Western Australian Burden of Disease Study 2015

Contribution of risk factors to burden

Western Australian Burden of Disease Study 2015 – Contribution of risk factors to burden

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Acknowledgements

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Introduction

Burden of disease studies provide an assessment of the impact of diseases, injuries and risk factors on a population. This impact is measured as 'disability-adjusted life years' (DALY); that is, the sum of 'years of life lost prematurely' (YLL) and 'years lived with disability' (YLD) (Prüss-Üstün, Mathers et al. 2003). YLL represents the number of deaths by sex and age multiplied by an 'ideal life span' (according to a reference life table) (Australian Institute of Health and Welfare 2019b).

YLD is a measure of years lived with ill-health or disability, which accounts for the person-time with the condition multiplied by a weight representing the severity of the condition (Australian Institute of Health and Welfare 2019b). Throughout this report, DALY will be referred to as 'total burden', YLD will be referred to as 'non-fatal burden' and YLL will be referred to as 'fatal burden'.

The Western Australian Burden of Disease Study (WABoDS) 2015 is a collaboration between the Australian Institute of Health and Welfare (AIHW) and the Epidemiology Branch of the Department of Health WA. In addition to estimating DALY, the study investigated the contribution of 38 risk factors by disease group and disease for the WA population including behaviour, metabolic and environmental factors.

Preventable risk factors such as tobacco use, dietary risks and being overweight (or obese) have a substantial impact on the health of a population (Global Burden of Disease 2016 Risk Factors Collaborators 2016). This study found that they are the leading risk factors for burden of disease and injury in Western Australia (WA) by presenting the burden of disease attributable to individual risk factors as well as their combined effects.

Key findings

39% of total burden in WA was attributable to risk factors in this study

Leading risk factors

Tobacco use **Overweight and obesity** **Dietary risks**
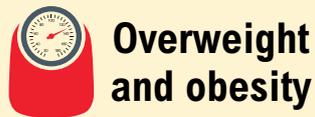
50% **Cardiovascular diseases and cancer contributed to nearly half of all risk factor attributable DALY**

Males experienced 1.6 times higher attributable burden than females

Methods

Deriving Population Attributable Fractions

The WABoDS methodology is based on the Australian Burden of Disease Study (ABDS) 2011 and 2015; with minor updates specific to WA's population. Similar to YLL and YLD, AIHW provided technical advice to the WABoDS, and the Australian Burden of Disease Study (ABDS) system infrastructure was used to calculate Population Attributable Fractions (PAFs) derived from WA-provided input data. PAFs are defined as 'the fraction of all cases of a particular disease or other adverse condition in a population that is attributable to a specific risk factor exposure' (Mansournia and Altman 2018). Detailed calculation and disease selection methods were described in ABDS 2015 methods and supplementary material (Australian Institute of Health and Welfare 2019b). The two fundamental pieces of information in the calculation were the relative risk and the prevalence of exposure to risk factors, described mathematically as:

$$PAF = \frac{\sum_c P_c(RR_c - 1)}{\sum_c P_c(RR_c - 1)+1} \times 100$$

where: $\sum_c$ is the sum over all categories
c is an index for category
P is prevalance
RR is relative risk

The relative risks were sourced from the Global Burden of Disease Study 2016 (Global Burden of Disease 2016 Risk Factors Collaborators 2016), while the WA prevalence exposure data were extracted using relevant surveys and other data sources; for example, the Australian Health Survey 2011-13, the Personal Safety Survey, the WA Health and Wellbeing Surveillance System (HWSS) and the WA Hospital Morbidity Data System (HMDS).

The Australian Health Survey 2011-2013 included the National Nutrition and Physical Activity Survey (NNPAS), National Health Survey (NHS) and National Health Measures Survey. The 24-hour dietary recall component of the NNPAS was utilised to estimate the exposure of the dietary risk factors. The NHS was also used to calculate exposure estimates for blood pressure, cholesterol and plasma glucose.

The Personal Safety Survey was used to calculate exposure data related to the risk factor of intimate partner violence. The prevalence of tobacco exposure, high Body Mass Index (BMI) and physical inactivity by sex and age groups were estimated from population weighted data in the WA HWSS. The WA HWSS surveys 6000 residents in WA each year to monitor the health status of the population (Department of Health Western Australia 2018). The WA Hospital Morbidity Data System (HMDS) was also used to calculate drug use, assault admissions and the smoking impact ratio, to name a few.

A total of 18 individual risk factors (e.g. all dietary risks) and their 91 linked diseases are presented in Appendix A Table A.1. For most of the estimates, the risk factors were analysed independently. For example, the burden of diabetes attributable to a diet high in sweetened beverages or the burden of diabetes attributable to overweight and obesity. The combined effect of the two risk factors (or more) are done through joint effect analysis (Australian Institute of Health and Welfare 2019a) to account for the complex pathways and interactions between risk factors (Box 1).

Quantifying attributable burden

The burden attributable to risk factors was estimated by applying the calculated PAF for each linked disease to the total burden for that disease. The following formula was used:

$$AB = PAF \times T$$

where:
AB   is attributable burden (YLD or YLL)

PAF   is population attributable fraction for a specific linked disease

T   is the burden (YLD or YLL) for a specific linked disease

Attributable burden was calculated by sex and 5-year age-group for each linked disease (Australian Institute of Health and Welfare 2019b).

Results

Contribution of individual risk factors and the joint effect of all risk factors

- Of the total burden of disease and injury in WA for 2015, 39% was attributable to all 38 risk factors (joint effect) included in this study.

- Almost half of the fatal burden (46.7%) could be attributed to the risk factors included in this study (Table 1). This is due to a high proportion of leading causes of fatal burden, such as cancer and cardiovascular disease, being attributable to these risk factors.

- The risk factors that contributed the most to fatal burden were tobacco use (12.5%), dietary risks (11.0%) and overweight and obesity (9.4%).

- Thirty-one per cent of the non-fatal burden (31.2%) was attributable to all risk factors. The leading causes of non-fatal burden were musculoskeletal disorders, neurological conditions and mental and substance use disorders.

- The risk factors that contributed the most to non-fatal burden were overweight and obesity (7.3%), tobacco use (5.8%) and alcohol use (4.0%).

- The risk factors that contributed the most to the total burden were tobacco use (9.1%), overweight and obesity (8.3%) and all dietary risks (7.1%).

Table 1: Number and proportion (%) of fatal, non-fatal and total burden attributable to each risk factor in WA, 2015

Risk factor	YLL		YLD		DALY	
	Number	% of total YLL	Number	% of total YLD	Number	% of total DALY
Behavioural						
Tobacco use	29 670	12.5%	14 119	5.8%	43 789	9.1%
All dietary risks	26 133	11.0%	8042	3.3%	34 174	7.1%
Alcohol use	14 358	6.0%	9722	4.0%	24 080	5.0%
Illicit drug use	12 691	5.3%	6988	2.9%	19 679	4.1%
Physical inactivity	9079	3.8%	3483	1.4%	12 563	2.6%
Child abuse & neglect	4766	2.0%	7336	3.0%	12 103	2.5%
Intimate partner violence	1178	0.5%	2915	1.2%	4092	0.9%
Unsafe sex	804	0.3%	223	0.1%	1026	0.2%
Metabolic						
Overweight & obesity	22 208	9.4%	17 733	7.3%	39 940	8.3%
High blood pressure	19 094	8.0%	5066	2.1%	24 160	5.0%
High blood plasma glucose	13 148	5.5%	9526	3.9%	22 673	4.7%
High cholesterol	12 145	5.1%	2605	1.1%	14 750	3.1%
Impaired kidney function	5421	2.3%	1507	0.6%	6928	1.4%
Iron deficiency	15	0.0%	1979	0.8%	1994	0.4%
Low bone mineral density	733	0.3%	1047	0.4%	1780	0.4%
Environmental						
Occupational exposures & hazards	3890	1.6%	5604	2.3%	9493	2.0%
Air pollution	3536	1.5%	1290	0.5%	4827	1.0%
High sun exposure	3458	1.5%	451	0.2%	3909	0.8%
Joint effect*	**110 843**	**46.7%**	**75 277**	**31.2%**	**186 120**	**38.9%**

*Complex pathways and interactions between risk factors mean it is not possible to sum the impact of individual risk factors. The joint effect analysis should be used to examine the impact of all risk factors included in the study.

- A total of 186 120 years of healthy life lost (DALY) could be attributable to risk factors. Of these, cardiovascular diseases (DALY=39 871, 21.4%) and cancers (DALY=36 494, 19.6%) contributed nearly half of all attributable DALY (Figure 1).

- While most of the DALY due to endocrine disorders, and kidney and urinary disease were attributable to risk factors, they accounted for only 12 564 (6.8%) and 5880 (3.2%) respectively of all DALY attributable to risk factors across all disease groups (joint effect).

- Over two-thirds of total burden (DALY) for coronary heart disease, chronic obstructive pulmonary disease (COPD), lung cancer, stroke and poisoning were attributed to combined risk factors (Figure 2).

- In contrast, only 3% (DALY=329) of rheumatoid arthritis and 9% (DALY=594) of hearing loss were attributable to the risk factors included in this study (joint effect).

- Of WA's leading 20 causes of burden (Department of Health Western Australia 2020), this study found that diabetes type 2, alcohol use disorders and drug use disorders were 100% attributable to the combined risk factors included in the study (Figure 2). For example, in the case of diabetes type 2, if the WA population was able to optimise dietary intake, avoid high blood plasma glucose, eliminate overweight and obesity, remain physically active and eradicate tobacco use, then all the burden associated with these combined risk factors would be removed. This, however, does not take account for any genetic factors that may contribute to the occurrence of the disease.

Figure 1: Disease group total burden due to all risk factors combined in WA in 2015
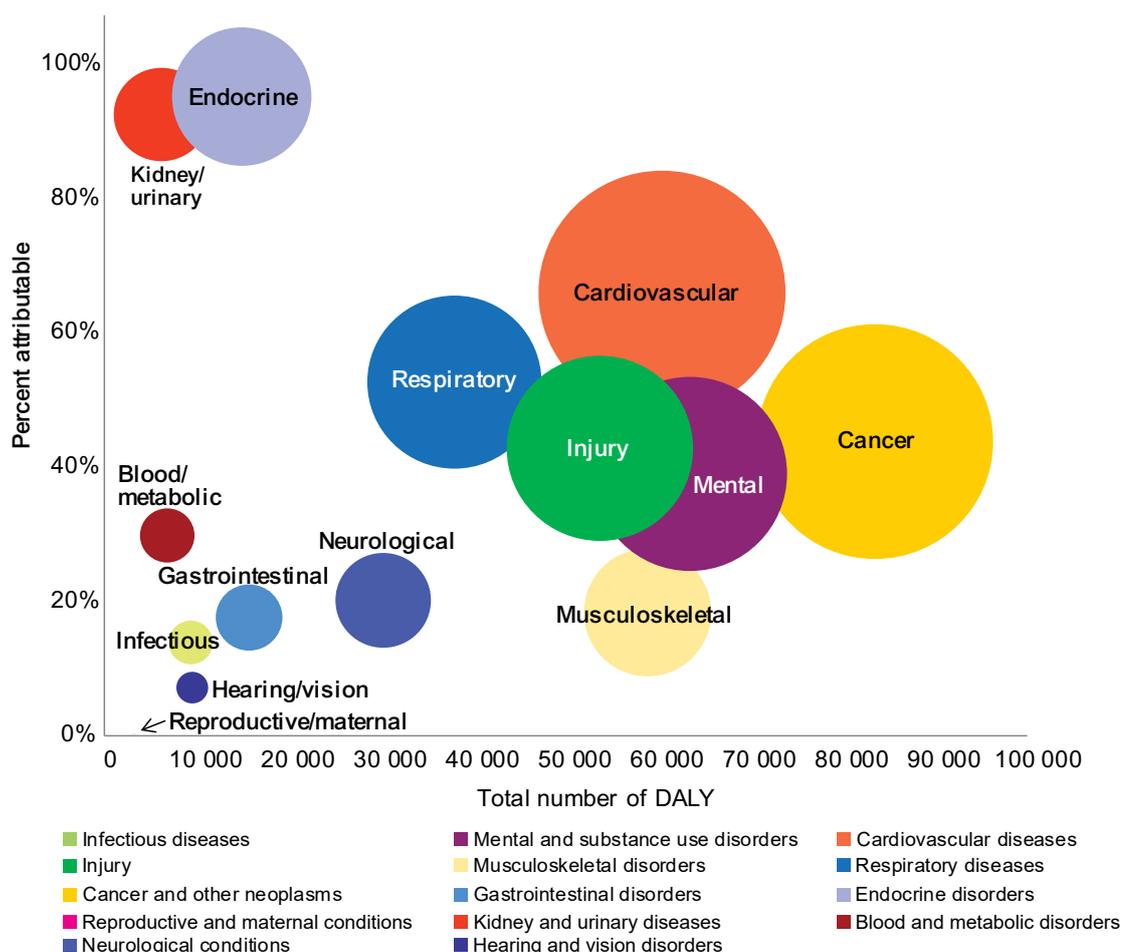
Note: The bubble size represents the magnitude of the burden (DALY) of the disease group attributed to the joint effect of risk factors.
For example, the cardiovascular bubble is larger than the injury bubble, indicating that a greater number of DALY is attributed to the risk factors.

Figure 2: Joint effect of included risk factors on top 20 leading diseases

Leading disease (% due to combined risk factors)

DALY

- ☐ DALY not attributed
- ☐ DALY due to joint effect of risk factors
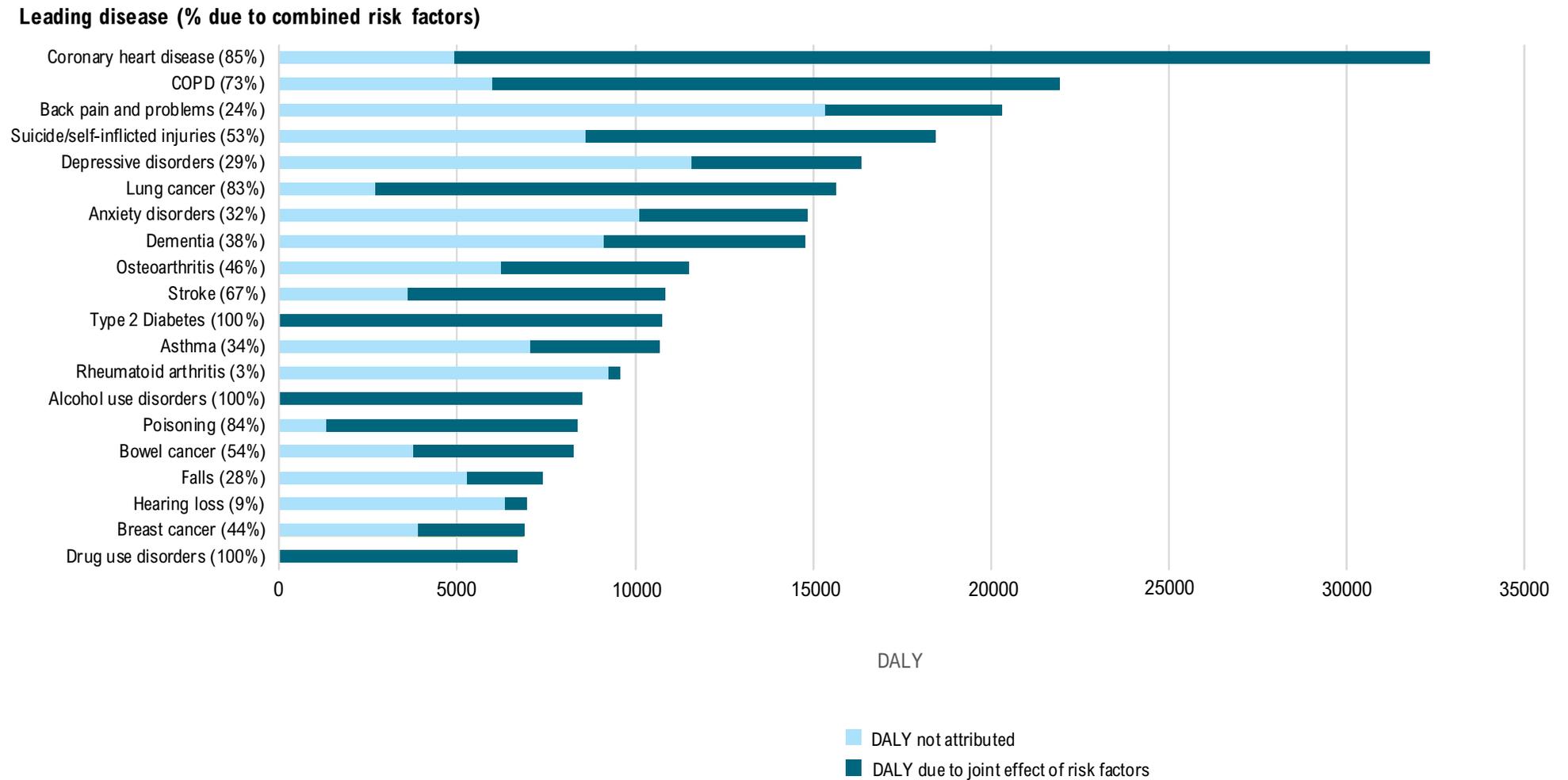
Note: 'Other' conditions, for example other musculoskeletal conditions, have been omitted in the DALY top 20 leading causes of burden.

Contribution of individual risk factors to burden

- The contribution of each risk factor was calculated as the number of attributable DALY for each disease. Table 2 shows the proportion of the total burden of disease in WA in 2015 attributed to each risk factor, as well as the contribution from each component of the risk factor, such as the burden from diet low in fruit as part of dietary risks.

- In total, 12 dietary risk factors were included in the WABoDS 2015 and each dietary risk factor was calculated independently. Dietary components were included if there was direct evidence to indicate that adequate amounts in the diet are required to prevent disease, or if excessive consumption of a food type contributes to disease development. Appendix A, Table A.2 outlines the dietary risk factors included in the study plus the defining exposure characteristics of each risk factor.

- Tobacco smoking was the leading individual risk factor in WA, accounting for 9.1% (DALY=43 789) of the total burden in 2015. Second-hand smoke is an estimate of the proportion of non-smokers that are exposed to environmental tobacco in the home.

- This was followed by overweight and obesity (or high BMI) as the second leading individual risk factor, which contributed to 8.3% (DALY=39 940) of the total burden in WA.

- Dietary risks together contributed 7.1% (DALY=34 174) of the total burden of disease in WA in 2015. The total impact of diet was measured through the joint effect of individual factors. Among the individual dietary risk factors, a diet low in fruit and a diet high in processed meat were the leading components and contributed equally to disease burden (1.6% each, DALY=7480 and 7428 respectively).

- High blood pressure and alcohol use were also in the top five leading risk factors contributing to total burden of disease, accounting for 5.0% (DALY=24 160 and 24 080 respectively) of attributable burden in WA each.

Table 2: Proportion (%) of total burden attributable to each risk factor in WA, 2015

Risk factor	%	Risk factor	%
Behavioural		**Environmental**	
Tobacco use	9.1%	Occupational exposures & hazards	2.0%
Tobacco use	9.0%	Air pollution	1.0%
Second-hand smoke	0.1%	High sun exposure	0.8%
Illicit drug use	4.1%	**Metabolic**	
Opioid use	1.4%	Overweight & obesity	8.3%
Amphetamine use	1.2%	Obesity	4.7%
Cocaine use	0.6%	Overweight	3.6%
Other illicit drug use	0.4%	High blood pressure	5.0%
Unsafe injecting practices	0.3%	High blood plasma glucose	4.7%
Cannabis use	0.3%	Diabetes	4.2%
Alcohol use	5.0%	Intermediate Hyperglycaemia	0.5%
Physical inactivity	2.6%	High cholesterol	3.1%
Intimate partner violence	0.9%	Impaired kidney function	1.4%
Unsafe sex	0.2%	Chronic kidney disease stage 4-5	1.2%
Child abuse and neglect	2.5%	Chronic kidney disease stage 1-3	0.3%
Dietary risks	7.1%	Iron deficiency	0.4%
Diet low in fruit	1.6%	Low bone mineral density	0.4%
Diet high in processed meat	1.6%		
Diet low in whole grains & high fibre cereal	1.4%		
Diet low in nuts & seeds	1.3%		
Diet low in vegetables	1.1%		
Diet high in sodium	1.0%		
Diet low in legumes	0.8%		
Diet low in polyunsaturated fat	0.6%		
Diet high in red meat	0.3%		
Diet low in milk	0.2%		
Diet high in sugar-sweetened beverages	0.2%		
Diet low in fish & seafood	0.1%		
		Joint effect	**38.9%**

- The proportion of burden attributable to each risk factor within a selected number of disease groups is presented in Table 3. Blank cells in the table indicate there is no evidence in this study that links the risk factor to any diseases or injuries in the disease group. When interpreting this table, note that the number of DALY for each disease group differs, so the percentages need to be considered in the context of the size of the disease group.

- Tobacco use contributed to 43% of respiratory diseases (DALY= 16 253), 22% of cancer (18 303), 11% of cardiovascular diseases (6780), 6.3% of infectious diseases (593), and 3.4% of endocrine disorders (459).

- Overweight and obesity also contributed to the burden in nine disease groups. The top five contributors for overweight and obesity were endocrine disorders (DALY=5972, 45%), kidney and urinary diseases (2442, 38%), cardiovascular diseases (12 860, 21%), musculoskeletal disorders (6925, 12%) and neurological conditions (2465, 8.2%) - Table 3.

- Alcohol use was linked to seven disease groups. Injuries (due to external causes) were the leading disease group with a contribution of 15% (DALY=7933).

- Dietary risks (combined) are linked to several disease groups. Most of the burden is associated with cardiovascular disease (DALY= 25 130, 42%) and endocrine disorders (4673, 35%).

- Physical inactivity contributed to 17% (DALY=2287) of endocrine disorders and 10% (DALY=5807) of cardiovascular diseases.

- High blood plasma glucose contributed to 94% (DALY=12 564) of endocrine disorders and 55% (DALY=3537) of kidney and urinary disorders.

- High blood pressure contributed to 36% (DALY=21 466) of cardiovascular diseases and 32% (DALY=2023) of kidney and urinary disorders.

- Impaired kidney function attributed to 92% (DALY=5871) of kidney and urinary diseases.

- The joint effect of all risk factors combined contributed most to the burden for endocrine disorders (DALY=12 564, 94%), kidney and urinary diseases (5880, 92%), cardiovascular diseases (39 871, 66%), respiratory diseases (19 927, 53%) and cancer (36 494, 44%).

Table 3: Proportion (%) of total burden attributable to selected risk factors for each disease group in WA, 2015

Risk factor	Cancer and other neoplasms	Mental & substance use disorders	Cardiovascular	Musculoskeletal	Injuries	Respiratory	Neurological	Gastrointestinal	Endocrine	Hearing and vision disorders	Infectious diseases	Blood and metabolic disorders	Kidney and urinary	Reproductive and maternal conditions
DALY (number)	83 439	63 505	60 453	58 885	53 676	37 854	30 165	15 663	13 376	9559	9392	6828	6382	3207
Attributable burden (%)														
Tobacco use	21.9%		11.2%	1.7%		42.9%	1.1%	0.3%	3.4%	0.3%	6.3%			
Overweight and obesity	7.8%		21.3%	11.8%		6.6%	8.2%	1.5%	44.6%	0.3%			38.3%	
Alcohol use	4.2%	13.4%	3.2%		14.8%		1.2%	10.1%			3.2%			
High sun exposure	4.7%													
Dietary risks	4.4%		41.6%	0.2%		0.3%	0.2%	0.03%	34.9%	0.01%			7.0%	
Physical inactivity	2.9%		9.6%				6.7%		17.1%					
High blood plasma glucose	2.7%		5.4%				3.3%		93.9%	0.4%			55.4%	
Occupational exposures and hazards	3.8%			5.5%	0.8%	5.4%				6.2%				
Illicit drug use	0.3%	10.9%			20.7%			8.5%			0.4%			
Unsafe sex	0.7%							0.7%			3.5%			
Air pollution	0.3%		5.8%			2.5%					1.3%			
Intimate partner violence		4.6%			2.2%									0.1%
Child abuse and neglect		11.5%			9.0%									
High blood pressure			35.5%				2.2%						31.7%	
High cholesterol			24.4%											
Impaired kidney function			1.3%	0.02%				0.8%					92.0%	
Low bone mineral density					3.3%									
Iron deficiency												29.2%		
Joint effect	**43.7%**	**38.9%**	**66.0%**	**18.3%**	**42.8%**	**52.6%**	**20.1%**	**18.4%**	**93.9%**	**7.2%**	**13.8%**	**29.2%**	**92.1%**	**0.1%**

Notes:
1. Attributable burden is expressed as a percentage of total burden (DALY) for that disease group. Disease groups are ordered by number of total burden.
2. The percentages cannot be added together by row or column and do not add up to the joint effect row at the bottom of the table (as the risk factors were analysed independently).
3. Blank cells indicate that the risk factor has no associated diseases or injuries in the disease group.
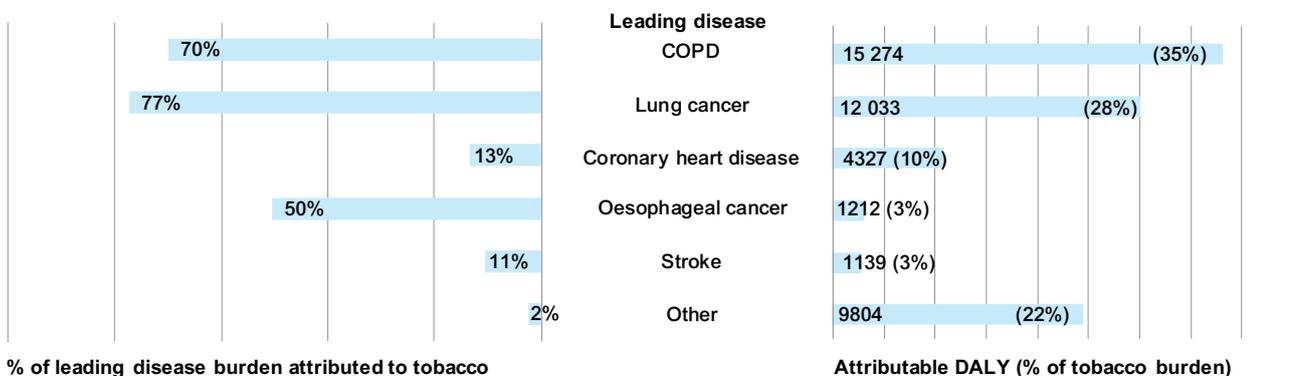
Selected risk factors and the contributable disease

Tobacco

- The impact of tobacco on the burden of disease and injury is measured through current and past tobacco smoking, and exposure to second-hand smoke.

- Tobacco caused 42.9% (DALY=16 253) of the respiratory disease burden and 21.9% (DALY=18 303) of cancer burden (Table 3).

- The majority (YLL=29 670, 68%) of the health loss due to tobacco was associated with premature death (Table 1).

- The two leading diseases associated with tobacco use in WA were COPD and lung cancer, contributing to 35% (DALY=15 274) and 28% (DALY=12 033) of tobacco burden respectively. Additionally, tobacco use contributed to 70% (DALY=21 920) of the burden associated with COPD and 77% (DALY=15 617) of the burden associated with lung cancer (Figure 3).

Figure 3: Total burden of tobacco use and its contribution to leading diseases

Leading disease	% of leading disease burden attributed to tobacco	Attributable DALY (% of tobacco burden)
COPD	70%	15 274 (35%)
Lung cancer	77%	12 033 (28%)
Coronary heart disease	13%	4327 (10%)
Oesophageal cancer	50%	1212 (3%)
Stroke	11%	1139 (3%)
Other	2%	9804 (22%)

Note: Other leading causes include pancreatic cancer, asthma and liver cancer, to name a few. For a full list of associated diseases for tobacco use please refer to Appendix A Table A.1.

Overweight and obesity (high BMI)

- Overweight and obesity caused 8.3% (DALY=39 940) of health loss in 2015 (Table 1). It was the second leading modifiable risk factor after tobacco.

- 56% of the overweight and obesity total burden was due to years of healthy life lost to death (YLL=22 208 - Table 1).

- The biggest impact of overweight and obesity was through its effect on coronary heart disease (DALY=8737), type 2 diabetes (DALY=5972) and osteoarthritis (DALY=5242). These conditions together caused half (50%) of the total burden associated with overweight and obesity.

- Overweight and obesity contributed to 44.6% (DALY=5972) of endocrine disorders burden, 21.3% (DALY=12 860) of cardiovascular disease burden and 38.3% (DALY=2442) of kidney and urinary disease burden (Table 3).

- Overweight and obesity was the second greatest contributor to cancers (DALY=6521, 7.8%), following tobacco use.

- Overweight and obesity attributed to 27% (DALY= 8737) of the burden associated with coronary heart disease and 56% (DALY=5972) of the burden associated with type 2 diabetes (Figure 4).

Figure 4: Total burden of overweight and obesity and its contribution to leading diseases

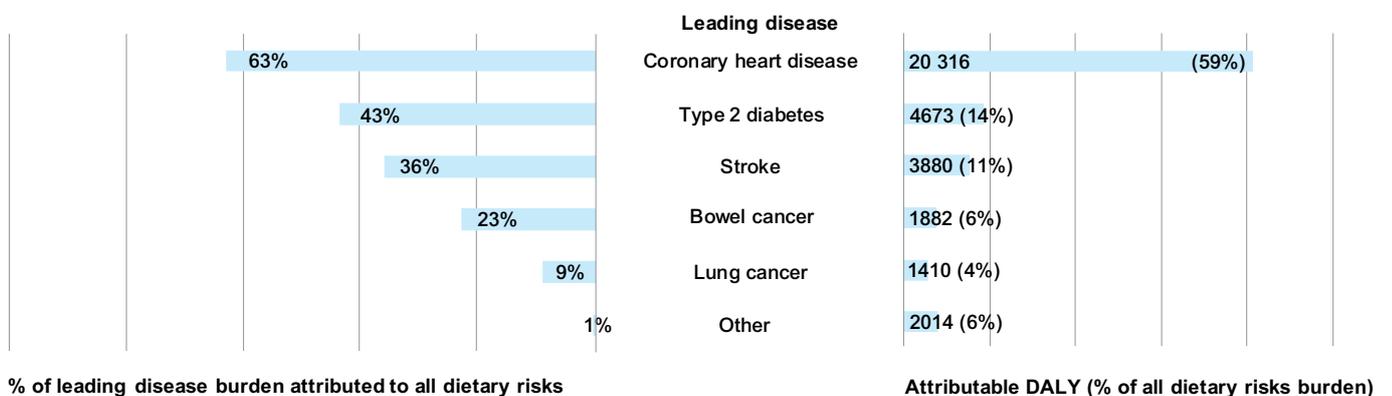| % of leading disease burden attributed to overweight & obesity	Leading disease	Attributable DALY (% of overweight & obesity burden)
27%	Coronary heart disease	8737 (22%)
56%	Type 2 diabetes	5972 (15%)
46%	Osteoarthritis	5242 (13%)
24%	Stroke	2642 (7%)
23%	Asthma	2492 (6%)
4%	Other	14 855 (37%)
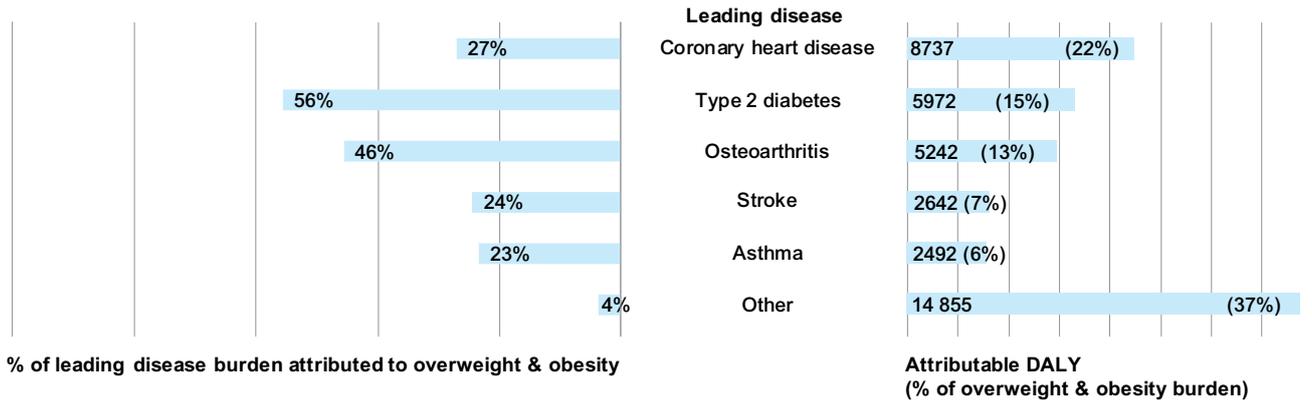
Note: Other leading causes include dementia, chronic kidney disease, breast cancer, to name a few. For a full list of associated diseases for overweight and obesity please refer to Appendix A, Table A.1.

Dietary risks combined

- The combined impact of all dietary risks was the third largest cause of health loss in WA in 2015, following tobacco and overweight and obesity. Twelve individual diet-related risks were included in WABoDS (Table 2). Joint analysis of these dietary risk factors indicated that 7.1% (DALY=34 174) of the total WA burden in 2015 could be attributed to diet (Table 2). The largest impact of a dietary risk factor was from a diet low in fruit (1.6% of total burden) and a diet high in processed meat (1.6%).

- Dietary risks caused 11.0% (YLL=26 133) of fatal burden and 3.3% (YLD=8042) of non-fatal burden. Three quarters of the total burden associated with dietary risks was due to early death (or YLL - Table 1).

- Dietary risks were associated with 41.6% (DALY=25 130) of cardiovascular disease burden and 34.9% (DALY=4673) of endocrine disorder burden (Table 3).

- The three leading diseases associated with dietary risks in WA were coronary heart disease (DALY=20 316), type 2 diabetes (DALY=4673), and stroke (DALY=3880), contributing to 59%, 14% and 11% of dietary risks burden, respectively. Additionally, dietary risks contributed to 63% (DALY=20 316) of the burden associated with coronary heart disease, 43% (DALY=4673) of type 2 diabetes and 36% (DALY=3880) of stroke (Figure 5).

Figure 5: Total burden of all dietary risks and its contribution to leading diseases

% of leading disease burden attributed to all dietary risks	Leading disease	Attributable DALY (% of all dietary risks burden)
63%	Coronary heart disease	20 316 (59%)
43%	Type 2 diabetes	4673 (14%)
36%	Stroke	3880 (11%)
23%	Bowel cancer	1882 (6%)
9%	Lung cancer	1410 (4%)
1%	Other	2014 (6%)

Note: Other leading causes include chronic kidney disease, atrial fibrillation and stomach cancer, to name a few. For a full list of associated diseases for dietary risks please refer to Appendix A, Table A.1.

Risk factors across age groups

- Risk factors and the impact on health varied immensely by age and sex. Risk factors ranked by their contribution to total burden (DALY) in each age group are shown for males and females (Figure 6). The number of attributable DALY and associated proportion are included by risk factor, age and sex.

- Overall, males [age standardised rate (ASR)= 129 per 1000 population] experienced higher attributable burden across all age groups than females (ASR= 81 per 1000 population). The total burden attributable to the joint effect of all risk factors for males was 41% (DALY=108 494) compared to 36% (DALY=77 625) for females.

- The risk factor of child abuse and neglect was estimated in people aged 5 years and over. It includes emotional abuse, physical abuse, sexual abuse and neglect. The maltreatment of children contributes to a substantial proportion of burden from depressive and anxiety disorders and intentional self-harm in Australia, and has adverse health consequences across a wide age group.

Children and young people aged under 15 years

- Child abuse and neglect was the leading contributor to total burden in people aged under 15 years. For males, child abuse and neglect contributed to 1.0% (DALY=139) and females 2.0% (DALY=228) of total burden.

- It must be noted that many other risk factors were not measured in this age group due to low disease burden of linked diseases at this age.

Young people aged 15 to 24 years

- Alcohol had a dominant impact on all burden for young people.

- Alcohol was the leading risk factor contributing to disease burden in males at 15% (DALY=2753). In contrast, for females, alcohol was the second leading risk factor, contributing to 6.8% (DALY=978) of total burden in this age group.

- Illicit drug use and child abuse and neglect were also leading causes for males, with12% (DALY=2281) and 5.5% (DALY=1027) of total burden, respectively.

- Child abuse and neglect was the leading risk factor contributing to total burden for females at 8.0% (DALY=1154).

- Occupational exposures and hazards ranked fourth for both males and females in this age group, contributing to 2.0% of burden (DALY=382) for males and 1.9% of burden (DALY=271) for females.

- Intimate partner violence was ranked fifth for females in this age group accounting for 1.6% (DALY=237) of total burden.

Adults aged 25 to 44 years

- Illicit drug use was the largest cause of burden in adults aged 25 to 44 years.

- The leading five causes of disease burden for males in this age group were illicit drug use (DALY=8237, 15%), alcohol (7379, 13%), child abuse and neglect (2763, 4.9%), overweight and obesity (2706, 4.8%) and all dietary risks (2545, 4.5%).

- Both alcohol use and illicit drug use contributed to a far greater proportion of the burden in men than in women. Alcohol ranked fourth leading cause of disease burden for women in this age group with 4.1% (DALY=1718) of the burden. Tobacco use ranked sixth most contributing factor to disease burden at 3.1% (DALY=1732) and 2.8% (DALY=1165) of total burden for males and females, respectively.

- Illicit drug use was the leading risk factor for women aged 25 to 44 years, contributing to 7.2% (DALY=2999) of burden. Child abuse and neglect (DALY=2806, 6.7%), intimate partner violence (1786, 4.3%), alcohol (1718, 4.1%) and overweight and obesity (1526, 3.7%) made up the remaining top five causes of disease burden for females.

Adults aged 45 to 64 years

- By middle age, the dominant causes of risk attributable burden were tobacco exposure, overweight and obesity, poor diet, and alcohol use.

- Tobacco (DALY=9880, 12.8%), overweight and obesity (9613, 12.5%) and poor diet (9093, 11.8%) were the leading causes of burden in males in this age group. Blood pressure (5130, 6.7%) was the fourth leading contributor of disease burden. Illicit drug use still appeared in the top 10 leading risk factors for men, ranking at 8th with 3.7% (DALY=2831) contribution.

- The five leading causes of burden for females were overweight and obesity (DALY=6835, 11%), tobacco (6602, 11%), all dietary risks (3697, 6.1%), high blood sugar glucose (2658, 4.4%) and alcohol (2201, 3.6%). Illicit drug use (DALY=1648, 2.7%) was the ninth leading risk factor for females.

Older adults aged 65 and over

- Among older adults, tobacco, overweight and obesity and dietary risks were the prevailing contributors to the risk related burden.

- In addition, high blood pressure and high blood sugar glucose ranked in the top five risk factors for men and women.

- Alcohol did not make an appearance in the top five contributors of burden for both males and females of this older age group. In fact, it was ranked the ninth leading risk factor at 2.5% (DALY=2393) and 2.2% (DALY=1959) of burden for males and females, respectively. In contrast to other age groups over 14 years, illicit drug use was ranked outside the top 10 contributors of disease burden, ranking at fourteenth and thirteenth leading contributor for males and females respectively (at DALY=497, 0.51% and DALY=433, 0.49%, respectively).

- For males of this group, tobacco use (DALY=14 426, 15%) was the dominant risk factor which outranked poor diet (10 883, 11%) and overweight and obesity (10 130, 10%).

- For females of this age group tobacco use (DALY=9982, 11%) was the leading cause of disease burden, followed closely by overweight and obesity (8886, 10%).

- Physical inactivity and high cholesterol ranked just out of the top five leading contributors of disease burden for both females and males in this older age group.

Figure 6: Leading risk factor contribution to total burden (DALY; proportion %), for male and female by age group in WA, 2015

Male Age Group (years)

Rank	0 to 14	15 to 24	25 to 44	45 to 64	65+
1st	Child abuse/neglect (139; 1.0%)	Alcohol (2753; 14.7%)	Illicit drug use (8237; 14.6%)	Tobacco (9880; 12.8%)	Tobacco (14 426; 15.0%)
2nd	Blood glucose (33; 0.2%)	Illicit drug use (2281; 12.2%)	Alcohol (7379; 13.1%)	Overweight/ Obesity (9613; 12.5%)	Diet (10 883; 11.3%)
3rd	Alcohol (22; 0.2%)	Child abuse/neglect (1027; 5.5%)	Child abuse/neglect (2763; 4.9%)	Diet (9093; 11.8%)	Overweight/ Obesity (10 130; 10.5%)
4th		Occupational (382; 2.0%)	Overweight/ Obesity (2706; 4.8%)	Blood pressure (5130; 6.7%)	Blood pressure (8696; 9.0%)
5th		Blood glucose (170; 0.9%)	Diet (2545; 4.5%)	Alcohol (4667; 6.1%)	Blood glucose (7377; 7.6%)
	All risks (1.6%)	All risks (32.7%)	All risks (42.3%)	All risks (45.4%)	All risks (44.8%)
	Rate 0.9	Rate 38.8	Rate 81.1	Rate 189.7	Rate 443.4

Female Age Group (years)

Rank	0 to 14	15 to 24	25 to 44	45 to 64	65+
1st	Child abuse/neglect (228; 2.0%)	Child abuse/neglect (1154; 8.0%)	Illicit drug use (2999; 7.2%)	Overweight/ Obesity (6835; 11.2%)	Tobacco (9982; 11.4%)
2nd	Iron defiency 104; 0.9%	Alcohol (978; 6.8%)	Child abuse/neglect (2806; 6.7%)	Tobacco (6602; 10.8%)	Overweight/ Obesity (8886; 10.1%)
3rd	Blood glucose (23; 0.2%)	Illicit drug use (754; 5.2%)	Intimate partner violence (1786; 4.3%)	Diet (3697; 6.1%)	Diet (7036; 8.0%)
4th		Occupational (271; 1.9%)	Alcohol (1718; 4.1%)	Blood glucose (2658; 4.4%)	Blood pressure (6849; 7.8%)
5th		Intimate partner violence (237; 1.6%)	Overweight/ Obesity (1526; 3.7%)	Alcohol (2201 3.6%)	Blood glucose (5898; 6.7%)
	All risks (3.3%)	All risks (25.4%)	All risks (33.3%)	All risks (40.7%)	All risks (39.7%)
	Rate 1.5	Rate 24.0	Rate 45.4	Rate 114.7	Rate 298.7

Notes:
1. Blank cells indicate the numbers are too small to display.
2. All risks: combined effect of all risk factors as a proportion across the specific age group and sex.
3. Rates: age specific rates per 1000 population

Implications for health policy and planning

This study demonstrates that a large proportion of burden of disease is preventable and identifies WA's leading risk factors as tobacco use, overweight and obesity, and dietary risks. The efficacy of evidence-based, population-wide prevention programs is well understood and is particularly important in the current climate of high chronic disease burden and growing healthcare costs.

A small shift in the average population levels of several risk factors can lead to a large overall reduction in the burden of chronic disease, which not only improves community health and wellbeing, but has significant implications for reducing demand for health services. Prevention offers cost-effective ways to improve health outcomes. The importance of investment in prevention is highlighted in the Sustainable Health Review Final Report to the Western Australian Government (Sustainable Health Review 2019), which includes recommendations to 'increase and sustain focus and investment in public health, with prevention rising to at least five per cent

of total health expenditure by July 2029', and highlights the need for a cultural shift away from a hospital-based system to one with a strong focus on prevention. Examples of prevention programs include earlier detection of cancer via national screening programs (e.g. breast, bowel and cervical) (Australian Institute of Health and Welfare 2019c), greater education about and awareness of tobacco use and advances in medical treatments.

Population health data plays a vital role in policy/program development and evaluation. Reports such as WABoDS enhance our understanding of the leading risk factors affecting the WA community, identify priority areas and target populations for prevention activity, and inform planning for future service delivery. Estimations of the impact of the health conditions caused by these risk factors over the life course are also essential for guiding planning for an integrated care approach which considers early intervention, management and treatment of these conditions within WA's health system and in the wider community.

Conclusion

This report quantifies the attributable burden of various risk factors. Almost two-fifths (39%) of the total burden was attributable to all 38 risk factor components in 2015 in WA, linked to 91 diseases. Tobacco remains the cause of the greatest health loss overall but is closely followed by overweight and obesity and dietary factors (combined). Of the 186,120 years of healthy life lost due to the joint impact of risk factors, most were related to cardiovascular disease and cancer, with coronary

heart disease, COPD, lung cancer and type 2 diabetes among the conditions with the greatest DALY attributable to risk factors.

Facilitating improvements in health behaviours and environments, and empowering people living with chronic conditions to better manage their health, will improve community health and wellbeing, as well as alleviate demand on WA's health services.

Appendix A[1]

Table A.1: Risk factors and associated conditions

Risk factor	Disease Group (broad cause)	Disease outcome (specific cause)
Air pollution	Cancer and other neoplasms	Lung cancer
	Cardiovascular diseases	Coronary heart disease, stroke
	Respiratory diseases	Chronic obstructive pulmonary disease (COPD)
	Infectious diseases	Lower respiratory infections
Alcohol use	Cancer and other neoplasms	Bowel cancer, breast cancer, laryngeal cancer, lip and oral cavity cancer, liver cancer, nasopharynx cancer, oesophageal cancer, other oral cavity and pharynx cancers
	Cardiovascular diseases	Atrial fibrillation and flutter, coronary heart disease, hypertensive heart disease, stroke
	Gastrointestinal disorders	Chronic liver disease, pancreatitis
	Infectious diseases	Lower respiratory infections
	Injuries	Drowning, falls, fire, burns and scalds, homicide and violence, other land transport injuries, other unintentional injuries, poisoning, Road traffic injuries (RTI) – motor vehicle occupants, RTI – motorcyclists, RTI – pedal cyclists, RTI – pedestrians, suicide and self-inflicted injuries
	Mental and substance use disorders	Alcohol use disorders
	Neurological conditions	Epilepsy
Child abuse and neglect	Injuries	Suicide and self-inflicted injuries
	Mental and substance use disorders	Anxiety disorders, depressive disorders

Risk factor	Disease Group (broad cause)	Disease outcome (specific cause)
Dietary risks	Cancer and other neoplasms	Acute lymphoblastic leukaemia, acute myeloid leukaemia, bowel cancer, breast cancer, chronic lymphocytic leukaemia, chronic myeloid leukaemia, gallbladder cancer, kidney cancer, liver cancer, lung cancer, lip and oral cavity cancer, myeloma, nasopharynx cancer, non-Hodgkin lymphoma, oesophageal cancer, other leukaemias, other oral cavity and pharynx cancers, ovarian cancer, pancreatic cancer, stomach cancer, thyroid cancer, uterine cancer
	Cardiovascular diseases	Aortic aneurysm, atrial fibrillation and flutter, cardiomyopathy, coronary heart disease, hypertensive heart disease, inflammatory heart disease, other cardiovascular diseases, peripheral vascular disease, rheumatic heart disease, stroke
	Endocrine disorders	Type 2 diabetes
	Gastrointestinal disorders	Gallbladder and bile duct disease
	Hearing and vision disorders	Cataract and other lens disorders
	Kidney and urinary diseases	Chronic kidney disease
	Musculoskeletal disorders	Back pain and problems, gout, osteoarthritis
	Neurological conditions	Dementia
	Respiratory diseases	Asthma
High blood plasma glucose	Cancer and other neoplasms	Bladder cancer, bowel cancer, breast cancer, liver cancer, lung cancer, ovarian cancer, pancreatic cancer
	Cardiovascular diseases	Coronary heart disease, peripheral vascular disease, stroke
	Endocrine disorders	Other diabetes, type 1 diabetes, type 2 diabetes
	Hearing and vision disorders	Cataract and other lens disorders glaucoma
	Kidney and urinary diseases	Chronic kidney disease
	Neurological conditions	Dementia

Risk factor	Disease Group (broad cause)	Disease outcome (specific cause)
High blood pressure	Cardiovascular diseases	Aortic aneurysm, atrial fibrillation and flutter, cardiomyopathy, coronary heart disease, hypertensive heart disease, inflammatory heart disease, other cardiovascular diseases, peripheral vascular disease, rheumatic heart disease, stroke
	Kidney and urinary diseases	Chronic kidney disease
	Neurological conditions	Dementia
High cholesterol	Cardiovascular disease	Coronary heart disease, stroke
High sun exposure	Cancer and other neoplasms	Melanoma, non-melanoma skin cancer
Illicit drug use	Cancer and other neoplasms	Liver cancer
	Gastrointestinal disorders	Chronic liver disease
	Injuries	Poisoning, RTI – motorcyclists, RTI – motor vehicle occupants, suicide & self-inflicted injuries
	Infectious diseases	Hepatitis B, hepatitis C, HIV/AIDS
	Mental and substance use disorders	Anxiety disorders, depressive disorders, drug use disorders (excluding alcohol), schizophrenia
Impaired kidney function	Cardiovascular diseases	Coronary heart disease, peripheral vascular disease, stroke
	Kidney and urinary diseases	Chronic kidney disease
	Neurological conditions	Dementia
	Musculoskeletal disorders	Gout
Intimate partner violence	Injuries	Homicide and violence, suicide and self-inflicted injuries
	Neurological conditions	Anxiety disorders, depressive disorders
	Mental and substance use disorders	Alcohol use disorders
	Reproductive and maternal conditions	Early pregnancy loss
Iron deficiency	Blood and metabolic disorders	Iron deficiency anaemia
Low bone mineral density	Injuries	Falls, hip fracture, humerus fracture, other fractures, tibia and ankle fractures

Risk factor	Disease Group (broad cause)	Disease outcome (specific cause)
Occupational exposures and hazards	Cancer and other neoplasms	Acute lymphoblastic leukaemia, acute myeloid leukaemia, chronic lymphocytic leukaemia, chronic myeloid leukaemia, kidney cancer, laryngeal cancer, lung cancer, mesothelioma, nasopharyngeal cancer, other leukaemias, ovarian cancer
	Hearing and vision disorders	Hearing loss
	Injuries	Drowning, falls, fire, burns and scalds, homicide and violence, RTI – motor vehicle occupants, RTI – motorcyclists, other land transport injuries, other unintentional injuries
	Musculoskeletal disorders	Back pain and problems
	Respiratory diseases	Asthma, COPD, Pneumoconiosis
Overweight and obesity	Cancer and other neoplasms	Acute lymphoblastic leukaemia, acute myeloid leukaemia, bowel cancer, breast cancer, chronic lymphocytic leukaemia, chronic myeloid leukaemia, gallbladder cancer, kidney cancer, liver cancer, myeloma, non-Hodgkin lymphoma, oesophageal cancer, other leukaemias, ovarian cancer, pancreatic cancer, thyroid cancer, uterine cancer
	Cardiovascular diseases	Atrial fibrillation and flutter, coronary heart disease, hypertensive heart disease, stroke
	Endocrine disorders	Type 2 diabetes
	Gastrointestinal diseases	Gallbladder and bile duct disease
	Hearing and vision disorders	Cataract & other lens disorders
	Kidney and urinary diseases	Chronic kidney disease
	Musculoskeletal disorders	Back pain and problems, gout, osteoarthritis
	Neurological conditions	Dementia
Physical inactivity	Cancer and other neoplasms	Breast cancer, bowel cancer, uterine cancer
	Cardiovascular diseases	Coronary heart disease, stroke
	Endocrine disorders	Type 2 diabetes
	Neurological conditions	Dementia

Risk factor	Disease Group (broad cause)	Disease outcome (specific cause)
Tobacco use	Cancer and other neoplasms	Acute lymphoblastic leukaemia, acute myeloid leukaemia, bladder cancer, bowel cancer, breast cancer, cervical cancer, chronic lymphocytic leukaemia, chronic myeloid leukaemia, kidney cancer, laryngeal cancer, lip and oral cavity cancer, liver cancer, lung cancer, nasopharynx cancer, oesophageal cancer, other leukaemias, pancreatic cancer, prostate cancer, stomach cancer
	Cardiovascular disease	Aortic aneurysm, atrial fibrillation and flutter, Coronary heart disease, hypertensive heart disease, other cardiovascular diseases, peripheral vascular disease, stroke
	Endocrine disorders	Type 2 diabetes
	Gastrointestinal disorders	Gallbladder and bile duct disease, gastroduodenal disorders
	Hearing and vision disorders	Age-related macular degeneration, cataract & other lens disorders
	Infectious diseases	Influenza, lower respiratory infections, otitis media, multiple sclerosis,
	Neurological conditions	Dementia
	Musculoskeletal disorders	Back pain and problems, rheumatoid arthritis
	Respiratory diseases	Asthma, COPD, other respiratory diseases
Unsafe sex	Cancer and other neoplasms	Cervical cancer, liver cancer
	Gastrointestinal disorders	Chronic liver disease
	Infectious diseases	Chlamydia, gonorrhoea, hepatitis B, hepatitis C, HIV/AIDS, syphilis, other sexually transmitted infections

Table A.2: Dietary risk factors and associated conditions

Dietary risk factor	Definition of exposure	Disease outcome (specific cause)
Diet low in fish and seafood	Average daily consumption of fish and seafood	Coronary heart disease
Diet low in fruit	Average daily consumption of fresh, frozen, cooked, canned, or dried fruits (excluding fruit juices)	Coronary heart disease, lung cancer, lip and oral cavity cancer, nasopharynx cancer, other oral cavity and pharynx cancers, stroke, type 2 diabetes
Diet low in legumes	Average daily consumption of fresh, frozen, cooked, canned, or dried legumes	Coronary heart disease
Diet low in milk	Average daily consumption of milk including non-fat, low-fat, and full-fat milk, excluding soy milk and other plant derivatives	Bowel cancer
Diet low in nuts and seeds	Average daily consumption of nut and seed foods	Coronary heart disease, type 2 diabetes
Diet low in polyunsaturated fats	Average daily consumption of polyunsaturated fats	Coronary heart disease
Diet high in processed meats	Average daily consumption of meat preserved by smoking, curing, salting, or addition of chemical preservatives	Bowel cancer, coronary heart disease, type 2 diabetes, stomach cancer
Diet high in red meat	Average daily consumption of red meat (beef, pork, lamb, and goat) (excluding poultry, fish, eggs and all processed meats)	Bowel cancer, diabetes
Diet high in sodium	Consumption of sodium	High blood pressure linked diseases: Aortic aneurysm, atrial fibrillation and flutter, cardiomyopathy, chronic kidney disease, coronary heart disease, dementia, hypertensive heart disease, inflammatory heart disease, other cardiovascular diseases, peripheral vascular disease, rheumatic heart disease, stroke

Dietary risk factor	Definition of exposure	Disease outcome (specific cause)
Diet high in sugar sweetened beverages	Consumption of beverages with ≥50 kcal per 226.8 g serving, including carbonated beverages, sodas, energy drinks and fruit drinks (excluding 100% fruit and vegetable juices)	Overweight and obesity linked diseases: Acute lymphoblastic leukaemia, acute myeloid leukaemia, asthma, atrial fibrillation and flutter, back pain and problems, bowel cancer, breast cancer, cataract and other lens disorders, chronic kidney disease, chronic lymphocytic leukaemia, chronic myeloid leukaemia, coronary heart disease, dementia, gallbladder and bile duct disease, gallbladder cancer, gout, hypertensive heart disease, kidney cancer, , liver cancer, myeloma, non-Hodgkin lymphoma, oesophageal cancer, osteoarthritis, other leukaemias, ovarian cancer, pancreatic cancer, stroke, thyroid cancer, type 2 diabetes, uterine cancer
Diet low in vegetables	Average daily consumption of fresh, frozen, cooked, canned, or dried vegetables (excluding vegetable juices, legumes and starchy vegetables such as potatoes or corn)	Coronary heart disease, stroke
Diet low in whole grains (including high fibre cereals)	Average daily consumption of wholegrain or higher fibre breads, cereals, rice, pasta, crumpets, muffins, crispbreads, relevant fortified cereals with 1 g of fibre per 10 g of carbohydrate	Coronary heart disease, stroke, type 2 diabetes

[1] The associated conditions in Appendix A has been extracted from the Australian Institute of Health and Welfare (2019b). Australian Burden of Disease Study: methods and supplementary material 2015. Australian Burden of Disease series no.20. Cat no. BOD 23. Canberra, AIHW.

Glossary[2]

Age-standardised rate: Rate that takes into account the age structure of the population.

Attributable burden: The disease burden attributed to a particular risk factor. It is the reduction in fatal and non-fatal burden that would have occurred if exposure to the risk factor had been avoided or reduced to a theoretical minimum value.

Burden of disease (and injury): The quantified impact of a disease or injury on a population using the disability-adjusted life year (DALY) measure.

Condition (health condition): A broad term that can be applied to any health problem, including symptoms, diseases and certain risk factors, such as high blood cholesterol and obesity. Often used synonymously with disorder or problem.

Disability: In burden of disease analysis, any departure from an ideal health state.

Disability-adjusted life years (DALY): A year of healthy life lost, either through premature death or living with disability due to illness or injury.

Disability weight: A factor that reflects the severity of health loss from a particular health state on a scale from 0 (perfect health) to 1 (equivalent to death).

Disease: A broad term that can be applied to any health problem, including symptoms, diseases, injuries and certain risk factors, such as high blood cholesterol and obesity. Often used synonymously with condition, disorder or problem.

External cause: The environmental event, circumstance or condition that causes injury, poisoning and other adverse effect.

Fatal burden: The burden from dying prematurely as measured by years of life lost. Often used synonymously with years of life lost (YLL).

Incidence: Refers to the occurrence of a disease or event. The incidence rate is the number of new cases occurring during a specified time period.

Morbidity: Ill health in an individual, and levels of ill health in a population or group.

Mortality: Death.

Non-fatal burden: The burden from living with ill health as measured by years lived with disability. Often used synonymously with years lived with disability (YLD).

Population attributable fraction (PAF): For a particular risk factor and causally linked disease or injury, the percentage reduction in burden for a population that would occur if exposure to the risk factor was avoided or reduced to its theoretical minimum.

Premature death: Deaths that occur at a younger age than a selected cut-off.

Prevalence: Refers to the existence of a disease or event, whether or not it is newly occurring the prevalence rate is the number of cases existing at a point in time (point prevalence) or over a specified time period (period prevalence).

Rate: A rate is one number (the numerator) divided by another number (the denominator). The numerator is commonly the number of events in a specified time. The denominator is the population at risk of the event. Rates (crude, age-specific and age-standardised) are generally multiplied by a number such as 100,000 to create whole numbers.

Reference life table: A table that shows, for each age, the number of remaining years a person could potentially live, to measure the years of life lost from dying at that age.

Risk factor: Any factor that causes or increases the likelihood of a health disorder or other unwanted condition or event.

Years lived with disability (YLD): Measures the years of what could have been a healthy life that were instead spent in states of less than full health. YLD represents non-fatal burden.

Years of life lost (YLL): Years of life lost due to premature death, defined as dying before the global ideal life span at the age of death. YLL represents fatal burden.

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[2] This glossary has been extracted from the AIHW Burden of Diseases 2015 report Australian Institute of Health and Welfare (2019). Australian Burden of Disease Study: impact and causes of illness and death in Australia 2015. Australian Burden of Disease series no.19. Cat no. BOD 22. Canberra, AIHW.

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