



Government of **Western Australia**  
Department of **Health**

# Evaluation of Cancers and Other Health Conditions Among Residents of the Shire of Murray, Western Australia

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Public and Aboriginal Health Division  
Department of Health WA  
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## Executive summary

The Department of Health Western Australia carried out an evaluation to assess the likelihood of a cancer cluster in the Shire of Murray based on the *Guidelines for the Investigation of Cancer Clusters in Western Australia*.<sup>1</sup> According to these guidelines, a suspected cancer cluster is more likely to be confirmed as a cluster if it meets the following 3 criteria:

1. the occurrence of a large number of cases of one type of cancer
2. the occurrence of a rare type (or types) of cancer
3. the occurrence of a large number of cases of a cancer type in an age group that is not usually affected by that cancer type.

Additional epidemiological analyses were also conducted to evaluate if there were elevated rates of certain non-cancer conditions, namely, asthma, other chronic respiratory diseases (such as emphysema, bronchitis, chronic obstructive lung disease and bronchiectasis), and chronic kidney diseases in the area.

The main findings are as follows.

### Cancers

- No cancer type was identified as a cancer cluster.
- The overall cancer incidence rate in the Shire of Murray was similar to the overall rate in country WA.
- There was no significant increase in the incidence of all cancers over time in the Shire of Murray.
- The age distributions (age-specific rates) of all cancers in the Shire of Murray were similar to those of country WA.
- There were 63 different types of cancers among the 1,997 cancer cases in the Shire of Murray between 2001 and 2020.
- The 5 most common cancers in the Shire of Murray were prostate cancer, cancers of the lung, bronchus or trachea, melanoma, breast cancer and colorectal cancer, which were similar to the 5 most common cancers in country WA.
- All cancer cases occurred in an age group that was normally affected by that cancer type.
- The overall incidence rates of prostate and lung cancers were slightly higher in the Shire of Murray compared to country WA. However, these cancers are not rare types of cancers, and they did not occur in an age group that is not usually affected by that cancer type. Furthermore, increased incidence of these cancers are observed in other Local Government Areas (LGAs), suggesting the observation is within the normal variation between LGAs.
- None of the cancer types included in the analysis showed a significant increase in incidence over time.
- There was a 3 per cent average annual decrease in the incidence of lung and breast cancers in the Shire of Murray over time.

### Other conditions

- The prevalence of asthma and chronic respiratory conditions (other than asthma) in the Shire of Murray was similar to that of country WA.

- The overall hospitalisation rates for asthma, chronic respiratory conditions (other than asthma) and chronic kidney diseases in the Shire of Murray were lower than those of country WA.
- There was no increase in hospitalisations from these conditions over time in the Shire of Murray.

### **Potential environmental exposure sources in Pinjarra and the surrounding areas**

- There are a number of potential sources of dust in Pinjarra and the surrounding areas, including Pinjarra Alcoa Alumina Refinery and residue storage areas (RSAs), materials transport and other industry.
- Health risk assessments commissioned by Alcoa have concluded that there was a low risk to human health from the Refinery and RSA emissions.
- Alcoa is required to have an ambient air dust monitoring program in accordance with its Department of Water and Environmental Regulation (DWER) licence conditions.
- DWER has been conducting independent ambient air dust monitoring, since April 2023, to measure dust impacts from all sources on specific community receptors. Results were not available at the time of publication.

### **Summary**

Based on the currently available data, this evaluation found no clear or consistent evidence to support the presence of a potential cancer cluster in the Shire of Murray and the need for a more detailed follow-up study. The evaluation did find that prostate and lung cancers rates in the Shire of Murray were slightly higher than those of country WA. However, given that these are not rare types of cancers, these cancers did not occur in an age group that is not usually affected by that cancer type, and there were several other LGAs in WA with raised rates of these cancers, it is unlikely that there is a potential cluster of these cancers in the Shire of Murray. This evaluation also did not find evidence of increase in other non-cancer conditions.

Based on previous health risk assessments, there is currently insufficient evidence of increased health risk from environmental exposures to the residents of the Shire of Murray. The DWER is currently undertaking an independent monitoring program in and around Pinjarra. This will provide data on current, but not historical, exposure.

### **Recommendation**

- To keep the current evaluation on file in the Department of Health and reassess it if additional concerns regarding cancer clusters are raised in the future.

## 1. Introduction

The Epidemiology Directorate, Public and Aboriginal Health Division, Department of Health Western Australia received a request on 1 February 2023 from the Manager Environmental Health of the Shire of Murray to carry out a cluster analysis of cancer cases and other non-cancer conditions in Pinjarra and the surrounding areas. The manager reported that residents of the communities in Pinjarra, North Pinjarra, South Yunderup and Ravenswood were concerned about the health impacts of exposure to dust and heavy metals from operations at the Pinjarra Alcoa Alumina Refinery. The residents of these communities reported that there were several people with cancer in the same street, which they attributed to the refinery. In his request, the manager also presented anecdotal and Australian Bureau of Statistics (ABS) 2021 Census data suggesting higher rates of respiratory illnesses and cancers within the local Pinjarra community.

In response to these concerns, the Department of Health carried out a primary evaluation to assess the likelihood of a cancer cluster in the area based on the *Guidelines for the Investigation of Cancer Clusters in Western Australia*.<sup>1</sup> In a primary evaluation, information is collected from the person or organisation reporting a suspected cancer cluster in order to determine whether a more detailed follow-up is required. Since adequate case information could not be obtained in the primary evaluation to make an informed decision, an additional evaluation was carried out to determine the likelihood of a cancer cluster and to assess whether there were elevated rates of certain non-cancer conditions using routinely collected data. The non-cancer conditions examined were asthma, other chronic respiratory conditions (such as bronchitis, emphysema, chronic obstructive lung diseases and bronchiectasis) and chronic kidney diseases. The purpose of this evaluation was to analyse population-level data on cancer and non-cancer conditions, and risk factors in the Shire of Murray community to determine whether a more detailed follow-up study was required.

### 1.1 Cancer in Western Australia

Cancer is relatively common in Western Australia (WA). There were 13,816 new cases registered in 2020 (Data source: WA Cancer Registry). The estimated lifetime risk of being diagnosed with cancer by the age of 75 years is 1 in 3 for males and 1 in 4 for females.<sup>2</sup>

In 2020, there were 7,796 new cancer cases in males and 6,020 new cancer cases in females. The 5 most common cancers in males in 2020 were prostate cancer, melanoma, colorectal cancer, lung cancer and cancers of the bladder and urinary tract. In females, the most common cancer was breast cancer followed by melanoma, lung, colorectal and uterine cancers (Data source: WA Cancer Registry).

There are many different types of cancer. There may be multiple known or suspected cancer-causing agents and risk factors associated with the development of each cancer type.<sup>3</sup> The development of cancers associated with exposure to cancer-causing agents may take many years, even decades before diagnosis, which makes it difficult to identify the cause of any one cancer case.

### 1.2 Cancer clusters

A cancer cluster is defined as the occurrence of a greater than expected number of cancer cases within a group of people in a geographical area over a period of time.<sup>1</sup> The identification of a cancer cluster using this definition does not necessarily indicate the presence of a causal agent since cancer clusters can also occur by chance. It indicates the need for further evaluation to assess factors other than chance that may be related to the cluster.



A suspected cancer cluster is more likely to be confirmed as a cluster in the absence or presence of an identifiable cause if the following are present:

- i) a large number of cases of one type of cancer
- ii) a rare type of cancer
- iii) a large number of cases of a type of cancer in an age group that is not usually affected.

The possibility of clustering of lifestyle behaviours associated with increased cancer risk and the community's access to health care (resulting in differences in cancer screening and detection) must also be considered during the evaluation of a cancer cluster.

### **1.3 Potential environmental exposure sources in Pinjarra and the surrounding areas**

The Pinjarra Alcoa Alumina Refinery is situated about 5.6 km from the outskirts of both Pinjarra and North Pinjarra (nearest towns). The residual storage areas (RSAs) extend west and north-west from the refinery. The boundary of the RSAs is about 2.6 km from the outskirts of Pinjarra, 2.2 km from the outskirts of North Pinjarra, 8.6 km from the outskirts of Ravenswood and nearly 10 km from the outskirts of Yunderup. Emissions from both the refinery and the RSAs are the primary concern for local communities.

Emissions from both the refinery and the RSAs have been subject to health risk assessments (HRAs).<sup>4,5,6</sup> These HRAs were all commissioned by Alcoa. Ground-level concentrations of a number of contaminants (see below) at sensitive receptor locations, including residential dwellings and the town of Pinjarra, were estimated from emissions from the refinery and the RSAs using air dispersion models. Modelled compounds of concern included:

1. Refinery: particulate matter (PM<sub>2.5</sub> and PM<sub>10</sub>), metals (arsenic, cadmium and compounds, nickel, mercury, selenium, and magnesium and compounds), organic compounds (40 including formaldehyde, benzene, toluene and xylene), ammonia, polycyclic aromatic hydrocarbons (PAHs), combustion gases (NO<sub>x</sub>, NO<sub>2</sub>, SO<sub>2</sub>, CO), dioxins, and furans.
2. RSAs: particulate matter (PM<sub>10</sub>) and metals (arsenic, beryllium, cadmium and compounds, chromium, cobalt, lead, magnesium and compounds, mercury, molybdenum, nickel, and selenium).

The conclusions of the HRAs from the refinery emissions were that there was little likelihood of health effects being caused by either acute or chronic exposure of the general public to refinery emissions.<sup>4,6</sup> For RSA emissions the potential carcinogenic and non-carcinogenic effects of emissions were considered below a level of concern.<sup>5</sup>

Ground-level concentrations for these studies were based on modelling data. There are very few historical monitoring data of actual concentrations of particles and gases at Pinjarra, North Pinjarra, Yunderup and Ravenswood. The DWER is currently undertaking a monitoring program in and around Pinjarra. This includes concentrations of PM<sub>10</sub> and metals. It will provide data on current, but not historical, exposure.

### **1.4 Community health profile of Shire of Murray**

The Shire of Murray covers an area of 1,703 square kilometres. In 2016, its total population was 16,698 representing 0.68 per cent of the State's population.<sup>7</sup> In the 2021 Census, its total population was 18,068 representing 0.68 per cent of the State's population (Table 1).<sup>8</sup>

Sociodemographic factors such as age, gender, education, income and occupation have been associated with cancer and other diseases incidence and risk factor prevalence.<sup>9</sup> In 2021, the Shire of Murray had a greater proportion of older population and unemployed persons compared to metropolitan WA, country WA, and WA state. Metropolitan WA refers to the areas of the state serviced by the East Metropolitan Health Service (EMHS), the North Metropolitan Health Service (NMHS) and the South Metropolitan Health Service (SMHS). Country WA refers to the areas of the state serviced by the WA Country Health Service (WACHS). WA state is the state as a whole, comprising metropolitan WA and country WA.

**Table 1. Demographic and socioeconomic characteristics in the Shire of Murray, metropolitan WA, country WA, and WA state, 2021 Census**

	Shire of Murray		Metropolitan WA	Country WA	WA state
Total population	18,068		2,120,882	530,587	2,651,469
Measure	Counts	%	%	%	%
Female	9,090	50.3	50.6	49.0	50.3
Aboriginal	498	2.8	2.0	8.5	3.3
0-14 years old	3,279	18.1	19.0	19.4	19.1
70+ years old	3,086	17.1	11.0	11.8	11.2
At primary school	1,467	8.1	8.4	8.2	8.4
At secondary school	1,179	6.5	6.7	6.1	6.6
At TAFE, CAE or University	683	3.8	7.3	3.4	6.5
Left school aged less than 15 years old	1,604	10.8	7.3	9.0	7.6
Persons with tertiary qualification	2,291	15.5	36.2	21.2	33.2
One-parent families	775	10.3	15.1	15.0	15.1
Unemployed	487	4.0	3.7	2.6	3.5
<b>Occupation (top responses)</b>					
Technicians and Trades Workers	1,553	21.1	14.7	17.6	15.3
Machinery Operators and Drivers	1,055	14.3	7.0	10.7	7.7
Labourers	879	11.9	8.7	12.5	9.4
Community and Personal Service Works	874	11.9	12.0	11.0	11.8
Professionals	787	10.7	23.7	14.6	22.0
Managers	777	10.5	11.9	14.3	12.3
<b>Industry of Employment (top responses)</b>					
Mining	967	13.1	6.6	11.2	7.5
Manufacturing	788	10.7	5.3	5.2	5.3
Health Care and Social Assistance	753	10.2	14.1	11.5	13.6
Construction	731	9.9	8.9	8.5	8.8
Retail Trade	667	9.1	8.9	8.5	8.8

## **2. Methods**

### **2.1 Data sources**

The following data sources were used for the analysis.

#### **2.1.1 Western Australian Cancer Registry (WACR)**

The WACR is a population-based registry that collects information on cancers and other neoplasms that are diagnosed across the state. In WA, notification of cancer is required by law and all diagnosed cancers in the state are captured in the WACR. The main information sources for the registry are reports from pathologists, haematologists and radiation oncologists, supplemented by death registrations, hospital statistical discharge records, as well as information from hospital files and clinical information systems. Analysis for this report was conducted on the number of individuals who were diagnosed with cancer in the period between 2001 to 2020. The data for 2021 and 2022 were not available at the time of analysis. The incidence cases (i.e., new cases) for each cancer type were used for analysis. International Classification of Diseases Oncology (ICD-O) was used to classify cancer types (Appendix 1).

#### **2.1.2 Health and Wellbeing Surveillance System (HWSS)**

The WA HWSS is a continuous data collection system developed to monitor the health and wellbeing of Western Australians.<sup>10</sup> Approximately 6,000 people throughout WA are interviewed each year. Respondents self-report on a range of questions related to health and wellbeing including chronic health conditions, lifestyle risk factors, protective factors, health service utilisation, mental health and socio-demographics.

Due to the small number of respondents in the Shire of Murray, data from 2011 to 2020 were aggregated and weighted using the 2016 Estimated Resident Population (ERP) for this report. The data were analysed to estimate the prevalence of lifestyle behaviours and risk factors associated with cancers. The data were also used to calculate prevalence estimates of asthma and chronic respiratory conditions (other than asthma). HWSS does not collect information on chronic kidney diseases.

#### **2.1.3 Western Australian Hospital Morbidity Data Collection (WA HMDC)**

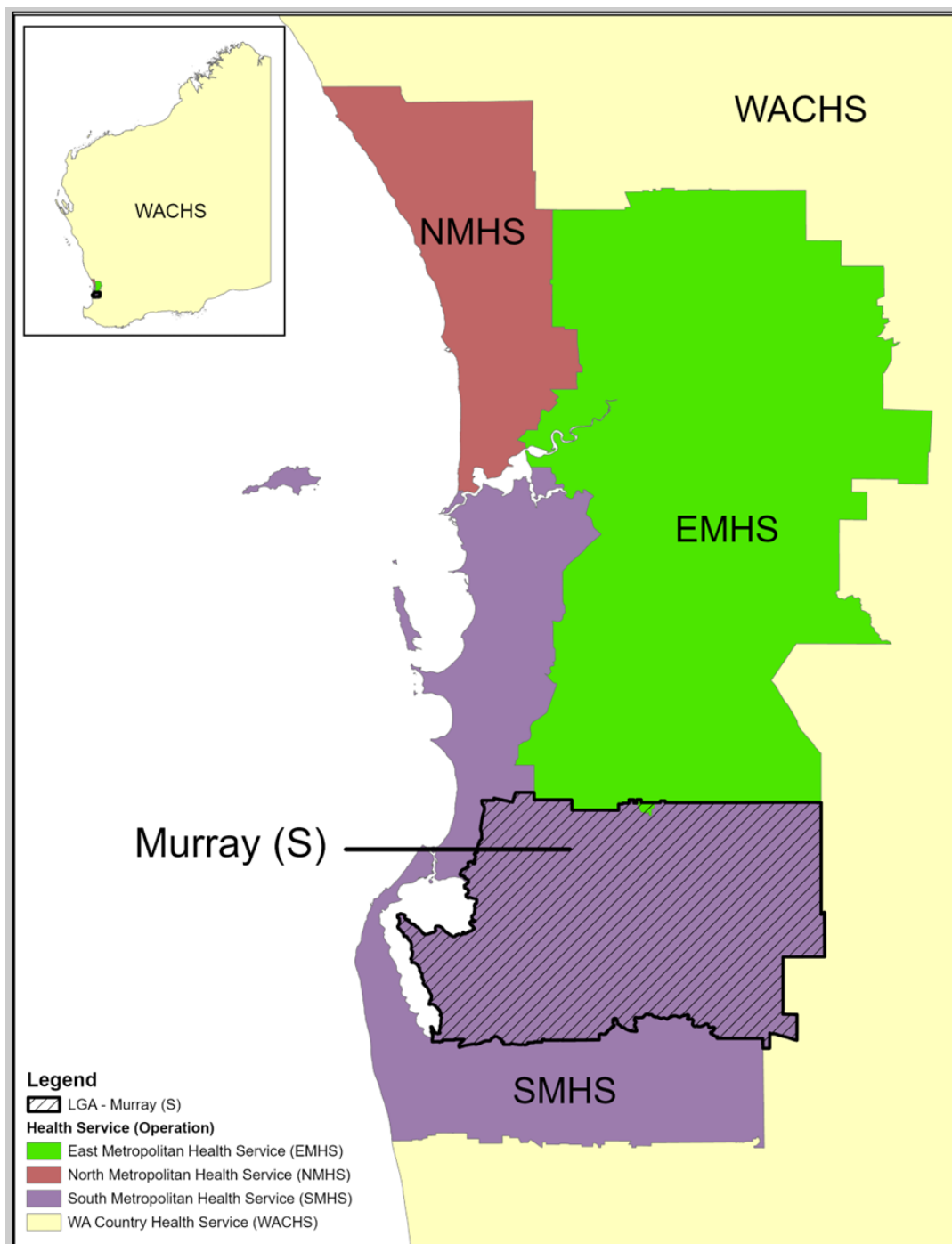
The WA HMDC contains all inpatient data from public and private hospitals in WA. Hospitalisations due to asthma, chronic respiratory conditions (other than asthma) and chronic kidney diseases were identified using principal diagnosis based on the International Classification of Diseases Version 10, Australian Modification (ICD10-AM) (Appendix 2). Analysis was conducted on the number of hospitalisations between 2001 and 2020.

### **2.2 Selection of area, comparison population, and time period for analysis**

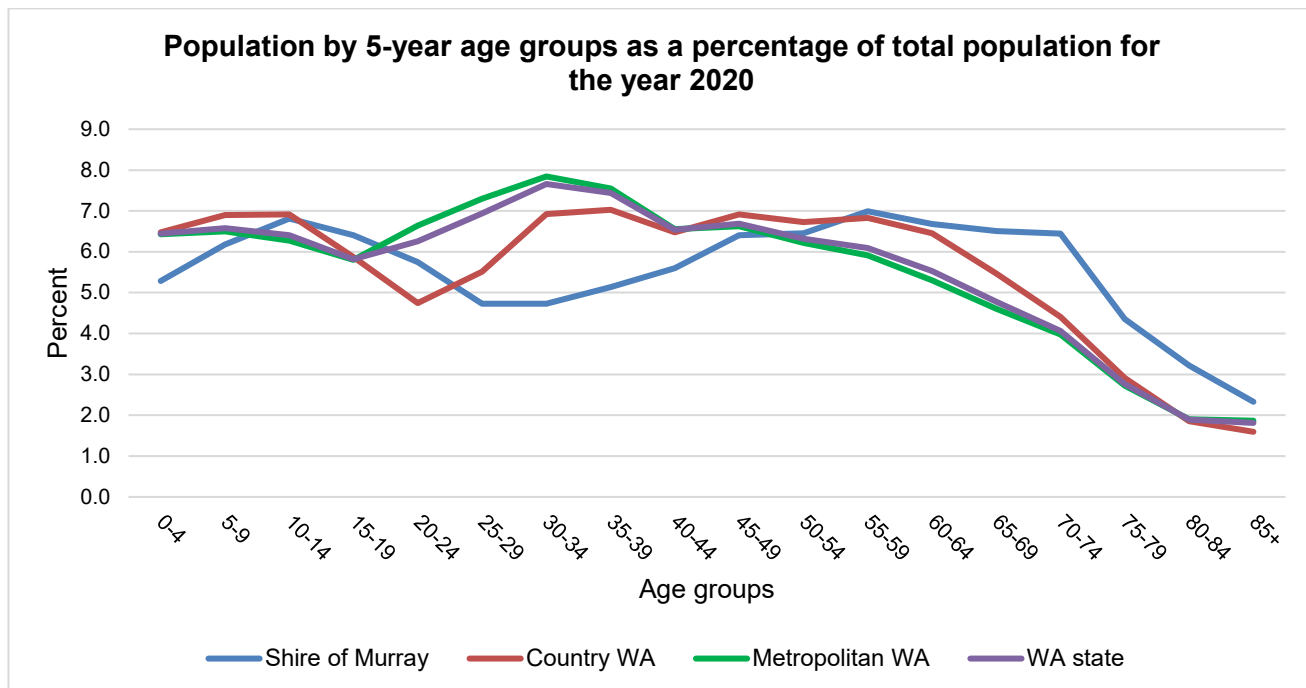
For this report, the local government area (LGA) the Shire of Murray as defined by the ABS as Murray (S) was selected as the area for analysis in order to include all the suburbs of interest, namely, Pinjarra, North Pinjarra, South Yunderup, and Ravenswood (Figure 1). Data for country WA were used for comparison. This area was selected because the population age distribution of the Shire of Murray was comparatively more similar to that of country WA than metropolitan WA or WA state (Figure 2). Age plays a crucial role in disease development with increasing age being one of the most important known risk factors for most chronic diseases.<sup>11</sup> In addition, the main occupations and industries of employment in the Shire of Murray were comparatively more similar to country WA than

metropolitan WA or WA state (Table 1). Furthermore, sensitivity analysis using WA state, country WA and metropolitan WA as comparison areas yielded similar results.

The time period for the cancer incidence analysis was 2001 to 2020. This time period was selected because reliable LGA population data were available only from 2001, and to incorporate the potential lag time for cancers to develop. The same time period (2001 to 2020) was used for the analysis of hospitalisations for other health conditions.



**Figure 1. Map of Western Australia (WA) showing the Shire of Murray, country WA and metropolitan WA.**



**Figure 2. Population by 5-year age groups as a percentage of total population for the year 2020 in the Shire of Murray, country WA, metropolitan WA and WA state**

### 2.3 Statistical analysis

Data were obtained for the residents of the Shire of Murray and country WA. Analysis was carried out with the following 2 aims:

- i. to establish whether the cancer and/or non-cancer conditions of interest were significantly higher in the Shire of Murray compared to country WA
- ii. to determine whether there were changes in cancer incidence and hospitalisations from non-cancer conditions in the Shire of Murray over time.

Age-standardised rates (ASRs) for cancers and non-cancer conditions of interest were calculated. Age-standardisation is a method of adjusting the crude rates to eliminate the effect of differences in population age structures when comparing crude rates for different time periods, different geographic areas and/or different population sub-groups.<sup>12</sup> In this report, the direct method of age-standardisation was applied using all age groups of the 2001 Australian standard population. At least 20 patients per condition were required for the calculation of ASRs to ensure reliability of estimates. ASRs are expressed per 100,000 population.

Standardised incidence ratios (SIRs) or standardised rate ratios (SRRs) were also calculated and were used for comparisons between rates in the Shire of Murray and country WA. The SIR or SRR is the ratio of the observed number of cases to the expected number of cases. In this report, SIRs and SRRs were calculated using the indirect method.<sup>12</sup> The age-specific rates for country WA were applied to age-specific populations in the Shire of Murray to obtain estimated age-specific counts for each age group. The sum of estimated counts for all age groups was the expected counts in the Shire of Murray. A ratio of 1 means that the rate for the Shire of Murray is the same as country WA, a ratio of 2 indicates the Shire of Murray rate is twice that of country WA and a ratio of 0.5 indicates that the Shire of Murray rate is half that of country WA. At least 5 patients per

condition were required for the calculation of SIRs or SRRs to ensure reliability of estimates.

Age-specific rates were calculated for all cancers to compare the age distribution of cancers between the Shire of Murray and country WA. Age-specific rate is the number of cases of disease in a specific age group for a specified geographic area, divided by the total population in the same age group for the same geographic area.<sup>12</sup>

For HWSS data, prevalence estimates were calculated for lifestyle behaviours and risk factors associated with cancers, and for asthma and chronic respiratory conditions (other than asthma). Prevalence is defined as the number of current cases of disease or risk factor (new and pre-existing) during a specified period of time.<sup>10</sup> Chi-squared tests were used to identify significant differences between the prevalence in the Shire of Murray and country WA.

In addition, 95 per cent confidence intervals (CIs) were calculated for ASRs, SIRs, SRRs and prevalence estimates. Small numbers of cancers and non-cancer conditions can lead to substantial volatility in the results. CIs of the rates and prevalence estimates help in assessing the underlying volatility of the rates and prevalence estimates.

For SIRs and SRRs, CIs were used to determine whether the rates were significantly different between 2 comparison areas. If the 95 per cent CIs contain a value of 1, it indicates that the rate in the area of interest is similar to the comparison area. If the lower CI is greater than 1, it indicates that the rate in the area of interest is significantly higher than the comparison area. If the upper CI is smaller than 1, it indicates that the rate in the area of interest is significantly lower than the comparison area.

The population denominators used in the calculation of rates were based on the ERPs for 2001 to 2020 from the ABS.

Poisson regression analysis was carried out to determine whether there were changes in cancer incidence and hospitalisations from non-cancer conditions of interest in the Shire of Murray over time.

For cancers, analysis was carried out for:

- i) all cancers combined
- ii) top 5 cancers – prostate, breast, colorectal, melanoma, lung
- iii) specific cancer types of interest (including lung, prostate, bladder, liver and kidney cancers). These cancers have been associated with exposure to heavy metals, which are potential exposure agents in Pinjarra.

For non-cancer conditions, analysis was carried out for:

- i) asthma
- ii) chronic respiratory conditions (other than asthma) such as bronchitis, emphysema, and chronic obstructive lung disease
- iii) chronic kidney diseases.

In addition, prevalence estimates of certain lifestyle behaviours and risk factors were calculated.

## 3. Cancers

### 3.1 Overall cancer rates

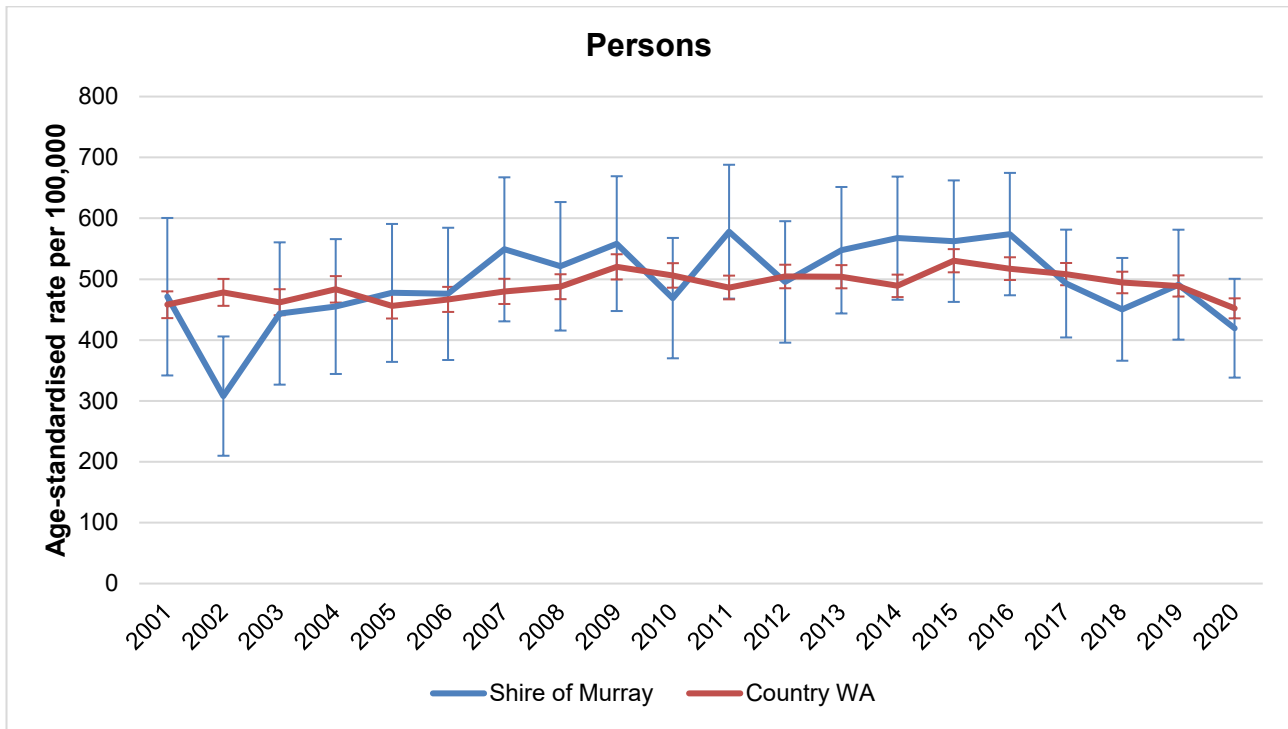
#### Persons

In all persons (males and females combined), there was a total of 1,997 cancer cases in the Shire of Murray during 2001 to 2020, with an age-standardised rate of 498.6 per 100,000 population (95% CI: 476.0-521.3) (Table 2). The overall cancer incidence rate was similar to the overall country WA rate (SIR=1.02, 95% CI: 0.97-1.06). When comparing the rates by individual years, the cancer incidence in the Shire of Murray was similar to that of country WA in all years except 2002, when the rate was significantly lower than the country WA rate (SIR 0.65, 95% CI: 0.47-0.87).

**Table 2. Number and rates of all cancers by year in all persons in the Shire of Murray compared to country WA, 2001 to 2020**

Year	Number	ASR*	95% CI	SIR	95% CI	Comparison with country WA rate**
2001	57	471.2	341.8-600.6	0.96	0.73-1.23	Similar
2002	42	307.9	209.9-405.9	0.65	0.47-0.87	Lower
2003	61	443.6	326.7-560.5	0.93	0.71-1.18	Similar
2004	71	455.1	344.3-565.8	0.98	0.76-1.22	Similar
2005	77	477.4	364.1-590.7	1.06	0.84-1.31	Similar
2006	81	475.9	367.2-584.5	1.05	0.84-1.29	Similar
2007	89	549.0	430.7-667.3	1.08	0.87-1.32	Similar
2008	100	521.2	415.6-626.7	1.13	0.92-1.36	Similar
2009	105	558.4	447.7-669.1	1.08	0.88-1.29	Similar
2010	93	468.9	370.0-567.8	0.96	0.78-1.17	Similar
2011	116	578.0	468.1-688.0	1.19	0.99-1.42	Similar
2012	102	495.5	395.7-595.3	0.97	0.79-1.17	Similar
2013	114	547.6	443.7-651.4	1.05	0.86-1.25	Similar
2014	131	567.4	466.2-668.5	1.18	0.99-1.39	Similar
2015	131	562.5	462.7-662.3	1.05	0.88-1.24	Similar
2016	137	574.1	473.6-674.6	1.10	0.92-1.29	Similar
2017	127	492.8	404.3-581.4	1.00	0.83-1.18	Similar
2018	120	450.5	366.0-534.9	0.93	0.77-1.11	Similar
2019	128	491.0	400.7-581.3	0.98	0.82-1.15	Similar
2020	115	419.5	338.3-500.6	0.91	0.75-1.08	Similar
<b>Total</b>	<b>1997</b>	<b>498.6</b>	<b>476.0-521.3</b>	<b>1.02</b>	<b>0.97-1.06</b>	<b>Similar</b>

\*All rates are per 100,000 population. ASR = Age-standardised rate; SIR = Standardised incidence ratio; 95% CI- 95% Confidence Intervals. \*\* Determined based on SIR and its 95% CIs.



**Figure 3. Age-standardised rates per 100,000 population for all cancers by year in persons in the Shire of Murray and country WA, 2001 to 2020**

The trends of cancer incidence rates in the Shire of Murray for all persons have remained fairly stable over time and were similar to those of country WA, except in 2002 when the rates were significantly lower than those of country WA (Table 2 and Figure 3). Due to the small number of cancer cases in the Shire of Murray, the resulting incidence rates show fluctuations over time with much wider confidence intervals than those of country WA.

Results of the regression analysis showed that there was no statistically significant difference in cancer incidence over time for all persons in the Shire of Murray (p value > 0.05).



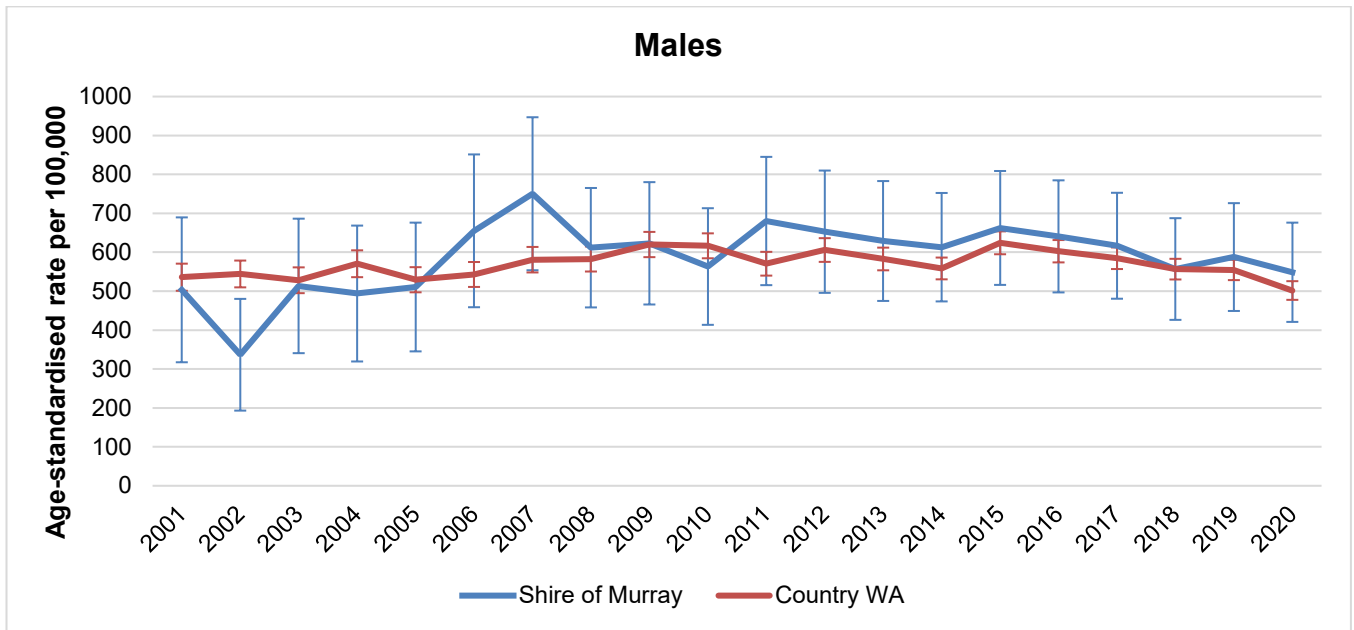
## Males

There was a total of 1,259 cancer cases in males in the Shire of Murray during 2001 to 2020, with an age-standardised rate of 588.3 per 100,000 population (95% CI: 554.6-622.0) (Table 3). The overall cancer incidence rate was similar to the overall country WA rate (SIR=1.04, 95% CI: 0.98-1.09). When comparing the rates by individual years, the cancer incidence in the Shire of Murray was similar to that of country WA in all years except 2002, when the rate was significantly lower than the country WA rate (SIR 0.62, 95% CI: 0.40-0.90).

**Table 3. Number and rates of all cancers by year in males in the Shire of Murray compared to country WA, 2001 to 2020**

Year	Number	ASR*	95% CI	SIR	95% CI	Comparison with country WA rate**
2001	34	503.5	317.3-689.6	0.93	0.65-1.27	Similar
2002	24	336.7	193.1-480.2	0.62	0.40-0.90	Lower
2003	38	513.5	340.7-686.3	0.95	0.67-1.28	Similar
2004	38	493.9	319.4-668.5	0.83	0.59-1.12	Similar
2005	44	510.7	345.3-676.1	0.97	0.70-1.28	Similar
2006	56	655.0	458.8-851.3	1.15	0.87-1.47	Similar
2007	65	750.3	553.8-946.9	1.22	0.94-1.53	Similar
2008	64	611.7	458.3-765.1	1.12	0.86-1.41	Similar
2009	64	623.0	465.8-780.1	1.02	0.78-1.28	Similar
2010	59	563.3	413.5-713.1	0.94	0.71-1.19	Similar
2011	71	680.3	515.5-845.1	1.17	0.91-1.46	Similar
2012	71	652.8	495.7-809.9	1.06	0.83-1.32	Similar
2013	69	628.9	474.9-782.9	1.03	0.80-1.28	Similar
2014	78	613.0	473.7-752.3	1.15	0.91-1.41	Similar
2015	84	662.4	516.1-808.8	1.08	0.86-1.32	Similar
2016	82	640.8	496.8-784.8	1.07	0.85-1.31	Similar
2017	84	616.7	480.6-752.8	1.08	0.86-1.33	Similar
2018	77	556.9	426.3-687.5	1.01	0.79-1.24	Similar
2019	79	587.6	449.1-726.2	1.01	0.80-1.25	Similar
2020	78	548.6	421.1-676.1	1.05	0.83-1.30	Similar
<b>Total</b>	<b>1,259</b>	<b>588.3</b>	<b>554.6-622.0</b>	<b>1.04</b>	<b>0.98-1.09</b>	<b>Similar</b>

\*All rates are per 100,000 population. ASR = Age-standardised rate; SIR = Standardised incidence ratio; 95% CI- 95% Confidence Intervals. \*\* Determined based on SIR and its 95% CIs.



**Figure 4. Age-standardised rates per 100,000 population for all cancers by year in males in the Shire of Murray and country WA, 2001 to 2020**

The trends of cancer incidence rates in the Shire of Murray for all males have remained fairly stable over time and were similar to those of country WA, except in 2002 when the rates were significantly lower than those of country WA (Table 3 and Figure 4). Due to the small number of cancer cases in males in the Shire of Murray, the resulting incidence rates show fluctuations over time with much wider confidence intervals than those of country WA.

Results of the regression analysis showed that there was no statistically significant difference in cancer incidence over time for males in the Shire of Murray ( $p$  value > 0.05).

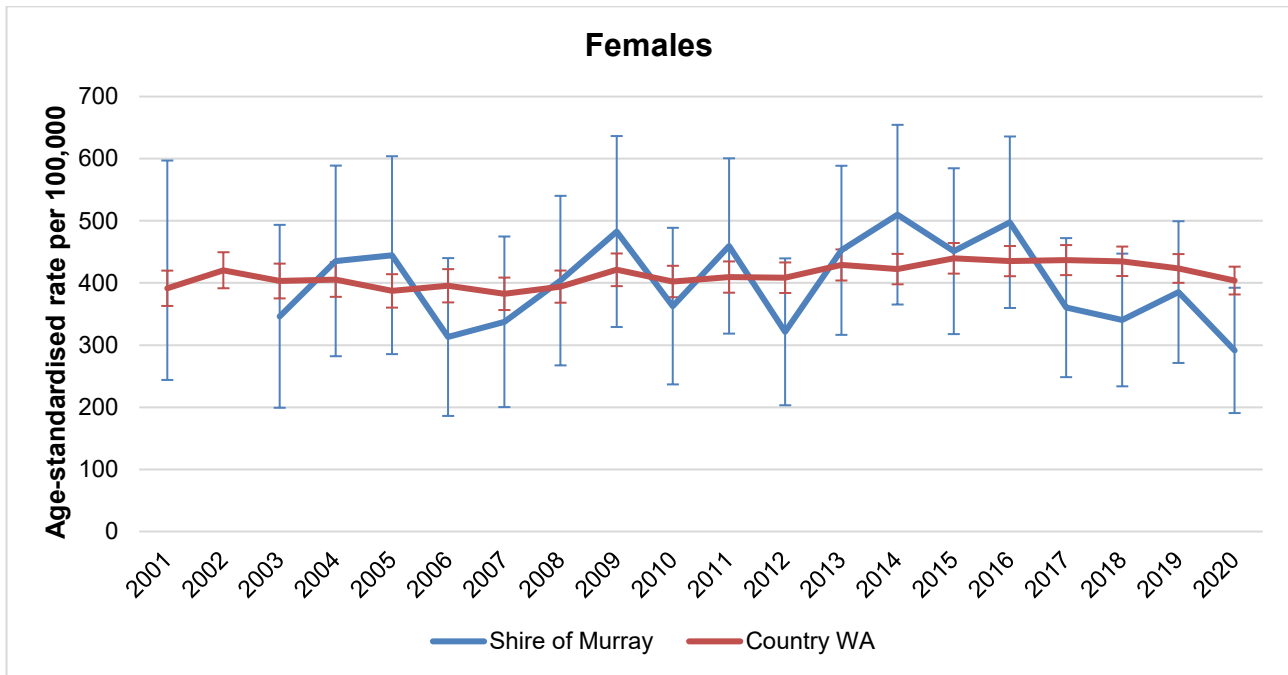
## Females

There was a total of 738 cancer cases in females in the Shire of Murray during 2001 to 2020, with an age-standardised rate of 397.7 per 100,000 population (95% CI: 368.0-427.4) (Table 4). The overall cancer incidence rate was similar to the overall country WA rate (SIR=0.96, 95% CI: 0.89-1.03). When comparing the rates by individual years, the overall cancer incidence in the Shire of Murray was similar to that of country WA in all years except 2020, when the rate was significantly lower than the country WA rate (SIR 0.70, 95% CI: 0.49-0.94).

**Table 4. Number and rates of all cancers by year in females in the Shire of Murray compared to country WA, 2001 to 2020**

Year	Number	ASR*	95%CI	SIR	95% CI	Comparison with country WA rate**
2001	23	420.5	243.9-597.1	0.96	0.61-1.39	Similar
2002	18	N/A	N/A	0.67	0.40-1.02	Similar
2003	23	346.4	199.2-493.5	0.87	0.55-1.26	Similar
2004	33	435.5	282.1-588.9	1.16	0.80-1.59	Similar
2005	33	444.7	285.5-604.0	1.17	0.81-1.60	Similar
2006	25	313.0	186.0-440.0	0.85	0.55-1.21	Similar
2007	24	337.5	200.2-474.8	0.80	0.51-1.16	Similar
2008	36	403.8	267.4-540.2	1.09	0.76-1.48	Similar
2009	41	482.8	329.1-636.5	1.13	0.81-1.51	Similar
2010	34	362.8	236.8-488.8	0.96	0.66-1.31	Similar
2011	45	459.6	318.5-600.6	1.18	0.86-1.55	Similar
2012	31	321.4	203.2-439.6	0.78	0.53-1.08	Similar
2013	45	452.6	316.5-588.6	1.05	0.77-1.38	Similar
2014	53	509.9	365.3-654.5	1.21	0.90-1.55	Similar
2015	47	451.2	317.7-584.6	0.98	0.72-1.28	Similar
2016	55	497.8	359.8-635.8	1.11	0.84-1.42	Similar
2017	43	360.3	248.4-472.2	0.85	0.62-1.13	Similar
2018	43	340.5	233.7-447.2	0.81	0.59-1.07	Similar
2019	49	385.3	271.3-499.4	0.92	0.68-1.19	Similar
2020	37	291.5	190.7-392.3	0.70	0.49-0.94	Lower
<b>Total</b>	<b>738</b>	<b>397.7</b>	<b>368.0-427.4</b>	<b>0.96</b>	<b>0.89-1.03</b>	<b>Similar</b>

\*All rates are per 100,000 population. ASR = Age-standardised rate; SIR = Standardised incidence ratio; 95% CI- 95% Confidence Intervals. \*\* Determined based on SIR and its 95% CIs; N/A =ASRs are not provided when the number of cancers is less than 20.



**Figure 5. Age-standardised rates per 100,000 population for all cancers by year in females in the Shire of Murray and country WA, 2001 to 2020**

The cancer incidence rates in females over time in the Shire of Murray were similar to those of country WA (Table 4 and Figure 5). Due to the small number of cancer cases in females in the Shire of Murray, the resulting incidence rates show fluctuations over time with much wider confidence intervals than those of country WA.

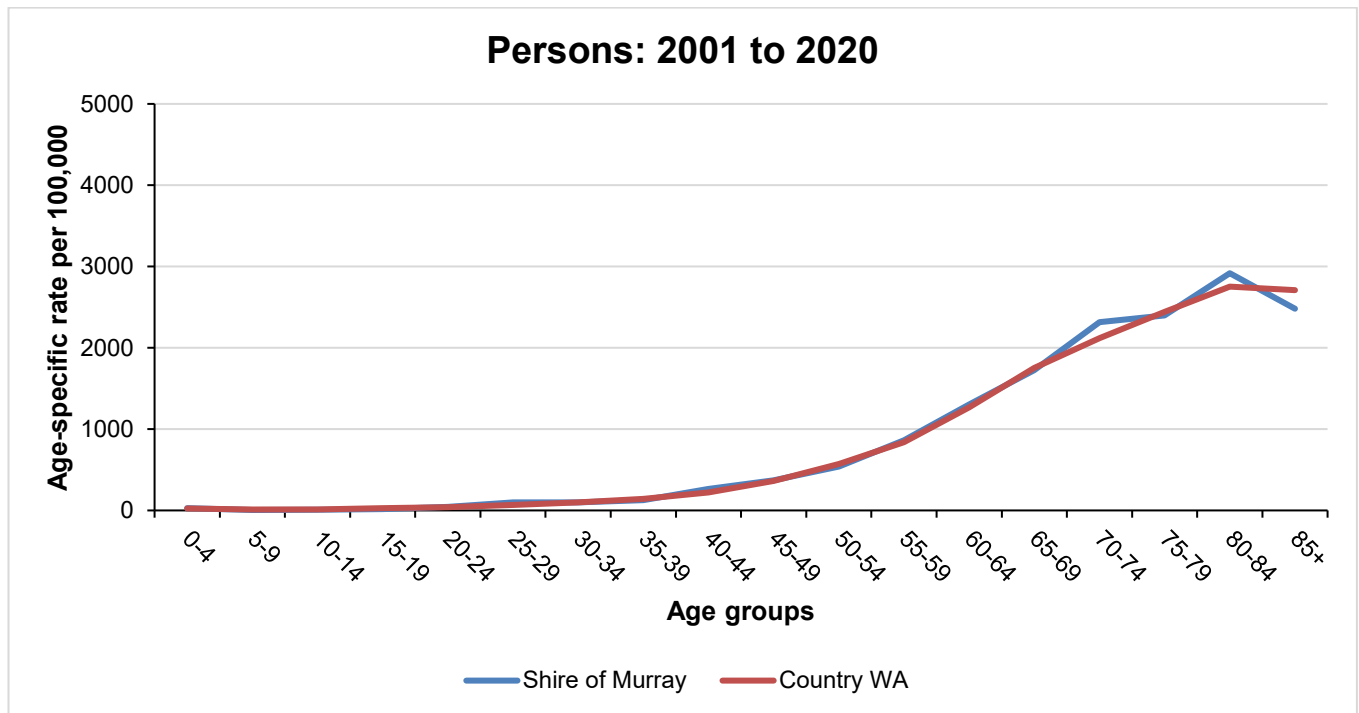
Results of the regression analysis showed that there was no statistically significant difference in cancer incidence over time for females in the Shire of Murray (p value > 0.05).

## 3.2 Age distribution of all cancers

### 3.2.1 Age-specific rates

#### Persons

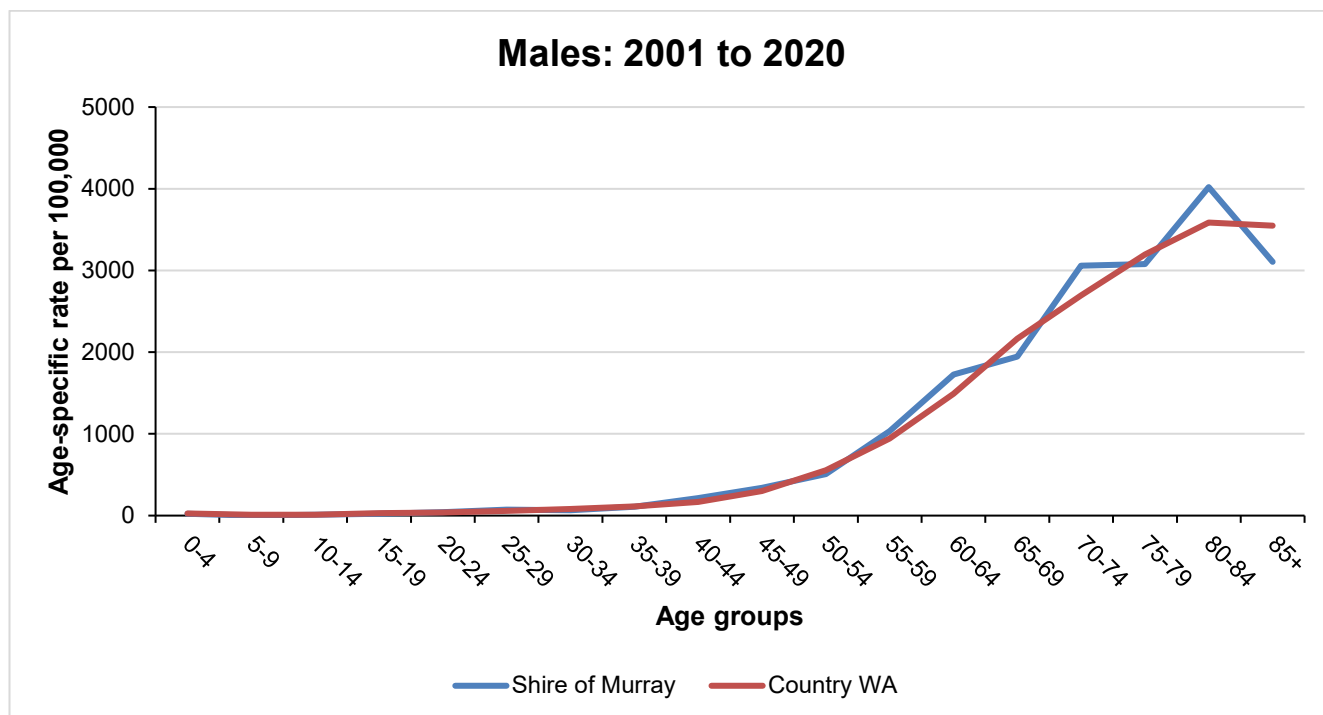
The age distribution (age-specific rates) of all cancers in all persons in the Shire of Murray was similar to that of country WA during 2001 to 2020 except, in the oldest age groups – for 80 to 84 years, the rate was slightly higher, and for over 85 years, the rate was slightly lower than that of country WA (Figure 6). The differences between the Shire of Murray and country WA for older ages were due to the small population and small number of cases in the Shire of Murray in these age groups.



**Figure 6. Age-specific rates per 100,000 population for all cancers in all persons in the Shire of Murray and country WA, 2001 to 2020**

## Males

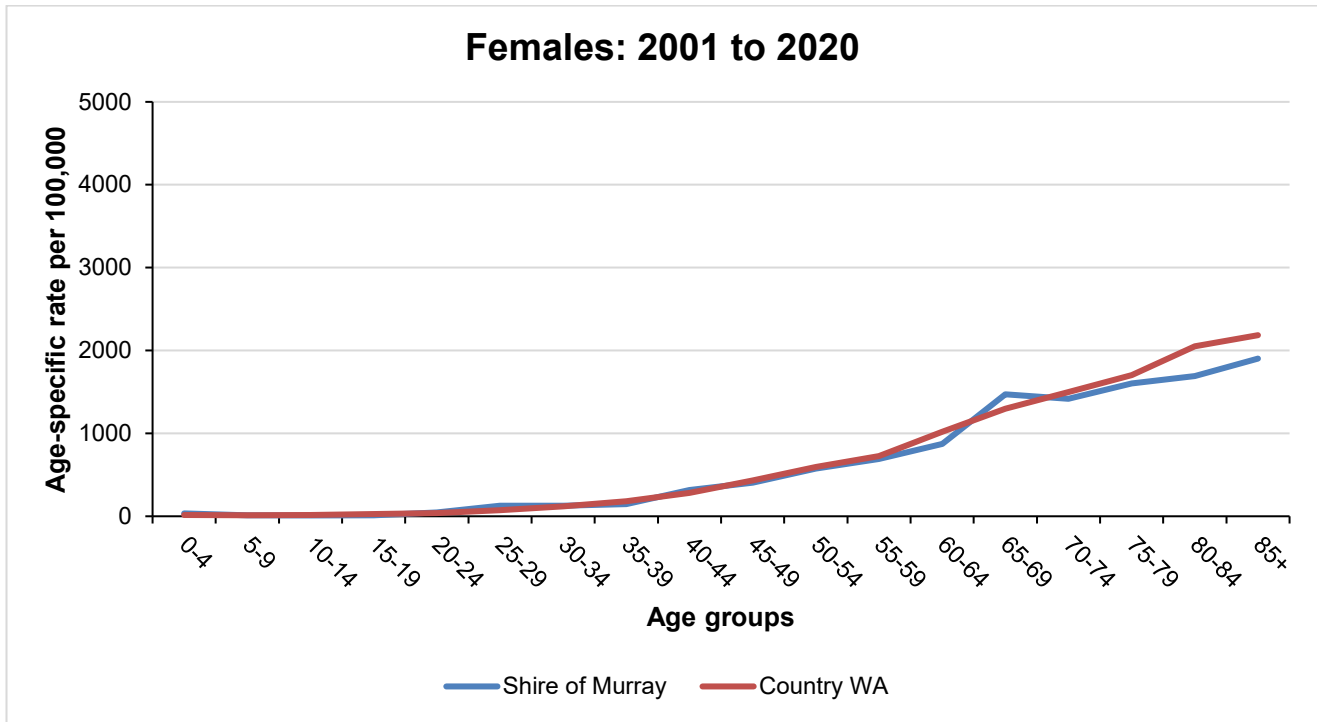
The age distribution (age-specific rates) of all cancers in males in the Shire of Murray was similar to that of country WA during 2001 to 2020 in the younger age groups (Figure 7). The differences between the Shire of Murray and country WA for older ages were due to the small population and small number of cases in the Shire of Murray.



**Figure 7. Age-specific rates per 100,000 population for all cancers in males in the Shire of Murray and country WA, 2001 to 2020**

## Females

The age distribution (age-specific rates) of all cancers in females in the Shire of Murray was similar to that of country WA during 2001 to 2020, except in the older age groups (70 years and above) where the rates were slightly lower (Figure 8). The differences between the Shire of Murray and country WA for older ages were due to the small population and small number of cases in the Shire of Murray.



**Figure 8. Age-specific rates per 100,000 population for all cancers in females in the Shire of Murray and country WA, 2001 to 2020**

### 3.2.2 Minimum and maximum age groups of cancer cases, 2001 to 2020

The minimum and maximum age groups of cancer cases for each cancer type in the Shire of Murray were within the age ranges of those for country WA (Table 5). Specifically, all types of cancers in the Shire of Murray occurred in older age groups compared to country WA, except for kidney cancers where the minimum age group in the Shire of Murray was the same as that for country WA.

**Table 5. Minimum and maximum age groups of cancer cases by cancer type in the Shire of Murray and country WA, 2001 to 2020**

Cancer type	Shire of Murray		Country WA	
	Minimum age group (years)	Maximum age group (years)	Minimum age group (years)	Maximum age group (years)
Prostate gland	45-49*	85+	10-14*	85+
Lung, bronchus and trachea	10-14*	85+	0-4*	85+
Melanoma	15-19*	85+	5-9*	85+
Breast	20-24*	85+	15-19*	85+
Colorectal	25-29	85+	0-4*	85+
Bladder and urinary tract	45-49*	85+	0-4*	85+
Lymphoma, non-Hodgkin, mature B cell	20-24*	85+	0-4*	85+
Kidney	0-4*	80-84	0-4	85+
Unknown primary site	40-44	85+	0-4*	85+
Lip, gum and mouth	25-29*	80-84	10-14*	85+
Pancreas	50-54*	85+	25-29*	85+
Thyroid gland	15-19*	85+	5-9*	85+
Oesophagus	40-44*	85+	30-34	85+
Stomach	45-49*	80-84	10-14*	85+
Brain	10-14*	80-84	0-4	85+
Corpus uteri	40-44*	85+	15-19*	85+
Mesothelioma	50-54*	80-84	35-39*	85+
Non melanoma, non-SCC/BCC skin	45-49*	85+	5-9*	85+

Note: Cancer types with less than 20 cases in the Shire of Murray are not presented; \* The minimum age group is based on less than 5 cases.



### 3.3 Cancer types

There were 63 different types of cancers among the 1,997 cancer cases in the Shire of Murray between 2001 and 2020. The 5 most common cancers during this period in the Shire of Murray were:

- i) prostate cancer
- ii) cancers of the lung, bronchus and trachea
- iii) melanoma
- iv) breast cancer
- v) colorectal cancer.

The 5 most common cancers in country WA in 2001 to 2020 were:

- i) prostate cancer
- ii) breast cancer
- iii) melanoma
- iv) colorectal cancer
- v) cancers of the lung, bronchus and trachea.

The specific cancer types of interest investigated in this report include lung, bladder, liver, kidney and prostate cancers. Table 6 shows the incidence rates for the top 5 cancers and the specific cancers of interest. The incidence rates were calculated for 2001 to 2020 combined (overall) since it was not possible to calculate yearly rates due to small numbers.

Among the 8 cancer types, the overall incidence rates of 2 cancers were higher in the Shire of Murray compared to country WA. The overall incidence rate of prostate cancer in the Shire of Murray was significantly higher than that of country WA (SIR=1.20, 95% CI: 1.09-1.31) and the overall incidence rate of cancers of the lung, bronchus and trachea in the Shire of Murray was significantly higher than that of country WA (SIR=1.20, 95% CI: 1.05-1.36).

Results of the regression analyses showed that there was a 3 per cent average annual decrease in the incidence of lung and breast cancers in the Shire of Murray over time (p value for lung cancer =0.01, p value for breast cancer =0.02). There were no statistically significant differences in cancer incidence over time for the other 6 cancer types (prostate, melanoma, colorectal, bladder and urinary tract, kidney and liver cancers) in the Shire of Murray (p value > 0.05).

The age distribution (age-specific rates) of all the 8 cancer types in the Shire of Murray were largely similar to those of country WA (Appendix 3).

**Table 6. Number and rates of cancer cases by cancer types – top 5 cancers and specific cancers of interest in the Shire of Murray and country WA, 2001 to 2020 combined**

Cancer type	Number		ASR*	95% CI	SIR	95% CI	Comparison with country WA rate**
	Observed	Expected					
Prostate gland	427	357	184.1	166.3-201.8	1.20	1.09-1.31	Higher
Lung, bronchus and trachea	225	188	53.1	46.0-60.2	1.20	1.05-1.36	Higher
Melanoma	213	215	55.6	47.8-63.3	0.99	0.86-1.13	Similar
Breast	207	216	111.7	95.9-127.5	0.96	0.83-1.10	Similar
Colorectal	208	225	52.5	45.2-59.9	0.92	0.80-1.05	Similar
Bladder and urinary tract	60	47	15.2	11.2-19.1	1.28	0.98-1.63	Similar
Kidney	48	48	12.6	8.9-16.3	1.00	0.74-1.30	Similar
Liver and intrahepatic bile ducts	15	22	N/A	N/A	0.68	0.38-1.06	Similar

\*All rates are per 100,000 population. ASR = Age-standardised rate; SIR = Standardised incidence ratio; 95% CI- 95% Confidence Intervals. \*\* Determined based on SIR and its 95% CIs. N/A =ASRs are not provided when the number of cancers is less than 20 because the derived rates are unreliable.

## 4. Other conditions

### 4.1 Asthma and chronic respiratory conditions (other than asthma) – HWSS data

Data from the HWSS are based on responses from 379 adults aged 16 years and over in the Shire of Murray compared to 31,315 adults in country WA. The lifetime and current prevalence of asthma and chronic respiratory conditions (other than asthma) in the Shire of Murray was similar to the prevalence of these conditions in country WA (Table 7).

**Table 7. Prevalence of asthma and chronic respiratory conditions (other than asthma), 16 years and over, in the Shire of Murray and country WA, 2011 to 2020**

	Shire of Murray		Country WA		Comparison with country WA prevalence*
	%	95% CI	%	95% CI	
Lifetime asthma (a)	22.5	12.6-32.4	14.4	13.8-15.1	Similar
Current asthma (b)	12.0**	6.0-18.0	8.8	8.3-9.3	Similar
Lifetime chronic respiratory conditions (c)	4.1**	1.9-6.3	3.1	2.9-3.3	Similar
Current chronic respiratory conditions (d)	2.0**	0.9-3.2	2.2	2.0-2.4	Similar

95% CI- 95% confidence intervals.

(a) People who reported they had been told by a doctor that they have asthma (ever).

(b) People who reported they have had symptoms of, or treatment for, asthma in the last 12 months

(c) People who reported they were told by a doctor that they have a respiratory condition other than asthma that lasted 6 months or more, such as bronchitis, emphysema, or chronic lung disease (ever).

(d) People who reported they had a respiratory condition other than asthma that lasted 6 months or more that is still present.

\* Determined based on the Chi -squared test.

\*\* Prevalence estimate has an RSE between 25%-50% and should be used with caution.

### 4.2 Asthma and chronic respiratory conditions (other than asthma) – WA HMDC

The hospitalisation rates for asthma were calculated for 2001 to 2020 combined since it was not possible to calculate yearly rates due to small numbers. There was a total of 361 hospitalisations for asthma in residents of the Shire of Murray during 2001 to 2020, with an age-standardised rate of 124.1 (95% CI: 111.0-137.3). The hospitalisation rates for asthma in the Shire of Murray were lower than those of country WA (SRR=0.65, 95% CI: 0.59-0.72) (data not shown). Results of the regression analysis showed that there was no statistically significant difference in asthma hospitalisations over time in the Shire of Murray (p value > 0.05).

There was a total of 1,047 hospitalisations for chronic respiratory conditions (other than asthma) in the residents of the Shire of Murray during 2001 to 2020 (Table 8). The yearly and overall hospitalisation rates for chronic respiratory conditions (other than asthma) were either lower than or similar to those of country WA. Results of the regression analysis showed that there was no statistically significant difference in hospitalisations from chronic respiratory conditions over time in the Shire of Murray (p value > 0.05).

**Table 8. Number and rates of hospitalisations for chronic respiratory conditions (other than asthma) in the Shire of Murray and country WA, 2001 to 2020**

Year	Number	ASR*	95% CI	SRR	95% CI	Comparison with country WA rate**
2001	42	358.2	243.0-473.4	0.85	0.61-1.13	Similar
2002	63	529.5	389.6-669.5	1.21	0.93-1.53	Similar
2003	52	420.3	299.1-541.5	0.96	0.72-1.24	Similar
2004	42	318.8	215.2-422.3	0.79	0.57-1.04	Similar
2005	39	243.4	160.2-326.7	0.79	0.56-1.05	Similar
2006	34	237.1	150.9-323.3	0.68	0.47-0.93	Lower
2007	31	190.7	120.6-260.8	0.55	0.37-0.76	Lower
2008	43	251.9	174.5-329.3	0.72	0.52-0.95	Lower
2009	47	253.3	178.9-327.7	0.83	0.61-1.09	Similar
2010	43	224.8	154.9-294.8	0.66	0.47-0.87	Lower
2011	50	240.6	172.2-309.0	0.78	0.58-1.02	Similar
2012	42	201.1	138.7-263.6	0.59	0.43-0.79	Lower
2013	40	174.1	119.3-228.9	0.63	0.45-0.85	Lower
2014	64	270.9	203.7-338.2	0.88	0.68-1.11	Similar
2015	74	295.1	227.0-363.2	0.95	0.74-1.18	Similar
2016	67	266.5	201.4-331.5	0.78	0.60-0.98	Lower
2017	60	227.4	167.8-286.9	0.68	0.52-0.87	Lower
2018	81	295.2	229.1-361.2	0.86	0.68-1.05	Similar
2019	75	240.7	185.7-295.6	0.77	0.61-0.95	Lower
2020	58	183.2	135.8-230.7	0.84	0.64-1.07	Similar
<b>Total</b>	<b>1047</b>	<b>253.3</b>	<b>237.6-269.0</b>	<b>0.79</b>	<b>0.74-0.83</b>	<b>Lower</b>

\*All rates are per 100,000 population. ASR = Age-standardised rate; SRR = Standardised rate ratio; 95% CI- 95% Confidence Intervals. \*\* Determined based on SRR and its 95% CIs

### 4.3 Chronic kidney diseases – WA HMDC data

The hospitalisation rates for chronic kidney diseases were calculated for 2001 to 2020 combined since it was not possible to calculate yearly rates due to small numbers. There was a total of 93 hospitalisations for chronic kidney diseases in residents of the Shire of Murray during 2001 to 2020, with an age-standardised rate of 23.9 (95% CI: 18.8-29.0). The hospitalisation rates for chronic kidney diseases in the Shire of Murray were lower than those of country WA (SRR=0.74, 95% CI: 0.60-0.90) (data not shown). Results of the regression analysis showed that there was no statistically significant difference in hospitalisations from chronic kidney diseases over time in the Shire of Murray ( $p$  value > 0.05).

Given that hospitalisations from chronic kidney diseases are higher in remote and very remote areas in Australia,<sup>13</sup> analysis was also carried out using the EMHS area as a comparison area. The EMHS area was selected because this area has a mix of urban and rural population with diverse socio-economic status. The hospitalisation rates for chronic kidney diseases in the Shire of Murray were similar to those of the EMHS area (SRR=1.06, 95% CI: 0.85-1.28) (data not shown).

## 5. Other contributing factors

Certain modifiable lifestyle behaviours and risk factors such as tobacco smoking, physical inactivity, obesity, inadequate diet, and risky alcohol consumption have been associated with cancers.<sup>3,9,14</sup> Prevalence estimates for lifestyle behaviours and risk factors were calculated using HWSS data.

The prevalence of adults who ate less than 5 serves of vegetables daily was lower in the Shire of Murray compared to country WA (Table 9). The prevalence of other lifestyle behaviours and risk factors in the Shire of Murray was similar to that of country WA.

**Table 9. Prevalence of lifestyle behaviours and risk factors, 16 years and over, in the Shire of Murray and country WA, 2011 to 2020**

Lifestyle behaviours and risk factors	Shire of Murray		Country WA		Comparison with country WA prevalence*
	%	95% CI	%	95% CI	
Currently smokes	13.4	6.8-19.9	14.9	14.2-15.5	Similar
Eats less than 2 serves of fruit daily	48.0	38.5-57.4	50.6	49.7-51.5	Similar
Eats less than 5 serves of vegetables daily	78.9	69.6-88.2	88.4	87.9-88.9	Lower
Eats fast food at least weekly	32.7	19.5-45.9	23.8	22.5-25.1	Similar
Drinks at high risk levels for long-term harm (a)	38.3	28.2-48.3	31.8	30.9-32.6	Similar
Drinks at high risk levels for short-term harm (b)	17.3**	7.7-26.9	13.3	12.6-14.0	Similar
Spends 21+ hours per week in sedentary leisure time	33.5	24.5-42.5	32.2	31.4-33.0	Similar
Completes less than 150 minutes of moderate physical activity per week (c)	39.6	30.6-48.6	40.3	39.4-41.2	Similar
Overweight (d)	36.3	27.4-45.3	38.4	37.5-39.2	Similar
Obese (d)	42.9	33.2-52.6	34.9	34.1-35.8	Similar

95% CI- 95% confidence intervals.

(a) Drinks more than 2 standard drinks on any one day.

(b) Drinks more than 4 standard drinks on any one day.

(c) Adults aged 18 years and over only. Refers to moderate minutes with minutes spent in vigorous physical activity doubled.

(d) Height and weight measurements have been adjusted for errors in self-report.

\* Determined based on the Chi -squared test.

\*\* Prevalence estimate has a RSE between 25% and 50% and should be used with caution.

## 6. Discussion

The aim of this evaluation was to assess the likelihood of a cancer cluster among residents of the Shire of Murray. The evaluation also included analysis to determine whether there were elevated rates of certain non-cancer conditions in the area and possible associated contributing factors among residents of the Shire of Murray.

## 6.1 Cancer incidence

According to the *Guidelines for the Investigation of Cancer Clusters in Western Australia*,<sup>1</sup> a suspected cancer cluster is more likely to be confirmed as a cluster if it meets the following 3 criteria:

1. the occurrence of a large number of cases of one type of cancer
2. the occurrence of a rare type (or types) of cancer
3. the occurrence of a large number of cases of a cancer type in an age group that is not usually affected by that cancer type.

Analysis of WA Cancer Registry data showed that there were no cancer types meeting the above criteria among residents of the Shire of Murray.

- The overall cancer incidence rates for males, females, and all persons in the Shire of Murray were similar to those of country WA (Tables 2, 3 and 4).
- The yearly rates for all cancers in the Shire of Murray did not show a significant increase over time from 2001 to 2020 and the trends were similar to those of country WA (Figures 3, 4 and 5).
- The age-specific incidence rates for all cancer in males, females and all persons in the Shire of Murray were largely similar to those of country WA (Figures 6, 7 and 8).
- All cancer cases occurred in age groups that were normally affected by that cancer type (Table 5).
- Although the analysis of specific cancer types showed that the incidence rates of prostate and lung cancers were higher than those of country WA (Table 6), these cancers are not rare types of cancers, and they did not occur in an age group that is not usually affected by that cancer type. If common cancers, such as lung and prostate, occurred in unexpected age-groups it would be more indicative of a potential specific risk factor for that area. However, increased rates of these common cancers are observed in other LGAs (see below), including many without specific environmental emission sources, suggesting the current observations are consistent with normal variation between LGAs.
- None of the cancer types included in the analysis showed a significant increase in incidence over time in the Shire of Murray.
- There was a 3 per cent average annual decrease in the incidence of lung and breast cancers in the Shire of Murray over time.

The rates of prostate and lung cancers in the Shire of Murray were slightly higher compared to country WA. However, analysis carried out for all the LGAs in WA showed that there were 23 other LGAs with prostate cancer rates higher than country WA (Appendix 4) and 18 LGAs with lung cancer rates higher than country WA (Appendix 5).

It is important to consider that there are many known or suspected causes and risk factors associated with the development of prostate and lung cancers. For prostate cancer, the exact causes are still not clear but the established risk factors for this cancer are increasing age, race, and positive family history of cancer.<sup>9,15</sup> Other factors that have been associated with prostate cancer risk are the Western diet (use of fat, dairy products and red meat), obesity, physical inactivity, sexually transmitted diseases, smoking and occupation (occupational exposure to pesticides and cadmium such as workers in nickel-

cadmium battery plants), but the role of these factors in the cause of prostate cancer is still uncertain.<sup>16</sup> Studies on cadmium exposure (a potential exposure agent in Pinjarra) and the risk of prostate cancer suggest an association, but the results are not consistent.<sup>17</sup> Positive associations with prostate cancer have mainly been observed with exposures to high concentrations of cadmium in occupational settings.<sup>17,18</sup> For lung cancer, the single most important cause is smoking cigarettes and other tobacco products.<sup>9,19,20</sup> The population attributable risk estimates for lung cancer show that active smoking is responsible for 80 to 90 per cent of lung cancers.<sup>19,21</sup> Other causally associated risk factors for lung cancer include exposure to second hand tobacco smoke, occupational exposure to lung carcinogens (such as benzo[a]pyrene, arsenic, hexavalent chromium, nickel, and asbestos), radiation, and indoor and outdoor pollution.<sup>9,20</sup> Additional risk factors for lung cancer are increasing age, family history of lung cancer, lung diseases such as tuberculosis and chronic obstructive pulmonary disease, and HIV infection.<sup>9</sup> Lifestyle factors associated with decreased risk of lung cancer are fruit and vegetable consumption and physical activity.<sup>19</sup> It is worth noting that the development of cancers after exposure to a cancer-causing agent may take many years, even decades before diagnosis, making it difficult to identify the exact cause of the cancer. For example, studies on temporal trends of lung cancer and smoking have shown that rates of lung cancer occurrence lag smoking rates by approximately 20 years.<sup>19</sup>

It should also be noted that the number of cancer cases in the Shire of Murray was small, resulting in greater fluctuations in the cancer incidence rates over time with much wider confidence intervals compared to those of country WA. This means that a small increase or decrease in the number of cancers could have a relatively large effect on the incidence rates in the Shire of Murray.

## **6.2 Other conditions**

The non-cancer conditions examined in this report were asthma, chronic respiratory conditions (other than asthma) and chronic kidney diseases, as requested by the Manager Environmental Health of the Shire of Murray.

The prevalence of asthma and chronic respiratory conditions (other than asthma) in the Shire of Murray was similar to that of country WA (Table 7). The overall hospitalisation rates for asthma, chronic respiratory conditions (other than asthma) (Table 8) and chronic kidney diseases in the Shire of Murray were lower than those of country WA. When the EMHS area was used as a comparison for chronic kidney diseases, results showed that hospitalisation rates in the Shire of Murray were similar to those of the EMHS area. Furthermore, there was no increase in hospitalisations from these conditions in the Shire of Murray over time.

## **6.3 Other contributing factors**

In this report, the prevalence of certain modifiable lifestyle behaviours and risk factors associated with cancers such as current smoking, physical inactivity, obesity, inadequate fruit and vegetable consumption, and risky alcohol consumption in the Shire of Murray and country WA was estimated. The prevalence of adults who ate less than 5 serves of vegetables daily was lower in the Shire of Murray compared to country WA. The prevalence of other lifestyle behaviours and risk factors in the Shire of Murray was similar to that of country WA. It should be noted that there is a considerable lag period between exposure to a cancer-causing agent or risk factor such as smoking and the development of cancer, and the prevalence of risk factors reported in this evaluation is the current prevalence.

## 6.4 Limitations

The WACR and WA HMDC data for this report were based on data for residents of the Shire of Murray at the time of cancer diagnosis or hospitalisations for non-cancer conditions. Hence, it was not possible to include residents who moved away from the Shire to other parts of the State, interstate or overseas and who were subsequently diagnosed with cancer or non-cancer conditions during the time period selected for the analysis. Moreover, the length of time a person resided in the Shire of Murray prior to diagnosis or hospitalisation was not able to be determined as part of this analysis. The HWSS data analysed for this report does not include children even though they represent a susceptible population for respiratory conditions such as asthma. The cancer rates and rates of hospitalisations for asthma, chronic respiratory conditions (other than asthma) and chronic kidney diseases were based on small numbers of cases in the Shire of Murray, resulting in large fluctuations in rates with wide confidence intervals. It was also not possible to analyse yearly data for specific cancers due to small numbers. Similarly, the prevalence of asthma, chronic respiratory conditions and risk factors were based on a small sample size, despite 10 years of aggregated data. This report also could not consider individual occupational and industrial exposures, family history of cancers, and individual co-morbidities and risk factors related to cancers.

## 7. Conclusions

Based on the currently available data, this evaluation found no clear or consistent evidence to support the presence of a potential cancer cluster in the Shire of Murray and the need for a more detailed follow-up study. The overall cancer incidence rates in the Shire of Murray were similar to those of country WA, with no significant increase in incidence over time. The age distribution for all cancers in the Shire of Murray were similar to those of country WA. All cancer cases occurred in age groups that would normally be affected by that cancer type. The evaluation did find that prostate and lung cancer rates in the Shire of Murray were slightly higher than country WA. However, given that these are not rare types of cancers, these cancers did not occur in an age group that is not usually affected by that cancer type (i.e., in younger age groups), and there were several other LGAs in WA with raised rates of these cancers, it is unlikely that there is a cluster of these cancers in the Shire of Murray.

This evaluation also did not find evidence of increased levels of other non-cancer conditions. The prevalence of asthma and other chronic respiratory conditions in the Shire of Murray was similar to that of country WA. The hospitalisation rates from asthma, chronic respiratory conditions (other than asthma) and chronic kidney diseases were lower in the Shire of Murray than in country WA. There was no increase in hospitalisations from these conditions in the Shire of Murray over time.

Based on previous health risk assessments, there is currently insufficient evidence of increased health risk from environmental exposures to the residents of the Shire of Murray. The DWER is currently undertaking an independent monitoring program in and around Pinjarra. This will provide data on current, but not historical, exposure.

Given the findings of this report, we recommend that the current evaluation is kept on file in the Department of Health and is reassessed if additional concerns regarding cancer clusters are raised in the future.



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## Appendices

### Appendix 1. ICD-O codes used to identify cancer types

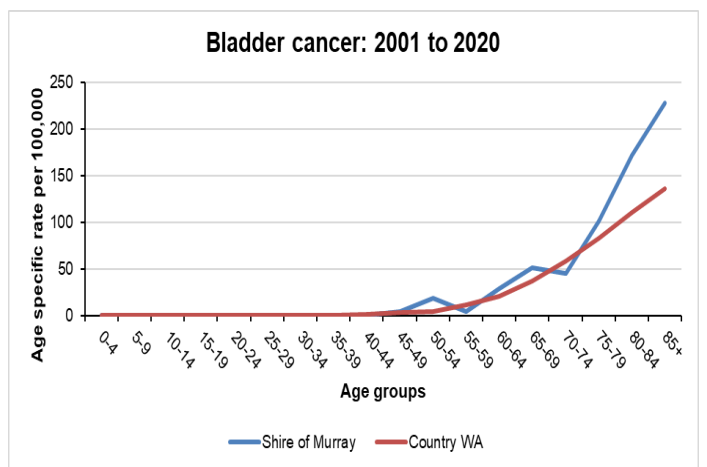
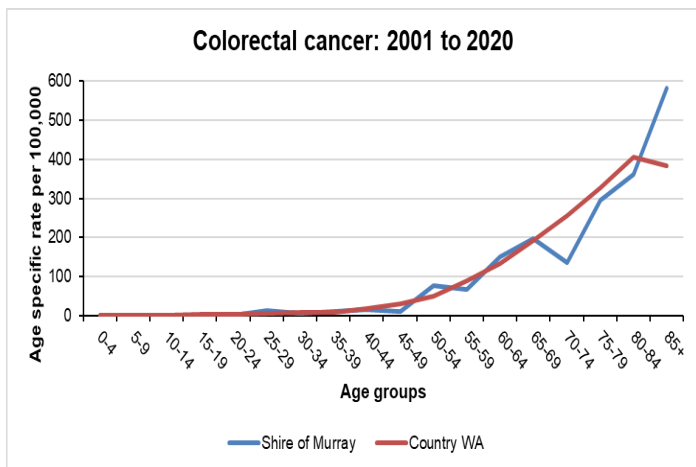
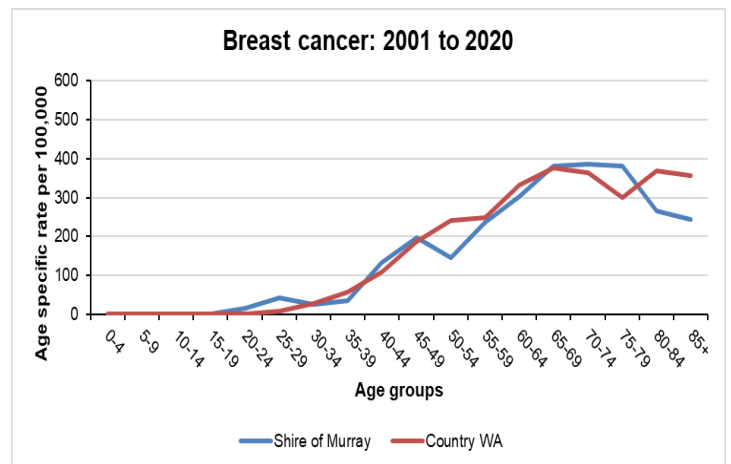
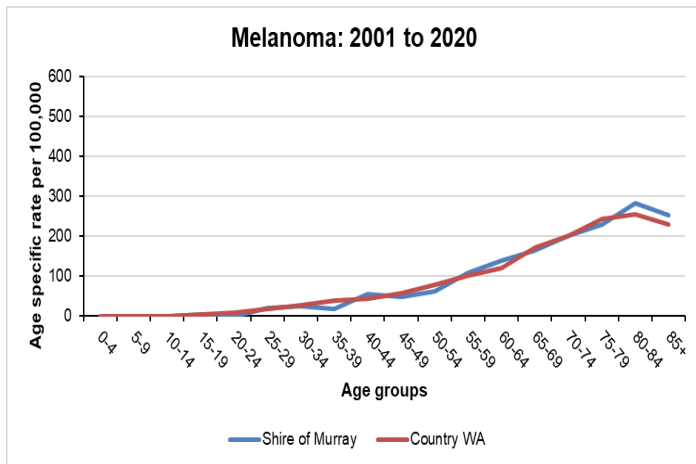
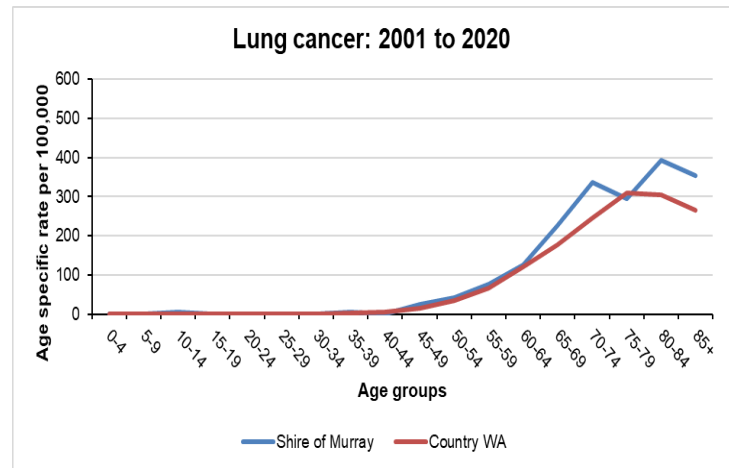
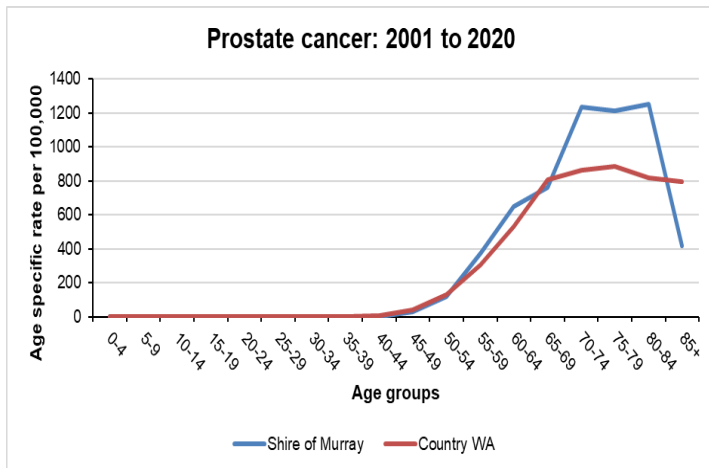
Cancer type code	Description	Cancer type code	Description
C00	Lip, gum and mouth	UNK	Unknown primary site
C01	Tongue	HCP	Polycyth. rubra vera
C07	Parotid gland	HCS	Myelofibrosis/sclerosis
C08	Major salivary glands (not parotid)	HCX	Chronic MPD, NOS
C09	Pharynx	HCO	Other chronic MPDs
C11	Nasopharynx	HIH	Malig. histiocytic/dendritic cell neo.
C15	Oesophagus	HIM	Mast cell malignancies
C16	Stomach	HII	Other and U/S immunoproliferative neo.
C17	Small intestine	HMR	Refractory anaemias/cytopenias
C21	Anus	HMS	Myelodysplastic syndromes
C22	Liver and intrahepatic bile ducts	LLA	Leukaemia, lymphoid, acute
C23	Gallbladder and bile ducts	LLC	Leukaemia, lymphoid, chronic
C25	Pancreas	LLO	Leukaemia, lymphoid, other/NOS
C30	Nasal cavity/sinuses, middle and inner ear	LMA	Leukaemia, myeloid, acute
C32	Larynx	LMC	Leukaemia, myeloid, chronic
C33	Lung, bronchus and trachea	LMO	Leukaemia, myeloid, other and NOS
C37	Thymus	LOT	Leukaemia, other
C38	Pleura, heart and mediastinum	LUC	Leukaemia, unclassifiable
C40	Bones, joints and articular cartilages	P	Myeloma and plasma cell tumours
C47	Nervous system, peripheral/autonomic	YHO	Lymphoma, Hodgkin
C48	Retroperitoneum and peritoneum	YNB	Lymphoma, non-Hodgkin, mature B Cell
C49	Connective, subcutaneous and other soft tissues	YNO	Lymphoma, non-Hodgkin, other / unclassifiable
C50	Breast	YNP	Lymphoma, non-Hodgkin, precursor cell lymphobla
C51	Vulva	YNT	Lymphoma, non-Hodgkin, mature T / N-K cell
C52	Vagina	YUC	Lymphoma, unclassifiable
C53	Cervix uteri	N/A	Not applicable
C54	Corpus uteri	nBR	Benign breast
C55	Uterus, nos	nCN	Benign CNS
C56	Ovary	nCO	Benign colon and rectum
C57	Uterine adnexa and oth. fem gen.	nCX	Benign cervix
C58	Placenta	nOT	Benign other
C60	Penis	sBR	In situ breast
C61	Prostate gland	sCO	In situ colon and rectum
C62	Testis	sCX	In situ cervix
C63	Other male genital	sME	In situ melanoma
C64	Kidney	sNM	In situ non melanoma, non-SCC/BCC skin

<b>Cancer type code</b>	<b>Description</b>	<b>Cancer type code</b>	<b>Description</b>
<b>C65</b>	Bladder and urinary tract	sOT	In situ other
<b>C69</b>	Eye and lacrimal gland	sSK	In situ skin SCC/BCC
<b>C70</b>	Meninges (cerebral and spinal)	sUB	In situ bladder
<b>C71</b>	Brain	sUO	In situ other urinary
<b>C72</b>	Spinal cord and cranial nerves	uCN	Uncertain CNS
<b>C73</b>	Thyroid gland	uCO	Uncertain colon and rectum
<b>C74</b>	Adrenal gland	uME	Uncertain melanocytic
<b>C75</b>	Endocrine glands (not adrenal)	uNH	Uncertain other non-LHN
<b>CRC</b>	Colorectal	uNM	Uncertain non melanoma, non-SCC/BCC skin
<b>CUT</b>	Skin SCC/BCC	uOV	Uncertain ovary
<b>NMS</b>	Non melanoma,non-SCC/BCC skin	uSK	Uncertain skin SCC/BCC
<b>KAP</b>	Kaposi sarcoma	huh	Mast cell neoplasms, unc. malignant potential
<b>MEL</b>	Melanoma	hun	Ill-def. lymphoprolif. neoplasms, unc. malignancy
<b>MES</b>	Mesothelioma	hup	Immunoglobulin-related neoplasms, unc. malignancy

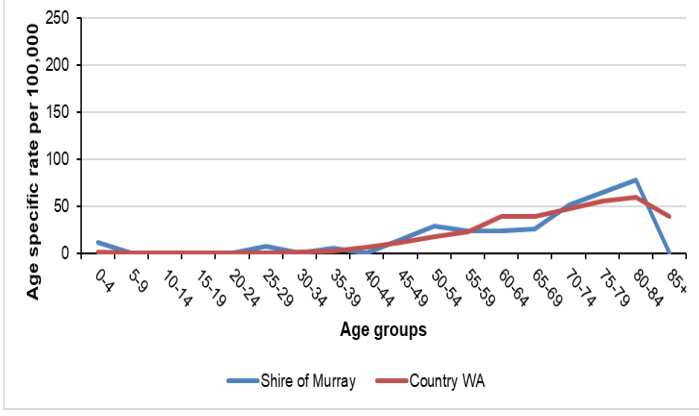
## Appendix 2. ICD-10-AM codes used to identify selected non-cancer conditions

<b>Cancer type code</b>	<b>Description</b>
Asthma	J45 (J45.0, J45.1, J45.8, J45.9) Asthma J46 Status asthmaticus
Chronic respiratory conditions (other than asthma)	J40 Bronchitis, not specified as acute or chronic J41 (J41.0, J41.1, J41.8) Simple and mucopurulent chronic bronchitis J42 Unspecified chronic bronchitis J43 (J43.0, J43.1, J43.2, J43.8, J43.9) Emphysema J44 (J44.0, J44.1, J44.8, J44.9) Other chronic obstructive pulmonary disease J47 Bronchiectasis
Chronic kidney diseases	N18 (N18.1, N18.2, N18.3, N18.4, N18.5, N18.9, N18.90, N18.91) Chronic kidney disease

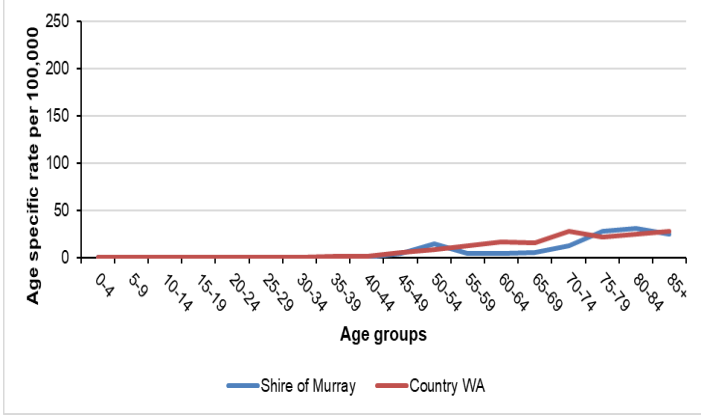
### Appendix 3. Age distribution of specific cancers



**Kidney cancer: 2001 to 2020**



**Liver cancer: 2001 to 2020**



#### Appendix 4. Local government areas (LGAs) in Western Australia with prostate cancer rates higher than country WA, 2001 to 2020 combined

Local Government Area (LGA)	Number	ASR*	95% CI	SIR	95% CI	Comparison with country WA rate**
Albany	806	178.6	166.2-191.0	1.15	1.07-1.23	Higher
Boyup Brook	74	279.7	214.8-344.6	1.88	1.48-2.34	Higher
Cambridge	661	230.9	213.2-248.5	1.48	1.37-1.60	Higher
Claremont	313	250.7	222.7-278.6	1.58	1.41-1.76	Higher
Coorow	44	214.2	147.7-280.6	1.44	1.05-1.90	Higher
Corrigin	39	219.0	148.8-289.2	1.49	1.06-1.99	Higher
Cottesloe	201	201.7	173.5-230.0	1.29	1.12-1.48	Higher
Dumbleyung	25	264.0	159.0-369.0	1.74	1.13-2.50	Higher
East Fremantle	166	193.7	164.0-223.4	1.26	1.08-1.46	Higher
Exmouth	56	179.9	131.6-228.2	1.36	1.03-1.74	Higher
Fremantle	597	168.7	155.1-182.2	1.09	1.01-1.18	Higher
Harvey	435	180.1	162.7-197.5	1.16	1.05-1.27	Higher
Joondalup	2792	176.2	169.4-183.0	1.15	1.11-1.20	Higher
Kojonup	59	210.1	156.4-263.8	1.35	1.03-1.72	Higher
Koorda	19	N/A	N/A	1.78	1.07-2.67	Higher
Mandurah	2176	207.1	198.2-215.9	1.34	1.28-1.39	Higher
Melville	2073	177.6	169.9-185.2	1.14	1.09-1.19	Higher
Mosman Park	187	184.6	157.9-211.3	1.18	1.02-1.36	Higher
Nedlands	552	215.4	197.3-233.5	1.38	1.27-1.50	Higher
Rockingham	1733	172.8	164.6-181.0	1.11	1.06-1.16	Higher
Serpentine-Jarrahdale	308	170.7	150.7-190.8	1.15	1.02-1.28	Higher
South Perth	733	171.5	158.9-184.0	1.10	1.02-1.18	Higher
Subiaco	325	181.1	161.1-201.0	1.19	1.07-1.32	Higher

\*All rates are per 100,000 population. ASR = Age-standardised rate; SIR = Standardised incidence ratio; 95% CI- 95% Confidence Intervals. \*\* Determined based on SIR and its 95% CIs. N/A =ASRs are not provided when the number of cancers is less than 20 because the derived rates are unreliable.



**Appendix 5. Local government areas (LGAs) in Western Australia with lung cancer rates higher than country WA, 2001 to 2020 combined**

Local Government Area (LGA)	Number	ASR*	95% CI	SIR	95% CI	Comparison with country WA rate**
Armadale	651	54.4	50.1-58.6	1.21	1.12-1.30	Higher
Bassendean	203	58.2	50.2-66.3	1.32	1.15-1.51	Higher
Belmont	416	51.9	46.9-56.9	1.18	1.07-1.29	Higher
Broome	109	62.1	48.7-75.5	1.41	1.16-1.69	Higher
Bruce Rock	21	73.7	41.8-105.6	1.66	1.03-2.45	Higher
Carnarvon	80	67.4	52.2-82.6	1.51	1.20-1.86	Higher
Coolgardie	39	79.0	51.5-106.5	1.95	1.39-2.61	Higher
Cunderdin	23	74.4	43.6-105.2	1.65	1.05-2.39	Higher
Derby-West Kimberley	53	59.1	41.5-76.8	1.38	1.04-1.78	Higher
Greater Geraldton	421	54.7	49.5-60.0	1.23	1.12-1.35	Higher
Kalgoorlie-Boulder	242	63.8	55.3-72.4	1.49	1.31-1.69	Higher
Kwinana	337	69.0	61.5-76.5	1.54	1.38-1.71	Higher
Mandurah	1057	48.8	45.8-51.8	1.10	1.03-1.17	Higher
Meekatharra	17	N/A	N/A	2.23	1.30-3.41	Higher
Northam	142	53.5	44.6-62.4	1.22	1.03-1.43	Higher
Port Hedland	76	66.9	48.5-85.4	1.39	1.09-1.72	Higher
Rockingham	1106	54.0	50.8-57.2	1.21	1.14-1.29	Higher
Swan	896	49.2	45.9-52.5	1.10	1.03-1.18	Higher

\*All rates are per 100,000 population. ASR = Age-standardised rate; SIR = Standardised incidence ratio; 95% CI- 95% Confidence Intervals. \*\* Determined based on SIR and its 95% CIs. N/A =ASRs are not provided when the number of cancers is less than 20 because the derived rates are unreliable.

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