |
| Liver                                                             | AC model                                                                                                                                           | AC model for males, APC model for females                                                                                                    |
| Lung                                                              | APC model with cigarette smoking exposure as a covariate                                                                                           | GLM: includes age, cohort and cigarette smoking exposure as a covariate                                                                      |
| Melanoma                                                          | APC model                                                                                                                                          | AC model                                                                                                                                     |
| Non-Hodgkin lymphoma                                              | APC model                                                                                                                                          | APC model                                                                                                                                    |
| Oesophagus                                                        | AP model for males, AC model for females                                                                                                           | APC model                                                                                                                                    |
| Ovary                                                             | AC model                                                                                                                                           | APC model                                                                                                                                    |
| Pancreas                                                          | AP model for males, APC model for females                                                                                                          | APC model                                                                                                                                    |
| Prostate                                                          | GLM: includes age, period and PSA testing rate as a covariate                                                                                      | APC model                                                                                                                                    |
| Stomach                                                           | APC model                                                                                                                                          | APC model                                                                                                                                    |
| Testis                                                            | APC model                                                                                                                                          | AP model                                                                                                                                     |
| Thyroid                                                           | APC model                                                                                                                                          | APC model                                                                                                                                    |
| Uterus                                                            | APC model                                                                                                                                          | APC model                                                                                                                                    |
| Other cancers (excluding the 21 selected individual cancer types) | APC model                                                                                                                                          | APC model                                                                                                                                    |

GLM: generalised linear model; AC: age-cohort; AP: age-period; APC: age-period-cohort; PSA: prostate specific antigen.

### ***1.3.4. Detailed statistical projection models and assumptions***

#### ***APC models***

To project cancer incidence and cancer mortality for all cancer types except lung, breast and prostate cancers, we used APC models including age, period and cohort components within the framework of a GLM with Poisson distribution. The APC models were fitted by the `apcspline` command in Stata 17 with natural cubic splines for smoothing.<sup>34</sup> Briefly, we compared a number of APC models with different numbers of knots for the age, period and cohort effects to identify the one with the lowest Bayesian information criterion (BIC). The APC model with the log-link function can be expressed as:

$$\ln D_{ij} = \ln N_{ij} + \alpha \text{Age}_i + \beta \text{Period}_j + \gamma \text{Cohort}_k$$

where  $D_{ij}$  denotes the number of new cases or deaths from cancer for the  $i^{\text{th}}$  age group during the  $j^{\text{th}}$  calendar period;  $N_{ij}$  denotes the number at risk in the population for the  $i^{\text{th}}$  age group during the  $j^{\text{th}}$  calendar period;  $\alpha$  is the coefficient of the age component for age group  $i$ ;  $\beta$  is the non-linear coefficient of the period component for period  $j$ , and  $\gamma$  is the non-linear coefficient of the cohort component for birth cohort  $k$ . To project mortality rates beyond the observed period, future periods and cohorts were assumed to have the same effect as those for the most recent observed period and cohort. As these historical trends will not continue indefinitely, the default setting for the damping factor (equal to 0.92) was used, so that the drift was reduced by 8% for each year following the last observation.<sup>34</sup> In this study, the log link model offered better model fit compared to the power function, therefore estimates based on the log link model were presented.

#### ***Projection method for prostate cancer incidence using a GLM***

In an analogous approach, to project the prostate cancer incidence rate we used a GLM with a Poisson distribution including age, period and age-specific PSA testing rate. The final fitted

model can be presented as a parsimonious equation:

$$\ln D_{ij} = \ln N_{ij} + \alpha \text{Age}_i + \beta \text{Period}_j + \delta \text{PSA}_{ij-1}$$

where  $D_{ij}$  denotes the number of new cases with prostate cancer for the  $i^{\text{th}}$  age group during the  $j^{\text{th}}$  calendar period;  $N_{ij}$  denotes the number at risk in the population for the  $i^{\text{th}}$  age group during the  $j^{\text{th}}$  calendar period;  $\alpha$  is the coefficient of the age component for age group  $i$ ;  $\beta$  is the non-linear coefficient of the period component for period  $j$ ;  $\delta$  is the coefficient of the  $\text{PSA}_{ij-1}$ , which denotes the age-period-specific PSA testing rates in the population for the  $i^{\text{th}}$  age group during  $j-1^{\text{th}}$  calendar period, which is lagged by 1 year based on the model selection process and model validation, reflecting that there is generally only a short lag between initial PSA testing and prostate cancer diagnosis.<sup>39</sup> To project prostate cancer incidence beyond the observed calendar period, these models assumed that the age effects remained constant over time,<sup>37,40</sup> and we used period-specific PSA testing rates to predict the future period effects.

### ***Projection method for lung cancer incidence using APC models with smoking as a covariate***

As period effects capture other factors that contribute to changes in incidence for lung cancer, including other risk factors and cancer diagnostic practices, we used a modified APC model incorporating cigarette tar exposure as an additional covariate to project lung cancer incidence. The final fitted model can be presented as a parsimonious equation:

$$\ln D_{ij} = \ln N_{ij} + \alpha \text{Age}_i + \beta \text{Period}_j + \gamma \text{Cohort}_k + \delta \text{CTC}_{ij-L}$$

where  $D_{ij}$  denotes the number of new cases with lung cancer for the  $i^{\text{th}}$  age group during the  $j^{\text{th}}$  calendar period;  $N_{ij}$  denotes the number at risk in the population for the  $i^{\text{th}}$  age group during the  $j^{\text{th}}$  calendar period;  $\alpha$  is the coefficient of the age component for age group  $i$ ;  $\beta$  is the non-linear coefficient of the period component for period  $j$ , and  $\gamma$  is the non-linear

coefficient of the cohort component for birth cohort  $k$ ;  $\delta$  is the coefficient of  $CTC_{ij-L}$ , which denotes the sex-age-period-specific cigarette tar exposure in the population for the  $i^{th}$  age group during  $j-L^{th}$  calendar period, which is lagged by  $L$  years (smoking exposure lagged 28 years for males and 30 years for females).<sup>1,41</sup>

The process of using the modified APC model involves two steps. First, the models were fitted by the updated `apcspline` command in Stata 17 with natural cubic splines for smoothing, which can include age-period-specific cigarette tar exposure as a covariate in the APC model.<sup>38</sup> Second, the coefficients for birth cohorts were extracted from the best model selected based on the BIC, which was merged with sex-cohort specific cigarette tar exposure. The future cohort parameters were estimated by fitting a linear regression model for cohort coefficients and the cohort-specific cigarette tar exposure.<sup>1</sup> To project lung cancer incidence rates beyond the observed calendar period these models assumed that the age effects remained constant over time.<sup>37,40</sup> The default setting for the damping factor (equal to 0.92) was used, so that the drift was reduced by 8% for each year following the last observation, and future periods were assumed to have the same effect as those for the most recent observed period.<sup>34</sup>

### ***Projection method for deaths from lung cancer using GLMs***

We previously developed and validated a GLM model with a Poisson distribution which included cigarette smoking exposure as one of the covariates for the projection of lung cancer mortality rates.<sup>1</sup> A detailed explanation of the method is provided elsewhere,<sup>1</sup> but the final fitted model for each sex can be presented as a parsimonious equation:

$$\ln D_{ij} = \ln N_{ij} + \alpha Age_i + \gamma Cohort_k + \delta CTC_{ij-L}$$

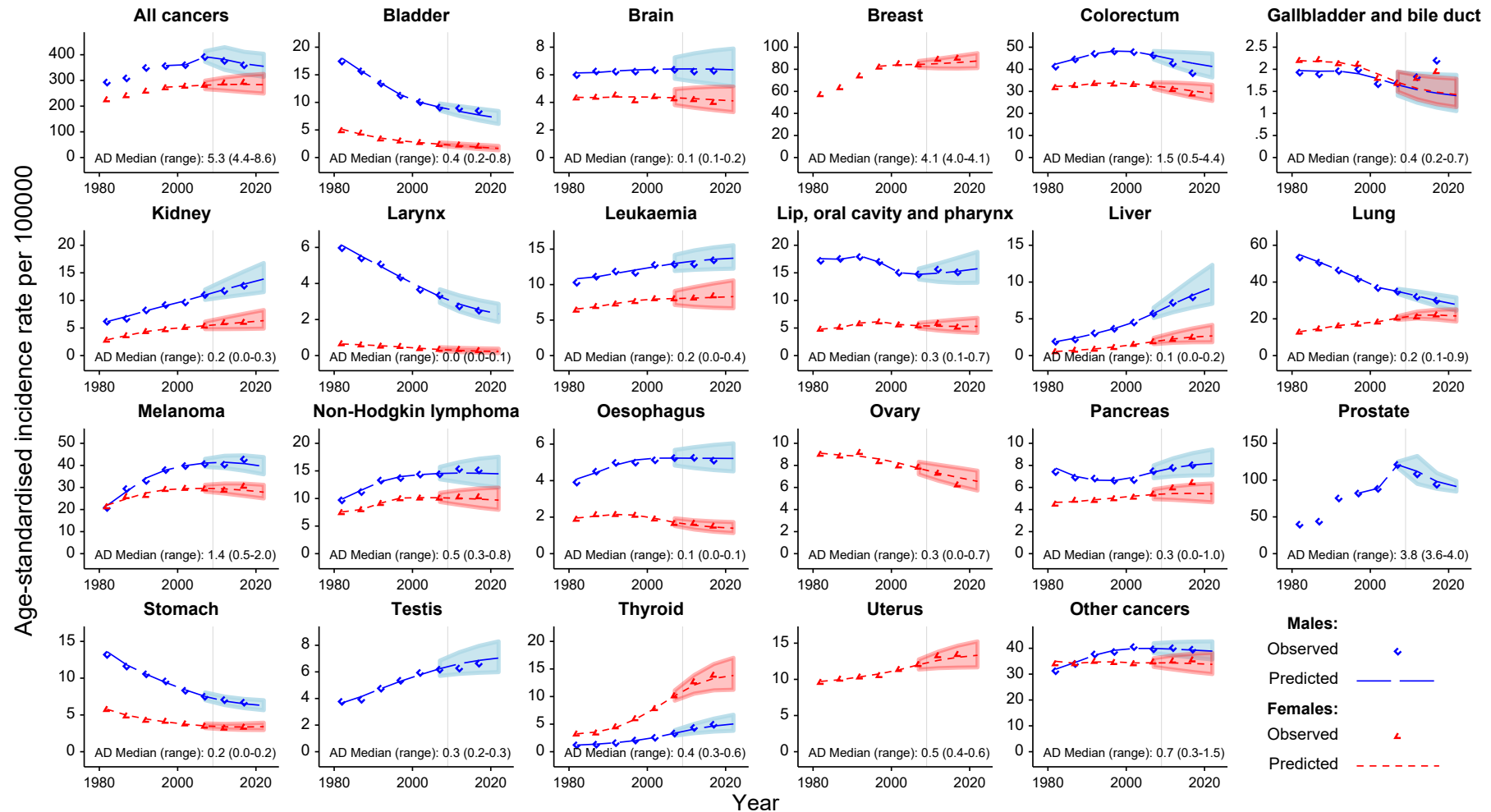
where  $D_{ij}$  denotes the number of deaths from lung cancer for the  $i^{th}$  age group during the  $j^{th}$

calendar period;  $N_{ij}$  denotes the number at risk in the population for the  $i^{th}$  age group during the  $j^{th}$  calendar period;  $\alpha$  is the coefficient of the age component for age group  $i$ ;  $\gamma$  is the non-linear coefficient of the cohort component for birth cohort  $k$ ;  $\delta$  is the coefficient of  $CTC_{ij-L}$ , which denotes the sex-age-period-specific cigarette tar exposure in the population for the  $i^{th}$  age group during  $j-L^{th}$  calendar period, which is lagged by  $L$  years (lagged 26 years for males and 29 years for females).<sup>1,41</sup> To project lung cancer mortality rates beyond the observed calendar period, these models assumed that the age effects remained constant over time,<sup>37,40</sup> and we used cohort-specific cigarette tar exposure to predict the future cohort effects.<sup>1</sup>

### **1.3.5. Model validation**

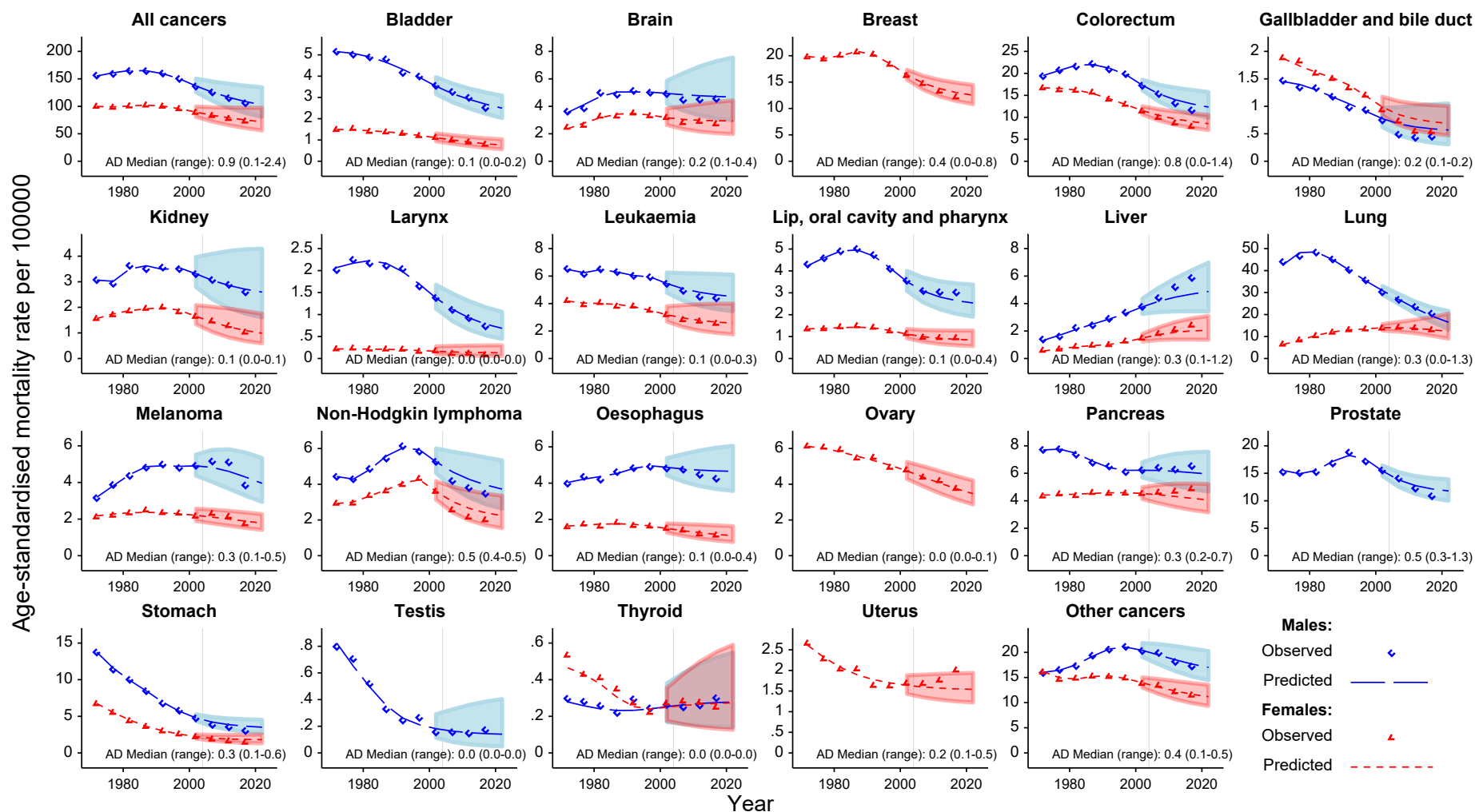
Model validation provides information on the performance and reliability of the projection model and can be undertaken by withholding the most recent observed data from the model fitting and then comparing the projected rates for those years with the actual observed rates. The graphed projected and observed cancer rates were visually inspected to assess the agreement in the overall trends. We also assessed the absolute differences between the projected and observed rates. Validations of 10-year projections for incidence rates and 15-year projections for mortality rates for all cancers combined as well as for 21 individual cancer types showed that the uncertainty intervals of the projected rates generally captured the observed rates, with low absolute differences (median [range] 0.3 [0.0-8.6] cases per 100 000 population for incidence and 0.2 [0.0-2.4] deaths per 100 000 population for mortality). This suggests that the models provide valid 10- and 15-year projections for incidence and mortality, respectively, for all cancers combined as well as for 21 cancer types in Australia (Figures A1.2 and A1.3). As the historical cancer incidence data available for this study were of much shorter duration, we were not able to conduct longer-term validations for the incidence projections.

**Figure A1.2. Validation of 10-year projections for age standardised incidence rates for all cancers combined and individual cancer types in Australia using observed data from 1982 to 2009 projected to 2019, compared to observed data for 2010-2019**



All rates are age-standardised to the Segi World standard population. Observed data for 2015-2019 were estimated based on the average number of cases in 2016-2017. AD: absolute difference between projected and observed rates per 100 000 population.

**Figure A1.3. Validation of 15-year projections for mortality rates for all cancers combined and individual cancer types in Australia using observed data from 1970 to 2004 projected to 2019, compared to observed data for 2005-2019**



All rates are age-standardised to the Segi World standard population. AD: absolute difference between projected and observed rates per 100 000 population.

#### **1.4. Limitations of baseline projection models**

While we have attempted to design a reliable method for modelling future cancer incidence and mortality rates, as with all modelled projections this study has some limitations which should be considered when interpreting the results. The main limitation of the baseline projections is their dependence on the assumptions made, including that the age effect will remain unchanged over time and reflects the general level of cancer risk in the population, that for cancers other than lung cancer the future cohort and future period effects will be the same as those for the most recent observed cohort and period,<sup>34</sup> and that for prostate and breast cancers the most recent trends in the PSA testing rate and breast cancer screening participation rate will continue into the future. These assumptions do not aim to capture any major quantitative changes in any underlying factors, such as the introduction of a new screening programme, the implementation of new cancer control initiatives, or the development of any new cancer treatments. There are also limitations in the data available, so that it was not always possible to use the most ideal model for each cancer type. For example, our models could not account for the impact of the human papilloma virus vaccination programme which was introduced in Australia in 2007 nor the new cervical screening programme that commenced in late 2017.<sup>29</sup> Similarly, the statistical projections for colorectal cancer provided in this report do not take into account the completed roll-out of the NBCSP. Detailed projections for colorectal cancer, based on microsimulation modelling, which reflect the full impact of the screening programme have been published elsewhere.<sup>42</sup> Another limitation of the study is that the observed incidence rates for 2015-2019 were estimated based on the average rates for 2016-2017. In addition, the population denominators were themselves projected by the ABS,<sup>33</sup> and it is unknown to what extent the COVID-19 pandemic will impact on population growth, including rates of migration, so this adds further uncertainty to our projections.

## 1.5. Additional results from the baseline projections

**Table A1.3. Observed and projected age-standardised incidence rates and numbers of new cases to 2044 for baseline projections of all cancers combined and 21 individual cancer types in Australia**

|                              | Annual age-standardised rate per 100 000 <sup>a</sup> |                                     |               |                                            |                | Number of new cases   |                                    |                   |                                                |               |                                          |                       |
|------------------------------|-------------------------------------------------------|-------------------------------------|---------------|--------------------------------------------|----------------|-----------------------|------------------------------------|-------------------|------------------------------------------------|---------------|------------------------------------------|-----------------------|
|                              | Observed<br>2015-2019                                 | Projected in 2040-<br>2044 (95% UI) |               | Change in rates %<br>(95% UI) <sup>b</sup> |                | Observed<br>2015-2019 | Projected in 2040-2044<br>(95% UI) |                   | Change in new<br>cases % (95% UI) <sup>c</sup> |               | Total projected in 2020-2044<br>(95% UI) |                       |
| Males                        |                                                       |                                     |               |                                            |                |                       |                                    |                   |                                                |               |                                          |                       |
| All cancer                   | 360.5                                                 | 327.8                               | (297.3-363.1) | -9.1                                       | (-17.5, 0.7)   | 380 306               | 560 744                            | (514 244-613 356) | 47.4                                           | (35.2, 61.3)  | 2 467 319                                | (2 289 133-2 665 718) |
| Bladder                      | 8.5                                                   | 7.5                                 | (6.5-8.5)     | -11.8                                      | (-23.5, 0.0)   | 10 727                | 16 858                             | (14 862-19 126)   | 57.2                                           | (38.6, 78.3)  | 73 785                                   | (66 415-82 019)       |
| Brain                        | 6.3                                                   | 5.9                                 | (5.0-7.2)     | -6.3                                       | (-20.6, 14.3)  | 5520                  | 7641                               | (6551-8956)       | 38.4                                           | (18.7, 62.2)  | 34 110                                   | (29 804-39 210)       |
| Colorectum <sup>d</sup>      | 38.4                                                  | 31.7                                | (27.7-36.5)   | -17.4                                      | (-27.9, -4.9)  | 41 827                | 51 819                             | (46 119-58 379)   | 23.9                                           | (10.3, 39.6)  | 236 630                                  | (215 604-260 273)     |
| Gallbladder and bile duct    | 2.2                                                   | 2.3                                 | (1.8-2.8)     | 4.5                                        | (-18.2, 27.3)  | 2629                  | 4640                               | (3777-5704)       | 76.5                                           | (43.7, 117.0) | 19 463                                   | (16 244-23 347)       |
| Kidney                       | 12.7                                                  | 17.0                                | (14.7-19.6)   | 33.9                                       | (15.7, 54.3)   | 12 348                | 24 251                             | (21 211-27 755)   | 96.4                                           | (71.8, 124.8) | 96 659                                   | (86 148-108 611)      |
| Larynx                       | 2.5                                                   | 1.7                                 | (1.4-2.1)     | -32.0                                      | (-44.0, -16.0) | 2702                  | 2857                               | (2373-3441)       | 5.7                                            | (-12.2, 27.4) | 13 630                                   | (11 614-16 013)       |
| Leukaemia                    | 13.5                                                  | 14.1                                | (12.8-15.6)   | 4.4                                        | (-5.2, 15.6)   | 13 425                | 23 108                             | (21 633-24 774)   | 72.1                                           | (61.1, 84.5)  | 97 143                                   | (91 220-103 774)      |
| Lip, oral cavity and pharynx | 15.2                                                  | 13.8                                | (12.0-15.9)   | -9.2                                       | (-21.1, 4.6)   | 14 404                | 20 442                             | (17 810-23 469)   | 41.9                                           | (23.7, 62.9)  | 92 318                                   | (82 382-103 525)      |
| Liver                        | 8.0                                                   | 9.4                                 | (7.8-11.6)    | 17.5                                       | (-2.5, 45.0)   | 8192                  | 15 785                             | (13 209-18 937)   | 92.7                                           | (61.2, 131.2) | 66 639                                   | (57 461-77 622)       |
| Lung                         | 30.1                                                  | 26.0                                | (23.4-29.0)   | -13.6                                      | (-22.3, -3.7)  | 35 336                | 50 558                             | (45 626-56 028)   | 43.1                                           | (29.1, 58.6)  | 221 893                                  | (203 901-241 567)     |
| Melanoma                     | 42.8                                                  | 35.4                                | (32.9-38.3)   | -17.3                                      | (-23.1, -10.5) | 43 388                | 61 712                             | (57 695-66 117)   | 42.2                                           | (33.0, 52.4)  | 284 348                                  | (268 458-301 593)     |
| Non-Hodgkin lymphoma         | 15.2                                                  | 14.6                                | (12.7-16.9)   | -3.9                                       | (-16.4, 11.2)  | 15 738                | 24 946                             | (21 903-28 456)   | 58.5                                           | (39.2, 80.8)  | 109 545                                  | (98 107-122 541)      |
| Oesophagus                   | 5.1                                                   | 4.8                                 | (4.3-5.4)     | -5.9                                       | (-15.7, 5.9)   | 5598                  | 8664                               | (7735-9705)       | 54.8                                           | (38.2, 73.4)  | 37 553                                   | (33 932-41 573)       |
| Pancreas                     | 8.1                                                   | 9.4                                 | (8.4-10.5)    | 16.0                                       | (3.7, 29.6)    | 9372                  | 18 145                             | (16 340-20 154)   | 93.6                                           | (74.3, 115.0) | 74 869                                   | (68 250-82 157)       |
| Prostate                     | 94.2                                                  | 76.8                                | (74.0-79.6)   | -18.5                                      | (-21.4, -15.5) | 99 565                | 133 917                            | (129 271-138 744) | 34.5                                           | (29.8, 39.4)  | 600 329                                  | (578 426-623 150)     |
| Stomach                      | 6.7                                                   | 5.8                                 | (5.2-6.3)     | -13.4                                      | (-22.4, -6.0)  | 7521                  | 10 818                             | (9916-11 806)     | 43.8                                           | (31.8, 57.0)  | 46 764                                   | (43 327-50 497)       |
| Testis                       | 6.6                                                   | 7.0                                 | (6.1-7.9)     | 6.1                                        | (-7.6, 19.7)   | 4403                  | 6221                               | (5460-7095)       | 41.3                                           | (24.0, 61.1)  | 27 690                                   | (24 637-31 157)       |
| Thyroid                      | 5.0                                                   | 6.9                                 | (5.5-8.5)     | 38.0                                       | (10.0, 70.0)   | 4229                  | 8635                               | (7020-10 651)     | 104.2                                          | (66.0, 151.9) | 36 320                                   | (30 429-43 468)       |
| Other cancers                | 39.6                                                  | 37.6                                | (34.8-40.7)   | -5.1                                       | (-12.1, 2.8)   | 43 380                | 69 728                             | (65 733-74 062)   | 60.7                                           | (51.5, 70.7)  | 297 630                                  | (282 775-313 619)     |

| Females                      |       |       |               |       |                |         |         |                   |       |               |                                 |
|------------------------------|-------|-------|---------------|-------|----------------|---------|---------|-------------------|-------|---------------|---------------------------------|
| All cancer                   | 293.3 | 290.1 | (261.7-323.0) | -1.1  | (-10.8, 10.1)  | 313 263 | 483 527 | (439 069-534 090) | 54.4  | (40.2, 70.5)  | 2 095 528 (1 930 498-2 280 337) |
| Bladder                      | 2.1   | 1.7   | (1.4-2.1)     | -19.0 | (-33.3, 0.0)   | 3316    | 4485    | (3686-5468)       | 35.3  | (11.2, 64.9)  | 19 727 (16 751-23 285)          |
| Brain                        | 4.0   | 3.5   | (2.9-4.3)     | -12.5 | (-27.5, 7.5)   | 3573    | 4773    | (4022-5671)       | 33.6  | (12.6, 58.7)  | 21 734 (18 678-25 332)          |
| Breast                       | 90.2  | 95.1  | (90.1-100.5)  | 5.4   | (-0.1, 11.4)   | 88 268  | 137 776 | (131 094-144 823) | 56.1  | (48.5, 64.1)  | 593 248 (568 630-619 034)       |
| Colorectum <sup>d</sup>      | 28.9  | 25.1  | (22.4-28.1)   | -13.1 | (-22.5, -2.8)  | 35 334  | 44 898  | (40 372-49 938)   | 27.1  | (14.3, 41.3)  | 203 811 (186 716-222 572)       |
| Gallbladder and bile duct    | 1.9   | 2.0   | (1.7-2.3)     | 5.3   | (-10.5, 21.1)  | 2718    | 4577    | (3874-5408)       | 68.4  | (42.5, 99.0)  | 18 968 (16 305-22 075)          |
| Kidney                       | 6.1   | 7.7   | (6.3-9.5)     | 26.2  | (3.3, 55.7)    | 6270    | 12 107  | (10 028-14 643)   | 93.1  | (59.9, 133.5) | 48 554 (41 366-57 133)          |
| Larynx                       | 0.3   | 0.2   | (0.1-0.4)     | -33.3 | (-66.7, 33.3)  | 322     | 393     | (245-634)         | 22.0  | (-23.9, 96.9) | 1760 (1178-2660)                |
| Leukaemia                    | 8.4   | 9.0   | (7.6-10.9)    | 7.1   | (-9.5, 29.8)   | 8665    | 15 256  | (13 448-17 398)   | 76.1  | (55.2, 100.8) | 62 636 (55 927-70 485)          |
| Lip, oral cavity and pharynx | 5.2   | 5.3   | (4.3-6.5)     | 1.9   | (-17.3, 25.0)  | 5678    | 8717    | (7140-10 644)     | 53.5  | (25.7, 87.5)  | 36 992 (31 253-43 832)          |
| Liver                        | 2.5   | 3.3   | (2.4-4.6)     | 32.0  | (-4.0, 84.0)   | 3087    | 6929    | (5369-9071)       | 124.5 | (73.9, 193.8) | 27 639 (22 359-34 638)          |
| Lung                         | 22.2  | 19.1  | (17.0-21.6)   | -14.0 | (-23.4, -2.7)  | 27 430  | 40 105  | (35 884-44 837)   | 46.2  | (30.8, 63.5)  | 180 070 (164 410-197 344)       |
| Melanoma                     | 30.6  | 25.6  | (23.5-28.0)   | -16.3 | (-23.2, -8.5)  | 30 622  | 43 304  | (40 000-46 940)   | 41.4  | (30.6, 53.3)  | 197 968 (184 845-212 263)       |
| Non-Hodgkin lymphoma         | 10.3  | 10.2  | (8.7-11.9)    | -1.0  | (-15.5, 15.5)  | 11 782  | 19 062  | (16 485-22 076)   | 61.8  | (39.9, 87.4)  | 82 307 (72 776-93 266)          |
| Oesophagus                   | 1.5   | 1.1   | (1.0-1.4)     | -26.7 | (-33.3, -6.7)  | 2062    | 2839    | (2388-3376)       | 37.7  | (15.9, 63.8)  | 12 412 (10 628-14 503)          |
| Ovary                        | 6.2   | 4.7   | (4.2-5.3)     | -24.2 | (-32.3, -14.5) | 6544    | 8075    | (7220-9035)       | 23.4  | (10.3, 38.1)  | 37 533 (34 032-41 412)          |
| Pancreas                     | 6.5   | 7.3   | (6.5-8.2)     | 12.3  | (0.0, 26.2)    | 8633    | 17 063  | (15 287-19 053)   | 97.6  | (77.1, 120.7) | 68 766 (62 436-75 774)          |
| Stomach                      | 3.4   | 3.4   | (3.0-3.9)     | 0.0   | (-11.8, 14.7)  | 4035    | 7077    | (6331-7918)       | 75.4  | (56.9, 96.2)  | 28 490 (25 820-31 460)          |
| Thyroid                      | 13.9  | 14.2  | (12.2-16.6)   | 2.2   | (-12.2, 19.4)  | 11 219  | 17 212  | (14 770-20 072)   | 53.4  | (31.7, 78.9)  | 77 979 (68 594-88 741)          |
| Uterus                       | 13.5  | 14.9  | (13.5-16.5)   | 10.4  | (0.0, 22.2)    | 14 056  | 23 488  | (21 263-25 949)   | 67.1  | (51.3, 84.6)  | 99 930 (91 649-108 988)         |
| Other cancers                | 35.6  | 36.5  | (33.2-40.4)   | 2.5   | (-6.7, 13.5)   | 39 651  | 65 388  | (60 162-71 136)   | 64.9  | (51.7, 79.4)  | 275 004 (256 146-295 538)       |

a. All rates are age-standardised to the Segi World standard population.

b. Overall percentage change in the age-standardised rate projected for 2040-2044 compared to the age-standardised rate observed in 2015-2019.

c. Overall percentage change in the numbers of cases projected for 2040-2044 compared to the numbers of cases in 2015-2019.

d. Projections for colorectal cancer do not take into account the completed roll-out of the National Bowel Cancer Screening Program. Detailed projections for colorectal cancer based on microsimulation modelling have been published elsewhere.<sup>42</sup>

UI: uncertainty interval.

**Table A1.4. Observed and projected age-standardised mortality rates and numbers of deaths to 2044 for baseline projections of all cancers combined and 21 individual cancer types in Australia**

|                              | Annual age-standardised rate per 100 000 <sup>a</sup> |                                     |              |                                            |                | Number of deaths      |                                    |                   |                                             |                |                                          |                   |
|------------------------------|-------------------------------------------------------|-------------------------------------|--------------|--------------------------------------------|----------------|-----------------------|------------------------------------|-------------------|---------------------------------------------|----------------|------------------------------------------|-------------------|
|                              | Observed<br>2015-2019                                 | Projected in 2040-<br>2044 (95% UI) |              | Change in rates %<br>(95% UI) <sup>b</sup> |                | Observed<br>2015-2019 | Projected in 2040-2044 (95%<br>UI) |                   | Change in deaths %<br>(95% UI) <sup>c</sup> |                | Total projected in 2020-2044<br>(95% UI) |                   |
| Males                        |                                                       |                                     |              |                                            |                |                       |                                    |                   |                                             |                |                                          |                   |
| All cancer                   | 106.3                                                 | 83.4                                | (68.0-105.1) | -21.5                                      | (-36.0, -1.1)  | 132 440               | 180 663                            | (152 719-217 126) | 36.4                                        | (15.3, 63.9)   | 816 221                                  | (713 958-943 249) |
| Bladder                      | 2.5                                                   | 1.9                                 | (1.5-2.3)    | -24.0                                      | (-40.0, -8.0)  | 3736                  | 5148                               | (4270-6220)       | 37.8                                        | (14.3, 66.5)   | 22 003                                   | (19 073-25 468)   |
| Brain                        | 4.6                                                   | 4.5                                 | (3.2-6.4)    | -2.2                                       | (-30.4, 39.1)  | 4330                  | 6493                               | (4838-8804)       | 50.0                                        | (11.7, 103.3)  | 28 738                                   | (22 430-37 177)   |
| Colorectum <sup>d</sup>      | 11.7                                                  | 9.0                                 | (7.3-11.3)   | -23.1                                      | (-37.6, -3.4)  | 14 397                | 17 609                             | (14 964-21 010)   | 22.3                                        | (3.9, 45.9)    | 81 851                                   | (71 737-94 349)   |
| Gallbladder and bile duct    | 0.5                                                   | 0.4                                 | (0.3-0.6)    | -20.0                                      | (-40.0, 20.0)  | 586                   | 892                                | (557-1427)        | 52.2                                        | (-4.9, 143.5)  | 3807                                     | (2538-5735)       |
| Kidney                       | 2.6                                                   | 2.2                                 | (1.6-3.0)    | -15.4                                      | (-38.5, 15.4)  | 3094                  | 4426                               | (3301-5967)       | 43.1                                        | (6.7, 92.9)    | 19 383                                   | (15 098-25 058)   |
| Larynx                       | 0.7                                                   | 0.4                                 | (0.3-0.6)    | -42.9                                      | (-57.1, -14.3) | 897                   | 815                                | (583-1140)        | -9.1                                        | (-35.0, 27.1)  | 4157                                     | (3126-5540)       |
| Leukaemia                    | 4.4                                                   | 3.5                                 | (2.8-4.5)    | -20.5                                      | (-36.4, 2.3)   | 5550                  | 7726                               | (6551-9247)       | 39.2                                        | (18.0, 66.6)   | 35 025                                   | (30 322-40 940)   |
| Lip, oral cavity and pharynx | 3.0                                                   | 2.9                                 | (2.3-3.6)    | -3.3                                       | (-23.3, 20.0)  | 3288                  | 4870                               | (3969-5981)       | 48.1                                        | (20.7, 81.9)   | 21 212                                   | (17 807-25 303)   |
| Liver                        | 5.9                                                   | 7.2                                 | (5.9-8.9)    | 22.0                                       | (0.0, 50.8)    | 6574                  | 13 866                             | (11 533-16 699)   | 110.9                                       | (75.4, 154.0)  | 57 792                                   | (49 508-67 584)   |
| Lung                         | 20.6                                                  | 11.7                                | (8.5-17.2)   | -43.2                                      | (-58.7, -16.5) | 25 133                | 24 646                             | (20 019-32 130)   | -1.9                                        | (-20.3, 27.8)  | 125 628                                  | (110 983-146 614) |
| Melanoma                     | 3.9                                                   | 2.0                                 | (1.7-2.5)    | -48.7                                      | (-56.4, -35.9) | 4647                  | 4824                               | (4001-5819)       | 3.8                                         | (-13.9, 25.2)  | 24 816                                   | (21 220-29 057)   |
| Non-Hodgkin lymphoma         | 3.5                                                   | 2.7                                 | (2.1-3.5)    | -22.9                                      | (-40.0, 0.0)   | 4487                  | 5998                               | (4766-7608)       | 33.7                                        | (6.2, 69.6)    | 27 824                                   | (22 920-34 036)   |
| Oesophagus                   | 4.3                                                   | 3.8                                 | (3.2-4.5)    | -11.6                                      | (-25.6, 4.7)   | 4885                  | 7250                               | (6124-8585)       | 48.4                                        | (25.4, 75.7)   | 31 582                                   | (27 303-36 555)   |
| Pancreas                     | 6.5                                                   | 6.3                                 | (5.5-7.3)    | -3.1                                       | (-15.4, 12.3)  | 7814                  | 12 897                             | (11 193-14 862)   | 65.0                                        | (43.2, 90.2)   | 55 479                                   | (49 100-62 716)   |
| Prostate                     | 10.9                                                  | 9.2                                 | (8.1-10.5)   | -15.6                                      | (-25.7, -3.7)  | 16 625                | 28 231                             | (24 954-31 942)   | 69.8                                        | (50.1, 92.1)   | 116 385                                  | (105 465-128 521) |
| Stomach                      | 3.0                                                   | 2.4                                 | (2.0-2.9)    | -20.0                                      | (-33.3, -3.3)  | 3624                  | 5087                               | (4226-6124)       | 40.4                                        | (16.6, 69.0)   | 22 296                                   | (18 999-26 183)   |
| Testis                       | 0.2                                                   | 0.2                                 | (0.1-0.4)    | 0.0                                        | (-50.0, 100.0) | 136                   | 206                                | (94-454)          | 51.5                                        | (-30.9, 233.8) | 888                                      | (444-1794)        |
| Thyroid                      | 0.3                                                   | 0.3                                 | (0.2-0.5)    | 0.0                                        | (-33.3, 66.7)  | 353                   | 637                                | (414-980)         | 80.5                                        | (17.3, 177.6)  | 2617                                     | (1758-3901)       |
| Other cancers                | 17.3                                                  | 12.7                                | (11.3-14.5)  | -26.6                                      | (-34.7, -16.2) | 22 284                | 29 041                             | (26 363-32 125)   | 30.3                                        | (18.3, 44.2)   | 134 739                                  | (124 126-146 716) |

| Females                      |      |      |             |        |                |         |         |                   |       |               |                           |
|------------------------------|------|------|-------------|--------|----------------|---------|---------|-------------------|-------|---------------|---------------------------|
| All cancer                   | 73·4 | 58·3 | (47·7-73·5) | -20·6  | (-35·0, 0·1)   | 102 103 | 139 482 | (118 186-167 527) | 36·6  | (15·8, 64·1)  | 628 792 (549 355-727 993) |
| Bladder                      | 0·8  | 0·5  | (0·4-0·6)   | -37·5  | (-50·0, -25·0) | 1517    | 1546    | (1221-1959)       | 1·9   | (-19·5, 29·1) | 7414 (6176-8930)          |
| Brain                        | 2·7  | 2·7  | (2·0-3·6)   | 0·0    | (-25·9, 33·3)  | 2803    | 4178    | (3226-5436)       | 49·1  | (15·1, 93·9)  | 18 214 (14 553-22 917)    |
| Breast                       | 12·2 | 9·8  | (8·8-10·8)  | -19·7  | (-27·9, -11·5) | 15 032  | 19 948  | (18 042-22 058)   | 32·7  | (20·0, 46·7)  | 90 831 (83 328-99 036)    |
| Colorectum <sup>d</sup>      | 8·0  | 5·9  | (4·9-7·0)   | -26·3  | (-38·8, -12·5) | 12 258  | 14 457  | (12 692-16 586)   | 17·9  | (3·5, 35·3)   | 66 585 (59 738-74 655)    |
| Gallbladder and bile duct    | 0·5  | 0·4  | (0·3-0·5)   | -20·0  | (-40·0, 0·0)   | 842     | 977     | (723-1320)        | 16·0  | (-14·1, 56·8) | 4372 (3353-5710)          |
| Kidney                       | 1·0  | 0·7  | (0·5-1·2)   | -30·0  | (-50·0, 20·0)  | 1590    | 1765    | (1220-2601)       | 11·0  | (-23·3, 63·6) | 8293 (6120-11 435)        |
| Larynx                       | 0·1  | 0·0  | (0·0-0·1)   | -100·0 | (-100·0, 0·0)  | 125     | 107     | (49-230)          | -14·4 | (-60·8, 84·0) | 549 (284-1074)            |
| Leukaemia                    | 2·6  | 2·0  | (1·5-2·9)   | -23·1  | (-42·3, 11·5)  | 3768    | 5162    | (4115-6592)       | 37·0  | (9·2, 74·9)   | 23 465 (19 428-28 790)    |
| Lip, oral cavity and pharynx | 1·0  | 0·8  | (0·6-1·1)   | -20·0  | (-40·0, 10·0)  | 1311    | 1975    | (1503-2597)       | 50·6  | (14·6, 98·1)  | 8488 (6674-10 810)        |
| Liver                        | 2·4  | 2·9  | (2·3-3·6)   | 20·8   | (-4·2, 50·0)   | 3334    | 7041    | (5720-8672)       | 111·2 | (71·6, 160·1) | 28 959 (24 191-34 709)    |
| Lung                         | 13·1 | 9·0  | (6·4-13·6)  | -31·3  | (-51·1, 3·8)   | 17 452  | 23 742  | (19 271-30 937)   | 36·0  | (10·4, 77·3)  | 109 372 (95 054-129 868)  |
| Melanoma                     | 1·8  | 1·3  | (1·1-1·6)   | -27·8  | (-38·9, -11·1) | 2360    | 3119    | (2696-3617)       | 32·2  | (14·2, 53·3)  | 14 543 (12 745-16 631)    |
| Non-Hodgkin lymphoma         | 2·0  | 1·4  | (1·0-1·9)   | -30·0  | (-50·0, -5·0)  | 3268    | 3683    | (2830-4863)       | 12·7  | (-13·4, 48·8) | 18 013 (14 468-22 717)    |
| Oesophagus                   | 1·1  | 0·8  | (0·6-1·1)   | -27·3  | (-45·5, 0·0)   | 1774    | 2347    | (1817-3034)       | 32·3  | (2·4, 71·0)   | 10 373 (8358-12 898)      |
| Ovary                        | 3·8  | 2·8  | (2·4-3·2)   | -26·3  | (-36·8, -15·8) | 4899    | 5955    | (5212-6808)       | 21·6  | (6·4, 39·0)   | 28 052 (25 055-31 437)    |
| Pancreas                     | 4·9  | 4·7  | (4·0-5·5)   | -4·1   | (-18·4, 12·2)  | 7165    | 12 223  | (10 539-14 178)   | 70·6  | (47·1, 97·9)  | 52 011 (45 785-59 115)    |
| Stomach                      | 1·5  | 1·3  | (1·0-1·6)   | -13·3  | (-33·3, 6·7)   | 2086    | 3149    | (2467-4019)       | 51·0  | (18·3, 92·7)  | 13 081 (10 588-16 181)    |
| Thyroid                      | 0·3  | 0·3  | (0·2-0·4)   | 0·0    | (-33·3, 33·3)  | 369     | 711     | (437-1155)        | 92·7  | (18·4, 213·0) | 2905 (1885-4491)          |
| Uterus                       | 2·0  | 2·3  | (2·0-2·6)   | 15·0   | (0·0, 30·0)    | 2695    | 5139    | (4449-5938)       | 90·7  | (65·1, 120·3) | 20 865 (18 264-23 845)    |
| Other cancers                | 11·5 | 8·9  | (7·8-10·4)  | -22·6  | (-32·2, -9·6)  | 17 455  | 22 259  | (19 955-24 924)   | 27·5  | (14·3, 42·8)  | 102 408 (93 307-112 745)  |

a. All rates are age-standardised to the Segi World standard population.

b. Overall percentage change in the age-standardised rate projected for 2040-2044 compared to the observed age-standardised rate in 2015-2019.

c. Overall percentage change in the numbers of deaths projected for 2040-2044 compared to the numbers of deaths in 2015-2019.

d. Projections for colorectal cancer do not take into account the completed roll-out of the National Bowel Cancer Screening Program. Detailed projections for colorectal cancer based on microsimulation modelling have been published elsewhere.<sup>42</sup>

UI: uncertainty interval.

**Table A1.5. Projected age-standardised incidence rates and numbers of new cases from 2020 to 2044 for all cancers combined and 21 individual cancer types in Australia**

|                             | Annual age-standardised rate per 100,000 <sup>a</sup> |              |              |              |              | Number of new cases |                |                |                |                |
|-----------------------------|-------------------------------------------------------|--------------|--------------|--------------|--------------|---------------------|----------------|----------------|----------------|----------------|
|                             | 2020-2024                                             | 2025-2029    | 2030-2034    | 2035-2039    | 2040-2044    | 2020-2024           | 2025-2029      | 2030-2034      | 2035-2039      | 2040-2044      |
| <b>Males</b>                |                                                       |              |              |              |              |                     |                |                |                |                |
| <b>All cancer</b>           | <b>347.3</b>                                          | <b>340.9</b> | <b>336.0</b> | <b>331.8</b> | <b>327.8</b> | <b>418 249</b>      | <b>459 032</b> | <b>497 769</b> | <b>531 526</b> | <b>560 744</b> |
| Bladder                     | 8.3                                                   | 8.0          | 7.8          | 7.6          | 7.5          | 12 237              | 13 669         | 14 985         | 16 035         | 16 858         |
| Brain                       | 6.2                                                   | 6.1          | 6.1          | 6.0          | 5.9          | 5918                | 6416           | 6867           | 7269           | 7641           |
| Colorectum <sup>b</sup>     | 34.8                                                  | 33.1         | 32.4         | 32.2         | 31.7         | 42 763              | 44 865         | 47 389         | 49 794         | 51 819         |
| Gallbladder and bile duct   | 2.2                                                   | 2.2          | 2.3          | 2.3          | 2.3          | 2998                | 3512           | 3970           | 4342           | 4640           |
| Kidney                      | 13.7                                                  | 14.6         | 15.5         | 16.3         | 17.0         | 14 510              | 16 870         | 19 285         | 21 744         | 24 251         |
| Larynx                      | 2.2                                                   | 2.0          | 1.9          | 1.8          | 1.7          | 2628                | 2661           | 2711           | 2774           | 2857           |
| Leukaemia                   | 13.7                                                  | 13.9         | 14.0         | 14.1         | 14.1         | 15 367              | 17 562         | 19 633         | 21 472         | 23 108         |
| Lip oral cavity and pharynx | 15.4                                                  | 15.2         | 14.8         | 14.3         | 13.8         | 16 027              | 17 475         | 18 697         | 19 677         | 20 442         |
| Liver                       | 9.0                                                   | 9.5          | 9.6          | 9.6          | 9.4          | 10 183              | 12 065         | 13 681         | 14 925         | 15 785         |
| Lung                        | 28.1                                                  | 27.1         | 26.6         | 26.3         | 26.0         | 37 951              | 41 140         | 44 564         | 47 679         | 50 558         |
| Melanoma                    | 41.9                                                  | 40.8         | 39.1         | 37.3         | 35.4         | 49 071              | 54 410         | 58 397         | 60 758         | 61 712         |
| Non-Hodgkin lymphoma        | 15.4                                                  | 15.3         | 15.1         | 14.9         | 14.6         | 18 168              | 20 375         | 22 277         | 23 780         | 24 946         |
| Oesophagus                  | 5.0                                                   | 4.9          | 4.9          | 4.9          | 4.8          | 6269                | 6930           | 7559           | 8131           | 8664           |
| Pancreas                    | 8.6                                                   | 9.0          | 9.2          | 9.3          | 9.4          | 11 401              | 13 366         | 15 187         | 16 770         | 18 145         |
| Prostate                    | 85.1                                                  | 81.3         | 79.1         | 77.7         | 76.8         | 106 148             | 113 096        | 120 154        | 127 014        | 133 917        |
| Stomach                     | 6.1                                                   | 5.9          | 5.8          | 5.8          | 5.8          | 7901                | 8597           | 9352           | 10 096         | 10 818         |
| Testis                      | 6.7                                                   | 6.8          | 6.9          | 7.0          | 7.0          | 4790                | 5206           | 5570           | 5904           | 6221           |
| Thyroid                     | 6.0                                                   | 6.6          | 6.9          | 6.9          | 6.9          | 5497                | 6582           | 7465           | 8140           | 8635           |
| Other cancers               | 38.9                                                  | 38.4         | 38.1         | 37.8         | 37.6         | 48 419              | 54 235         | 60 026         | 65 221         | 69 728         |

| <b>Females</b>               |              |              |              |              |              |                |                |                |                |                |
|------------------------------|--------------|--------------|--------------|--------------|--------------|----------------|----------------|----------------|----------------|----------------|
| <b>All cancer</b>            | <b>292·8</b> | <b>292·4</b> | <b>291·7</b> | <b>291·0</b> | <b>290·1</b> | <b>349 036</b> | <b>386 230</b> | <b>422 089</b> | <b>454 646</b> | <b>483 527</b> |
| Bladder                      | 2·0          | 1·8          | 1·8          | 1·7          | 1·7          | 3429           | 3653           | 3935           | 4225           | 4485           |
| Brain                        | 3·9          | 3·8          | 3·7          | 3·6          | 3·5          | 3869           | 4131           | 4374           | 4587           | 4773           |
| Breast                       | 91·8         | 93·0         | 93·9         | 94·6         | 95·1         | 98 623         | 109 142        | 119 117        | 128 590        | 137 776        |
| Colorectum <sup>b</sup>      | 26·6         | 25·6         | 25·1         | 25·0         | 25·1         | 36 485         | 38 545         | 40 864         | 43 020         | 44 898         |
| Gallbladder and bile duct    | 1·9          | 1·9          | 2·0          | 2·0          | 2·0          | 2963           | 3385           | 3819           | 4224           | 4577           |
| Kidney                       | 6·4          | 6·8          | 7·1          | 7·4          | 7·7          | 7384           | 8506           | 9678           | 10 879         | 12 107         |
| Larynx                       | 0·3          | 0·2          | 0·2          | 0·2          | 0·2          | 320            | 331            | 347            | 369            | 393            |
| Leukaemia                    | 8·5          | 8·7          | 8·8          | 8·9          | 9·0          | 9763           | 11 125         | 12 550         | 13 942         | 15 256         |
| Lip, oral cavity and pharynx | 5·2          | 5·2          | 5·2          | 5·2          | 5·3          | 6150           | 6723           | 7365           | 8037           | 8717           |
| Liver                        | 2·9          | 3·1          | 3·2          | 3·2          | 3·3          | 3939           | 4787           | 5623           | 6360           | 6929           |
| Lung                         | 21·6         | 20·7         | 20·2         | 19·7         | 19·1         | 30 822         | 33 809         | 36 594         | 38 740         | 40 105         |
| Melanoma                     | 30·0         | 29·2         | 28·1         | 26·8         | 25·6         | 34 153         | 37 681         | 40 473         | 42 357         | 43 304         |
| Non-Hodgkin lymphoma         | 10·5         | 10·4         | 10·4         | 10·3         | 10·2         | 13 484         | 15 133         | 16 657         | 17 970         | 19 062         |
| Oesophagus                   | 1·3          | 1·2          | 1·2          | 1·2          | 1·1          | 2144           | 2289           | 2475           | 2665           | 2839           |
| Ovary                        | 5·8          | 5·4          | 5·1          | 4·9          | 4·7          | 6925           | 7201           | 7516           | 7815           | 8075           |
| Pancreas                     | 6·6          | 6·9          | 7·1          | 7·2          | 7·3          | 10 248         | 12 042         | 13 858         | 15 554         | 17 063         |
| Stomach                      | 3·2          | 3·2          | 3·3          | 3·4          | 3·4          | 4428           | 4984           | 5645           | 6355           | 7077           |
| Thyroid                      | 14·9         | 15·2         | 15·1         | 14·7         | 14·2         | 13 244         | 14 828         | 15 966         | 16 729         | 17 212         |
| Uterus                       | 14·1         | 14·4         | 14·7         | 14·8         | 14·9         | 16 241         | 18 261         | 20 110         | 21 829         | 23 488         |
| Other cancers                | 35·4         | 35·6         | 35·8         | 36·2         | 36·5         | 44 421         | 49 673         | 55 122         | 60 399         | 65 388         |

a. All rates are age-standardised to the Segi World standard population.

b. Projections for colorectal cancer do not take into account the completed roll-out of the National Bowel Cancer Screening Program. Detailed projections for colorectal cancer based on microsimulation modelling have been published elsewhere.<sup>42</sup>

**Table A1.6. Projected age-standardised mortality rates and numbers of deaths from 2020 to 2044 for all cancers combined and 21 individual cancer types in Australia**

|                              | Annual age-standardised rate per 100,000 <sup>a</sup> |             |             |             |             | Number of deaths |                |                |                |                |
|------------------------------|-------------------------------------------------------|-------------|-------------|-------------|-------------|------------------|----------------|----------------|----------------|----------------|
|                              | 2020-2024                                             | 2025-2029   | 2030-2034   | 2035-2039   | 2040-2044   | 2020-2024        | 2025-2029      | 2030-2034      | 2035-2039      | 2040-2044      |
| <b>Males</b>                 |                                                       |             |             |             |             |                  |                |                |                |                |
| <b>All cancer</b>            | <b>99·1</b>                                           | <b>93·8</b> | <b>89·7</b> | <b>86·2</b> | <b>83·4</b> | <b>142 239</b>   | <b>153 904</b> | <b>165 334</b> | <b>174 081</b> | <b>180 663</b> |
| Bladder                      | 2·2                                                   | 2·0         | 1·9         | 1·9         | 1·9         | 3755             | 3979           | 4354           | 4766           | 5148           |
| Brain                        | 4·6                                                   | 4·6         | 4·6         | 4·6         | 4·5         | 4892             | 5389           | 5804           | 6159           | 6493           |
| Colorectum <sup>b</sup>      | 10·6                                                  | 9·9         | 9·6         | 9·2         | 9·0         | 14 912           | 15 687         | 16 516         | 17 127         | 17 609         |
| Gallbladder and bile duct    | 0·4                                                   | 0·4         | 0·4         | 0·4         | 0·4         | 622              | 693            | 767            | 833            | 892            |
| Kidney                       | 2·5                                                   | 2·3         | 2·3         | 2·2         | 2·2         | 3316             | 3590           | 3886           | 4166           | 4426           |
| Larynx                       | 0·6                                                   | 0·5         | 0·5         | 0·5         | 0·4         | 863              | 839            | 825            | 816            | 815            |
| Leukaemia                    | 4·2                                                   | 3·9         | 3·7         | 3·6         | 3·5         | 6063             | 6634           | 7127           | 7475           | 7726           |
| Lip, oral cavity and pharynx | 3·0                                                   | 2·9         | 2·9         | 2·9         | 2·9         | 3588             | 3931           | 4257           | 4566           | 4870           |
| Liver                        | 6·8                                                   | 7·2         | 7·3         | 7·3         | 7·2         | 8499             | 10 322         | 11 947         | 13 157         | 13 866         |
| Lung                         | 17·7                                                  | 15·8        | 14·3        | 12·9        | 11·7        | 24 978           | 25 337         | 25 528         | 25 138         | 24 646         |
| Melanoma                     | 3·4                                                   | 3·0         | 2·6         | 2·3         | 2·0         | 4866             | 4987           | 5092           | 5047           | 4824           |
| Non-Hodgkin lymphoma         | 3·3                                                   | 3·1         | 2·9         | 2·8         | 2·7         | 4947             | 5351           | 5665           | 5862           | 5998           |
| Oesophagus                   | 4·1                                                   | 4·0         | 3·9         | 3·8         | 3·8         | 5329             | 5838           | 6348           | 6816           | 7250           |
| Pancreas                     | 6·5                                                   | 6·5         | 6·4         | 6·4         | 6·3         | 8980             | 10 181         | 11 264         | 12 156         | 12 897         |
| Prostate                     | 10·1                                                  | 9·7         | 9·4         | 9·3         | 9·2         | 18 215           | 20 540         | 23 375         | 26 024         | 28 231         |
| Stomach                      | 2·8                                                   | 2·6         | 2·5         | 2·4         | 2·4         | 3839             | 4125           | 4460           | 4785           | 5087           |
| Testis                       | 0·2                                                   | 0·2         | 0·2         | 0·2         | 0·2         | 146              | 163            | 179            | 193            | 206            |
| Thyroid                      | 0·3                                                   | 0·3         | 0·3         | 0·3         | 0·3         | 399              | 467            | 529            | 585            | 637            |
| Other cancers                | 15·9                                                  | 14·8        | 13·9        | 13·2        | 12·7        | 24 029           | 25 850         | 27 410         | 28 409         | 29 041         |

| <b>Females</b>               |             |             |             |             |             |                |                |                |                |                |
|------------------------------|-------------|-------------|-------------|-------------|-------------|----------------|----------------|----------------|----------------|----------------|
| <b>All cancer</b>            | <b>69·6</b> | <b>66·0</b> | <b>63·0</b> | <b>60·4</b> | <b>58·3</b> | <b>109 625</b> | <b>118 259</b> | <b>127 096</b> | <b>134 330</b> | <b>139 482</b> |
| Bladder                      | 0·7         | 0·6         | 0·5         | 0·5         | 0·5         | 1434           | 1443           | 1478           | 1513           | 1546           |
| Brain                        | 2·7         | 2·7         | 2·7         | 2·7         | 2·7         | 3091           | 3372           | 3652           | 3921           | 4178           |
| Breast                       | 11·8        | 11·1        | 10·6        | 10·1        | 9·8         | 16 096         | 17 202         | 18 321         | 19 263         | 19 948         |
| Colorectum <sup>b</sup>      | 7·2         | 6·6         | 6·3         | 6·0         | 5·9         | 12 233         | 12 650         | 13 306         | 13 939         | 14 457         |
| Gallbladder and bile duct    | 0·5         | 0·4         | 0·4         | 0·4         | 0·4         | 787            | 817            | 868            | 924            | 977            |
| Kidney                       | 0·9         | 0·8         | 0·8         | 0·7         | 0·7         | 1581           | 1594           | 1646           | 1707           | 1765           |
| Larynx                       | 0·1         | 0·1         | 0·1         | 0·1         | 0·0         | 116            | 111            | 109            | 107            | 107            |
| Leukaemia                    | 2·4         | 2·3         | 2·2         | 2·1         | 2·0         | 4108           | 4442           | 4756           | 4997           | 5162           |
| Lip, oral cavity and pharynx | 0·9         | 0·9         | 0·9         | 0·9         | 0·8         | 1402           | 1550           | 1708           | 1854           | 1975           |
| Liver                        | 2·7         | 2·8         | 2·9         | 2·9         | 2·9         | 4262           | 5144           | 5938           | 6575           | 7041           |
| Lung                         | 12·3        | 11·4        | 10·6        | 9·7         | 9·0         | 19 133         | 20 772         | 22 350         | 23 375         | 23 742         |
| Melanoma                     | 1·7         | 1·6         | 1·5         | 1·4         | 1·3         | 2595           | 2780           | 2963           | 3086           | 3119           |
| Non-Hodgkin lymphoma         | 1·9         | 1·7         | 1·5         | 1·4         | 1·4         | 3423           | 3563           | 3657           | 3687           | 3683           |
| Oesophagus                   | 1·0         | 0·9         | 0·9         | 0·9         | 0·8         | 1809           | 1923           | 2073           | 2221           | 2347           |
| Ovary                        | 3·5         | 3·2         | 3·0         | 2·9         | 2·8         | 5166           | 5429           | 5664           | 5838           | 5955           |
| Pancreas                     | 4·9         | 4·9         | 4·8         | 4·8         | 4·7         | 8292           | 9450           | 10 555         | 11 490         | 12 223         |
| Stomach                      | 1·4         | 1·3         | 1·3         | 1·3         | 1·3         | 2153           | 2330           | 2583           | 2866           | 3149           |
| Thyroid                      | 0·3         | 0·3         | 0·3         | 0·3         | 0·3         | 446            | 514            | 584            | 650            | 711            |
| Uterus                       | 2·1         | 2·2         | 2·2         | 2·2         | 2·3         | 3135           | 3674           | 4211           | 4705           | 5139           |
| Other cancers                | 10·8        | 10·1        | 9·6         | 9·2         | 8·9         | 18 363         | 19 498         | 20 675         | 21 613         | 22 259         |

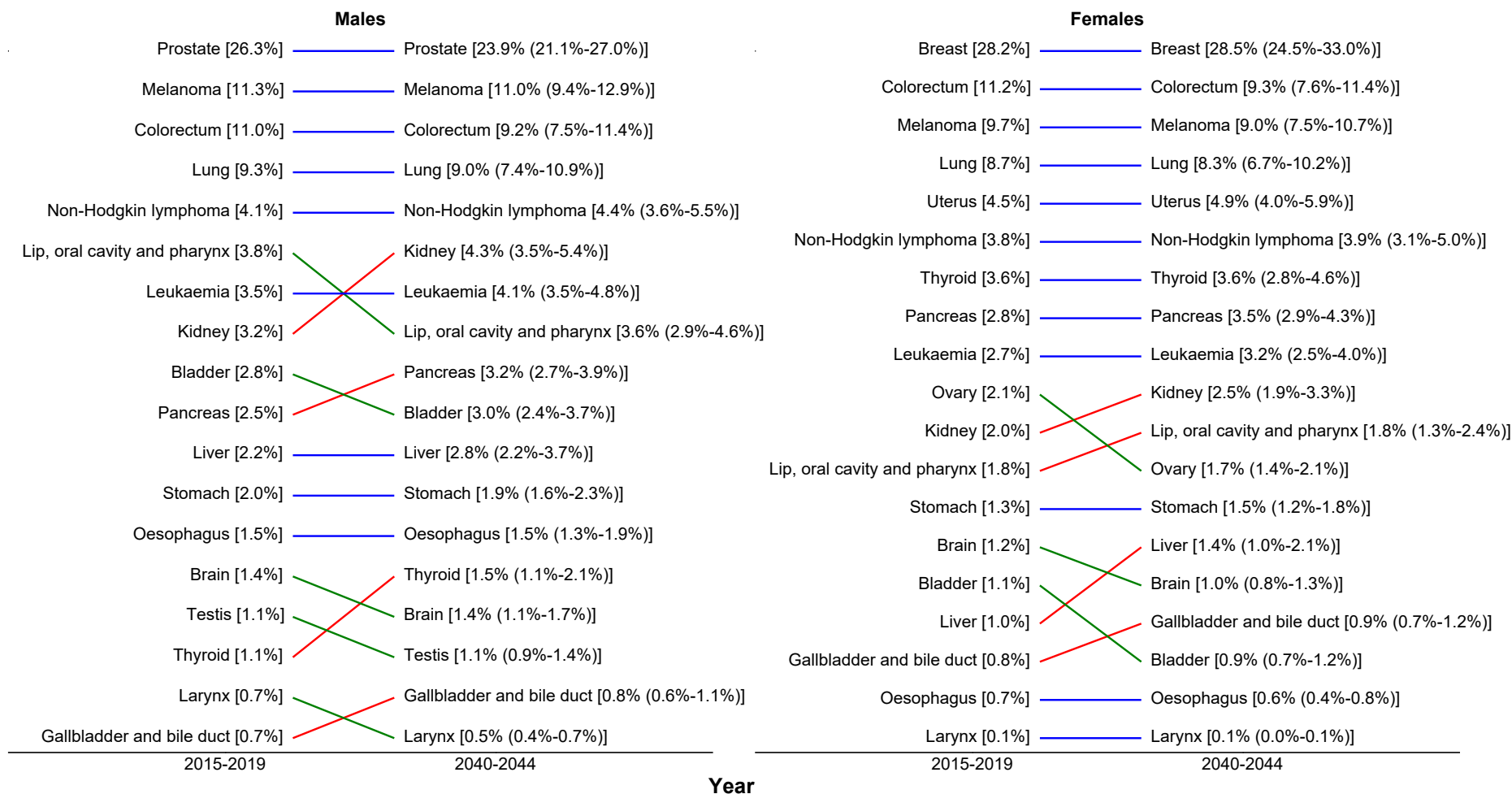
a. All rates are age-standardised to the Segi World standard population.

b. Projections for colorectal cancer do not take into account the completed roll-out of the National Bowel Cancer Screening Program. Detailed projections for colorectal cancer based on microsimulation modelling have been published elsewhere.<sup>42</sup>

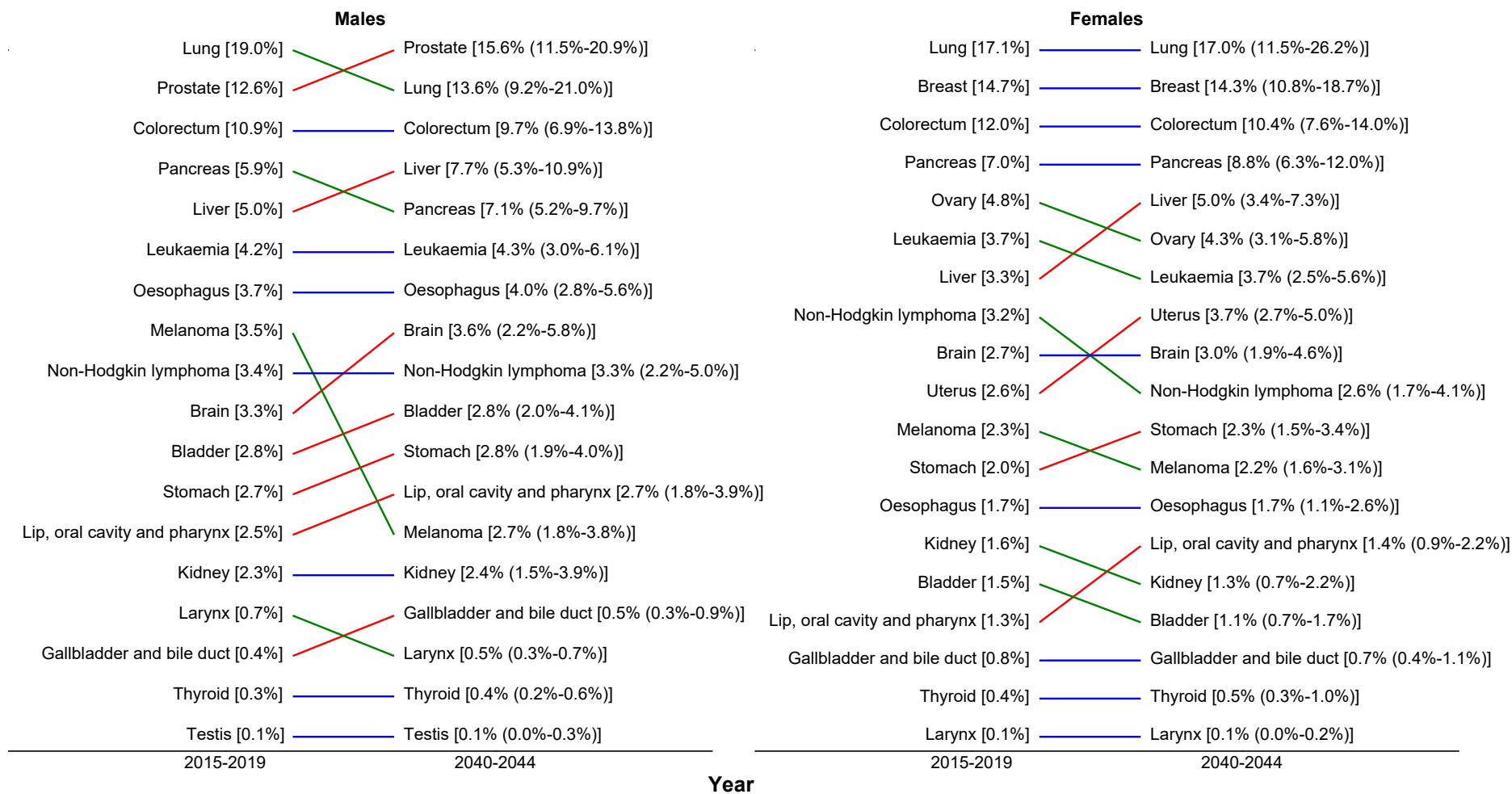
**Table A1.7. Observed and projected numbers of new cases and deaths to 2044 for baseline projections of all cancers combined and 21 individual cancer types for males and females combined in Australia**

|                              | Number of new cases    |                    |                                 |                                                                |                              |                                 | Number of deaths       |                        |                           |                                                           |                              |                           |
|------------------------------|------------------------|--------------------|---------------------------------|----------------------------------------------------------------|------------------------------|---------------------------------|------------------------|------------------------|---------------------------|-----------------------------------------------------------|------------------------------|---------------------------|
|                              | Projected in 2040-2044 |                    |                                 | Change in new cases<br>from 2015-<br>2019 to 2040-<br>2044 (%) | Total projected in 2020-2044 |                                 | Projected in 2040-2044 |                        |                           | Change in deaths from<br>2015-2019 to<br>2040-2044<br>(%) | Total projected in 2020-2044 |                           |
|                              | Observed<br>2015-2019  | Number of<br>cases | % of all<br>cancer<br>new cases |                                                                | Number of<br>cases           | % of all<br>cancer new<br>cases | Observed<br>2015-2019  | Number<br>of<br>deaths | % of all<br>cancer deaths |                                                           | Number of<br>deaths          | % of all<br>cancer deaths |
|                              |                        |                    |                                 |                                                                |                              |                                 |                        |                        |                           |                                                           |                              |                           |
| All cancer                   | 693 569                | 1 044 271          | 100·0                           | 50·6                                                           | 4 562 846                    | 100·0                           | 234 543                | 320 145                | 100·0                     | 36·5                                                      | 1 445 014                    | 100·0                     |
| Bladder                      | 14 043                 | 21 343             | 2·0                             | 52·0                                                           | 93 512                       | 2·0                             | 5 253                  | 6695                   | 2·1                       | 27·5                                                      | 29 417                       | 2·0                       |
| Brain                        | 9093                   | 12 414             | 1·2                             | 36·5                                                           | 55 844                       | 1·2                             | 7 133                  | 10 671                 | 3·3                       | 49·6                                                      | 46 951                       | 3·2                       |
| Breast                       | 88 268                 | 137 776            | 13·2                            | 56·1                                                           | 593 248                      | 13·0                            | 15 032                 | 19 948                 | 6·2                       | 32·7                                                      | 90 831                       | 6·3                       |
| Colorectum                   | 77 161                 | 96 717             | 9·3                             | 25·3                                                           | 440 441                      | 9·7                             | 26 655                 | 32 066                 | 10·0                      | 20·3                                                      | 148 436                      | 10·3                      |
| Gallbladder and bile duct    | 5347                   | 9217               | 0·9                             | 72·4                                                           | 38 431                       | 0·8                             | 1428                   | 1868                   | 0·6                       | 30·8                                                      | 8179                         | 0·6                       |
| Kidney                       | 18 619                 | 36 358             | 3·5                             | 95·3                                                           | 145 213                      | 3·2                             | 4684                   | 6190                   | 1·9                       | 32·2                                                      | 27 677                       | 1·9                       |
| Larynx                       | 3024                   | 3250               | 0·3                             | 7·5                                                            | 15 391                       | 0·3                             | 1022                   | 921                    | 0·3                       | -9·9                                                      | 4706                         | 0·3                       |
| Leukaemia                    | 22 089                 | 38 364             | 3·7                             | 73·7                                                           | 159 779                      | 3·5                             | 9318                   | 12 888                 | 4·0                       | 38·3                                                      | 58 490                       | 4·0                       |
| Lip, oral cavity and pharynx | 20 082                 | 29 159             | 2·8                             | 45·2                                                           | 129 310                      | 2·8                             | 4599                   | 6846                   | 2·1                       | 48·9                                                      | 29 700                       | 2·1                       |
| Liver                        | 11 280                 | 22 714             | 2·2                             | 101·4                                                          | 94 277                       | 2·1                             | 9908                   | 20 907                 | 6·5                       | 111·0                                                     | 86 751                       | 6·0                       |
| Lung                         | 62 766                 | 90 663             | 8·7                             | 44·4                                                           | 401 963                      | 8·8                             | 42 585                 | 48 389                 | 15·1                      | 13·6                                                      | 235 000                      | 16·3                      |
| Melanoma                     | 74 011                 | 105 016            | 10·1                            | 41·9                                                           | 482 317                      | 10·6                            | 7007                   | 7943                   | 2·5                       | 13·4                                                      | 39 360                       | 2·7                       |
| Non-Hodgkin lymphoma         | 27 519                 | 44 008             | 4·2                             | 59·9                                                           | 191 852                      | 4·2                             | 7755                   | 9681                   | 3·0                       | 24·8                                                      | 45 837                       | 3·2                       |
| Oesophagus                   | 7659                   | 11 503             | 1·1                             | 50·2                                                           | 49 966                       | 1·1                             | 6659                   | 9598                   | 3·0                       | 44·1                                                      | 41 955                       | 2·9                       |
| Ovary                        | 6544                   | 8075               | 0·8                             | 23·4                                                           | 37 533                       | 0·8                             | 4899                   | 5955                   | 1·9                       | 21·6                                                      | 28 052                       | 1·9                       |
| Pancreas                     | 18 006                 | 35 209             | 3·4                             | 95·5                                                           | 143 634                      | 3·1                             | 14 979                 | 25 121                 | 7·8                       | 67·7                                                      | 107 490                      | 7·4                       |
| Prostate                     | 99 565                 | 133 917            | 12·8                            | 34·5                                                           | 600 329                      | 13·2                            | 16 625                 | 28 231                 | 8·8                       | 69·8                                                      | 116 385                      | 8·1                       |
| Stomach                      | 11 556                 | 17 895             | 1·7                             | 54·9                                                           | 75 254                       | 1·6                             | 5710                   | 8236                   | 2·6                       | 44·2                                                      | 35 376                       | 2·4                       |
| Testis                       | 4403                   | 6221               | 0·6                             | 41·3                                                           | 27 690                       | 0·6                             | 136                    | 206                    | 0·1                       | 51·5                                                      | 888                          | 0·1                       |
| Thyroid                      | 15 448                 | 25 847             | 2·5                             | 67·3                                                           | 114 300                      | 2·5                             | 722                    | 1347                   | 0·4                       | 86·6                                                      | 5522                         | 0·4                       |
| Uterus                       | 14 056                 | 23 488             | 2·2                             | 67·1                                                           | 99 930                       | 2·2                             | 2695                   | 5139                   | 1·6                       | 90·7                                                      | 20 865                       | 1·4                       |
| Other cancers                | 83 031                 | 135 117            | 12·9                            | 62·7                                                           | 572 633                      | 12·5                            | 39 739                 | 51 300                 | 16·0                      | 29·1                                                      | 237 146                      | 16·4                      |

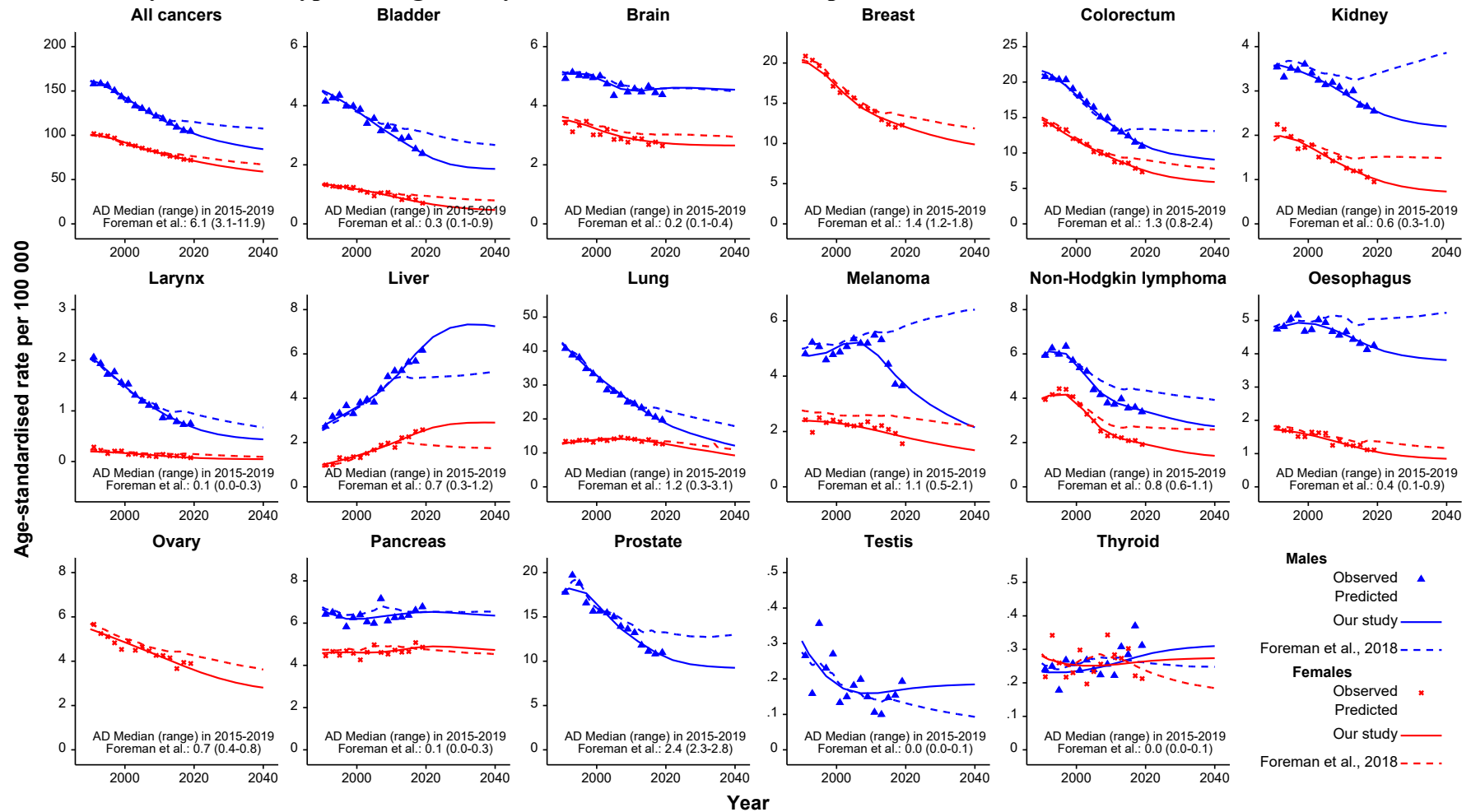
**Figure A1.4. Change in the ranking of cancer types by the proportion among all new cases in 2015-2019 and 2040-2044 by sex, Australia (showing selected cancer types)**



**Figure A1.5. Change in the ranking of cancer types by the proportion among all cancer deaths in 2015-2019 and 2040-2044 by sex, Australia (showing selected cancer types)**



**Figure A1.6. Comparison of Australian cancer mortality rate projections published by Foreman and colleagues 2018 and the results from this study for cancer types with generally consistent observed data reported in both studies**



Results from Foreman and colleagues 2018 were extracted from the open source online resource <https://vizhub.healthdata.org/gbd-foresight/> (accessed 18 October 2021). All rates are age-standardised to the Segi World standard population. AD: absolute difference between projected and observed rates per 100 000 population.

Reference: Foreman KJ, Marquez N, Dolgert A, et al. Forecasting life expectancy, years of life lost, and all-cause and cause-specific mortality for 250 causes of death: reference and alternative scenarios for 2016-40 for 195 countries and territories. *The Lancet* 2018;392(10159):2052-90.

## **1.6. Additional discussion on baseline projections for individual cancer types**

To our knowledge, no long-term projections (for 20 or more years) of both the incidence and mortality rates for all cancers in Australia have been published previously, although a global study (Foreman et al., 2018) has reported projections of cancer mortality rates for 2016-2040 for 195 countries including Australia.<sup>15</sup> Foreman and colleagues used single year data for 1990-2016 from the GBD 2016 estimates, with three model components: a component reflecting changes in risk factors and selected interventions; the mortality rate for each cause that is a function of the sociodemographic index (a composite measure of income per capita, mean years of education, and total fertility under 25 years), location, age and time; and an autoregressive integrated moving average model for unexplained changes correlated with time.<sup>15</sup> Due to lags in reporting, GBD 2016 estimates for the most recent years were obtained from model estimates.<sup>16</sup> As Foreman and colleagues used different ICD groups which include benign tumours, we only included the comparison of mortality rates for cancer types with similar ICD codes and consistent trends in the observed data period 1990-2014 (Figure A1.6). For most cancer types with decreasing trends, projections from Foreman and colleagues generally overestimated the true rate in 2015-2019. These differences are likely to be due to the different observed data periods and methods used. While these GBD studies provide important insights into the distribution of global health issues, their standardised modelling approach may not explicitly capture the trends of individual cancers in a specific population.

In this study, we used a previously validated method including sex-age-period specific cigarette smoking exposure to project lung cancer incidence and mortality.<sup>1</sup> We also explicitly incorporated age-period-specific PSA testing rates and breast cancer screening programme participation rates in the projections of prostate and breast cancer incidence. In contrast to previous studies, our projections suggested that the incidence rate for prostate

cancer will continue to decrease in Australia, although the decrease will be at a slower pace after 2025. Earnest and colleagues projected an increase in prostate cancer incidence rates in Australia for 2013-2022 based on observed data from 1982 to 2012 using an autoregressive integrated moving average (ARIMA) model,<sup>43</sup> which did not incorporate PSA testing rates and overestimated the true rates in 2013-2019.<sup>17</sup> We found a significant association between the rate of participation in the breast cancer screening programme and breast cancer incidence. The BreastScreen Australia services for breast cancer screening were introduced between 1989 and 1994, which probably contributed to the increase in breast cancer incidence observed over the corresponding period.<sup>13</sup> Our study projected that a slight increasing trend in female breast cancer incidence rates will continue to 2044. As recent data indicated that the overall use of menopausal hormone therapy by women aged in their 50s and 60s in Australia was relatively stable,<sup>44</sup> the small increasing trend in breast cancer incidence is more likely due to the extension from July 2013 of the breast cancer screening target age group from 50–69 years to 50–74 years,<sup>27</sup> or the introduction of digital mammography.<sup>45</sup> The influence of other risk factors, including the prevalence of overweight and obesity, alcohol use and physical inactivity, should also be considered.

There are a number of cancer types where decreasing incidence trends were observed and projected for both males and females, including cancers of the bladder, colorectum, lung, oesophagus and larynx and melanoma and non-Hodgkin lymphoma, which are likely to be related to changes in life-style factors including smoking, alcohol consumption, and fruit and vegetable intake, as well as the impact of cancer prevention strategies and cancer screening.<sup>46</sup> Our projections suggest that the incidence rates for melanoma are expected to decline from 2020 to 2044 for both males and females. This is likely to reflect lower levels of sun exposure attributable to the success of the public health campaigns aiming to prevent skin cancer which

have been implemented over the last two decades.<sup>47</sup> Our projections showed a decreasing trend in colorectal cancer incidence, which may be the result of the early detection and removal of pre-cancerous conditions due to opportunistic screening from the early 2000s and the introduction of the NBCSP in 2006.<sup>48</sup> Different trends in lung cancer incidence for males and females reflect differences in sex-specific smoking behaviours in the population. Consistent with our previous work on lung cancer mortality, this study showed that the lung cancer incidence rate for males is likely to continue to decrease, but at a slower pace than the expected decrease in mortality. For females, the lung cancer incidence rate is expected to peak in the early 2020s, before then starting to decline gradually to 2044.<sup>1</sup>

In contrast to the general overall decrease in incidence, our projections suggest increases in incidence rates for kidney, liver, thyroid and pancreatic cancers for both males and females. Kidney, thyroid, pancreatic and liver cancers are estimated to account for 3.5%, 2.5%, 3.4% and 2.2% of all new cancer cases in 2040-2044, respectively. In addition to cigarette smoking there are numerous other risk factors which may contribute to an increased risk of developing these cancers, including obesity, physical inactivity and diabetes.<sup>13,46,49-52</sup> The use of more sophisticated imaging techniques is likely to contribute to the increasing trends in the diagnoses of thyroid cancer,<sup>53</sup> kidney cancer<sup>13</sup> and pancreatic cancer.<sup>54</sup> Despite the projected increase in incidence rates for thyroid, kidney and pancreatic cancers, the mortality rates for these cancers are projected to remain stable or to decrease. There were also some cancer types for which incidence appears to be relatively stable, showing just a slight change in incidence rate (<2 per 100,000) over the projection period, including lip, oral cavity and pharynx, testicular, leukaemia and uterus cancers.

Mortality rates for most of the major cancer types are projected to decrease over time, while

the mortality rates for testis, thyroid and uterus cancers appear to be relatively stable. The declining mortality trends for most of the major cancer types are likely due to multiple factors, including the control of risk factors, as well as improvements in cancer detection and treatment. A reduction in the prevalence of smoking is likely to have contributed to the declining trend in mortality rates observed from 1985 for cancer types associated with smoking, including lung, laryngeal and oral cancers.<sup>49</sup> For cancer types such as breast, prostate and colorectal cancers, screening and diagnostic practices are likely to be factors contributing to the reduced cancer mortality rates. The projected decline in mortality rate for melanoma is likely due to extensive and ongoing developments in new diagnostic techniques and treatments reducing the risk of recurrence.<sup>55</sup>

Our projections suggest increases in the incidence and mortality rates for liver cancer for both males and females. Risk factors including obesity, diabetes, alcohol consumption and hepatitis infection may be the cause of these increases.<sup>46</sup> The prevalence of hepatitis B and C has remained high in some migrant communities, and among Aboriginal and Torres Strait Islander Australians.<sup>56</sup> However, our projections show that the incidence and mortality rates for liver cancer appear to plateau in the 2030s, which is likely to be partially attributable to the development of highly effective medication for hepatitis B and C in the mid-2000s and 2010s.<sup>57,58</sup>

## **2. Estimating the number of excess colorectal cancer deaths due to treatment delays during the COVID-19 pandemic**

### **2.1. Overview**

#### ***Treatment delays during the COVID-19 pandemic***

Delays in treatment can happen at any time from cancer diagnosis to the start of treatment, and may result in adverse consequences for survival outcomes.<sup>59</sup> It can be difficult to define a delay in treatment or to determine their effect, and there are heterogeneous approaches to measuring time to treatment between studies.<sup>60</sup> In this study, treatment delay for colorectal cancer patients was defined as a longer time from initial diagnosis or cancer recurrence to cancer treatment than would be expected under status quo conditions prior to the COVID-19 pandemic, and which was associated with health system disruptions during the COVID-19 pandemic. Health system disruptions in this study refer to any changes in how services were delivered during the pandemic, including the suspension of non-urgent elective surgery, the reduction in health service capacity, and the reduction in seeking of health services by cancer patients due to COVID-19 restrictions.

#### ***Treatment for colorectal cancer***

Of newly diagnosed colorectal cancer patients in Australia, 95% receive surgical treatment.<sup>61</sup> Therefore, for newly diagnosed cases, we focused on two treatment categories: surgery only, and surgery with other therapy (i.e. neoadjuvant or adjuvant therapy). While neoadjuvant treatment refers to treatment given prior to surgery, adjuvant therapy is any treatment that is given in addition to a standard curative cancer treatment such as surgery.<sup>62</sup> The benefit of neoadjuvant chemoradiation is well established for locally advanced rectal cancer, and the benefit of adjuvant treatment has been demonstrated for patients with stage III colon and rectal cancers.<sup>62</sup> For recurrent colorectal cancer, surgery alone is usually considered to be

inadequate,<sup>62,63</sup> so we focused on surgery with other treatment (i.e. neoadjuvant or adjuvant therapy) for recurrent cancer cases.

### ***Outcome of interest***

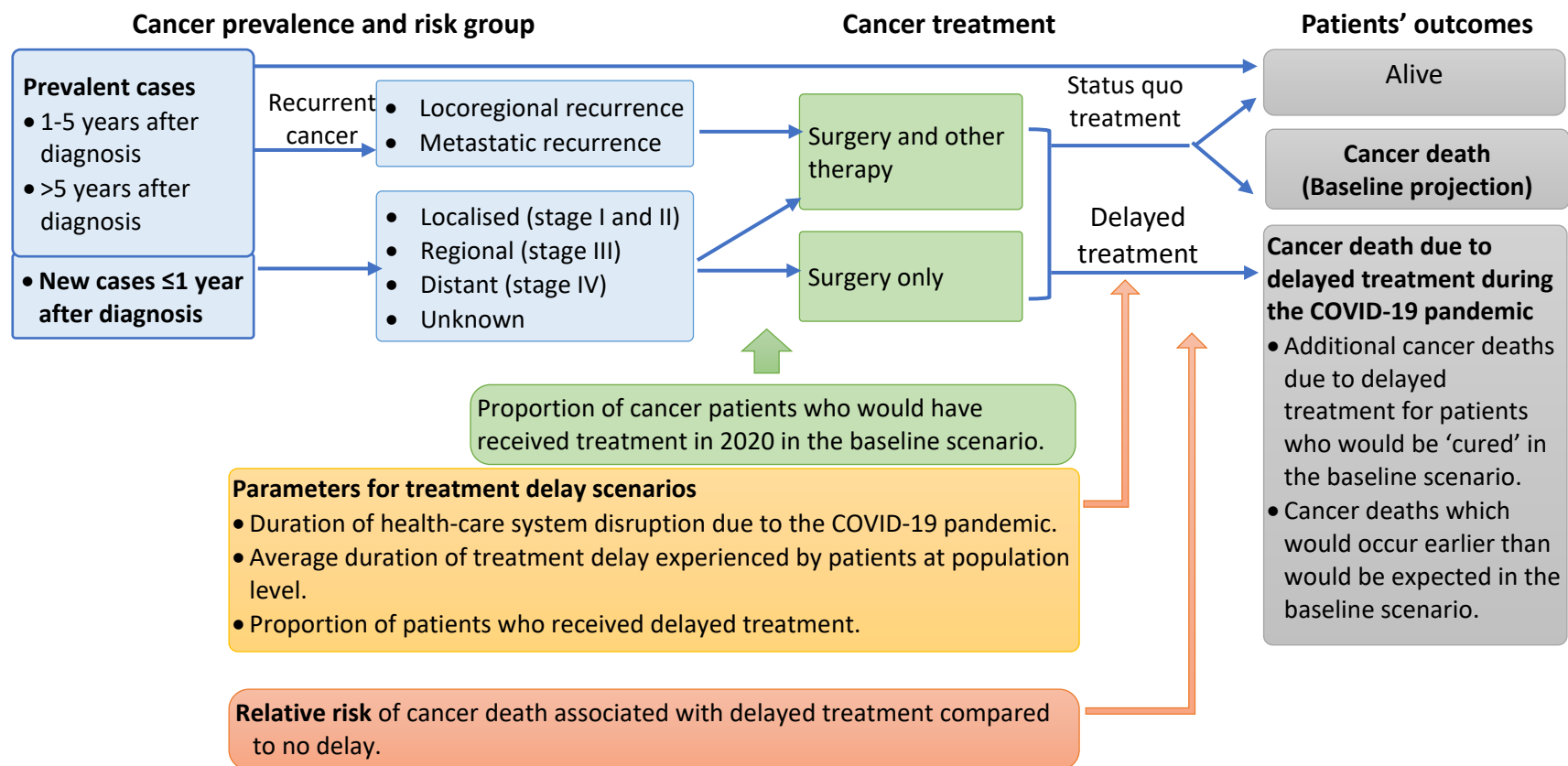
In this study, the outcome of interest was the number of deaths from colorectal cancer attributable to delayed treatment due to health-care system disruptions. This outcome consists of two separate components that correspond to different risk groups:

- (1) Additional deaths: deaths from colorectal cancer in patients who would not have died from colorectal cancer after receiving timely curative treatment and who would have been expected to have similar life expectancy as the general population.
- (2) Deaths which occurred earlier than would have been expected: deaths of colorectal cancer patients that occurred earlier than would have been expected had they received timely treatment.

## **2.2. Conceptual framework**

We developed a conceptual framework for estimating changes in the number of deaths from colorectal cancer due to delayed treatment during a period of health system disruption (Figure A2.1). The formulas used for the calculations, model parameters and data inputs are described in the sections below.

**Figure A2.1. Conceptual model for projections of cancer mortality which reflect the impact of treatment delays during the COVID-19 pandemic**



### 2.3. Calculating the number of excess cancer deaths from colorectal cancer due to treatment delays

On the basis of the colorectal cancer mortality rates from the baseline projections, the death rates in 2021 for each of the risk groups could be expressed as:

$$\begin{aligned} \text{Death rate}_{s1-2021} \\ = \text{Death rate}_{s0-2021} \times (P_{\text{Timely treatment received or do not need treatment}} \times 1 \\ + \sum P_{\text{Received delayed treatment } i} \times RR_{\text{Death due to delayed treatment } i}) \end{aligned}$$

(assuming that other factors contributing to cancer deaths remain the same as in the baseline scenario).

$\text{Death rate}_{s0-2021}$  denotes the baseline death rate with the status quo cancer treatment expected without the COVID-19 pandemic.

$P_{\text{Timely treatment received or do not need treatment}}$  denotes the proportion of cancer patients not experiencing delayed treatment (e.g. who receive timely treatment or do not need treatment due to a health condition), and who comprise the reference group for the relative risk of death due to delayed treatment.

$P_{\text{Received delayed treatment } i}$  denotes the proportion of cancer patients who receive delayed treatment  $i$  (e.g. surgery only, or surgery and other treatment).

$RR_{\text{Death due to delayed treatment } i}$  denotes the relative risk of death for patients who received treatment  $i$  (e.g. RR associated with delayed surgery only, or surgery and other treatment) delayed by  $m$  weeks, derived from the systematic review by Hanna and colleagues (see below).<sup>59</sup>

The increase in the number of colorectal cancer deaths due to treatment delay for a 12-month

health system disruption period could be estimated as:

$$\begin{aligned}
& \text{Number of deaths due to treatment delay}_{s1-2021} \\
&= Prevalence_{2020} \\
&\times \left[ Death\ rate_{s0-2021} \right. \\
&\times \left( P_{Timely\ treatment\ received\ or\ do\ not\ need\ treatment} \times 1 \right. \\
&+ \sum P_{Received\ delayed\ treatment\ i} \times RR_{Death\ due\ to\ delayed\ treatment\ i} \left. \right) \\
&\left. - Death\ rate_{s0-2021} \right]
\end{aligned}$$

$Prevalence_{2020}$  denotes the number of prevalent colorectal cancer patients in 2020.

To calculate the number of colorectal cancer deaths due to treatment delay during a health-care system disruption period of less than 12 months (i.e. disruption by 3 and 6 months), the numbers of prevalent colorectal cancer patients were scaled by 25% and 50%, respectively.

#### 2.4. Treatment delay scenarios during the COVID-19 pandemic included in this study

Due to the lack of available real-time Australian data on delays in cancer treatment during the COVID-19 pandemic, we explicitly modelled a number of hypothetical scenarios to represent the range of different health-care system disruptions experienced in Australia and internationally, with some potential parameter choices informed by the available data. Each of the hypothetical scenarios was based on the combination of three parameters: (1) duration of system disruption, (2) average duration of treatment delay experienced by patients at the population level, and (3) proportion of patients who received delayed treatment. We defined 3-month and 6-month system disruption periods to represent the situation in Australia, and a 12-month disruption period to represent the worst level of health-care system disruption that may be experienced in other countries. As no real-time data on the duration of treatment

delays for individual patients are available, nor any data on the proportion of cancer patients who would experience a delay to their treatment during the period of disruption to the health-care system, we examined different treatment delay durations for each of the defined disruption periods. The key parameters for the treatment delay scenarios are listed in Table A2.1.

**Table A2.1. Description of the treatment delay scenarios included in this study**

| Period of health-care system disruption | Duration of treatment delay                           | Description                                                                                                                                 |
|-----------------------------------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 3 months                                | 4, 8 and 12 weeks delay                               | Possible scenario in NSW and Australia generally in 2020.                                                                                   |
| 6 months                                | 4, 8, 12, 16 and 20 weeks delay                       | Possible scenario in Victoria, Australia e.g. two partial shutdowns totalling about 6 months disruption in 2020.                            |
| 12 months                               | 4, 8, 12, 16, 20 weeks, and 26 weeks (6 months) delay | Extreme scenario, possibly as experienced in other countries which have been more severely impacted by the pandemic than Australia in 2020. |

\* for all scenarios we assume that 100% of patients who would have received treatment experienced delayed treatment.

## 2.5. Model parameters and assumptions

Table A2.2 summarises the model parameters and assumptions included in this study, and detailed information for key model parameters are provided in the following sections.

**Table A2.2. Parameters and assumptions used to model colorectal cancer mortality rates under different treatment delay scenarios**

| Model parameters, assumptions and justifications                                                                                                                                                                                                                                                                                                                                                                       | Source                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| <i>Colorectal cancer patients at risk and risk groups (section 2.6.1)</i>                                                                                                                                                                                                                                                                                                                                              |                                                             |
| The stage distribution for new colorectal cancer cases in 2020 is approximated using data for 2016.                                                                                                                                                                                                                                                                                                                    | AIHW 2021 <sup>17</sup>                                     |
| The distribution of prevalent patients by numbers of years since initial diagnosis in 2020 is approximated using data for 2018.                                                                                                                                                                                                                                                                                        | AIHW 2021 <sup>17</sup><br>Ferlay et al. 2020 <sup>64</sup> |
| The proportion of patients experiencing metastatic recurrence by years after initial diagnosis is approximated using data for NSW.<br><br>Justification: NSW is the most populous state in Australia with almost one third of the total national population, <sup>65</sup> and has mortality rates for most cancer types, including colorectal cancer, which are almost identical to the national rates. <sup>17</sup> | Luo et al. 2017 <sup>66</sup><br>AIHW 2021. <sup>17</sup>   |
| The proportion of patients experiencing locoregional recurrence is                                                                                                                                                                                                                                                                                                                                                     | Luo et al. 2017 <sup>66</sup>                               |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| approximated using the proportion of patients experiencing metastatic disease progression.                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Obrand and Gordon 1997 <sup>67</sup><br>Bouvier et al. 2015 <sup>68</sup>          |
| Justification: Multiple studies reported that similar proportions of patients experience locoregional and distant recurrence.                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                    |
| <b><i>Cancer treatment provision pre-COVID-19 pandemic (section 2.6.2)</i></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                    |
| For new colorectal cancer cases, the proportion of patients who would have received treatment (surgery only, and surgery with other therapy) is approximated using data from ICBP SurvMark-2.                                                                                                                                                                                                                                                                                                                                                |                                                                                    |
| Justification: We did not have access to cancer treatment data for Australia. As the stage-specific survival for colorectal cancer in Australia was generally consistent with that in other high-income countries including Canada, Denmark, Ireland and Norway, treatment patterns are also likely to be generally consistent. In addition, it has been shown that the overall proportion of patients who received surgical treatment in the ICBP SurvMark-2 dataset is generally consistent with that reported in Australia. <sup>61</sup> | Araghi et al. 2021 <sup>69</sup><br>Goldsbury et al. 2012 <sup>61</sup>            |
| For recurrent cancers (locoregional recurrence or metastatic progression), the proportion of patients who would have received surgery and other treatment is approximated using the average proportion of patients with recurrent cancers who received curative surgical treatment as reported in the literature.                                                                                                                                                                                                                            | Cancer Council Australia 2021 <sup>62</sup><br>Hellinger et al. 2006 <sup>63</sup> |
| <b><i>Health-care system disruption and treatment delays during the COVID-19 pandemic (section 2.6.3)</i></b>                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                    |
| We defined 3-month and 6-month system disruption periods to represent the situation in Australia, and a 12-month disruption period to represent the worst level of health-care system disruption that may be experienced in other countries.                                                                                                                                                                                                                                                                                                 | Services Australia <sup>31</sup><br>BHI 2020 <sup>70</sup>                         |
| We assume that 100% of patients who would have received treatment experienced delayed treatment.                                                                                                                                                                                                                                                                                                                                                                                                                                             | Simplifying assumption due to lack of real-time data                               |
| <b><i>Relative risk of cancer death due to system-caused treatment delays (section 2.6.4)</i></b>                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                    |
| The relative risk of cancer death due to pandemic-related treatment delays for new cancer patients receiving surgery only is approximated using the relative risk of cancer death due to any system-caused surgical treatment delays prior to the pandemic (but not treatment delays due to individual patients' characteristics).                                                                                                                                                                                                           | Hanna et al. 2020 <sup>59</sup>                                                    |
| The relative risk of cancer death due to pandemic-related treatment delays for new cancer patients or recurrent cancers receiving surgery and other treatment is approximated using the relative risk of cancer death due to any system-caused adjuvant treatment delays prior to the pandemic (but not treatment delays due to individual patients' characteristics), which are the only relevant data available for this study.                                                                                                            | Hanna et al. 2020 <sup>59</sup>                                                    |
| <b><i>Colorectal cancer deaths due to delayed treatment during the COVID-19 pandemic</i></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                    |
| The excess colorectal cancer deaths associated with delayed treatment and the adjusted relative risks per duration of treatment delay remain constant across age and stage at diagnosis.                                                                                                                                                                                                                                                                                                                                                     | Simplifying assumption due to lack of in-depth data                                |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| <p>Additional colorectal cancer deaths for new cases are estimated by the colorectal cancer deaths associated with treatment delays for patients who would have been expected to be cured with timely treatment. We used 5-year observed survival as a proxy for the proportion cured for each stage.</p> <p>Additional cancer deaths for prevalent patients 1-5 years after initial diagnosis are estimated as the cancer deaths associated with treatment delays for patients who would have been expected to survive another 5 years with timely treatment. We used 5-year conditional survival as a proxy for the proportion cured for prevalent patients 1-5 years after initial diagnosis.</p> <p>As for prevalent patients &gt;5 years after diagnosis, the excess cancer deaths attributable to delayed treatment are additional cancer deaths.</p> <p>Justification: Colorectal cancer patients are considered to be cured if they survive more than 5 years and will die from other causes in the future. The absolute risk of death from colorectal cancer diminished sharply over time and was below 7% after 5 years.</p> | <p>AIHW 2021<sup>17</sup><br/>Baade et al 2011<sup>71</sup><br/>van Erning et al. 2014<sup>72</sup></p> |
| <p>For patients who would have been expected to die from colorectal cancer within 5 years, the deaths associated with treatment delays are estimated as deaths occurring earlier than would have been expected.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                         |

AIHW: Australian Institute of Health and Welfare; BHI: Bureau of Health Information; ICBP: International Cancer Benchmarking Partnership; NSW: New South Wales.

## 2.6. Data sources and model input

### 2.6.1. Colorectal cancer patients at risk of experiencing treatment delay and risk groups

#### *Colorectal cancer incidence and survival by stage of disease at diagnosis*

We obtained data on colorectal cancer incidence rates and 1-year to 5-year relative survival by sex, age group and stage at diagnosis from the AIHW.<sup>17</sup> We also obtained 1-year to 10-year observed overall survival, and 1-year to 5-year observed sex and age-specific survival from the AIHW.<sup>17</sup>

#### *Colorectal cancer prevalence data*

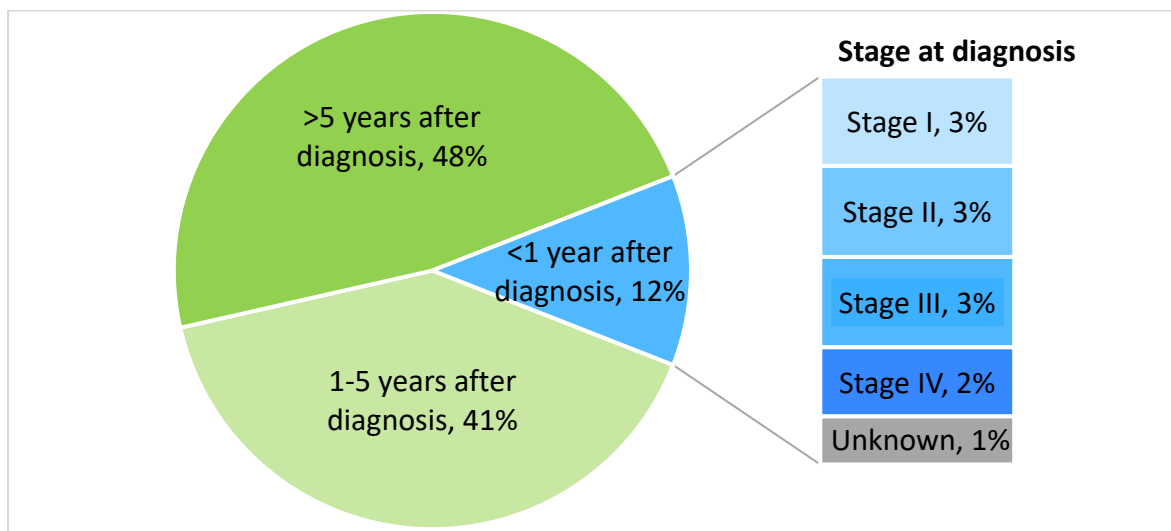
The 1-year, 5-year and 33-year prevalence of colorectal cancer by sex were obtained from the AIHW,<sup>17</sup> and the 5-year prevalence by sex and age group were obtained from the Global Cancer Observatory database on 23 April 2020. The sources and methods used in compiling the estimates in the Global Cancer Observatory database are described in detail elsewhere<sup>73</sup> and are also available online at the Global Cancer Observatory ([gco.iarc.fr](http://gco.iarc.fr)).

### *Prevalent cancers by time since diagnosis and stage at disease*

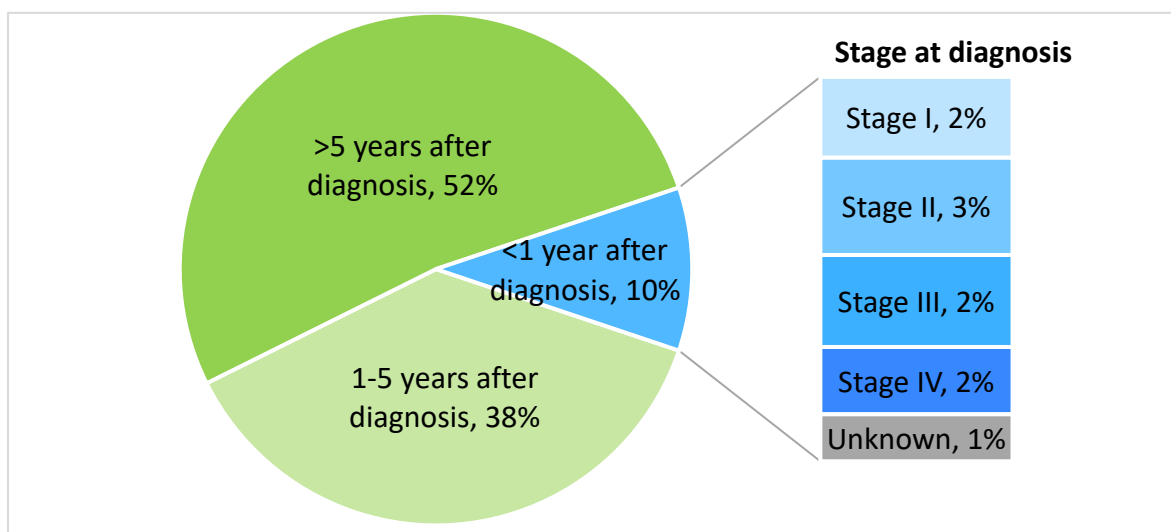
As age, time after diagnosis and stage at initial diagnosis are important factors in making treatment decisions, we disaggregated the prevalent cancer patients into more homogeneous groups that are likely to require similar levels of cancer treatment: new cancer patients within the first year after initial diagnosis by stage of disease, prevalent patients between 1 and 5 years after diagnosis, and patients who had survived more than 5 years (Figure A2.2).

**Figure A2.2. Estimated prevalence of colorectal cancer by years since initial diagnosis in 2020, Australia**

#### **A. Males**



#### **B. Females**



### ***Recurrent disease for prevalent colorectal cancer patients***

In this study, recurrent colorectal cancer is categorised in two groups: locoregional recurrence and metastatic recurrence.<sup>62</sup> There are no data available on the proportion of all Australian colorectal cancer patients experiencing disease recurrence, with the only relevant data available to us being the average proportion of colorectal cancer patients experiencing metastatic recurrence after initial diagnosis in the state of NSW (reported in Luo and colleagues 2017).<sup>66</sup> As it has been reported that the proportion of patients experiencing locoregional and distant recurrence are similar,<sup>67</sup> we therefore used the proportion of patients experiencing metastatic recurrence as a proxy for the proportion of patients experiencing locoregional recurrence, and used the NSW data as a proxy for all of Australia.

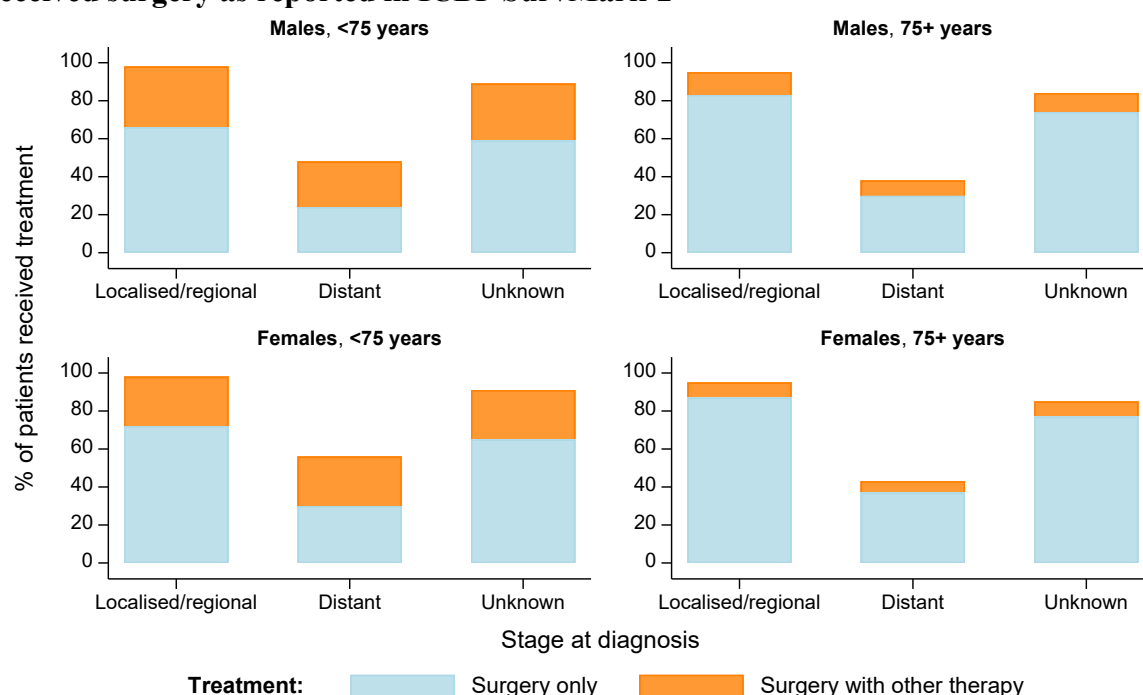
### ***2.6.2. Colorectal cancer treatment provision prior to the COVID-19 pandemic***

#### ***Treatment for patients within the first year of initial diagnosis***

We did not have access to sex-age-stage-specific colorectal cancer treatment data for Australia, but as the stage-specific survival for colorectal cancer in Australia is generally consistent with that reported for other high-income countries including Canada, Denmark, Ireland and Norway, we used the treatment data in the International Cancer Benchmarking Partnership (ICBP) SurvMark-2 project<sup>74</sup> as a proxy for Australian data to estimate the proportion of cancer patients who would have received treatment in the absence of the COVID-19 pandemic. The ICBP SurvMark-2 project collected data on diagnosis, stage at diagnosis, and treatment (where available) for patients from population-based cancer registries in several high-income countries including Australia, Canada, Denmark, Ireland, New Zealand, Norway and the United Kingdom. Detailed descriptions of the data sources for the ICBP SurvMark-2 project have been described previously.<sup>69,74</sup> The treatment type was categorised as surgery only or surgery with other therapy (radiotherapy and chemotherapy,

including pre- and post-surgery). As the dates of treatment receipt were not available in SurvMark-2, we are not able to distinguish neoadjuvant and adjuvant therapy. The proportions of colorectal cancer patients who would have received surgical treatment with or without other therapy in the first year after their initial diagnosis by sex, age and stage at diagnosis are shown in Figure A2.3.

**Figure A2.3. Proportions of new colorectal cancer patients by age and stage who received surgery as reported in ICBP SurvMark-2**



### ***Treatment for disease recurrence >1 year after diagnosis***

We did not have access to treatment data for prevalent colorectal cancer patients in Australia, so we used the proportion of recurrent colorectal cancer cases who received re-resection as reported in the literature<sup>62</sup> as a proxy for Australian data to estimate the proportion of patients with recurrent colorectal cancer who would have received treatment in the absence of the COVID-19 pandemic. Systematic reviews have reported that, on average, 55% of patients with locoregional recurrence and 59% of patients with distant metastases underwent curative surgery.<sup>62</sup>

### ***2.6.3. Health-care system disruption and colorectal cancer treatment provision during the COVID-19 pandemic in Australia***

We defined 3-month and 6-month system disruption periods to represent Australia's experience during the COVID-19 pandemic. As a result of the efforts to control the spread of the novel coronavirus a number of changes in how health-care services were delivered occurred, including the suspension of non-urgent elective surgery and a reduction in elective surgery capacity from March 2020.<sup>70</sup> From 15 May 2020, three stages for reopening elective surgery were in place, with stages 1, 2 and 3 respectively allowing up to 50%, 75% and 100% of normal surgery capacity as safely as possible.<sup>70</sup> Selection of these example disruption periods was generally supported by the changes to the cancer treatment performed during the COVID-19 pandemic in Australia as shown in the next section.<sup>70</sup>

### ***Colorectal cancer treatment provision during the COVID-19 pandemic***

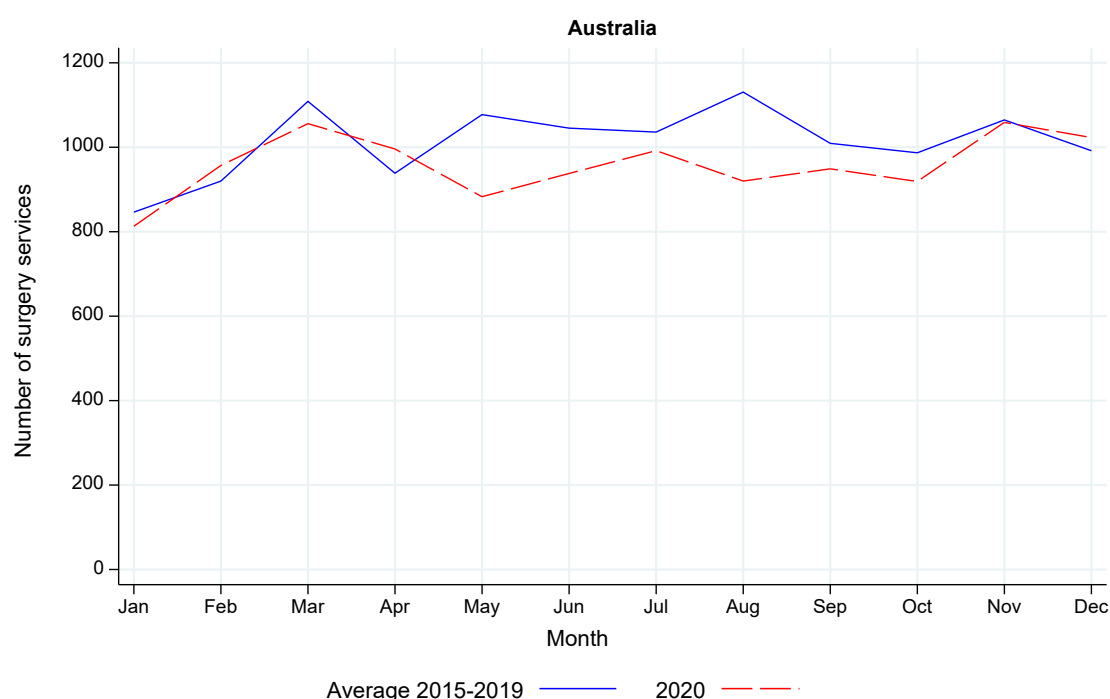
We examined some available health service data in Australia to understand the changes in health services during the pandemic. We obtained the MBS monthly data on colorectal surgery from Services Australia for January 2015 to November 2021.<sup>31</sup> The MBS records include health services (including colorectal cancer surgeries) subsidised by the Australian Government; MBS item codes for colorectal cancer surgery are listed in Table A2.3.

**Table A2.3. List of MBS item codes for selected colorectal cancer surgeries**

| <b>Procedure</b>              | <b>MBS item numbers</b>                                                                                                                                                                                                 |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Colorectal surgery procedures | 32000, 32003, 32004, 32005, 32006, 32009, 32012, 32024, 32025, 32026, 32028, 32039, 32042, 32045, 32046, 32099, 32102, 32103, 32104, 32105, 32106, 32108, 32015, 32018, 32021, 32023, 32030, 32047, 32051, 32054, 32057 |

Figure A2.4 shows the total monthly numbers of MBS services for colorectal cancer surgical procedures in 2020 compared with the average number of services in 2015-2019 in Australia. The biggest decrease in the total number of colorectal cancer surgeries recorded in the MBS data was seen in May 2020, which coincided with the peak of the COVID-19 pandemic in 2020. The total number of colorectal surgeries in May and August 2020 was 18% and 19% lower than that for 2015-2019, respectively.<sup>31</sup> All these results indicate that there was a three- to six- month disruption to the health-care system due to the COVID-19 pandemic in 2020.

**Figure A2.4. Total monthly numbers of MBS services for colorectal cancer surgery in 2020 compared with the average number of services in 2015-2019, Australia**



Data source: Medicare Item Reports.<sup>31</sup>

#### **2.6.4. Relative risk of colorectal cancer death due to system-caused treatment delays**

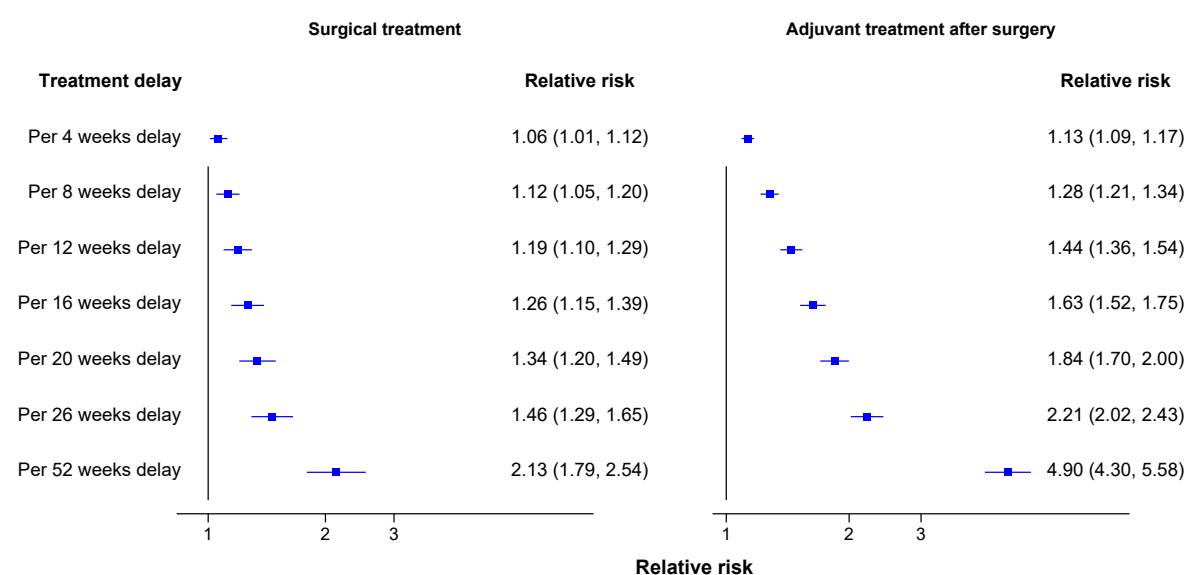
We used the adjusted hazard ratio (HR) reported in the systematic review by Hanna and colleagues as a proxy for the relative risks (RRs) of cancer death per four-week treatment delay.<sup>59</sup> As the RR is not expected to be constant over different delay durations, we adapted the formula described by Hanna and colleagues to convert the RR for different durations of treatment delay, expressed in units of weeks:

$$RR \text{ per } m \text{ week delay} = RR \text{ per } 4 \text{ week delay}^{m/4}$$

The resulting relative risks for different delay periods are shown in Figure A2.5.

Hanna and colleagues suggested that the approach should only be applied to the range of treatment delays considered in the studies included in the systematic review (4 weeks to 16 weeks). As a more hypothetical exploration, we also examined the converted RRs for longer delays up to 52 weeks (12 months), and compared the results to other estimates of excess risk of death (see below).

**Figure A2.5. Converted relative risk of cancer death due to treatment delays**



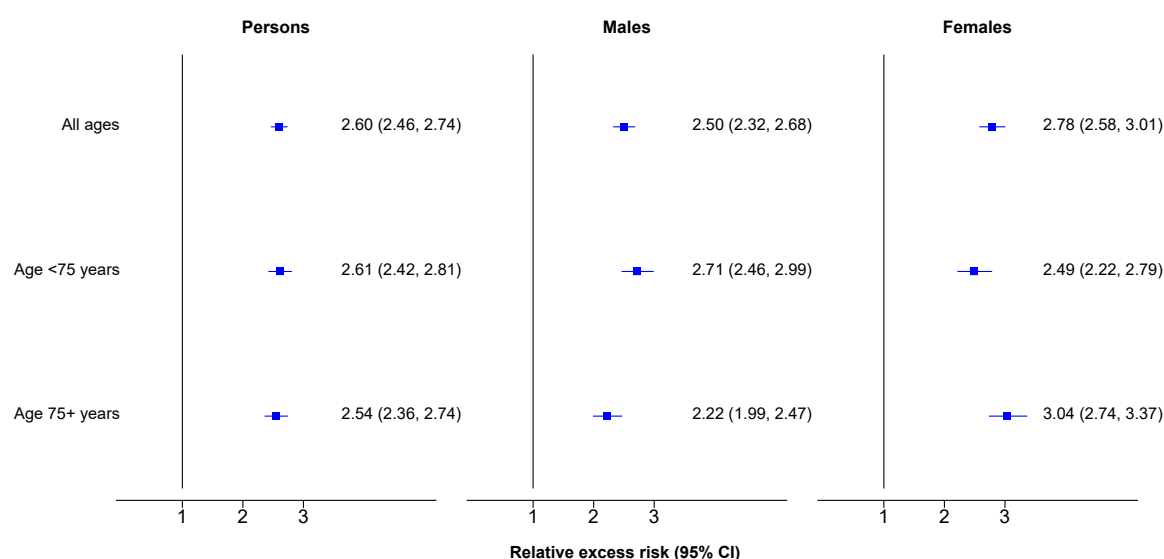
Surgical treatment: based on 2 studies for colon cancer.

Adjuvant treatment: based on 7 studies for colon cancer and 1 study for rectal cancer.

As the RR for treatment delay will not increase indefinitely over time, we assumed that the maximum RR of death would be realised with a 12-month treatment delay, which would be equivalent to the RR for a cancer patient who did not receive any treatment. As a cross-validation, we compared the converted RR per 12-month delay with the relative excess risk (RER) of death from the ICBP SurvMark-2 data. The RER is the ratio of the excess risk of

death for the group of patients who did not receive surgical treatment within 12 months after initial diagnosis, compared to the reference group who received surgical treatment. After adjusting for sex, age and stage at diagnosis, the relative excess risks of death associated with no surgical treatment within the first year of initial diagnosis were generally consistent with the converted RR per 12 months delay. Minor differences were likely due to the RER from ICBP SurvMark-2 only accounting for sex, age and stage at diagnosis, while treatment delays could be due to other patient factors (e.g. comorbidities) or due to the need for additional investigations (Figure A2.6). The sensitivity analysis that was conducted by stratifying the RRs by sex and age group using the sex-age-specific RERs resulted in only minimal changes to the point estimates (Table A2.4).

**Figure A2.6. Relative excess risk of death from colorectal cancer for patients who did not receive surgical treatment within the first year after initial diagnosis, from ICBP SurvMark-2 data**



\*Adjusted for sex, age and stage at diagnosis.

## **2.7. Limitations of modelling the number of excess colorectal cancer deaths due to treatment delays**

The primary limitation of our estimation of excess colorectal cancer deaths due to treatment delays during the COVID-19 pandemic is that we do not have real-time clinical data on actual delays in treatment, or the relative risk of death due to delayed treatment. Another limitation is that the proportion of colorectal cancer patients who would have received surgical treatment by sex, age and stage was estimated using the ICBP SurvMark-2 data, although it has been shown that the overall proportion of patients who received surgical treatment in that dataset is generally consistent with that reported in Australia.<sup>61</sup> The proportion of colorectal cancer patients with recurrence who would have received curative treatment was estimated based on published literature. We also assumed that all prevalent patients between 1 and 5 years after diagnosis would require the same level of treatment<sup>75</sup> and that cancer screening or diagnosis were not delayed. The exploratory analysis also did not take into account the impact of delays on non-surgical treatment only or on patients requiring non-surgical treatment after surgery during the disruption period. It is therefore possible that the number of deaths occurring earlier is an underestimate. However, as Australian data suggest that only small changes in systemic cancer therapy in Australia occurred during the pandemic,<sup>76</sup> this possible under-estimation is likely small. In addition, the relative risk of death due to delayed treatment of colorectal cancer was derived from a systematic review which was based on a meta-analysis of two colon cancer studies for surgical treatment and eight studies for adjuvant therapy, and were estimated for death from any cause. Studies have shown that survival for colon and rectal cancers differ, and clinical guidelines for treatment of the two cancer types differ.<sup>69,74</sup> It was suggested that the method used to convert the RR can only be applied to the range of treatment delays (4 to 16 weeks) considered in the studies included in the systematic review.<sup>59</sup> The results for a longer delay

should therefore be interpreted with caution. Also, we used the relative risk associated with delayed adjuvant treatment as a proxy for the relative risk associated with surgery and other therapy, and it is possible that a small number of these other treatments may be performed before surgery. Another limitation is that we used the RR associated with delayed adjuvant therapy for new cases as a proxy for the RR associated with delayed adjuvant therapy for recurrent cancers, and the survival after recurrent cancer is likely to be different to that for patients with primary colorectal cancer.<sup>77</sup>

## 2.8. Additional results from modelling the number of excess colorectal cancer deaths due to treatment delays

**Table A2.4. Sensitivity analysis using the sex-age-specific relative risks - Estimated additional colorectal cancer deaths or deaths occurring earlier due to treatment delays during the COVID-19 pandemic in 2020 for a range of disruption scenarios, Australia, 2020-2044**

| Period of health-care system disruption                                                                                        |              | Duration of treatment delay experienced by patients during the COVID-19 pandemic in 2020 |                        |                        |                         |                          |                           |
|--------------------------------------------------------------------------------------------------------------------------------|--------------|------------------------------------------------------------------------------------------|------------------------|------------------------|-------------------------|--------------------------|---------------------------|
|                                                                                                                                |              | 4 weeks                                                                                  | 8 weeks                | 12 weeks               | 16 weeks                | 20 weeks                 | 26 weeks                  |
| <b>Additional colorectal cancer deaths due to delayed treatment <sup>a</sup></b>                                               |              |                                                                                          |                        |                        |                         |                          |                           |
| <b>3 months</b>                                                                                                                | <b>Total</b> | <b>50 (25 - 75)</b>                                                                      | <b>105 (67 - 144)</b>  | <b>165 (116 - 218)</b> |                         |                          |                           |
|                                                                                                                                | Males        | 29 (15 - 43)                                                                             | 61 (39 - 83)           | 96 (68 - 126)          |                         |                          |                           |
|                                                                                                                                | Females      | 21 (10 - 32)                                                                             | 44 (28 - 61)           | 69 (48 - 92)           |                         |                          |                           |
| <b>6 months</b>                                                                                                                | <b>Total</b> | <b>99 (50 - 150)</b>                                                                     | <b>209 (134 - 288)</b> | <b>330 (232 - 436)</b> | <b>465 (341 - 599)</b>  | <b>614 (464 - 779)</b>   |                           |
|                                                                                                                                | Males        | 57 (30 - 86)                                                                             | 121 (79 - 166)         | 192 (136 - 252)        | 270 (200 - 346)         | 357 (272 - 451)          |                           |
|                                                                                                                                | Females      | 42 (20 - 64)                                                                             | 88 (55 - 122)          | 138 (96 - 184)         | 195 (141 - 253)         | 257 (192 - 328)          |                           |
| <b>12 months</b>                                                                                                               | <b>Total</b> | <b>198 (101 - 299)</b>                                                                   | <b>417 (269 - 575)</b> | <b>660 (462 - 872)</b> | <b>929 (683 - 1197)</b> | <b>1228 (927 - 1557)</b> | <b>1739 (1350 - 2171)</b> |
|                                                                                                                                | Males        | 115 (60 - 172)                                                                           | 242 (158 - 332)        | 383 (271 - 504)        | 540 (400 - 692)         | 714 (543 - 901)          | 1,012 (790 - 1258)        |
|                                                                                                                                | Females      | 83 (41 - 127)                                                                            | 175 (111 - 243)        | 277 (191 - 368)        | 389 (283 - 505)         | 514 (384 - 656)          | 727 (560 - 913)           |
| <b>Colorectal cancer deaths occurring earlier resulting from shortened survival time due to delayed treatment <sup>b</sup></b> |              |                                                                                          |                        |                        |                         |                          |                           |
| <b>3 months</b>                                                                                                                | <b>Total</b> | <b>47 (23 - 73)</b>                                                                      | <b>99 (63 - 139)</b>   | <b>158 (108 - 211)</b> |                         |                          |                           |
|                                                                                                                                | Males        | 25 (12 - 38)                                                                             | 52 (34 - 73)           | 83 (57 - 110)          |                         |                          |                           |
|                                                                                                                                | Females      | 22 (11 - 35)                                                                             | 47 (29 - 66)           | 75 (51 - 101)          |                         |                          |                           |
| <b>6 months</b>                                                                                                                | <b>Total</b> | <b>95 (46 - 145)</b>                                                                     | <b>199 (125 - 279)</b> | <b>315 (217 - 421)</b> | <b>442 (320 - 578)</b>  | <b>585 (435 - 748)</b>   |                           |
|                                                                                                                                | Males        | 50 (24 - 76)                                                                             | 105 (66 - 146)         | 165 (115 - 220)        | 233 (169 - 303)         | 308 (230 - 392)          |                           |
|                                                                                                                                | Females      | 45 (22 - 69)                                                                             | 94 (59 - 133)          | 150 (102 - 201)        | 209 (151 - 275)         | 277 (205 - 356)          |                           |
| <b>12 months</b>                                                                                                               | <b>Total</b> | <b>190 (92 - 293)</b>                                                                    | <b>400 (250 - 558)</b> | <b>631 (434 - 843)</b> | <b>886 (639 - 1155)</b> | <b>1168 (872 - 1497)</b> | <b>1651 (1267 - 2080)</b> |
|                                                                                                                                | Males        | 100 (49 - 153)                                                                           | 210 (133 - 291)        | 332 (230 - 441)        | 466 (339 - 605)         | 615 (462 - 785)          | 871 (672 - 1092)          |
|                                                                                                                                | Females      | 90 (43 - 140)                                                                            | 190 (117 - 267)        | 299 (204 - 402)        | 420 (300 - 550)         | 553 (410 - 712)          | 780 (595 - 988)           |

a. Additional deaths: deaths from colorectal cancer for patients who would have been considered as cured after timely curative treatment and were expected to have life expectancy similar to that of the general population.

b. Colorectal cancer deaths occurring earlier than expected for patients with colorectal cancer who would have benefitted with extended life expectancy from timely treatment. These patients were expected to die from colorectal cancer within 25 years.

**Table A2.5. Estimated proportion of additional colorectal cancer deaths or deaths occurring earlier due to treatment delays during the COVID-19 pandemic in 2020 for a range of disruption scenarios, Australia, 2020-2044**

| Period of health-care system disruption | Total number of deaths from a cohort of prevalent patients in 2020 in the baseline scenario |        | Proportion of additional colorectal cancer deaths or deaths occurring earlier resulting from shortened survival time due to delayed treatment within total number of deaths in the baseline scenario over the period 2020-2044 (% with 95% uncertainty intervals) |                 |                 |                 |                 |                  |
|-----------------------------------------|---------------------------------------------------------------------------------------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|-----------------|------------------|
|                                         |                                                                                             |        | 4 weeks                                                                                                                                                                                                                                                           | 8 weeks         | 12 weeks        | 16 weeks        | 20 weeks        | 26 weeks         |
|                                         | without treatment delay                                                                     |        | Proportion of additional colorectal cancer deaths due to delayed treatment <sup>a</sup>                                                                                                                                                                           |                 |                 |                 |                 |                  |
| 3 months                                | Total                                                                                       | 19 975 | 0.2 (0.1 - 0.4)                                                                                                                                                                                                                                                   | 0.5 (0.3 - 0.7) | 0.8 (0.6 - 1.1) |                 |                 |                  |
|                                         | Males                                                                                       | 12 025 | 0.2 (0.1 - 0.4)                                                                                                                                                                                                                                                   | 0.5 (0.3 - 0.7) | 0.8 (0.6 - 1.1) |                 |                 |                  |
|                                         | Females                                                                                     | 7950   | 0.3 (0.1 - 0.4)                                                                                                                                                                                                                                                   | 0.5 (0.3 - 0.8) | 0.8 (0.6 - 1.1) |                 |                 |                  |
| 6 months                                | Total                                                                                       | 19 975 | 0.5 (0.2 - 0.7)                                                                                                                                                                                                                                                   | 1.0 (0.7 - 1.4) | 1.6 (1.1 - 2.2) | 2.3 (1.7 - 3.0) | 3.0 (2.3 - 3.9) |                  |
|                                         | Males                                                                                       | 12 025 | 0.5 (0.2 - 0.7)                                                                                                                                                                                                                                                   | 1.0 (0.7 - 1.4) | 1.6 (1.1 - 2.1) | 2.3 (1.7 - 2.9) | 3.0 (2.3 - 3.8) |                  |
|                                         | Females                                                                                     | 7950   | 0.5 (0.2 - 0.8)                                                                                                                                                                                                                                                   | 1.1 (0.7 - 1.5) | 1.7 (1.2 - 2.3) | 2.4 (1.7 - 3.1) | 3.1 (2.3 - 4.0) |                  |
| 12 months                               | Total                                                                                       | 19 975 | 1.0 (0.5 - 1.5)                                                                                                                                                                                                                                                   | 2.1 (1.3 - 2.9) | 3.3 (2.3 - 4.3) | 4.6 (3.4 - 6.0) | 6.1 (4.6 - 7.7) | 8.6 (6.7 - 10.8) |
|                                         | Males                                                                                       | 12 025 | 1.0 (0.5 - 1.4)                                                                                                                                                                                                                                                   | 2.0 (1.3 - 2.8) | 3.2 (2.3 - 4.2) | 4.5 (3.4 - 5.8) | 6.0 (4.6 - 7.5) | 8.5 (6.6 - 10.5) |
|                                         | Females                                                                                     | 7950   | 1.0 (0.5 - 1.6)                                                                                                                                                                                                                                                   | 2.1 (1.3 - 3.0) | 3.4 (2.3 - 4.5) | 4.7 (3.4 - 6.2) | 6.3 (4.6 - 8.0) | 8.8 (6.7 - 11.1) |
|                                         |                                                                                             |        | Proportion of colorectal cancer deaths occurring earlier resulting from shortened survival time due to delayed treatment <sup>b</sup>                                                                                                                             |                 |                 |                 |                 |                  |
| 3 months                                | Total                                                                                       | 19 975 | 0.2 (0.1 - 0.4)                                                                                                                                                                                                                                                   | 0.5 (0.3 - 0.7) | 0.8 (0.5 - 1.0) |                 |                 |                  |
|                                         | Males                                                                                       | 12 025 | 0.2 (0.1 - 0.3)                                                                                                                                                                                                                                                   | 0.4 (0.3 - 0.6) | 0.7 (0.5 - 0.9) |                 |                 |                  |
|                                         | Females                                                                                     | 7950   | 0.3 (0.1 - 0.4)                                                                                                                                                                                                                                                   | 0.6 (0.3 - 0.8) | 0.9 (0.6 - 1.2) |                 |                 |                  |
| 6 months                                | Total                                                                                       | 19 975 | 0.5 (0.2 - 0.7)                                                                                                                                                                                                                                                   | 1.0 (0.6 - 1.4) | 1.6 (1.1 - 2.1) | 2.2 (1.6 - 2.9) | 2.9 (2.1 - 3.7) |                  |
|                                         | Males                                                                                       | 12 025 | 0.4 (0.2 - 0.6)                                                                                                                                                                                                                                                   | 0.9 (0.6 - 1.2) | 1.4 (1.0 - 1.9) | 2.0 (1.5 - 2.6) | 2.6 (2.0 - 3.3) |                  |
|                                         | Females                                                                                     | 7950   | 0.5 (0.2 - 0.9)                                                                                                                                                                                                                                                   | 1.1 (0.7 - 1.6) | 1.8 (1.2 - 2.4) | 2.5 (1.7 - 3.3) | 3.3 (2.4 - 4.2) |                  |
| 12 months                               | Total                                                                                       | 19 975 | 0.9 (0.5 - 1.5)                                                                                                                                                                                                                                                   | 2.0 (1.2 - 2.8) | 3.1 (2.1 - 4.2) | 4.4 (3.1 - 5.7) | 5.8 (4.3 - 7.4) | 8.1 (6.2 - 10.3) |
|                                         | Males                                                                                       | 12 025 | 0.8 (0.4 - 1.3)                                                                                                                                                                                                                                                   | 1.8 (1.1 - 2.5) | 2.8 (2.0 - 3.8) | 4.0 (2.9 - 5.2) | 5.3 (4.0 - 6.7) | 7.5 (5.8 - 9.3)  |
|                                         | Females                                                                                     | 7950   | 1.1 (0.5 - 1.7)                                                                                                                                                                                                                                                   | 2.2 (1.3 - 3.2) | 3.5 (2.4 - 4.8) | 5.0 (3.5 - 6.6) | 6.5 (4.7 - 8.5) | 9.2 (6.9 - 11.7) |

a. Additional deaths: deaths from colorectal cancer for patients who would have been considered as cured after timely curative treatment and were expected to have life expectancy similar to that of the general population.

b. Colorectal cancer deaths occurring earlier than expected for patients with colorectal cancer who would have benefitted with extended life expectancy from timely treatment. These patients were expected to die from colorectal cancer within 25 years.

## **2.9. Broader impacts of the COVID-19 pandemic on people with cancer and the future cancer burden**

Our study focused on the effects of delayed treatment, however, there are additional consequences of the COVID-19 pandemic on cancer outcomes. It is currently very difficult to be sure of the full impact of the COVID-19 pandemic on cancer patients and outcomes, or to even be able to identify and untangle the numerous and complex ways in which the pandemic may interact with and affect all stages of the cancer journey. There are, however, some defined consequences of the pandemic which are likely to result in excess cancer morbidity and premature deaths. First, cancer screening services have been disrupted in a number of countries, including Australia,<sup>78</sup> with BreastScreen Australia services pausing in April-May 2020,<sup>79</sup> and reports of cancer screening being cancelled in the UK.<sup>80</sup> The National Bowel Cancer Screening Program (NBCSP) in Australia plays a crucial role in colorectal cancer prevention through the identification and removal of pre-cancerous conditions,<sup>48</sup> but it has been reported that in April 2020 the number of MBS procedures for the removal of polyps was half that for March 2020,<sup>81</sup> indicating the potential impact of the COVID-19 pandemic on cancer detection and prevention. Furthermore, there are possible delays in diagnosis and a subsequent shift in stage towards more advanced stage,<sup>78</sup> which is likely to result in additional numbers of excess deaths. Moreover, population-level health-care-seeking behaviour may be impacted, meaning that cancer diagnosis and treatment could have been delayed or missed.<sup>78,82,83</sup> In countries which are more severely affected by the COVID-19 pandemic, front-line medical workers and hospital facilities bear important responsibilities and pressure to prevent and control the novel coronavirus. Cancer patients may therefore suffer from postponed treatment due to a shortage of hospital beds, resources, and workforce, or due to patients' choices to avoid situations perceived as being a risk for coronavirus infection. All these disruptions to cancer care may result in potential excess cancer deaths irrespective of

cancer patients' COVID-19 infection status.<sup>78,84</sup>

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