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Climate change and environmental health indicators: reporting framework

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Summary

Environmental determinants of health are the elements of the natural and built environments that affect human health. Clean air outdoors and in the home, access to water that is safe for drinking and recreation, and access to public parks to play and exercise in are some of the ways the environment helps to keep us healthy. However, increasing pressure from factors such as climate change and human activities are negatively affecting the environment, which is in turn threatening the health of the population, for example through exposure to extreme weather events or air, soil or water pollution (Creswell et al. 2021).

Understanding how, and the extent to which, the environment affects health, and the change over time is essential for the development of, and informing on, policies and strategies to protect human health from environmental hazards. We need to be able to measure and monitor environmental determinants of health, and to do so we need a framework that sets out the relevant issues in Australia, and suitable indicators for tracking progress on these.

Australian government public health policy is increasingly including a stronger focus on the environmental determinants of health. The National Preventive Health Strategy 2021–30 recognises the need for indicators of environmental determinants of health to contribute to the comprehensive monitoring and surveillance system for preventive health (Department of Health and Aged Care 2021). The National Health and Climate Strategy also acknowledges the need for relevant environmental health indicators to prepare for and respond to the impacts of climate change on health (Department of Health and Aged Care 2023b).

This report outlines a framework of indicators for measuring and monitoring environmental determinants of health in Australia. The scope of the framework includes indicators of the natural and built environment and the impact of these on the Australian population's health. Although a related concept, occupational indicators are out of scope for this report.

The framework was developed using a 3-stage process (adapted from Mason et al. 2018), involving scoping, selection and design:

Scoping

Background research was conducted to:

- evaluate international examples of environmental health indicator sets and tracking programs, and identification of issues relevant to the Australian context
- identify environmental health conceptual frameworks that exist within the literature. Conceptual frameworks provide a structured approach to define the key themes or concepts for which to identify indicators.

In addition, the Australian environment and health data landscapes were surveyed to identify available data sources for populating the indicators, and to identify data gaps.

Selection

The conceptual framework selected was the **Driving force, Pressure, State, Exposure, Effect and Action (DPSEEA)** framework (Corvalán et al. 1996). This was used to guide the organisation of information on the relationship between drivers of environmental hazards, and the health outcomes of these, ensuring the causal relationships between them are clearly defined, and supported by evidence.

This led to the identification of 8 overarching domains relevant to environmental health in Australia:

- Air quality (indoor and outdoor)
- Water quality
- UV and sun radiation
- Climate and extreme weather
- Housing
- Built environment
- Food environment
- Waste

Indicators for measuring and monitoring specific issues relevant to each domain were identified, and those that met defined selection criteria were included. The indicators chosen included the following elements of the DPSEEA framework:

- Indicators of effect describe the human health impact of a hazard, as measured using either burden of disease and/or illness or injury-based methodology.
- Indicators at the exposure level in the framework provide context on the amount of exposure to a natural or built environmental hazard within the population.
- Indicators of the state describe how much of the hazard exists in the environment.

The final indicator framework:

- consists of 30 indicators for which data are currently available to enable reporting on climate change and environmental health in Australia. These are termed the 'reportable' indicators.
- highlights those issues and data gaps which were identified as relevant for inclusion in the indicator framework but are not currently reportable.

This framework is intended to be flexible and updated as new evidence becomes available about linkages between emerging environmental issues and their impact on health.

Design

As a final step indicator profile tables were developed for each of the reportable indicators. The table contains the technical specifications of the indicator, including:

- the rationale for the inclusion of the indicator,
- information on the measure used,
- the data sources and frequency,
- possible disaggregations to examine differences among specific groups,
- a summary of specific issues relating to the indicator.

Next steps

Reporting of these indicators will:

- provide a cohesive national approach for collection of data and future reporting on environmental determinants of health.
- enable monitoring of the impacts of climate change on health, and evaluation of the success of strategies, policies and/or measures implemented to mitigate or improve the impacts of the environment on human health.
- align Australia with other countries, regions and organisations that use indicators to measure and monitor environmental determinants of health, such as the United States, New Zealand, Europe, and the World Health Organization (Briggs 1999; CDC 2023; EEA n.d.; EHINZ n.d.; Environment and Health Fund and Ministry of Health 2020; OECD n.d.; WHO 2000).

1 Introduction

Safe, healthy, supportive, and sustainable environments are required for good health. The environment we live in, both natural and built, plays an important role in our health and wellbeing. Extreme weather events such as heatwaves, bushfires and storms can cause injury, health problems, hospitalisations, and death. Our built environment, including neighbourhood walkability and commuting distance, can influence how and when we do physical activity, as well as other aspects of our health. According to the World Health Organization, in 2012, 22% of the global disease burden was attributable to environmental factors (Prüss-Üstün et al. 2016).

Box 1.1: What is environmental health?

Environmental health examines the interaction between the environment and our health. It encompasses the physical, chemical, biological and social factors external to a person and all related behaviours that can directly or indirectly affect health and wellbeing. It also focuses on aspects of the environment that can be reasonably modified (EHINZ n.d.; WHO 2019).

Factors such as our social, economic, and physical environment as well as individual characteristics and behaviours, also known as determinants of health, can affect our health in various ways (WHO 2017). Therefore, understanding the extent to which the environment affects health, and monitoring changes to this over time, depends on identifying relevant environmental domains and associated health outcomes. This can be done using indicators and indicator sets – summary measures that point to, measure and provide insights into a specific concept. An important and distinguishing feature of environmental health indicators is that the choice of indicator is informed by known or plausible cause -and -effect relationships between the environment and health (EHINZ n.d.; Mason et al. 2018).

Environmental health indicators have been developed and explored internationally, including in the United States, New Zealand, Europe and Israel and by the World Health Organization (WHO) and the Organisation for Economic Co-operation and Development (OECD) (Briggs 1999; CDC 2023; EEA n.d.; EHINZ n.d.; Environment and Health Fund and Ministry of Health 2020; OECD n.d.; WHO 2000). While Australia has several nationally agreed indicator sets for assessing our health and health care system, it lacks a comprehensive set of designated environmental health indicators for measuring and monitoring the increasingly relevant issue of environmental health. In 2021, the National Preventive Health Strategy 2021–2030 identified the need for data indicator development on the environmental determinants of health, to deliver better health outcomes through preventive action (Department of Health and Aged Care 2021). The need to measure and monitor the impacts of climate change on public health and wellbeing is also noted in the National Health and Climate Strategy, released in 2023, as part of a coordinated program to deliver healthy, climate resilient communities and a sustainable, high quality, net-zero health system (Department of Health and Aged Care 2023b).

Why monitor environmental health?

Public health policy should be informed by evidence, and indicators are useful tools for providing information on relevant issues for this purpose. The Australian Health Performance Framework, the National Preventive Health Strategy 2021–2030, and the National Health and Climate Strategy all note the need for indicators to measure and monitor the impact of

the environment on public health (NHIPPC 2017; Department of Health and Aged Care 2021, 2023b). Furthermore, ongoing monitoring is important for identifying current and emerging impacts of the environment on human health.

Using clearly defined indicators to repeatedly measure and monitor environmental health will assist with:

- understanding the size of the current problem
- contribute to comprehensive monitoring and surveillance for preventive health
- assessing the effectiveness and impact of policies, strategies, and interventions
- informing policy makers and the public
- identifying the availability of resources
- research and data analysis.

A key feature of environmental health is that it does not focus solely on health; rather, it is multi-sectoral as it considers the broader context of the environment. An advantage of an environmental health indicator set is the potential to provide useful, cross-cutting information to inform policy and provide direction for future action in both the health and the environment sectors.

Natural environment and health

The natural environment comprises the atmosphere, land, water, oceans, and the diversity of living things (UN 2019). It provides essential resources for health and wellbeing including food, fresh water, wood, fibre, fuel, and medicines. It also helps regulate weather, vegetation, soils and the quality of water and air, while also providing aesthetic, cultural, recreational, and spiritual services to people (Whitmee et al. 2015).

Most Australians have access to clean drinking water, safe food, effective waste collection and sanitation. However, factors such as population growth and distribution, extreme weather events and climate change are placing increasing pressure on the natural environment (AIHW 2018). This may, in turn, adversely affect the health of the population, by increasing the prevalence of infectious, vector-borne, and communicable diseases, as well as increasing deaths, injuries, hospitalisations, and poor mental health (AIHW 2022b). The 2021 State of Environment Report found that, overall, the state and trend of the Australian environment is poor and continuing to deteriorate due to increasing pressures from climate change, habitat loss, invasive species, pollution, and resource extraction (Cresswell et al. 2021).

Understanding the impact of the natural environment on human health is complex. Nationally, various initiatives have been implemented to manage the ongoing effects of the natural environment on health. Examples of these include:

- the National Clean Air Agreement (DCCEEW 2022)
- the Australian Drinking Water Guidelines (NHMRC 2011)
- Australia's Strategy for Nature 2019–2030 (Biodiversity Working Group 2019).

Built environment and health

Australia has a diverse built environment that influences our health in many ways, including through activity levels, access to nutritious food, the houses we live in, where we work, contact with nature and the spaces we have for social interactions. It also affects the air we breathe and the water we drink, and shelters us from the weather (AIHW 2022a).

Between 2001 and 2016, Australia's population increased by just over 25% (ABS 2019), and in 2022, 72% of the population lived in *Major cities* (ABS 2023b). Population and economic growth, in addition to climate change, are placing more pressure on the liveability of the built environment by increasing:

- the need for space and buildings (urban footprint)
- traffic congestion and pollution
- consumption of resources (particularly for water and energy)
- waste generation
- frequency of extreme weather events
- sea level (State of the Environment Committee 2011).

The health impacts relating to the built environment are wide ranging. Factors such as mode of transport, walkability and accessibility to public open spaces affect physical activity (AIHW 2022a). This has the potential to influence associated chronic disease risk and other related risk factors such as overweight and obesity. Similarly, housing construction and design and the social and neighbourhood environment can affect physical and mental health and quality of life (Giles-Corti et al. 2012).

Several strategies, frameworks and plans relating to the built environment exist nationally, many at the state and territory level. They intend to guide urban development in a way that supports and promotes, as well as recognises, the importance of human health in the urban context. Examples of these include:

- the 2017 National Cities Performance Framework (Department of the Prime Minister and Cabinet 2017)
- the Queensland 2020 Model Code for Neighbourhood Design (Queensland Treasury 2020)
- Plan Melbourne's '20-minute neighbourhood' concept (State Government of Victoria 2021)
- 2017 30 Year Plan for Greater Adelaide (Government of South Australia 2017).

Environmental health indicators and population groups

The needs and purpose of environmental health indicators can vary based on the environmental context and population they refer to. This indicator framework is based on issues identified as being relevant to the population as a whole. Differences in outcomes can be examined, for example by age, sex, or socio-economic position. However, it is acknowledged that certain groups within the population experience environmental health differently, and therefore frameworks that focus on them specifically may be preferable, although this is out of scope for this report (Briggs 2003).

Population groups who are potentially at risk of experiencing a greater health burden from climate change and other environmental pressures include those who already face health disparities due to their particular circumstances. This includes people who:

- are Aboriginal and Torres Strait Islander people (First Nations people) (see Box 1.2)
- live in rural and remote areas
- live with chronic illness.
- live with a disability
- are from culturally and linguistically diverse (CALD) communities
- are in the justice system
- are carers or receiving care
- are experiencing homelessness
- identify as lesbian, gay, bisexual, trans/transgender, intersex, queer, and other sexuality (including asexual), gender and bodily diverse people (LGBTIQ+).

Many of the existing population health data sources have data gaps with respect to collecting information about these populations. Although national health information collections continue to develop and improve, attention should be given to ensuring that information on people experiencing these situations is captured in future data collections. This will assist with understanding the extent to which climate change and environmental hazards compound existing health disparities in a range of contexts.

Box 1.2: How do First Nations people environmental health indicators differ from environmental health indicators for the general population?

First Nations people have strong cultural connections to their land and country. These connections are the basis of relationships, identities, cultural practices and First Nations people's wellbeing at both the individual and community level (AIHW and NIAA 2020). Many First Nations people also live in areas more vulnerable to climate change. For these reasons, they disproportionally experience the ill health effects of environmental and climate change earlier and more significantly than other population groups (Australian Indigenous Health*Info*Net n.d).

Rural and remote communities and climate change

In 2021, approximately 60% of Aboriginal and Torres Strait Islander people lived in rural and remote areas (ABS 2021). Those living in rural and remote communities are often more exposed to the effects of climate change. For example, frequent bushfires and air borne dusts (due to a dry climate and wind erosion from nearby mining activities) in these areas can result in increased exposure to particulate matter pollution and subsequently poorer physical health (that is, disease and disorders), as well as mental health and social and emotional wellbeing (Clifford et al. 2015; HEAL Network and CRE-STRIDE 2021; Wright et al. 2023). Bushfires and floods also pose risks to health through destruction of significant cultural sites and contamination of fresh water supplies (HEAL Network and CRE-STRIDE 2021).

Additionally, rising sea levels have inundated townships, important cultural sites and contaminated fresh water sources in the Torres Strait and other coastal areas leading to the displacement of communities and migration away from traditional homelands.

The increased intensity and frequency of extreme weather events limits First Nations people's ability to undertake cultural responsibilities, affecting physical and mental health in addition to social and emotional wellbeing (HEAL Network and CRE-STRIDE 2021; Wright et al. 2023). Modelling shows that climatic events such as cyclones are likely to continue into the future and affect a larger geographic area (HEAL Network and CRE-STRIDE 2021).

Housing conditions

Housing is an important factor for health and wellbeing. Functional housing encompasses basic facilities, infrastructure and habitability which enable households to carry out healthy living practices (AIHW and NIAA 2022). First Nations people are more likely than non-Indigenous people to live in poor quality housing, particualrly in rural and remote areas (AIHW and NIAA 2022; Baker et al. 2013). Due to lack of adequate maintenance programs, they are more likely to have decreased access to equipment and utlities needed for healthy living practices (also known as 'health hardware'), with this being more apparent with increasing remoteness (AIHW and NIAA 2022). This includes functional toilets, showers, taps and sinks, which are required for adequate sanitation, and if not available can lead to increases in infectious and bacterial diseases and exacerbation of chronic conditions (AIHW and NIAA 2022; Clifford et al. 2015).

Improving environmental health conditions is important, particularly for First Nations people living in *Remote* areas, given the higher prevalence of infectious diseases and hospitalisations among this population group. Furthermore, many First Nations people experience repeated exposure to some infectious diseases, which can lead to long-term health effects, such as rheumatic heart disease and chronic kidney disease. Therefore, improving First Nations people's environmental conditions can positively affect their health and wellbeing, and reduce health care costs (Queensland Health 2019).

First Nations people living in cities and urban areas

Despite the majority of First Nations people living in cities and regional towns, there is a lack of evidence and available data to measure their wellbeing, experiences and circumstances in the urban environment (Hill et al. 2021). Available data show that First Nations people living in *Major cities* and *Inner regional* areas still face issues with housing conditions and overcrowded housing. While these issues are equally important irrespective of where First Nations people live, the prevalence is lower outside rural and remote areas (AIHW and NIAA 2022, 2023).

First Nations people living in cities and regional towns are also more likely to experience heat stress due to urbanisation, otherwise known as the 'urban heat island effect'. This occurs when there is a lack of nautral cooling systems such as vegetation and water sources, and when heat is generated from materials used in infrastructure such as buildings and roads, leading to higher temperatures in the surrounding areas (HEAL Network and CRE-STRIDE 2021).

Environmental health indicators for First Nations people

Some of the reportable climate change and environmental health indicators in the framework are particularly relevant to First Nations people: for example, acute rheumatic fever. In other instances, indicators can be disaggregated by Indigenous status. However, this is not possible for all indicators. Therefore, further research and a specific environmental health indicator set for First Nations people is required to reflect knowledge and concepts valued by First Nations people. Indicators need to be developed by community and preferably utilise data sets that are driven and governed by First Nations people to most meaningfully capture both positive and negative environmental health stories and subsequent differences the community experiences in health outcomes.

Purpose of the report

This report presents a framework and set of indicators that reflect key environmental health issues and their impact on human health in Australia. These indicators are designed to assist with measuring and monitoring the environmental determinants of health. This will enable a

snapshot of the current status of environmental health and support future work to collect data in a consistent and comparable manner. The report also provides further information on the:

- availability of, and recommended data sources for, reporting on environmental health issues, or where there may be data gaps and/or development required
- presentation of indicator specifications for future measuring and reporting.

It should be noted that the indicators included in the framework do not capture all environmental health-related issues. Rather, the purpose is to provide a useable framework of indicators for a range of important environmental determinants of health. It is intended that the reporting framework be responsive to new indicator development and have the scope for revision, addition of new indicators, and deletion of existing indicators, to reflect emerging evidence and supporting data availability. See ‘Chapter 5: Data gaps and development activities’.

Scope

The scope of the report relates to environmental health indicators of the natural and built environment which are relevant nationally, and aims to report data on past and present occurrences. Future projections are out of scope.

These indicators have been developed specifically for Australia, as indicators differ by each country’s contextual factors and needs. They have been considered in relation to the Sustainable Development Goals during the development process.

2 Development and selection of indicators

To ensure the integrity, quality and transparency of the indicators, a 3-stage development process was followed (adapted from Mason et al. 2018) involving scoping, selection, and design phases. The selection phase is detailed below; the scoping and design phases are detailed in 'Appendix A: Methodology for development and selection of indicators'.

Purpose of the indicators

Based on the policy context, expert and stakeholder consultation, and the project scope, the purpose of the climate change and environmental health indicator set is to:

- present data to monitor health effects linked to environmental exposures over time, including those hazards relating to climate change
- identify, where possible, populations most vulnerable to, or at risk of, environmental health hazards
- provide data to inform policy
- increase awareness of the impacts of climate change and the environment on health.

The intended audience of the indicators is broad and includes policy makers at all levels of government; academic researchers; and members of the public with an interest in climate change and environmental health.

Conceptual framework

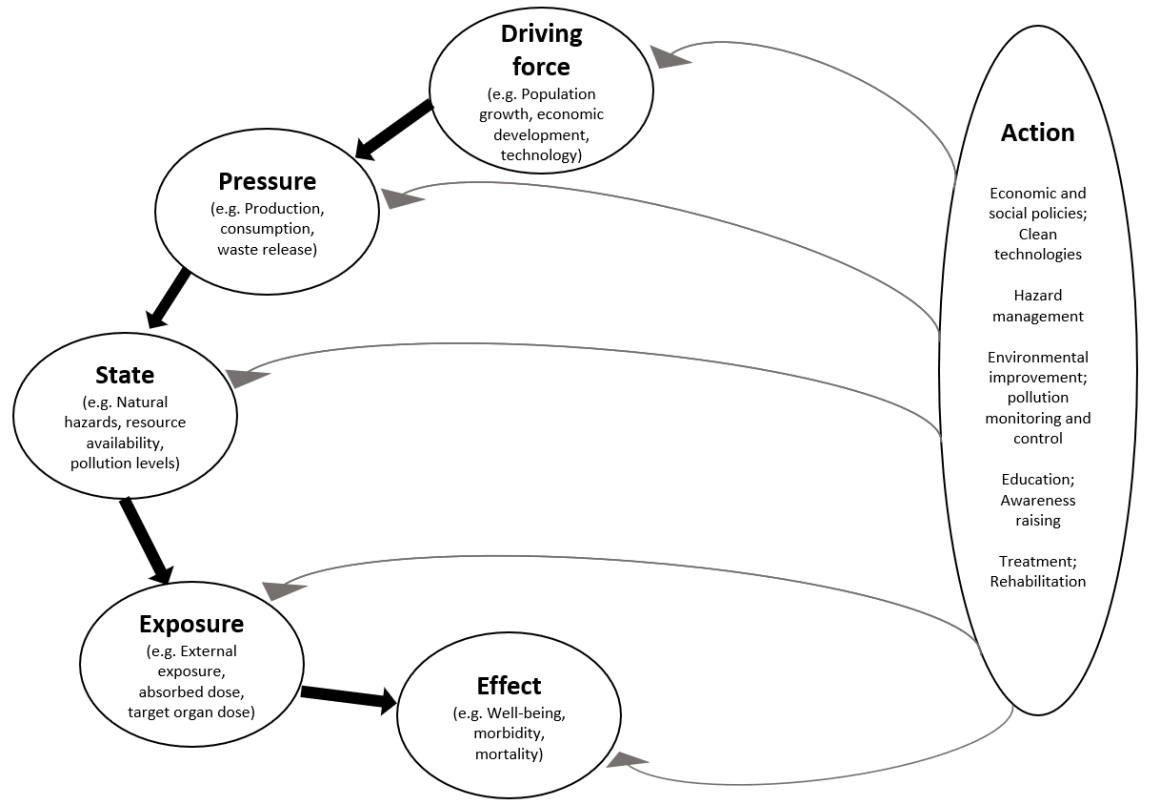
Conceptual frameworks provide a structured approach to define the key themes or concepts to identify appropriate indicators. The framework selected was the Driving forces, Pressure, State, Exposure, Effect, Action (DPSEEA) framework, (see Box 2.1 for further details). This framework was selected based on the reviewed literature during the scoping stage (see 'Appendix A: Methodology for development and selection of indicators').

Box 2.1: A conceptual framework for defining and reporting indicators

Understanding the impact of the environment on health is complex due to the many interactions between geographic, political, socioeconomic and individual factors. Environmental health conceptual frameworks are useful for systematically organising information on the relationships and interactions between the environment and health, for the purpose of defining and developing environmental health indicators (Hambling et al. 2011).

The Driving forces, Pressure, State, Exposure, Effect and Action (DPSEEA) framework is one example of a framework which has been widely used for developing environmental health indicators (Briggs 1999; Boylan et al. 2018; Edokpolo et al. 2019; Hambling et al. 2011; Hanigan et al. 2020; Maroosi et al. 2019; WHO 2000). The framework is designed to clarify the chain of events linking environmental hazards and health outcomes, from the most upstream elements (or 'the causes of the causes') through to the eventual health impacts, along with highlighting entry points for action or intervention to address these (Corvalán et al. 2000).

Figure 2.1: The DPSEEA framework



Source: Briggs et al. 1999.

Identifying environmental health indicators using the DPSEEA framework

The DPSEEA framework outlines the key themes or concepts for which to identify appropriate indicators. However, the aim of this indicator set is to measure the impact of climate change and environment hazards on health, and to do this there need to be demonstrated links between the hazard and the outcome (Corvalán et al. 2000). The causal certainty of the impact of a hazard or exposure on a health outcome decreases the further one moves up the chain, away from the health outcome and towards the driving forces. This is due to the inability to account for the many contextual circumstances being exerted, such as the policy context, infrastructure, and societal factors (Corvalán et al. 2000).

Given the stated purpose of the project, the focus is on indicators of the parts of the framework closer to health outcome. Therefore, the indicator set includes indicators of effect, exposure and, in some cases, state. In the future there may be a case for measuring and monitoring the more distal factors (see ‘Chapter 5: Data gaps and development activities’).

Indicators of effect

Indicators of **effect** are those which measure health impacts that are likely to be causally related to an exposure. Based on data sources available in Australia, there are 2 main approaches for measuring and reporting on this:

- Use of **burden of disease methodology** to attribute medical conditions, injuries or deaths to environmental exposure. The AIHW's Australian Burden of Disease Study (ABDS) currently attributes injuries and illnesses to risk factors, some of which are environmental in nature (such as air pollution). This indirect method requires sufficient evidence of a causal association between the exposure and health outcomes from high quality epidemiological studies and that certain criteria are met to enable estimation and inclusion in the dataset (AIHW 2021). It is out of scope for this report to review whether the data sources identified (other than those already included in the ABDS) are appropriate for analysis using this approach.
- An **illness or injury-based approach**, where medical conditions, injuries or deaths with explicitly related diagnoses are identified in health care and deaths databases – these are known as administrative data. This includes data sources such as the:
    - National Hospital Morbidity Database (NHMD)
    - National Mortality Database (NMD)
    - National Notifiable Diseases Surveillance System (NNDSS).

  In some cases, it is possible to estimate the effect based on available exposure data. The use of International Statistical Classification of Diseases and Health Problems ICD-10 codes (for deaths data), and the Australian Modification ICD-10-AM codes (for morbidity data) in health administrative data sets provide information relating to associated or underlying causes of illness or death (such as code X30: exposure to excessive natural heat). These are referred to in this report as external cause codes.

Indicators of exposure

Indicators of **exposure** are also important in the context of environmental health. Exposure data on their own may prove useful inclusions in environmental health indicator sets, particularly where causal associations between the exposure and health effects are well established (Lauriola et al. 2020).

Furthermore, exposure data (such as data on weather events) can be combined with health and deaths data to identify whether hospitalisations, deaths or dispensing of certain prescription medications is temporally and spatially related to the environmental exposure episode; for example, calculation of excess mortality (deaths) due to an environmental event, at a certain time and location. Data development in this way is beyond the scope of this report, but, 'Chapter 5: Data gaps and development activities' highlights potential indicators that may be of use in the set but require data development.

Indicators of state

A number of **state** indicators are also included in the set. These provide useful information about whether a hazard is present or the extent of a hazard, for example, the number of declared floods, or high levels of air pollution. But they differ from 'exposure' indicators as they do not provide information about how many people are exposed or who has been exposed to the hazard. However, when explored, for example in terms of the geographic location of the hazard, they can help to give more detailed understanding of the likely exposure.

Indicator selection criteria and evaluation of data sources

Potential indicators for the effect, exposure and state parts of the framework were identified and a data scan was conducted to identify suitable data sources for each indicator. The AIHW developed a selection criteria to specifically address the purpose of the indicator framework, systematically assess the indicators and evaluate the available data. These criteria were informed by existing examples in research used for indicators and input from expert advisers (Box 2.2). Indicators were required to meet at least 4 of the selection criteria to be eligible for inclusion in the final indicator set.

Box 2.2: Selection criteria

Indicator selection criteria:

1. Be relevant
2. Be intelligible/easy to be interpreted
3. Be technically sound (valid, reliable, sensitive to changes over time, and robust)
4. Be feasible to collect and report
5. Be timely, and able to be updated regularly
6. Be able to be disaggregated – can be broken down by population groups of interest (for example, ethnicity, age, sex, socioeconomic area, and remoteness area).

Data source selection criteria:

Identified data sources were assessed for their suitability for providing data in terms of their:

- representativeness – that is, of the relevant population
- availability – either continuously collected or collected at regular intervals
- sustainability – have funding to support ongoing data collection
- accessibility – can be accessed for the purpose of populating the indicator (PAHO 2018).

3 The climate change and environmental health indicator framework

The environmental health indicator framework is arranged here in ‘domains’, or overarching environmental health themes, and various ‘sub domains’ of these themes, each of which has a number of indicators for measuring and monitoring them. Some important points to note about the framework as presented here are:

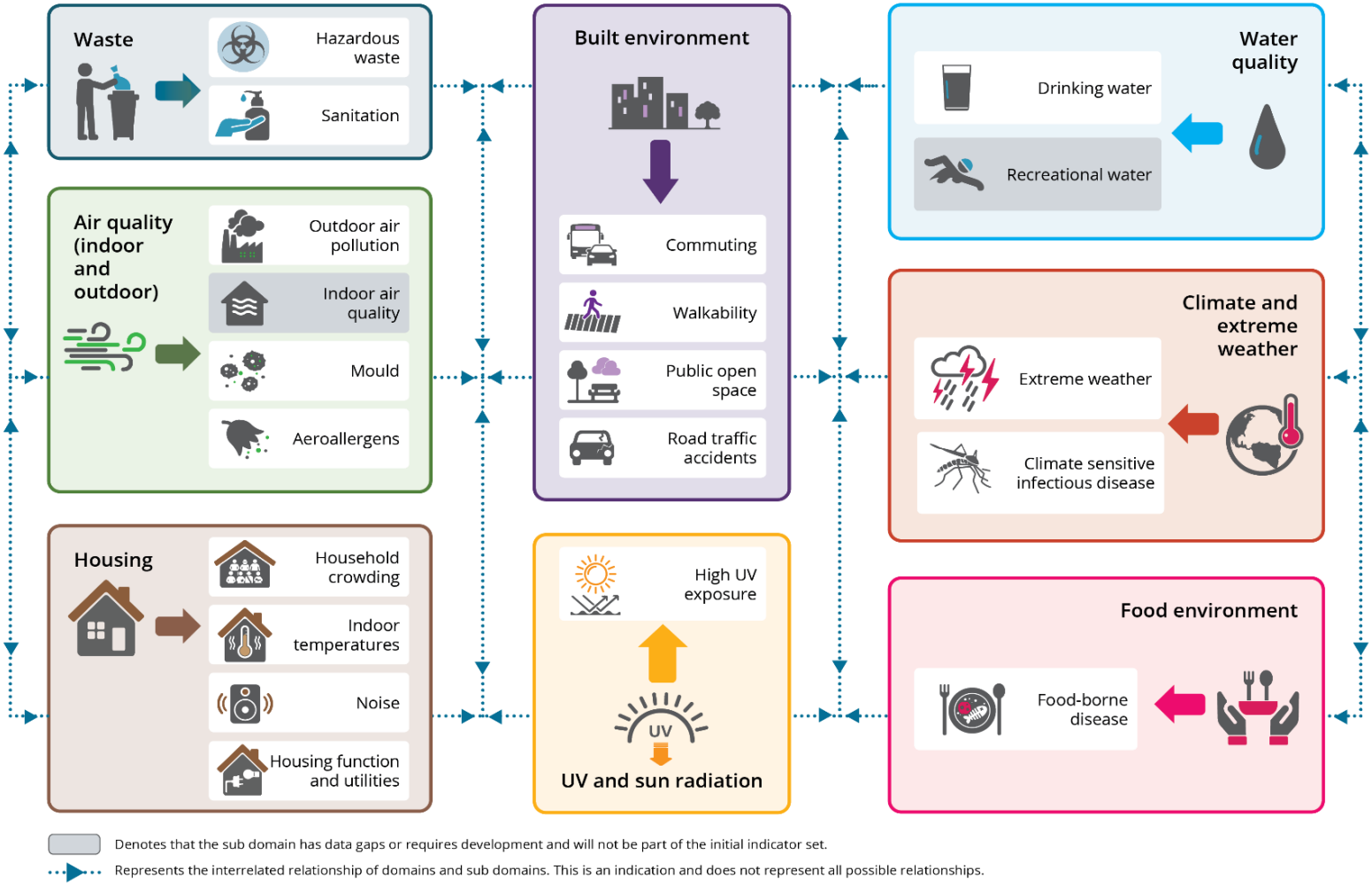
- The order in which the domains and sub domains are reported does not imply order of importance for environmental health.
- Not all of the domains can be reported on currently, but they have been included in the framework as they have been identified as important issues of environmental determinants of health.
- The framework can be updated with new indicators and, if necessary, new domains or sub domains, as evidence of additional environmental health issues becomes available.

Figure 3.1 is a graphical representation of the framework, by domain and sub domain. The domains are represented by figures in the circles, while the sub domains are those in the boxes. Boxes that are greyed-out are those that currently have data gaps and/or require data development and cannot be included in the reportable indicator set at this stage.

Although the issues have been categorised into domains and sub domains for the purposes of the reporting framework there is much overlap among them, as our environments do not exist in isolation, and health impacts of environmental events are often wide-reaching. For example, outdoor air pollution is a sub domain of ‘air quality’. Air quality can be affected by features of the built environment, as well as some climate and extreme weather events, such as bushfires. The dotted lines in Figure 3.1 are intended to represent this complexity and interrelatedness of environmental health issues (although it is beyond the scope of this report to identify all possible interactions).

The structure of the framework as set out in this report is for organisational purposes, allowing the grouping of indicators that report on related measures. Each of the indicator profiles (see ‘Appendix C: Environmental health indicator profile tables’) refers to related indicators within the framework, where appropriate.

Figure 3.1: Framework for monitoring climate change and environmental health in Australia, including domains and sub domains, and an illustration of interrelationships

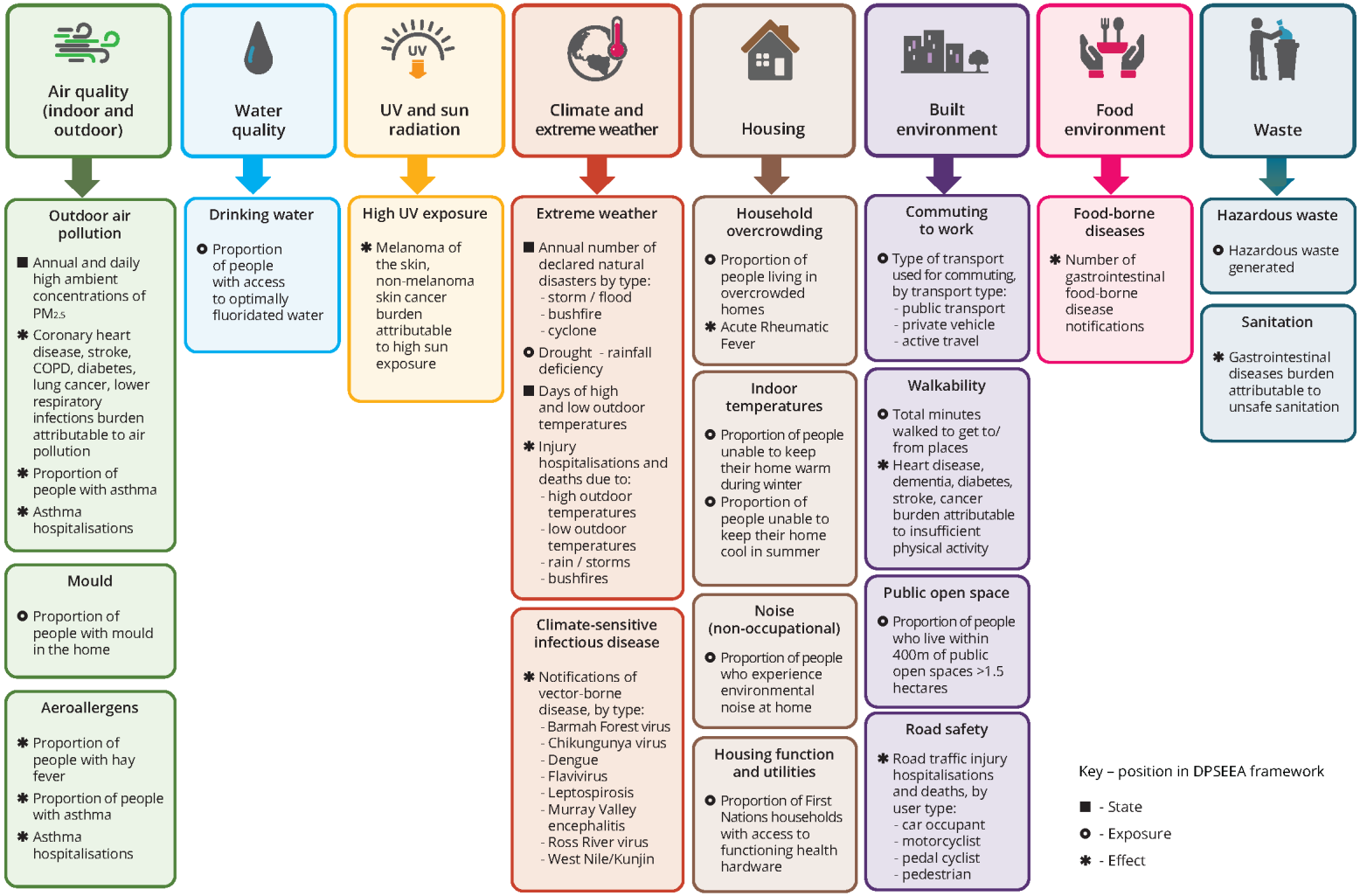


4 Reportable climate change and environmental health indicators

A set of 30 indicators arranged within 8 broad environmental health domains was identified to form the basis for the Australian indicator framework for environmental determinants of health, based on the methods outlined in ‘Chapter 2: Development and selection of indicators’. These are termed the ‘reportable’ indicators, as they meet the indicator and data selection criteria (see Box 2.2), and therefore can be used for measuring and monitoring environmental health.

Figure 4.1 outlines the framework with the indicators that have been identified for each domain and sub domain. Each dot point in the coloured boxes represents an indicator in the set. See ‘Appendix C: Environmental health indicator profile tables’ for more information.

Figure 4.1 Reportable climate change and environmental health indicators by domain and sub domain



Indicator profile specifications

These indicator profile specifications are broadly based on information in the Metadata Online Registry (METEOR), Australia's repository for national metadata standards for health, housing and community services statistics and information (AIHW n.d.a). METEOR includes specifications for many of the indicators in high-level national frameworks. For indicators not in METEOR, specifications are based on information from relevant reports.

A template indicator profile table is presented below, with an explanation of what will be included for each field of the table. An indicator profile specification table has been developed for each of the reportable indicators – see 'Appendix C: Environmental health indicator profile tables'.

The fields include:

Description	A short statistical description of an indicator. Value examples include percentage, count, proportion, mean (average), and percentile.
Indicator type	Identification of the position of the indicator in the DPSEEA conceptual framework.
Rationale	A justification for inclusion of the indicator.
Definition(s)	A plain text description of concepts and the formulae used to calculate an indicator.
Numerator	A description of the number above the line in a fraction showing how many of the parts indicated by the denominator are taken.
Denominator	A description of the number below the line in a fraction.
Possible disaggregation(s)	Identification of priority or important populations for which disaggregations are possible. For example, age group, sex, First Nations people, socioeconomic and remoteness area.
Data source(s) and frequency	The data source in a specific data set and/or database. How often the indicator has been reported in publications, and most recent reporting. 'Appendix D: Data sources' contains a brief description of each of the data sources used for the indicators in this framework. Hyperlinks to the data source will be included as a guide to where to go to find further details/specifications about the indicator.
Issues	Any issues surrounding use of the indicator.

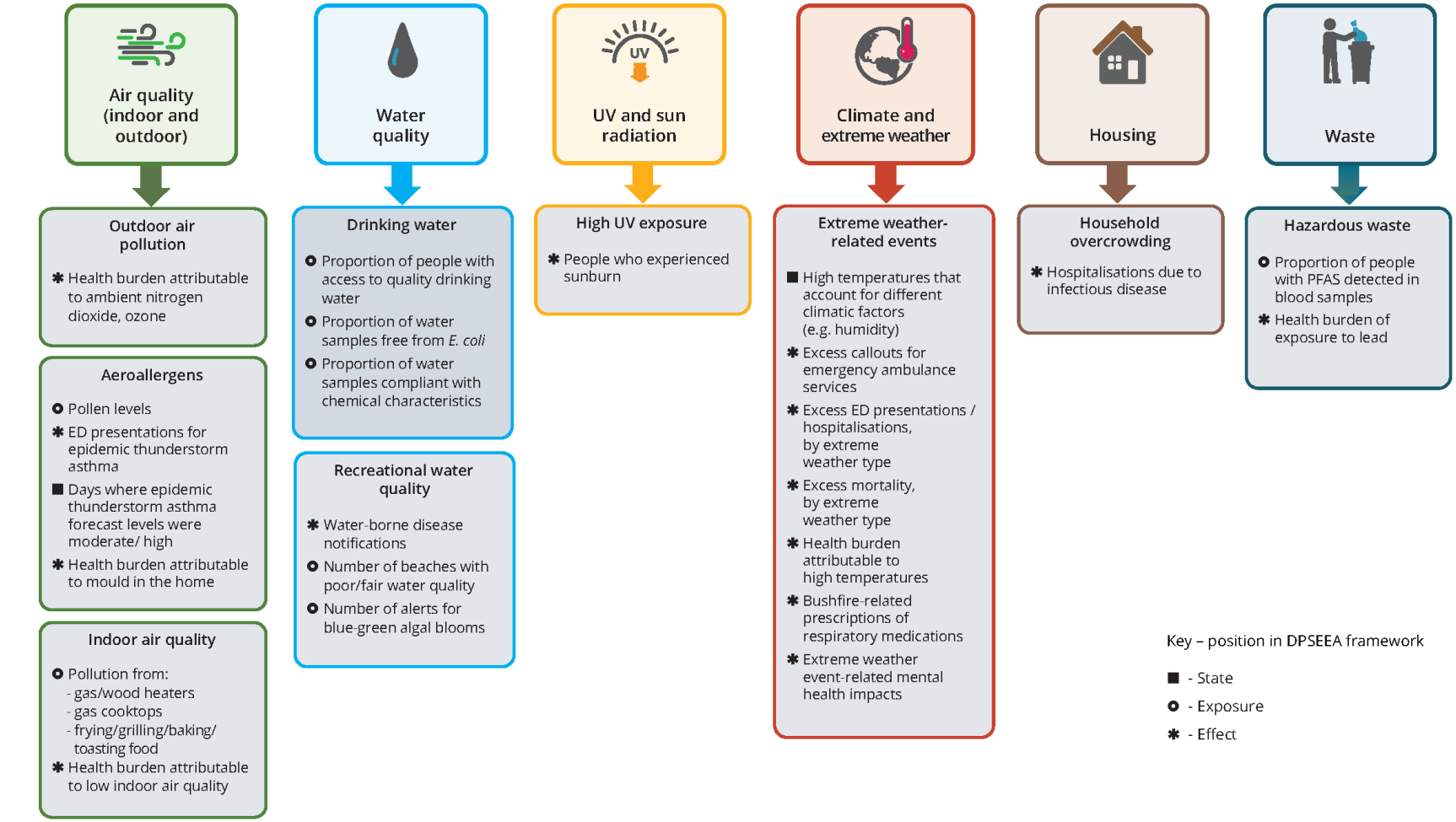
Interpretation	A short description to explain the meaning of the indicator; that is, whether a value going up or down is a measure of success.
Related SDG goal/target(s)	Identification as to whether the indicator has a relationship with any Sustainable Development Goal (SDG) targets (UN n.d.).
Related national government policies and/or strategies	Identification as to whether there are topic area relationships with specific national government policies/strategies.
See also	Relevant climate change and environmental health indicators from the indicator framework that relate.
References	Sources used to support the use of the indicator in the table.

5 Data gaps and development activities

The indicator framework (as presented in ‘Chapter 3: The climate change and environmental health indicator framework’) is intended to represent a range of environmental health determinants that are important in Australia.

However, there are known gaps in this indicator framework. That is, a number of issues were identified (through research and expert advice) as being relevant, suitable and, in some cases, necessary, for inclusion in a representative environmental health indicator set, but data availability, evidence and other issues prevented their being incorporated in the current framework, as seen in Figure 5.1. The data development activities highlighted here provide some examples of ways in which the indicator framework could be enhanced by provision of better or more specific data.

Figure 5.1: Environmental health indicators by each domain and sub domain that have data gaps or require data development



Note: This list of indicators is not exhaustive, rather a select relevant list. It is anticipated that this list will be further developed and expanded over time.
ED – emergency department
PFAS – Per- and polyfluorinated substances

Specific details on the data development activities required are outlined in the following tables. It is envisaged that these indicators would become reportable should the data gaps be filled, or the data development activities could be undertaken.

Air quality (indoor and outdoor)

Sub domain	Indicator	Potential Data Source	Data gaps/proposed development
Outdoor air pollution	Health burden attributable to ambient nitrogen dioxide, ozone	Australian Burden of Disease Study	Potential for inclusion in the Australian Burden of Disease Study, depending on meeting criteria for inclusion. Data are not available until 2026.
Aeroallergens	Pollen levels	PollenForecast	Data not available nationally, and only for selected areas in Victoria, Western Australia, Tasmania, Australian Capital Territory and the Northern Territory which limits applicability.
	Emergency department presentations for epidemic thunderstorm asthma	National Non-Admitted Patient Emergency Department Care Database, meteorological data	Would require work to link increased emergency department visits to thunderstorm events. Could also consider ambulance call outs, hospitalisations, deaths, respiratory medication sales during epidemic thunderstorm asthma periods. All require data development.
	Number of days when epidemic thunderstorm asthma forecast levels reach moderate/high levels	Emergency Management Victoria	Data not available nationally.
Mould	Health burden of mould in the home	Australian Burden of Disease Study* *estimates of health burden for Australia have been estimated by Bentley et al. (2021).	Potential for inclusion in the Australian Burden of Disease Study, depending on meeting criteria for inclusion. Data are not available until 2026.

Sub domain	Indicator	Potential Data Source	Data gaps/proposed development
Indoor air quality	Indoor air pollution from gas / wood heaters	Asthma Australia Report	Some data available, but only for people with asthma and therefore not generalisable to the whole population. Not collected regularly.
	Indoor air pollution from gas cooktops, frying, grilling, baking or toasting food	Asthma Australia Report	Some data available, but only for people with asthma and therefore not generalisable to the whole population. Not collected regularly.
	Health burden attributable to low indoor air quality	Australian Burden of Disease Study	Potential for inclusion in the Australian Burden of Disease Study. Potential to incorporate a range exposures and health outcomes of low indoor air quality, including from types of air pollution and air-borne viruses, depending on meeting criteria for inclusion.

Water quality

Sub domain	Indicator	Potential Data Source	Data gaps/proposed development
Drinking water	Proportion of Australians who have access to quality drinking water (by area of remoteness)	ABS 2013. Environmental Issues: Water use and conservation	Lack of recent data – no national data since 2013.
	Percentage of water samples free from *E.coli* by systems and zones	Bureau of Meteorology National Performance Report	Report includes data from urban water utilities only, due to challenges in collecting data in non-urban areas.

Sub domain	Indicator	Potential Data Source	Data gaps/proposed development
			Expert input being sought on whether data from non-urban water utilities may be available from water suppliers in states and territories.
	Percentage of water samples compliant with chemical characteristics	Bureau of Meteorology National Performance report	This indicator is not currently reported on. Requires development of definition of thresholds for the purpose of the indicator/choice of chemical(s) for inclusion.
Recreational water quality	Water-borne disease notifications related to recreational water	National Notifiable Diseases Surveillance System	No information on source of infection in data set.
	Number of beaches with fair, poor or very poor water quality	Beach-watch reports	Data available, but differences in collection and reporting methods by jurisdiction and hence a lack of standardised measures at a national level.
	Number of alerts for blue-green algal blooms in recreational water	Local council notifications	No data publicly available. Requires development of a standard measure for reporting purposes.

UV and sun radiation

Sub domain	Indicator	Potential Data Source	Data gaps/proposed development
High UV exposure	Proportion of people who experienced sunburn in the last week	Sun Protection Behaviours Module, ABS Multi-purpose Household Survey	Ongoing data currently unavailable and only planned as a one-off collection in the survey.

Climate and extreme weather

Sub domain	Indicator	Potential Data Source	Data gaps/proposed development
Extreme weather–related events	Number of excess callouts for state emergency ambulance services	Productivity Commission	Would require data linkage from occurrence of natural disasters and number of emergency ambulance calls made. Data typically capture health effects at the more extreme end of the spectrum.
	Measures of high temperatures which account for other climatic factors such as humidity, for example Excess Heat Factor (based on a 3-day-averaged daily mean temperature)	Bureau of Meteorology	Work required to determine most appropriate measure

Sub domain	Indicator	Potential Data Source	Data gaps/proposed development
	Excess mortality due to excessive natural heat/ excessive natural cold	National Mortality Database	Data development required to derive a methodology that estimates excess mortality relating to future extreme weather events; that is, number of deaths that are above what would be expected under 'normal' conditions. Data typically capture health effects at the more extreme end of the spectrum.
	Excess emergency department/admitted patient hospitalisations during periods of excessive natural heat	National Non-Admitted Patient Emergency Department Care Database, temperature data	Data development required to derive a methodology that estimates excess health service use for future extreme weather events. Data typically capture health effects at the more extreme end of the spectrum.
	Health burden of high temperatures	Australian Burden of Disease Study* *estimates of health burden have been calculated for Australia by Liu et al. (2023)	Potential for inclusion in the Australian Burden of Disease Study; data will not be published until 2026.
	Excess emergency department/admitted patient hospitalisations due to respiratory conditions on smoke-affected days **(bushfires)**	National Non-Admitted Patient Emergency Department Care Database, bushfire smoke data	Data development required to derive a methodology that estimates health service use relating to future extreme weather events. Data typically capture health effects at the more extreme end of the spectrum.

Sub domain	Indicator	Potential Data Source	Data gaps/proposed development
	Prescriptions dispensed for respiratory medications **(bushfires)**	Pharmaceutical Benefits Scheme	Analysis required to determine appropriateness and sensitivity as an indicator of bushfire impact on respiratory health.
	Extreme weather event-related mental health impacts	Various	Further work required to determine appropriate metrics based on administrative or survey data to estimate mental health impacts due to extreme weather-related events (see Box 5.2).

Housing

Sub domain	Indicator	Potential Data Source	Data gaps/proposed development
Household crowding	Hospitalisations due to infectious diseases caused by household crowding	National Hospital Morbidity Database	Lack of use of ICD-10-AM Z codes (social indicators) in administrative hospitals data making exposure difficult to determine.

Waste

Sub domain	Indicator	Potential Data Source	Data gaps/proposed development
Hazardous waste	Proportion* of people with PFAS detected in blood samples	National Health Measures Survey (NHMS) 2023	Baseline collection in 2023 NHMS and there are no set thresholds for PFAS detected in the blood. *Appropriate measure to be determined when data becomes available. Plans for future collection yet to be determined. Evidence of links between PFAS types and specific health impacts are still emerging and requires further investigation.
	Health burden of exposure to lead	Australian Burden of Disease Study	Potential for inclusion in the Australian Burden of Disease Study – data will not be published until 2026. Depending on identifying national data sources for exposure and meeting other criteria for inclusion.

Environmental health issues of emerging concern

Using indicators for tracking and monitoring environmental health over time can help highlight developing issues, for example through identifying changing patterns in disease incidence, prevalence, or geographic location (see Box 5.1). However, indicators are developed to answer questions about known relationships between the environment and health, and consequently they are less useful for informing on emerging or as yet unidentified issues (Briggs 2003).

Research is continually uncovering environmental issues and relationships of concern – whether it is clarifying relationships between exposures and effects of existing issues or identifying emerging threats from ongoing pressures due to climate change, increasing urbanisation and other human processes.

Box 5.1: Japanese encephalitis virus in Australia

Climate change is altering our environment – we are seeing increasing global temperatures, more frequent and heavier rain, longer and more severe droughts, and increased frequency of other catastrophic events, such as bushfires. Alterations to ecosystems as a result of these events has the potential to affect human health.

Survival of disease vectors and their hosts is dependent on their environment, and altered weather patterns and geographic expansion of vector-favourable climatic conditions have the potential to lead to changes in vector-borne disease presentations (Wu et al. 2016). With the wider geographic spread comes the potential for more people to be exposed to these vector-borne diseases.

An example of this in Australia is Japanese encephalitis virus (JEV). A mosquito-borne disease endemic in parts of Asia and the Pacific, local transmission of JEV was first recorded in Australia in 1995 (Hanna et al. 1996), and until 2021, only 5 locally-acquired cases had been reported (McGuinness et al. 2023). All cases occurred in the Torres Strait Islands-Cape York Peninsular region. However, 2021–2022, 45 cases were recorded – 14 in NSW, 12 in Victoria, and the remaining cases in the Northern Territory, Queensland and South Australia (Department of Health and Aged Care 2023a). It has been suggested that flooding driven by consecutive La Niña events may have facilitated the outbreak by providing suitable conditions for mosquito breeding, and migration of water bird animal hosts to these regions (Mackenzie and Williams 2022).

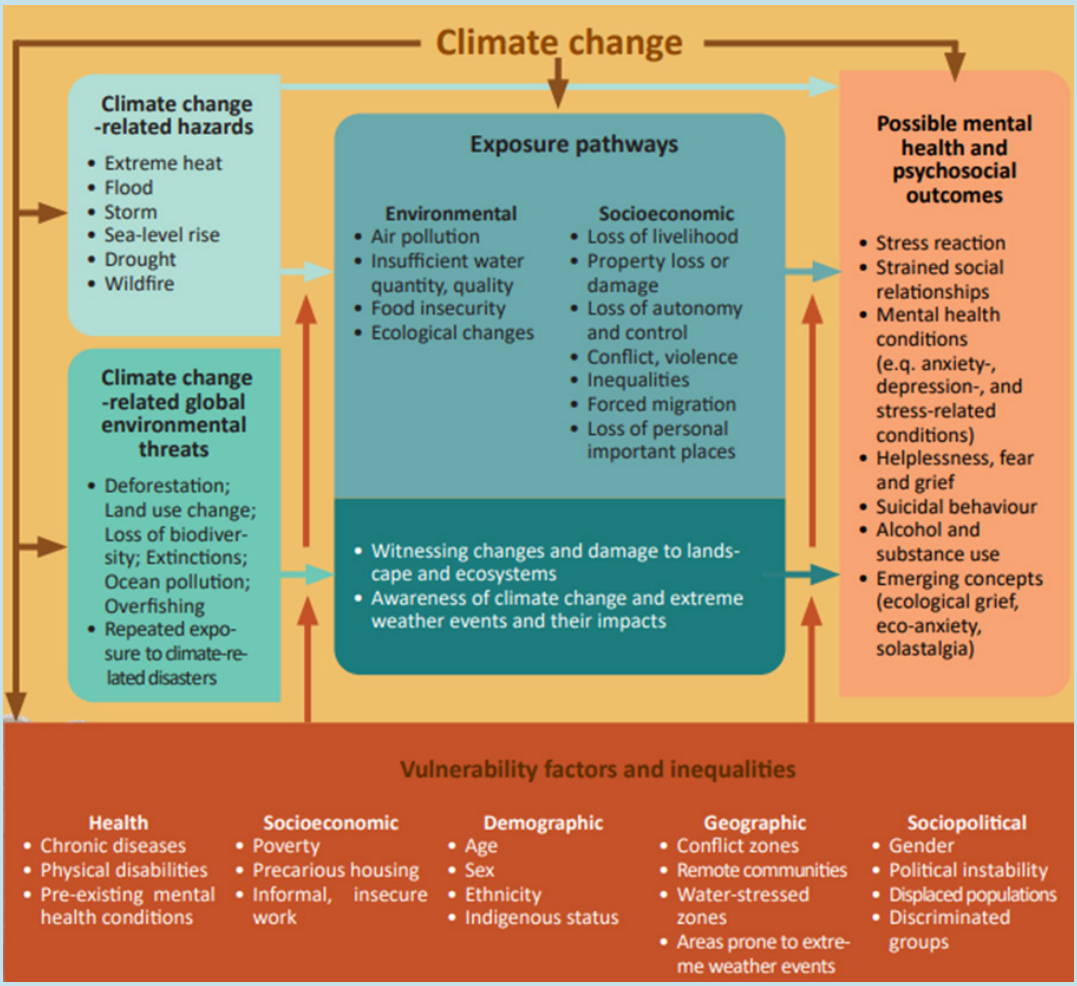
The extent to which the changing climate and weather events will affect patterns of JEV and other vector-borne disease is difficult to predict, due to complex and climate-sensitive reproductive and transmission cycles. Nonetheless, based on evidence of changing vector-borne disease epidemiology, both internationally (WHO 2014) and locally (as seen with JEV), it will be important to monitor for changes in the distribution of case notifications. This equally applies to other infectious diseases of seasonal nature, such as some intestinal infectious diseases, where it has been theorised that climate change may also drive increased cases (Lake 2017).

More recently, research is coming to light on the impacts that the environment and climatic events have on mental health outcomes both immediately and in the long term. Box 5.2 highlights this while also proposing the types of indicator development required to monitor and measure impacts.

Box 5.2: Mental health, the environment and climate change

The increasing effects of climate change are not only having an impact on our environment but also directly and indirectly affecting mental health and psychosocial well-being. This can be as a result of acute environmental hazards, for example, floods and bushfires, but also of slower-on-set issues such as food and water insecurity. This can lead to poorer mental health, emotional distress and development and/or worsening of mental health conditions, particularly among vulnerable population groups (WHO 2022). Figure 5.2 summarises the pathways in which climate change can affect people's mental and psychosocial well-being.

Figure 5.2: Main interlinkages between climate change and mental health



Source: WHO 2022.

The 2019 Global Burden of Disease Study has shown that mental disorders are one of the top 10 leading causes of burden worldwide, and the burden due to mental disorders has increased since 1990 (GBD 2019 Mental Disorders Collaborators 2022). The burden is likely to be higher when the broader impacts of climate change on mental health are included (WHO 2022).

There are significant gaps in Australia in investment in response to climate-related disasters and it is often time limited, ad hoc and immediate only, rather than for long-term mental health needs (AIHW 2020; Department of Health and Aged Care 2023b). Further work to develop indicators and data sources for measuring and monitoring purposes would be useful to understand the link between climate change and mental health outcomes (WHO

2022). Other aspects specifically relating to environmental/climatic events that could be explored include:

1. Geography and time.
2. New clients accessing Medicare Benefits Schedule (MBS) – subsidised mental health services in the last 5 years.
3. Addition of further MBS-subsidised services as was temporarily introduced during the 2019–20 bushfire period. These new services were shown to increase the number of claims substantially during this period (AIHW 2020).
4. Access to mental health help/crisis lines. Limited available data show that in the direct aftermath of the 2019–20 bushfire period Lifeline crisis support hotline received a 10%–15% increase in calls (AIHW 2020).
5. Presentations to emergency departments and hospital admissions
6. Mental health care services provided by Primary Health Networks, which can vary widely by network. It would help to inform the quantity and quality of services delivered and subsequently where there may be gaps.
7. Delivery of mental health and suicide prevention services in the primary health care setting (such as the Primary Mental Health Care Minimum Data Set (PMHC MDS)).

However, it is important also to note that not all mental health impacts may be observed directly during or after a climatic/environmental event and an increase in reported mental illness and service usage can be expected in the months and years that follow the event (AIHW 2020). This is generally not possible with currently available data and accounting for this and determining which factors are best to describe and measure the issue, will be useful for future environmental health indicator reporting.

When developing the indicator framework, research and stakeholder consultations identified a range of issues of emerging concern for environmental determinants of health in Australia (in addition to those regarding changed patterns of disease spread). Examples included:

- microplastics
- per- and polyfluoroalkyl substances (PFAS) chemicals
- pesticides
- other hazardous chemicals, such as those listed in the National Pollutant Inventory
- electronic, or e-waste
- food security
- novel infectious diseases.

Some of these were found to be unsuitable for inclusion in the current indicator set due to a lack of evidence on, for example:

- causality (does the exposure cause a specific health outcome?)
- clinically meaningful thresholds (what dose is required to cause an adverse health outcome?)
- exposure routes (can the source of the exposure be clearly identified?)
- challenges in measuring exposures or effects.

Others (such as PFAS and pesticides) fall under emerging issues but are also included in the framework (Indicator 29 – Hazardous waste generation). A body of evidence exists regarding

potential toxicity and health impacts, but complexities around the multitude of different chemical types and exposure routes, across the life span, are still being unravelled by a substantial body of research. However, the level of concern generated by current findings on PFAS has been sufficient for governments across the globe to regularly monitor PFAS levels in the environment and in humans (CDC 2022; EEA 2023). As a result, Australia has introduced the collection of PFAS blood levels in the ABS National Health Measures Survey (ABS 2022). Collection is currently underway. Nonetheless, these chemicals are included here as issues of emerging concern, as it is expected that more evidence will come to light regarding health impacts of exposure.

It will be important to regularly review the literature on these and other emerging issues and update the indicator framework as and when the evidence supports their inclusion, and as data become available, following the methods outlined in this report – that is, determining their suitability based on the conceptual framework, ability to satisfy the indicator selection criteria, and data availability. However, further development of the framework in this way would be part of future work, and is out of scope for this report.

Interactions with other health determinants

In addition to environmental determinants, social, economic, and commercial factors play a significant role in affecting people's health (AIHW 2022c). The environmental health domains and indicators included in this report interact and are interdependent with these other health determinants, particularly the social determinants of health. For example, the ability to cool homes is determined by having appropriate home energy efficiency and cooling systems (built environment) and being able to afford to run the cooling systems (socioeconomic characteristics). Access to working facilities ('health hardware') is considered a social indicator within the Aboriginal and Torres Strait Islander Health Performance Framework (Department of Health and Aged Care 2024).

Further work is required to define and scope national indicators of social and commercial determinants of health as identified in the National Preventive Health Strategy 2021–2030 (Department of Health and Aged Care 2021).

Occupational exposures and hazards

People working in particular occupations and industries can be at increased risk from environmental health determinants. This may be due to requirements to work outside or in hot locations, such as on roofs, or to activities of the occupation which expose workers to hazardous materials. The burden due to occupational exposure and hazards is included in the Australian Burden of Disease Study. The burden was linked to 26 diseases and injuries, including 11 types of cancer, 8 types of injury, hearing loss, back pain and problems, asthma, chronic obstructive pulmonary disease (COPD), silicosis, asbestosis and other pneumoconiosis (AIHW 2021). In addition, the AIHW is reviewing the methods used to estimate burden due to occupational exposure and hazards, as described in Chapter 6.

Health care system

Climate change and the environment not only affect the health of individuals – they also affect health care systems. Extreme weather can damage health care infrastructure, affect the ability to deliver vital supplies to providers, and affect the health care work force. Conversely, the health care system itself affects the environment and contributes to climate

change. It is estimated that the health care system contributes about 5% of Australia's carbon footprint, directly through emissions from energy use by the sector, and indirectly through the manufacture and use of consumables (Department of Health and Aged Care 2023b). These health system performance factors were out of scope for this report, and further work is required to define indicators of climate change and environment in relation to the health care system.

6 Future work

It should be noted that indicator frameworks cannot be static, and should be capable of being developed and updated as new information becomes available (Briggs 1999). The data development activities highlighted in Chapter 5 provide some examples of ways in which the indicator framework could be enhanced by better or more specific data. Additionally, as more evidence about the impact of the environment, and in particular climate change, on health comes to light, it will be important to add these to the framework.

Future development activities relating to specific data sources that could be used for work on environmental health indicators are outlined below.

Burden of disease

Burden of disease methodology provides information about the health impact of diseases, injuries, and risk factors on the population, as measured by years of life (YLL) lost due to premature death, years lived with a disability (YLD), and disability-adjusted life years (DALY) (AIHW 2021).

While some indicators already use burden of disease data, a major update of the ABDS is planned, and as part of this update, the methods used to estimate disease and injury burden and the burden attributable to risk factors are being reviewed. Consideration will be given to how to make these data more suitable for monitoring the impact of climate change and the environment on health. These changes include:

- reporting additional diseases and injuries from groups, such as other infectious diseases, needed for climate-sensitive conditions
- producing estimates by small geographies
- adding more risk factors, for example, heatwaves, lead, and mould in the home (as in ‘Chapter 5: Data gaps and development activities’)
- adding measures such as other air pollutants to existing risk factors and linked diseases.

Administrative data collections

Enhancing administrative data to increase information about environmental health impacts relating to Emergency Department presentations and hospitalisations would increase the amount of information available on the impact of these events. There is currently no external cause information available for the Emergency Department data. Adding an item for the location of an injury would provide relevant information about the impact of climatic events on health and health service use.

Primary health care administrative data

Currently there are no national data on primary health care activities (other than the use of certain MBS items) – that is, activities relating to conditions with less severe symptoms that do not require hospitalisation. Some conditions that are exacerbated by environmental exposures, such as hay fever or asthma due to aeroallergens, are managed within the primary care system, for example by general practitioners, due to their low severity.

Information on these types of presentations would be very useful for monitoring less extreme environmental health effects.

The AIHW is leading the development of the National Primary Health Care Data Collection, to fill this data gap, although the data will not be available for some time, due to the complexities of the sector and establishing the data collection.

Data linkage of administrative data

Data linkage refers to the bringing together of person-level data from multiple sources (such as administrative health data or survey data) to provide a more detailed picture of people's journeys through the health care system over time. Data linkage could therefore provide greater context for the impact of the environment on the health of individuals over time, such as longer-term health conditions or use of medications in the aftermath of a major bushfire event, in particular for sub-populations.

Excess mortality and health service use

The impact of an environmental exposure can be estimated by excess health service use or mortality, where 'excess' is defined as the amount observed during an event or crisis, compared with the amount that could be expected under normal conditions (Checchi and Roberts 2005). Internationally this methodology is used to monitor mortality relating to environmental and communicable disease events (Karlinksy and Kobak, 2021, Msemburi et al. 2023). In Australia, the ABS currently publishes data on excess mortality relating to the COVID-19 pandemic (ABS 2023a). Increases in health care use for specific conditions such as respiratory disease was observed during the 2019–20 bushfires and related to $PM_{2.5}$ levels (AIHW 2020). A similar methodology could be developed to estimate excess mortality and health service use relating to future extreme weather events.

Geography and time-specific health data

A recent AIHW project has published 20 years of weekly data on health service use relating to specific health conditions by geographic area (Statistical Area 4 – SA4). Data are presented for respiratory, cardiovascular, and mental health conditions including:

- hospitalisations
- hospital emergency department presentations
- Medicare Benefits Schedule service claims
- Pharmaceutical Benefits Scheme (PBS) and Repatriation Pharmaceutical Benefits Scheme (RPBS) prescriptions dispensed.

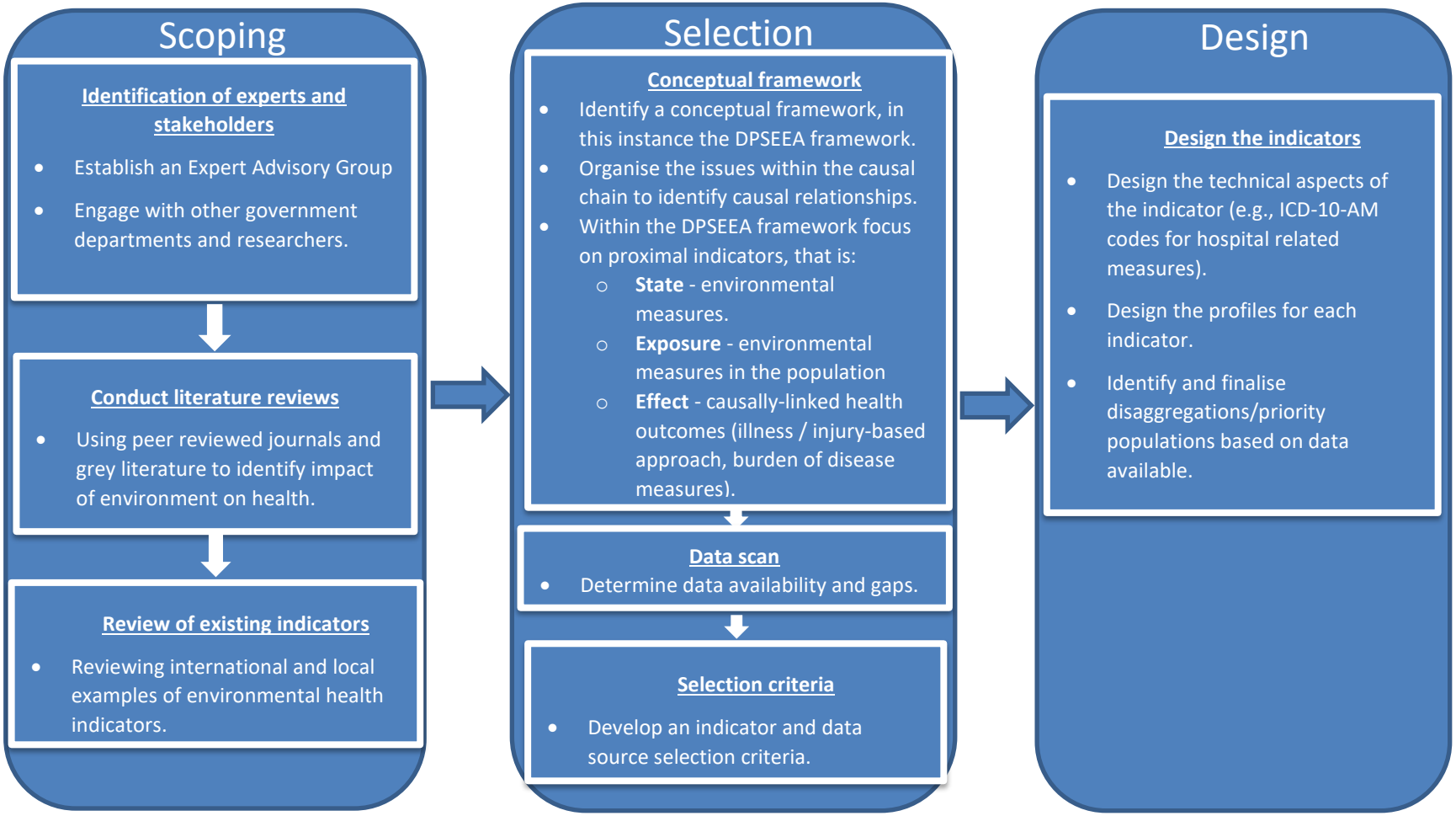
The data set also includes hospitalisations and emergency department visits for other health conditions (burns, dehydration, eye conditions, diabetes, chronic kidney disease, fractures, and cellulitis).

This project contains service use data for health conditions that are potentially associated with or exacerbated by bushfire and bushfire smoke. However, the data do not include information that directly relates the service use to specific environmental events, and further research would be needed to derive causal attribution. The data set can be used by researchers in conjunction with environmental data (for example, bushfire smoke data or temperature data) to derive insights about health service use coinciding with particular events, and to help identify topics for more detailed study (AIHW 2024).

Appendix A: Methodology for development and selection of indicators

To ensure the integrity, quality and transparency of the indicators, a 3-stage indicator development process was followed (adapted from Mason et al. 2018) – involving scoping, selection, and design phases. In practice, some of the steps within the stages could be carried out concurrently Figure A1).

Figure A1: Three stage process for indicator development



Source: Adapted from Mason et al. 2018.

Stage 1: Scoping of indicators

The first step in the process was to understand the context of climate change and environmental health. Extensive background research using peer-reviewed scientific literature was conducted, to uncover the multifaceted and complex issues relating to environmental health, both existing and emerging, internationally and in Australia. Research specifically focused on identifying causal relationships between exposure to environmental hazards and health outcomes. This included burden of disease studies, to assist in determining how much health is lost due to an exposure.

Additionally, a key consideration in the development of indicator sets for climate change and environmental health is the requirement of a conceptual framework. These assist with organising the complexities and determining the direct and indirect explicit linkages between the environment and health. The literature search examined a range of appropriate conceptual frameworks.

Concurrently, a scan identified international examples of environmental health indicators, indicator sets, and tracking programs. This step was important in providing information about the types of indicators that are being used to measure and monitor environmental health elsewhere, in addition to the methodologies used for developing indicator sets, possible data sources, and approaches for presenting the indicators.

Expert consultation and feedback

To ensure the quality of the environmental indicators, experts and stakeholders were consulted broadly throughout the development stage. The consultations assisted with:

- determining the appropriateness of the indicators to the environment and health
- clarifying data availability
- highlighting additional indicator and data gaps
- drawing attention to other indicator frameworks compatible with certain domains and indicators.

Stage 2: Selection of a conceptual framework

Various conceptual frameworks were considered relevant to environmental health. The Driving forces, Pressure, State, Exposure, Effect and Action (DPSEEA) framework was chosen for this report. Refer to ‘Chapter 2: Development and selection of indicators’ for further information.

The DPSEEA framework

A strength of the DPSEEA framework is that it represents the relationship between causes (distal and proximal to the health of people) of environmental issues and the impacts of these on human health. The framework is contextual to the problem under consideration.

Take for example the issue of ambient air quality:

- The **driving forces (D)** (or most upstream elements) include factors such as population growth, economic development, urbanisation or industrialisation.

- These driving forces exert a **pressure (P)** on the environment. In this case this could include increased emissions, or more specifically $PM_{2.5}$ from industrial processes required to support the population.
- The pressures exerted lead to an environmental **state (S)** – in this instance, concentrations of $PM_{2.5}$ in the atmosphere.
- People who live in affected areas then breathe in the polluted air, which comes into contact with their lungs **(exposure – E)**.
- Research has shown this strongly causally linked to a range of negative health effects **(effect – E)**, such as asthma and other respiratory conditions.
- **Actions (A)** or interventions can occur at each point and may range from government policies at the distal end (for example, to improve air quality) to specific health interventions at the most proximal end (for example, public awareness campaigns).

It is important to note that the DPSEEA framework, although linear in appearance, is intended to be a network of interlinking issues. That is, a driving force will affect health in many ways, and particular illnesses can be caused by multiple exposures. Therefore, there is often great overlap when organising environmental issues within the causal chain, and it is important to acknowledge these interlinkages to avoid over-simplifying the issues (Hambling et al. 2011).

It is not necessary for an environmental health indicator set to include indicators for all links in the DPSEEA chain – this would lead to a large and unmanageable set of indicators. Rather, the purpose and audience of the indicator set will determine the choice of indicators, as it is unlikely that one indicator set can ever fulfil all stakeholder needs. However, a strength of the DPSEEA framework is that it can be adapted and modified for different situations and environmental health issues (Hambling et al. 2011).

Approach to using the DPSEEA framework

The identified climate change and environmental health issues of relevance in Australia were arranged within the DPSEEA framework. This systematic and thorough approach ensured that consideration was given to the identification of issues with an established relationship between human health and the environment. Following this 8 ‘domains’, or themes, of climate change and environmental health were identified, representing the broad, overarching concepts. Each domain has at least one corresponding ‘sub domain’ which identifies more specific issues relating to their respective domain. Finally, each sub domain has at least one specific exposure, effect, or state indicator (as per the DPSEEA framework) for measuring and reporting purposes. Using this approach, as an example air quality can be categorised as follows:

Domain: Air quality (indoor and outdoor)

Sub domain: Outdoor air pollution

Indicators:

1. Annual and daily high ambient concentration of $PM_{2.5}$ across Australia.
2. Health burden of outdoor air pollution.

Refer to ‘Chapter 3: The climate change and environmental indicator framework’ and ‘Appendix C: Environmental health indicator profile tables’ for more details.

Although the DPSEEA framework allows for identification of indicators at all parts of the chain, based on the report's purpose, most indicators sit within the 'effect' and 'exposure' components. In some cases, indicators of 'state' were also included, for additional context. For further information relating to these types of indicators refer to 'Chapter 2: Development and selection of indicators'.

Data gaps

Through extensive research and consultation, indicators that were identified as relevant, but lacked available data and hence required development, were excluded from the main indicator set established in 'Chapter 4: Reportable climate change and environmental health indicators'. Further details on the indicators with data gaps are detailed in 'Chapter 5: Data gaps and development activities'.

Selection and data source criteria

Following extensive research and consultation, selection and data source criteria were developed. Refer to 'Chapter 2: Development and selection of indicators' for more information.

Stage 3: Indicator design

Once the indicator set had been finalised, indicator profile tables were constructed. Each profile table included the technical aspects of each indicator. These included a description and definition of the indicator, rationale for inclusion, data sources, frequency of data collection, disaggregation/s, along with any issues specific to the indicator and links to related goals/targets, such as the Sustainable Development Goals (SDG). Refer to 'Chapter 4: Reportable climate change and environmental health indicators' and 'Appendix C: Environmental health indicator profile tables' for more information.

The aim of developing this indicator set is to have a range of relevant and important indicators for measuring and monitoring climate change and environmental health in Australia. Ideally, these would be presented as a 'suite' of measures, in an accessible and visual format, consistent with other countries and regions internationally. However, to do so is beyond the scope of this project.

Appendix B: Expert consultation and feedback

The following people and organisations were consulted:

- **Internal AIHW consultation** – Feedback was provided from experts from all areas of the AIHW, with expertise in selected health conditions, data sets and indicator frameworks and reporting.
- **AIHW Environmental Health Expert Advisory Group** – Two sessions were conducted with members from the group (April–May 2023 and August 2023), to discuss potential indicators and data sources, and the draft report was circulated to members for comment. The group consisted of academics with extensive experience in the environment and health. Members included:
    - Associate Professor Paul Beggs
    - Professor Rebecca Bentley
    - Professor Peng Bi
    - Professor Yuming Guo
    - Dr Ivan Hanigan
    - Dr Alana Hansen
    - Professor Jane Heyworth
    - Professor Fay Johnston
    - Dr Veronica Matthews
    - Associate Professor Geoffrey Morgan
    - Professor Sotiris Vardoulakis
    - Associate Professor Ying Zhang.
- **enHealth, the Australian Health Protection Principal Committee's standing committee on environmental health, and the following Expert Reference Panels** – Aboriginal and Torres Strait Islander Environmental Health, Environmental Health, and Water Quality.
- **Members of other government departments and agencies** – Australian Bureau of Statistics; Australian Climate Service, Bureau of Meteorology; Department of Climate Change, Energy, the Environment and Water; National Health and Medical Research Council and the Productivity Commission.

Appendix C: Environmental health indicator profile tables

Domain: Air quality (indoor and outdoor)

Sub domain: Outdoor air pollution

1. Annual and daily high ambient concentration of $PM_{2.5}$

Description	Number of times when the average annual and daily ambient $PM_{2.5}$ concentration across Australia exceeded the Australian National Environment Protection Measure (NEPM) reporting standard.
Indicator type	**State**
Rationale	$PM_{2.5}$ are very small particles in the atmosphere that have a diameter of 2.5 micrometres (0.0025mm) or smaller. Sources that produce $PM_{2.5}$ include motor vehicles, industry, wood burning heaters, dust storms and bushfires (Emmerson and Keywood 2021). Levels of $PM_{2.5}$ are increasing in Australian cities. The State of Environment report found that maximum measured $PM_{2.5}$ concentrations in all Australian cities are above the standard NEPM (Emmerson and Keywood 2021). Health affects due to $PM_{2.5}$ can occur after short-term (over hours or days) and long-term (over many years) exposure. Short-term exposure can exacerbate pre-existing diseases (such as asthma and heart attacks) while long-term exposure is more likely to cause disease and/or increase the rate of progression of a disease (such as cardiovascular and respiratory diseases and reduced life expectancy) (NSW Health 2020). $PM_{2.5}$ can also cause various environmental effects including visibility impairment and environmental damage; for example, damaging farm crops and affecting the diversity of ecosystems (US EPA 2023).
Definition	Levels of pollution due to $PM_{2.5}$ are measured by all state and territory environment agencies and compiled into the National Air Pollution Monitoring Database (NAPMD) by the National Health Medical Research Council (NHMRC) Centre for Safe Air's Clean Air Research Data Analysis Technology platform (CARDAT). The state indicator measure includes: • **annual average $PM_{2.5}$ concentration** – when the NEPM reporting standard of 8 $\mu g/m^3$ is exceeded over 1 year based on Australian monitoring stations.

	• **daily average concentrations** - when the NEPM reporting standard of 25 µg/m^3 is exceeded over 1 day based on Australian monitoring stations over a 12-month period.
Numerator	Number of annual average $PM_{2.5}$ concentrations that exceeded the NEPM across Australian monitoring stations. Number of daily average $PM_{2.5}$ concentrations that exceeded the NEPM across Australian monitoring stations over a 12-month period.
Denominator	Not applicable
Possible disaggregation(s)	State and territories, geographical disaggregations at the smallest level possible (for example, SA4 and Local Government Area level).
Data source(s) and frequency	Clean Air and health Research Data and Analysis Technology (CARDAT) – daily and annual data are available. For further information about the data source see 'Appendix D: Data sources'.
Issues	Monitoring stations provide only an indication of the state (that is, the level of pollution) rather than exposure that people in the region are experiencing. Many monitoring stations are located away from densely populated zones, and it is likely that the pollution levels recorded differ from the actual levels experienced by the population. There is likely to be significant variation between sites in the amount of time that people generally spend outside being exposed to air pollution and, due to differences in planning history and population density, the effects of industrial pollution may be greater in some cities than others (AIHW 2010). Note for future reporting the NEPM standards will change in 2025 to a goal for maximum concentration of $PM_{2.5}$ to 20µg/m^3 per day and 7 µg/m^3 per year (Australian Government Federal Register of Legislation 2021).
Interpretation	A low percentage/estimate for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution contaminants. SDG 11.6: By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.
Related national government policies and/or strategies	National Clean Air Agreement National Health and Climate Strategy

	National Preventive Health Strategy 2021–2030
See also	Indicator 2: Health burden of outdoor air pollution Indicator 3: Prevalence of asthma Indicator 4: Asthma hospitalisations Indicator 6: Prevalence of hay fever Indicator 9: Annual declared natural disasters
References	AIHW (2010) *Monitoring the impact of air pollution on asthma in Australia: a methods paper*, AIHW, Australian Government, accessed 24 August 2023. Australian Government Federal Register of Legislation (2021) *National Environment Protection (Ambient air Quality) Measure*, Australian Government, accessed 21 December 2023. Emmerson KM and Keywood MD (2021) *Australia state of the environment 2021: air quality*, Department of Agriculture, Water and the Environment, Australian Government, accessed 22 December 2022. NSW Health (2020) *Particulate matter (PM10 and PM2.5)*, NSW Health, NSW Government, accessed 24 August 2023. US EPA (United States Environmental Protection Agency) (2023) *Health and Environmental Effects of Particulate Matter (PM)*, EPA, United States Government, accessed 24 August 2023.

2. Health burden of outdoor air pollution

Description	Health burden of air pollution ($PM_{2.5}$) – attributable fatal (YLL), non-fatal burden (YLD) and deaths.
Indicator type	**Effect**
Rationale	$PM_{2.5}$ are very small particles in the atmosphere that have a diameter of 2.5 micrometres (0.0025mm) or smaller. Sources that produce $PM_{2.5}$ include motor vehicles, industry, wood burning heaters, dust storms and bushfires (Emmerson and Keywood 2021). $PM_{2.5}$ particles are very fine and have a greater impact on health due to being easier to inhale into the lungs (Emmerson and Keywood 2021). Health affects due to $PM_{2.5}$ can occur after short-term (over hours or days) and long-term (over many years) exposure. Short-term exposure can exacerbate pre-existing diseases (such as asthma and heart attacks) and long-term exposure more likely to cause disease and/or increase the rate of progression of a disease (such as cardiovascular

	and respiratory diseases and reduced life expectancy) (NSW Health 2020). In 2018, the proportion of total disease burden attributable to outdoor air pollution estimated by $PM_{2.5}$ for the following linked diseases was: • 8.6% of coronary heart disease • 8.3% of stroke • 6.7% of chronic obstructive pulmonary disease (COPD) • 6.7% of type 2 diabetes • 5.7% of lower respiratory infections • 3.4% of lung cancer (AIHW 2021). Furthermore, between 2006 and 2016 Hanigan et al. (2021) estimated that around 2,600 deaths were attributable to $PM_{2.5}$ exposure in Australia each year.
Definition	Attributable burden is the disease burden attributed to a particular factor. It is the reduction in fatal (YLL) and non-fatal (YLD) burden as well as deaths that would have occurred if exposure to the risk factor had been avoided (or more precisely had been at its theoretical minimum) (see Glossary). These estimates reflect the amount of burden that could have been avoided if all people in Australia were not exposed to particulate matter ($PM_{2.5}$). Crude and age-standardised rates (directly age-standardised to the 2001 Australian population) will be reported.
Numerator	Number of YLD attributable to air pollution ($PM_{2.5}$) Number of YLL attributable to air pollution ($PM_{2.5}$) Number of deaths attributable to air pollution ($PM_{2.5}$)
Denominator	Total number of people in the estimated resident Australian population
Possible disaggregation(s)	Sex, age, socioeconomic area, remoteness area, state and territories, First Nations people.
Data source(s) and frequency	AIHW Australian Burden of Disease Study – data available approximately every 3 years and 3–6 years for First Nations Australian Burden of Disease. Specific related conditions include: • coronary heart disease • chronic obstructive pulmonary disease (COPD) • stroke • type 2 diabetes • lung cancer

	• lower respiratory conditions. For further information about the data source see 'Appendix D: Data sources'.
Issues	Air pollution has only recently (since 2018) been incorporated in the Australian Burden of Disease Study, therefore there is limited trend data at this stage.
Interpretation	A low percentage/estimate for this indicator can be interpreted as a positive result.
See also	Indicator 1: Annual and daily high ambient concentration of $PM_{2.5}$ across Australia Indicator 3: Prevalence of asthma Indicator 4: Asthma hospitalisations Indicator 6: Prevalence of hay fever Indicator 9: Annual declared natural disasters
Related SDG goal/target(s)	SDG 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution contaminants. SDG 11.6: By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.
Related national government policies and/or strategies	National Clean Air Agreement National Health and Climate Strategy National Preventive Health Strategy 2021–2030
References	AIHW (Australian Institute of Health and Welfare) (2021) *Australian Burden of Disease Study 2018: Interactive data on risk factor burden*, AIHW, Australian Government, accessed 22 December 2022. Emmerson KM and Keywood MD (2021) *Australia state of the environment 2021: air quality*, Department of Agriculture, Water and the Environment, Australian Government, accessed 22 December 2022. Hanigan IC, Broome RA, Chaston TB, Cope M, Dennekamp M, Heyworth JS, Heathcote K, Horsley JA, Jalaludin B, Jegasothy E, Johnston FH, Knibbs LD, Pereira G, Vardoulakis S, Vander Hoorn S, Morgan GG (2021) 'Avoidable Mortality Attributable to Anthropogenic Fine Particulate Matter (PM2.5) in Australia', *International Journal of Environmental Research and Public Health,* 18(1):254, doi:10.3390/ijerph18010254. NSW Health (2020) *Particulate matter (PM10 and PM2.5)*, NSW Health, NSW Government, accessed 24 August 2023.

3. Prevalence of asthma[1]

Description	Prevalence of asthma
Indicator type	**Effect**
Rationale	Asthma is a chronic lung disease affecting people of all ages. Various environmental factors can trigger or exacerbate asthma, so it is difficult to isolate the contribution of any single factor. Examples of contributing factors include: • viral respiratory infections • indoor allergens (for example, house dust mites in bedding, carpets, and stuffed furniture; pollution; and pet dander) • outdoor allergens (such as pollens and moulds) • tobacco smoke • chemical irritants, including at the workplace • air pollution • strong odours, such as perfume (AIHW 2023a). Asthma exacerbation has been linked to cold air, poor air quality, change in temperature, and thunderstorms as well as gas appliances and wood heaters (AIHW 2023a; Asthma Australia n.d.). Two natural events that have affected asthma in recent times are the 2016 thunderstorm asthma event in Victoria and the bushfires of 2019–20 (AIHW 2023a). Asthma also has varying degrees of impact on the physical, psychological and social wellbeing of people living with the condition, depending on disease severity and the level of control. Refer to National asthma indicators 2c and 5 for data relating to the severity of asthma (AIHW 2023b).
Definition	The National Health Survey collects data on long-term health conditions including asthma. A respondent to the NHS is considered to have a chronic respiratory condition if they reported ever having been told by a doctor or nurse that they had asthma, and their asthma is still current at the time of interview and had lasted or was expected to last 6 months or more. Crude and age-standardised rates (directly age-standardised to the 2001 Australian population) will be reported.
Numerator	Number of people who reported having asthma.
Denominator	Total number of people in the estimated resident Australian population.
Possible disaggregation(s)	Socioeconomic area, remoteness area, age, sex, state, First Nations people, and geographical disaggregations at the

[1] This indicator is also applicable to the sub domain ‘aeroallergens’

	smallest level possible (for example, SA4 and Local Government Area level).
Data source(s) and frequency	ABS National Health Survey – data are available every 3 years. ABS National Aboriginal and Torres Strait Islander Health Survey (NATSIHS) – data available every 6 years. For further information about the data sources see 'Appendix D: Data sources'.
Issues	Due to COVID-19 the survey was completed online, which is likely to affect the results. Therefore, data for 2020–21 is a break in time series and should be used only for point-in-time analysis.
Interpretation	A low percentage/estimate for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 3.4: By 2030, reduce by one-third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and wellbeing. SDG 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.
Related national government policies and/or strategies	National Asthma Strategy 2018
See also	Indicator 1: Annual and daily high ambient concentration of $PM_{2.5}$ across Australia Indicator 2: Health burden of outdoor air pollution Indicator 4: Asthma hospitalisations Indicator 6: Prevalence of hay fever Indicator 9: Annual declared natural disasters
References	AIHW (2023a) *Asthma*, AIHW, Australian Government, accessed 24 August 2023. AIHW (2023b) *National asthma indicators*, AIHW, Australian Government, accessed 24 August 2023. Asthma Australia (n.d.) *Homes, health and asthma*, Asthma Australia, accessed 24 August 2023.

4. Asthma hospitalisations[2]

Description	Annual number of hospitalisations for asthma.
Indicator type	**Effect**
Rationale	With more frequent natural disasters (such as bushfires) happening because of climate change, this is likely to exacerbate asthma and lead to increased hospitalisations. For example, during the 2019–20 bushfire season there were 36% (2.4 per 100,000 people or about 600) more asthma hospitalisations than the previous 5-year average of 1.7 per 100,000 people (about 420 hospitalisations) (AIHW 2021). Additionally, nitrogen dioxide (NO_2) emissions due to air pollution have been linked to asthma hospitalisations. During 2006 in Melbourne 193 (3.1%) or between 0.6% and 4.8% of the 6,200 asthma hospitalisations were related to exposure to NO_2 (AIHW 2010). Refer to National asthma indicators for more detailed data relating to asthma (AIHW 2023).
Definition	ICD-10-AM codes used for identifying hospitalisations for asthma include J45–J46. Number of and crude and age-standardised rates (directly age-standardised to the 2001 Australian population) will be reported.
Numerator	Annual number of hospitalisations for asthma.
Denominator	Total number of people in the estimated resident Australian population.
Possible disaggregation(s)	Remoteness area, First Nations people, sex, age, state and territories and geographical disaggregations at the smallest level possible (for example, SA4 and Local Government Area level).
Data source(s) and frequency	AIHW National Hospital Morbidity Database (NHMD) – data are available annually. For further information about the data source see ‘Appendix D: Data sources’.
Issues	None applicable.
Interpretation	A low percentage/estimate for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 3.4: By 2030, reduce by one-third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and wellbeing.

[2] This indicator is also applicable to the sub domain ‘aeroallergens’

	SDG 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.
Related national government policies and/or strategies	National Asthma Strategy 2018
See also	Indicator 1: Annual and daily high ambient concentration of $PM_{2.5}$ across Australia Indicator 2: Health burden of outdoor air pollution Indicator 3: Prevalence of asthma Indicator 6: Prevalence of hay fever Indicator 9: Annual declared natural disasters
References	AIHW (2010) *Monitoring the impact of air pollution on asthma in Australia: a methods paper*, AIHW, Australian Government, accessed 24 August 2023. AIHW (2021) *Data update: Short-term health impacts of the 2019–20 Australian bushfires*, AIHW, Australian Government, accessed 24 August 2023. AIHW (2023) *National asthma indicators*, AIHW, Australian Government, accessed 8 December 2023.

Sub domain: Mould

5. Mould in the home

Description	Prevalence of mould in housing/rental housing.
Indicator type	**Exposure**
Rationale	It is estimated that mould affects 10%–50% of indoor environments in Australia, Europe, India, Japan and North America (WHO 2009). Buildings that are designed, constructed and maintained well, are important to prevent and control excess moisture and humidity that can lead to mould growth (WHO 2009). Changing and intensifying weather patterns (for example, rain, storms and flooding) also provide a favourable environment for mould growth (Health Canada 2023). Mould produces spores which when carried in the air can contribute to health problems, particularly in those who have asthma or allergies (Asthma Australia n.d.; NSW Health 2022). Breathing in mould spores has also been linked to respiratory infections. As a result, the WHO (2018) specifies that no level of exposure to mould is safe. Mould is likely to be more prevalent in poorly maintained housing, particularly among people in socioeconomically

	disadvantaged areas. Given these population groups already experience increased burden of disease, remediation for mould is considered a priority to prevent further ill health (WHO 2009).
Definition	The Australian Housing Conditions and Australian Rental Housing Conditions datasets collect self-reported data on any major building problems people may be experiencing in their home, including the presence of mould.
Numerator	Number of people who report having mould in owned housing (Australian Housing Conditions Dataset). Number of people who report having mould in rental housing (Australian Rental Housing Conditions Dataset).
Denominator	Total number of people in the Australian Housing Conditions Dataset. Total number of people in the Australian Rental Housing Conditions Dataset.
Possible disaggregation(s)	Age, sex, Australian states and territories.
Data source(s) and frequency	The Australian Housing Conditions Dataset The Australian Rental Housing Conditions Dataset These 2 data sets will be merged. Surveys will be conducted in 2024, 2025, and 2026. Certainty of future iterations yet to be determined. For further information about the data sources see 'Appendix D: Data sources'.
Issues	The initial data collection of the Australian Housing Conditions Dataset had a smaller sample size (around 4,500 people) and was conducted in only 3 Australian states (New South Wales, Victoria and South Australia) compared with the subsequent Australian Rental Housing Conditions Dataset which was conducted with 15,000 people Australia-wide.
Interpretation	A low percentage/estimate for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 11.1: By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.
Related national government policies and/or strategies	None identified.
See also	Indicator 6: Prevalence of hay fever

References	Asthma Australia (n.d.) *Homes, Health and Asthma*, Asthma Australia, accessed 24 August 2023. Health Canada (2023) *Guide to addressing moisture and mould indoors*, Health Canada, Government of Canada, accessed 24 August 2023. NSW Health (2022) *Mould*, NSW Health, NSW Government, accessed 24 August 2023. WHO (World Health Organization) (2009) *WHO guidelines for indoor air quality: dampness and mould*, Geneva: WHO, accessed 12 January 2023. WHO (2018) *WHO Housing and Health Guidelines*, Geneva: WHO, accessed 24 August 2023.

Sub domain: Aeroallergens[3]

6. Prevalence of hay fever

Description	Prevalence of hay fever.
Indicator type	**Effect**
Rationale	Air-borne allergens from grasses, weeds, trees and fungal spores (such as Alternaria) are associated with allergic rhinitis (hay fever) and exacerbation of asthma symptoms. Various changes in climate and weather can affect the production, distribution and dispersion of air borne pollen and spores (US EPA 2008). Research shows that over time increases in temperature are one of the main drivers of longer pollen seasons and higher pollen concentrations, hence increasing the risk of associated health effects (Anderegg 2021). Above-average rainfall and minimum temperatures in winter, increased carbon dioxide levels, and increasingly dry and warm climates have been associated with increases in air-borne pollen and spores (ACT Health 2022; Albertine 2014; Baxi and Phipatanakul 2010; Ozdenir 2015). Additionally, there is evidence to show that air pollution such as particulate matter can exacerbate or lead to development of allergic diseases (Takizawa 2011).
Definition	The National Health Survey (NHS) collects data on long-term health conditions, including hay fever. A respondent in the NHS is considered to have hay fever if their condition was current at the time of interview and had lasted, or was expected to last, 6 months or more. Crude and age standardised rates (directly age-standardised to the 2001 Australian population) will be reported.

[3] This subdomain includes asthma prevalence and hospitalisations – refer to indicators 3 and 4 in sub domain 'Outdoor air pollution' for indicator specifications.

Numerator	Number of people who reported having hay fever.
Denominator	Total number of people in the estimated resident Australian population.
Possible disaggregation(s)	Age, sex, socioeconomic area, remoteness area, state, First Nations people and geographical disaggregations at the smallest level possible (for example SA4 and Local Government Area level).
Data source(s) and frequency	ABS National Health Survey – data available every 3 years ABS National Aboriginal and Torres Strait Islander Health Survey (NATSIHS) – data available every 6 years. For further information about the data sources see 'Appendix D: Data sources'.
Issues	Due to COVID-19 the survey was completed online, which is likely to affect the results. Therefore, data for 2020–21 is a break in time series and should be used only for point-in-time analysis.
Interpretation	A low percentage/estimate for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	None identified.
Related national government policies and/or strategies	None identified.
See also	Indicator 1: Annual and daily high ambient concentration of $PM_{2.5}$ across Australia Indicator 3: Prevalence of asthma Indicator 5: Mould in the home
References	ACT Health (2022) *Pollen allergy*, ACT Government website, accessed 10 January 2023. Albertine JM, Manning WJ, DaCosta M, Stinson KA, Muilenberg ML and Rogers CA (2014) 'Projected carbon dioxide to increase grass pollen and allergen exposure despite higher ozone levels', *PloS One*, 9(11):111712, doi: 10.1371/journal.pone.0111712. Anderegg WR, Abatzoglou JT, Anderegg LD, Bielory L, Kinney PL and Ziska L (2021) 'Anthropogenic climate change is worsening North American pollen seasons', *Proceedings of the National Academy of Sciences*, *118*(7):e2013284118, doi: 10.1073/pnas.2013284118. Baxi SN and Phipatanakul W (2010) 'The role of allergen exposure and avoidance in asthma', *Adolescent Medicine State of the Art Reviews*, 21(1):57.

	Ozdemir N (2015) 'Molds and respiratory allergy – part 1', *MOJ Immunology*, 2(2):00045, doi: 10.15406/moji.2015.02.00045. Takizawa H (2011) 'Impact of air pollution on allergic diseases', *The Korean Journal of Internal Medicine*, 26(3):262, doi: 10.3904/kjim.2011.26.3.262. US EPA (United States Environmental Protection Agency) (2008) *A review of the impact of climate variability and change on aeroallergens and their associated effects (final report)*, EPA, United States Government, accessed 10 January 2023.

Domain: Water quality

Sub domain: Water quality

7. Drinking water fluoridation

Description	Proportion of people with access to optimally fluoridated water.
Indicator type	**Exposure**
Rationale	In most Australian communities, fluoride is added to water and is considered a safe and effective way to reduce and prevent tooth decay (AIHW 2020). Around 89% of the Australian population has access to fluoridated drinking water although this varies by state and territory (NHMRC 2017). Dental caries are a major public health problem globally and are considered the most widespread noncommunicable disease (WHO 2017). In 2023, dental caries ranked in the leading 15 causes of non-fatal burden (YLD) for males and females in Australia (AIHW 2023). The Australian Government National Health and Medical Research Council (NHMRC) (2017) found that water fluoridation reduced decay by 26% to 44% in children and adolescents, and by 27% in adults. Additionally, fluoridation of community water benefits those with lower incomes who have less access to affordable dental care and other forms of fluoridation (NHMRC 2017). Oral health is important for maintaining overall health and quality of life. Oral disease can have multiple impacts on general health (such as difficulty eating, poor diet, pain, diabetes and cardiovascular health) as well as social (such as low self-esteem) and economic (such as high treatment costs) impacts (COAG Health Council 2015).
Definition	As in the NHMRC Australian Drinking Water Guidelines, the target fluoride concentration is between 0.6 and 1.1 mg/L, with the lower concentrations applying where the climate is hot, to allow for a higher average consumption of water (NHMRC 2017).

Numerator	Number of people residing in areas with access to optimally fluoridated drinking water in the reticulated water supply.
Denominator	Total number of people in the estimated resident Australian population.
Possible disaggregation(s)	Australian states and territories.
Data source(s) and frequency	**Health departments** State/territory health departments sourcing data from state/territory water authorities. **ABS** Australian Bureau of Statistics Census of Population and Housing (for total population by state/territory) – data available every 5 years. For further information about the data sources see 'Appendix D: Data sources'.
Issues	None applicable.
Interpretation	A high value can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 6.1: By 2030, achieve universal and equitable access to safe and affordable drinking water for all.
Related national government policies and/or strategies	National Water Quality Management Strategy, which includes the Australian Drinking Water Quality Guidelines.
See also	None identified.
References	AIHW (2020) *National Oral Health Plan 2015–2024: performance monitoring report*, AIHW, Australian Government, accessed 24 August 2023. AIHW (2023) *Australian Burden of Disease Study 2023*, AIHW, Australian Government, accessed 16 February 2024. Council of Australian Governments (COAG) Health Council (2015) *Australia's National Oral Health Plan 2015–2024*, COAG Health Council, Australian Government, accessed 25 August 2023. NHMRC (National Health and Medical Research Council) (2017) *NHMRC Public Statement 2017 – Water Fluoridation and Human Health in Australia*, NHMRC, Australian Government, accessed 24 August 2023.

Domain: UV and sun radiation

Sub domain: High UV exposure

8. Health burden of high UV exposure

Description	Health burden of high sun exposure (melanoma and non-melanoma skin cancer) – attributable fatal (YLL), non-fatal burden (YLD) and deaths.
Indicator type	**Effect**
Rationale	Everyone is exposed to solar ultraviolet (UV) radiation; however, the level of exposure depends on many environmental factors including: • Sun elevation – high elevation is associated with higher UV radiation levels. • Latitude – being closer to the equator leads to higher UV radiation levels. • Altitude – increasing altitude is associated with increased UV radiation. • Cloud cover – UV radiation is often higher on cloudy days. • Ozone – absorbs some of the UV radiation before reaching Earth. Therefore, less ozone means more UV radiation reaches the Earth's surface. • Reflection – more reflection leads to increased UV radiation (WHO 2022). Small amounts of UV radiation are essential for human health and production of vitamin D. However, too much exposure to UV radiation can lead to cataracts, sunburn, skin damage and skin cancer (WHO 2022). Australia has some of the highest rates of skin cancer worldwide (Cancer Council NSW 2021). In 2018, high sun exposure was responsible for 90% of melanoma of the skin and 70% of non-melanoma cancer total disease burden (AIHW 2021a).
Definition	Attributable burden is the disease burden attributed to a particular factor. It is the reduction in fatal (YLL) and non-fatal (YLD) burden as well as deaths that would have occurred if exposure to the risk factor had been avoided (or more precisely had been at its theoretical minimum) (see Glossary). The direct population attributable fractions (PAF) used here are a proportion of current burden due to past and current sun exposure in the population. See Australian Burden of Disease Study methods for more details on how PAFs were calculated (AIHW 2021b). Crude and age-standardised rates (directly age-standardised to the 2001 Australian population) will be reported.

Numerator	Number of YLD attributable to high sun exposure. Number of YLL attributable to high sun exposure. Number of deaths attributable to high sun exposure.
Denominator	Total number of people in the estimated resident Australian population.
Possible disaggregation(s)	Sex, age, remoteness area, state and territory.
Data sources and frequency	AIHW Australian Burden of Disease Study – data available every 3 years. Specific related conditions include: • melanoma of the skin • non-melanoma skin cancer. For further information about the data sources see 'Appendix D: Data sources'.
Issues	The Australian-appropriate estimate for the population attributable fraction of melanoma due to sun exposure was based on the range estimate from the global study on the burden of disease from solar ultraviolet radiation (Lucas et al. 2006). No estimates for socioeconomic group and First Nations people were available. See Australian Burden of Disease methods report for more details (AIHW 2021b). It should be noted that health burden from UV exposure is also relative to skin type (Australian Skin and Skin Cancer Research Centre 2023).
Interpretation	A low percentage/estimate for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 3.4: By 2030, reduce by one-third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being.
Related national government policies and/or strategies	None identified.
See also	Indicator 11: High outdoor temperatures Indicator 13: Injury hospitalisations due to extreme weather-related events Indicator 14: Deaths due to injuries caused by extreme weather-related events
References	AIHW (2021a) *Australian Burden of Disease Study 2018: Interactive data on risk factor burden*, AIHW, Australian Government, accessed 5 September 2023.

	AIHW (2021b) *Australian Burden of Disease Study: Methods and supplementary material 2018*, AIHW, Australian Government, accessed 22 February 2024. Australian Skin and Skin Cancer Research Centre (ASSC) (2023) *Balancing the harms and benefits of sun exposure*, ASCC, accessed 27 March 2024. Cancer Council NSW (2021) *About skin cancer*, Cancer Council NSW website, accessed 12 September 2023. WHO (World Health Organization) (2022) *Ultraviolet radiation*, WHO, Geneva, accessed 9 January 2023.

Domain: Climate and extreme weather

Sub domain: Extreme weather-related events

9. Annual declared natural disasters

Description	Annual number of declared natural disasters due to flood, bushfire, cyclone, storm, thunderstorm.
Indicator type	**State**
Rationale	Natural disasters are increasing in intensity and frequency, and climate change is a likely contributing factor (WHO n.d.). The public health impacts due to natural disasters can be acute and/or chronic. For example, immediate effects experienced include deaths or injuries; long-term effects include physical and psychological damage and exacerbation of chronic health issues (Knap and Rusyn 2016). Environmentally, natural disasters can also contribute to contamination of land, air, and water, and disrupt supply chains of essential goods and services (AIDR 2022; UNEP 2019).
Definition	Data for the annual number of declared natural disasters are captured by disaster type and start and end date.
Numerator	Number of annual declared natural disasters due to flood, bushfire, cyclone, storm, thunderstorm within a 12-month period.
Denominator	Not applicable.
Possible disaggregation(s)	State and territory, and geographical disaggregations at the smallest level possible (for example SA4 and Local Government Area level).
Data source(s) and frequency	Department of Home Affairs Disaster Assist – data continually updated in accordance with natural disaster occurrence. For further information about the data source see ‘Appendix D: Data sources’.

Issues	Data on the types of natural disasters that have occurred in Australia are available only from 2006 onwards.
Interpretation	A low number for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations. SDG 13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.
Related national government policies and/or strategies	National Climate Resilience and Adaptation Strategy 2021–2025 National Strategy for Disaster Resilience National Disaster Risk Reduction Framework National Health and Climate Strategy National Preventive Health Strategy 2021–2030
See also	Indicator 1: Annual and daily high ambient concentration of $PM_{2.5}$ across Australia Indicator 10: Drought – rainfall deficiencies Indicator 11: High outdoor temperatures Indicator 13: Injury hospitalisations due to extreme weather-related events Indicator 14: Deaths due to injuries caused by extreme weather-related events Indicator 15: Vector-borne disease notifications Indicator 28: Gastrointestinal food-borne disease notifications
References	AIDR (Australian Institute for Disaster Resilience) (2022) *Major incidents report* 2021–22, AIDR, Australian Government, accessed 25 August 2023. Knap AH and Rusyn I (2016) 'Environmental exposures due to natural disasters', *Reviews on Environmental Health*, 31(1):89–92, doi: 10.1515/reveh-2016-0010. UNEP (United Nations Environment Programme) (2019) *Five ways in which natural disasters worsen air pollution*, UN, accessed 25 August 2023. WHO (n.d.) *Environmental health in emergencies*, WHO, Geneva, accessed 25 August 2023.

10. Drought – rainfall deficiencies

Description	Rainfall deficiencies across Australia for the recent period (previous 6, 9 and 14 months), in comparison with the entire national rainfall record from 1900.
Indicator type	**Exposure**
Rationale	Australia has experienced numerous periods of extended drought, with the most recent notable severe drought affecting many parts of eastern Australia from 2017 to 2019 (Trewin et al. 2021). Drought can have various impacts on human health, including malnutrition and mortality, water-borne disease such as those caused by E. *coli*, air-borne and dust-related disease, vector-borne diseases such as dengue fever, mental health effects and distress (Stanke et al. 2013). However, the full extent of the impact of droughts on health can be difficult to determine, as they generally develop over a long period, and are geographically widespread. Effects may also differ according to baseline population health and vulnerabilities, infrastructure and resources (Stanke et al. 2013).
Definition	Drought is 'a prolonged, abnormally dry period when the amount of available water is insufficient to meet normal use' (Bureau of Meteorology n.d.). Drought can be measured in many different ways, including by precipitation, temperature, streamflow, water availability, and soil moisture. This indicator is based on rainfall deciles (Gibbs and Maher 1967). Rainfall levels are compared to a historical average, and reported in deciles, from the lowest 10% of values (decile 1), to the highest 10% of values (decile 10). The 5th decile is the median. Rainfall deficiency is indicated by the following categories: • Lowest rainfall on record • Decile 1 – very much below average rainfall • Deciles 2-3 – below average rainfall.
Numerator	Areas recording rainfall in the lowest 3 deciles for the previous 6, 9 and 14 months per reporting period.
Denominator	Not applicable.
Possible disaggregation(s)	State and territory, geographical disaggregations at the smallest level possible (for example, SA4 and Local Government Area level).
Data source(s) and frequency	Australian Bureau of Meteorology– data are available monthly and yearly. For further information about the data source see 'Appendix D: Data sources'.

Issues	This indicator is a 'simple indicator', in that it reports solely on the amount of rainfall, by decile, but does not consider the impact of other climate variables that contribute to drought (WMO and GWP 2016). The indicator is a broad overview of low rainfall conditions across Australia. Local entities may use different measures to monitor drought, and as such this is not intended to replace local advice on drought that may more accurately describe the conditions. A combined drought index that includes other relevant information (such as water availability, soil moisture, temperature and so on) would provide greater accuracy in identifying drought conditions, (WMO and GWP 2016). A combined drought indicator for use in Australia that tracks the severity and extent of drought is being evaluated (Guillory et al. 2023) and could potentially replace this simple indicator, once it is available for public use.
Interpretation	Areas where rainfall is in the lowest 3 deciles (or lowest on record) compared with the historical average are considered to be at risk of, or experiencing drought conditions.
Related SDG goal/target(s)	SDG 15.3: By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.
Related national government policies and/or strategies	National Drought Agreement
See also	Indicator 9: Annual declared natural disasters Indicator 11: High outdoor temperatures
References	BOM (Bureau of Meteorology) (n.d) *Understanding drought*, Bureau of Meteorology, Australian Government, accessed 9 January 2023. Gibbs WJ and Maher JV (1967) *'Rainfall deciles as drought Indicators'*, Bureau of Meteorology Bulletin No. 48, Melbourne, Australia. Guillory L, Pudmenzky C, Nguyen-Huy T, Cobon D and Stone R (2023) 'A drought monitor for Australia', *Environmental Modelling and Software*, 170:105852, doi: 10.1016/j.envsoft.2023.105852. Stanke C, Kerac M, Prudhomme C, Medlock J and Murray V (2013) 'Health effects of drought: a systematic review of the evidence', *PLoS Currents,* 5, doi: 10.1371/currents.dis.7a2cee9e980f91ad7697b570bcc4b004. Trewin B, Morgan-Bulled Damian and Cooper Sonia (2021) Australia State of Environment report: drought, independent

	report to the Australian Government Minister for the Environment, Australian Government, doi: 10.26194/rdze-5d59. World Meteorological Organization (WMO) and Global Water Partnership (GWP) (2016), *Handbook of drought indicators and indices*, (M. Svoboda and BA Fuchs), Integrated Drought Management Programme, *Integrated drought management tools and guidelines* series 2, Geneva.

11. High outdoor temperatures

Description	Annual number of times when the maximum and minimum temperatures are unusually hot (see definition) over a 3-day period at specific locations in Australia
Indicator type	**State**
Rationale	Globally average annual temperatures have been increasing since the 20th century and are predicted to continue to rise (US EPA and CDC 2016). Climate change is also leading to increased exposure to excessive heat and subsequent health impacts (WHO n.d.). Living in urban areas puts people at greater risk of exposure to extreme heat due to the urban heat island effect. That is, developed areas have less greenery to provide cooling and shade and more buildings, roads, and footpaths which attract and trap heat leading to higher daytime maximum temperatures and reduced cooling overnight (US EPA and CDC 2016).
Definition	'Unusually hot' is defined by comparing to the local-long-term climate and past weather at a particular location (Bureau of Meteorology n.d.b, n.d.c). It should be noted that heatwaves are not purely based on maximum day time temperatures, but also how much the temperature decreases overnight, as nights with high temperatures can lead to the maximum temperature being reached sooner the following day (Bureau of Meteorology n.d.c.).
Numerator	Number of times per year where the maximum and minimum temperatures were 'unusually hot' over a 3-day period.
Denominator	Not applicable.
Possible disaggregation(s)	States and territories, areas across Australia with stations (112 in total) (Bureau of Meteorology n.d.a), and geographical disaggregations at the smallest level possible (for example SA4 and Local Government Area level).
Data source(s) and frequency	Australian Bureau of Meteorology ACORN SAT – data available daily, monthly and annually.

	For further information about the data source see 'Appendix D: Data sources'.
Issues	None applicable.
Interpretation	A low number for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations. SDG 13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.
Related national government policies and/or strategies	National Climate Resilience and Adaptation Strategy 2021–2025 National Health and Climate Strategy
See also	Indicator 8: Health burden of high UV exposure Indicator 13: Injury hospitalisations due to extreme weather-related events Indicator 14: Deaths due to injuries caused by extreme weather-related events Indicator 15: Vector-borne disease notifications Indicator 19: Hot indoor temperatures Indicator 28: Gastrointestinal food-borne disease notifications
References	Bureau of Meteorology (n.d.a.), *Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT)*, Bureau of Meteorology, Australian Government, accessed 5 February 2024. Bureau of Meteorology (n.d.b.) *Heatwave assessment and forecast*, Bureau of Meteorology, Australian Government, accessed 12 January 2023. Bureau of Meteorology (n.d.c.) *Understanding heatwaves*, Bureau of Meteorology, Australian Government, accessed 12 January 2023. US EPA (United States Environmental Protection Agency) and CDC (Centers for disease Control and Prevention) (2016) *Climate change and extreme heat, what can you do to prepare*, US Government, accessed 25 August 2023. WHO (n.d.) *Heatwaves*, World Health Organization website, accessed 12 January 2023.

12. Low outdoor temperatures

Description	Annual number of days when the maximum temperature is below the 10th percentile.
Indicator type	**State**
Rationale	Despite global warming, in recent years Australia has faced periods of very cold weather. Strong wind patterns that blow from the Antarctic coast are thought to be a contributor (DCCEEW 2020). Climate change is also thought to influence the frequency and severity of these events (Environmental and Energy Institute 2022).
Definition	The Bureau of Meteorology utilises the measure of lowest percentile temperatures to indicate the level of weather extremes in regions across Australia, and the variable nature of temperatures (Bureau of Meteorology n.d.b.).
Numerator	Number of days when the maximum temperature is below the 10th percentile.
Denominator	Not applicable.
Possible disaggregation(s)	Areas across Australia with stations (112 in total) (Bureau of Meteorology n.d.a.), states and territories, and geographical disaggregations at the smallest level possible (for example SA4 and Local Government Area level).
Data source(s) and frequency	Australian Bureau of Meteorology ACORN SAT – data available daily, monthly and annually. For further information about the data source see 'Appendix D: Data sources'.
Issues	None identified.
Interpretation	A low number for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations. SDG 13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.
Related national government policies and/or strategies	None identified.
See also	Indicator 13: Injury hospitalisations due to extreme weather-related events

	Indicator 14: Deaths due to injuries caused by extreme weather-related events Indicator 18: Cold indoor temperatures.
References	Bureau of Meteorology (n.d.a.), *Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT)*, Bureau of Meteorology, Australian Government, accessed 5 February 2024. Bureau of Meteorology (n.d.b.) *Temperature percentile maps*, Bureau of Meteorology, Australian Government, accessed 25 August 2023. DCCEEW (Department of Climate Change, Energy, the Environment and Water) (2020) *From the katabatic to the polar vortex*, DCCEEW, Australian Government, accessed 12 January 2023. Environmental and Energy Institute (2022) *Living with climate change: the polar vortex policies to anticipate threats and build preparedness*, Environmental and Energy Institute website, accessed 12 January 2023.

13. Injury hospitalisations due to extreme weather-related events

Description	Annual number of hospitalised injury cases due to extreme weather-related events (exposure to excessive natural heat, excessive natural cold, extreme rain and storms, and bushfires).
Indicator type	**Effect**
Rationale	Extreme weather events are events that are beyond human control, frequently resulting in catastrophic consequences. Injuries caused by exposure to extreme weather events are those which occur when environmental conditions become dangerous. This includes exposure to too much natural heat, or cold, rain and storm events (including cyclones and heavy or prolonged rainfall, which can lead to flooding and landslides) and bushfires (AIHW 2023). Natural weather events not only cause damage to the environment but can also cause unintentional human injury, resulting in hospitalisation and potentially death. Injuries due to forces of nature also have a strong seasonal pattern, with data showing a peak in summer, which is likely due to exposure to excessive natural heat. Additionally, between 2019–20 and 2021–22, data show that hospitalisation rates due to exposure to extreme weather-related events were higher for males and people aged 65 and over (AIHW 2023).
Definition	Hospitalisations due to extreme weather-related events are collected in the National Hospital Morbidity Database (NHMD). The NHMD is a comprehensive data set that has records for all episodes of admitted patient care from all public and private

	hospitals in Australia. In the NHMD, records are presented by hospital cases (discharges, transfers, deaths, or changes in care type) by time period. For more detailed information on coding of hospitalisations data, see the *Injury in Australia* technical notes (AIHW 2023). Crude and age-standardised rates (directly age-standardised to the 2001 Australian population) will be reported.
Numerator	Number of hospitalisations due to extreme weather-related events, including: • excessive natural heat • excessive natural cold • extreme rain and storms • bushfires.
Denominator	Total number of people in the estimated resident Australian population.
Possible disaggregation(s)	Where data allow: age, sex and state and territory.
Data source(s) and frequency	AIHW National Hospital Morbidity Database (NHMD) – data are available annually. For further information about the data source see 'Appendix D: Data sources'.
Issues	Cases do not include episodes of non-admitted care provided in outpatient clinics or emergency departments. Refer to *Injury in Australia* 'Limitations in ascribing injuries to weather' for further details (AIHW 2023). Health effect data based on hospitalisations captured for climate and extreme weather can account for only immediate (that is, short-term) and acute health effects. It is recognised that there are also associated long-term health impacts, for example on mental health, but data available on this are limited. Additionally, data are likely to be an underestimate as not all injuries caused by extreme weather events will be hospitalised. Injury cases include primary diagnoses outside the normal injury scope, for example, heat stroke, and an external cause code.
Interpretation	A low number for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters,

	with a focus on protecting the poor and people in vulnerable situations. SDG 13.1: Strengthen resilience and adaptive capacity to climate- related hazards and natural disasters in all countries.
Related national government policies and/or strategies	None identified.
See also	Indicator 1: Annual and daily high ambient concentration of $PM_{2.5}$ across Australia Indicator 2: Health burden of outdoor air pollution Indicator 9: Annual declared natural disasters Indicator 11: High outdoor temperatures Indicator 12: Low outdoor temperatures Indicator 14: Deaths due to injuries caused by extreme weather-related events.
References	AIHW (2023) *Let's talk about the weather: injuries related to extreme weather*, AIHW, Australian Government, accessed 8 February 2024.

14. Deaths due to injuries caused by extreme weather-related events

Description	Annual number of deaths due to extreme weather-related events (exposure to excessive natural heat, excessive natural cold, rain and storms and bushfires).
Indicator type	**Effect**
Rationale	Extreme weather events are beyond human control, frequently resulting in catastrophic consequences. Injuries caused by exposure to extreme weather events are those which occur when environmental conditions become dangerous. This includes exposure to too much natural heat or cold, rain and storm events (including thunderstorms, cyclones and heavy or prolonged rainfall, which can lead to flooding and landslides) and bushfires (AIHW 2023). Extreme weather events not only cause damage to the environment but can also cause unintentional human injury, resulting in hospitalisation and potentially death. Between 2018–19 and 2020–21, data show that mortality rates due to extreme weather-related events were higher for males and people aged 65 and over. Extreme heat caused the most deaths, followed by cold weather (AIHW 2023).
Definition	Deaths resulting from injuries due to extreme weather are collected in the AIHW National Mortality Database (NMD). It is compulsory that all deaths in Australia are registered, and information about a person's death is recorded on a death certificate, certified either by a medical practitioner or by the

	Coroner. The Australian Bureau of Statistics (ABS) is the agency responsible for coding according to the ICD-10-AM and publishing deaths data. The National Coronial Information System provides additional details to the ABS about those deaths which required certification by a coroner. Most deaths resulting from injury require certification by a coroner. In these cases, additional information regarding external cause coding is required. For more detailed information on coding of deaths data, see the *Injury in Australia* technical notes (AIHW 2023). Crude and age-standardised rates (directly age-standardised to the 2001 Australian population) will be reported.
Numerator	Number of deaths due to injuries caused by extreme weather events, due to exposure to: • excessive natural heat • excessive natural cold • rain and storms • bushfires.
Denominator	Not applicable.
Possible disaggregation(s)	Where data allow: age and sex.
Data source(s) and frequency	AIHW National Mortality Database (NMD) – data available annually. For further information about the data source see 'Appendix D: Data sources'.
Issues	Codes do not include deaths from longer-term exposure effects, for example, deaths from chronic respiratory disease caused by long-term and repeated exposure to bushfire smoke. Additionally, the data do not include road traffic deaths occurring during extreme weather. Therefore, the number of deaths is most likely an under-count. Refer to *Injury in Australia* 'Limitations in ascribing injuries to weather' for further details (AIHW 2023).
Interpretation	A low number for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations. SDG 13.1: Strengthen resilience and adaptive capacity to climate- related hazards and natural disasters in all countries.

Related national government policies and/or strategies	None identified.
See also	Indicator 1: Annual and daily high ambient concentration of $PM_{2.5}$ across Australia Indicator 2: Health burden of outdoor air pollution Indicator 9: Annual declared natural disasters Indicator 11: High outdoor temperatures Indicator 12: Low outdoor temperatures Indicator 13: Injury hospitalisations due to extreme weather-related events.
References	AIHW (2023) *Let's talk about the weather: injuries related to extreme weather*, AIHW, Australian Government, accessed 8 February 2024.

Sub domain: Climate-sensitive infectious disease

15. Vector-borne disease notifications

Description	Number of notifications of vector-borne diseases – Barmah Forest, Chikungunya virus, dengue, Flavivirus, Japanese encephalitis, Murray Valley encephalitis, Ross River virus, West Nile/Kunjin virus, and leptospirosis.
Indicator type	**Effect**
Rationale	Our changing climate and environment are having an impact on the spread, transmission and re-emergence of vector-borne diseases (Rocklöv and Dubrow 2020). Vector-borne diseases are highly sensitive to climatic factors including heat, rainfall and flooding which provide favourable environments for breeding. Additionally, longer-term climate change is likely to alter transmission from short (annual) to longer (decadal) time frames (Campbell-Lendrum et al. 2015). Indirect effects related to the climate and environment also have a relationship with vector-borne diseases, such as the built environment. For example, flooding can degrade housing quality leading to increased permeability of housing and hence increased vector-human contact. Population density and land use also increase human contact with vector-borne diseases (Coalson et al. 2021). Therefore, access to adequate water and sanitation play an important role in control and elimination. Importantly, demographic and social (for example, health inequities) factors also play a role in distribution of vector-borne diseases (WHO 2020). The impacts of transmission are far-reaching, from individuals to households and health systems, overall due to the large disease burden that they carry (Campbell-Lendrum et al. 2015).

Definition	The National Notifiable Diseases Surveillance System (NNDSS) reports the number of cases of various mosquito and vector-borne diseases associated with flooding. Notifications are received from state and territory health authorities to advise on new cases. Refer to the NNDSS Dashboard for details on data availability by year for diseases.
Numerator	Number of notifications for vector-borne diseases.
Denominator	Not applicable.
Possible disaggregation(s)	State and territory, sex, and age.
Data source(s) and frequency	Department of Health and Aged Care National Notifiable Diseases Surveillance System (NNDSS) – data are continually available (fortnightly and annually). For further information about the data source see 'Appendix D: Data sources'.
Issues	Notifications are based on laboratory confirmation from clinical specimens and in some cases notifications from clinicians based on symptoms. However, many people do not present to the health system when suffering from the disease, and so the NNDSS notification numbers are known to be an under-report of actual cases. States and territories have different ways of reporting cases, which can affect the quality and completeness of information. Additionally, notifications for some high-volume conditions are uploaded only quarterly by some jurisdictions, which can result in apparent large variability over time.
Interpretation	A low number for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 3.3: By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases.
Related national government policies and/or strategies	National Health and Climate Strategy
See also	Indicator 9: Annual declared natural disasters Indicator 10: Drought – rainfall deficiencies Indicator 11: High outdoor temperatures
References	Campbell-Lendrum D, Manga L, Bagayoko M and Sommerfeld J (2015) 'Climate change and vector-borne diseases: what are the implications for public health research and policy?', *Philosophical Transactions of the Royal Society B:*

	Biological Sciences, 370(1665):20130552, doi: 10.1098/rstb.2013.0552. Coalson JE, Anderson EJ, Santos EM, Madera Garcia V, Romine JK, Luzingu JK, Dominguez B, Richard DM, Little AC, Hayden MH and Ernst KC (2021) 'The complex epidemiological relationship between flooding events and human outbreaks of mosquito-borne diseases: a scoping review', *Environmental Health Perspectives*, 129(9):096002, doi:10.1289/EHP8887. Rocklöv J and Dubrow R (2020) 'Climate change: an enduring challenge for vector-borne disease prevention and control', *Nature Immunology,* 21:479–483, doi: 10.1038/s41590-020-0648-y. WHO (2020) *Vector-borne disease*, WHO, Geneva, accessed 5 February 2024.

Domain: Housing

Sub domain: Household overcrowding

16. Prevalence of household overcrowding

Description	Proportion of people living in overcrowded and severely overcrowded housing.
Indicator type	**Exposure**
Rationale	The WHO defines household crowding as 'where the number of occupants exceeds the capacity of the dwelling space available, whether measured as rooms, bedrooms or floor area' (WHO 2018). Conditions of the dwelling also relate to crowding. For example, people may crowd in one room to avoid cold temperatures and save on heating and other costs. Household crowding can affect health and increase the spread of infectious diseases such as acute rheumatic fever, hepatitis A, meningococcal disease, lower respiratory tract infections, tuberculosis, *Haemophilus influenzae* (Hib) disease, trachoma and *Helicobacter pylori* infection (Baker et al. 2013; Jaine et al. 2011). Household crowding is affected by factors including availability of housing, housing affordability, cultural obligations, and First Nations people's movement between communities (Dockery et al. 2022). It is often unevenly distributed and is a risk factor for certain population groups including those living in rental houses (particularly social housing), multi-families, low household income, unemployment, lower educational attainment levels and First Nations people (AIHW and NIAA 2023; Baker et al. 2012).
Definition	The concept of crowding is based upon a comparison of various factors including number of bedrooms in a house, age,

	sex and relationship of household members to one another (AIHW n.d.). Based on this a house is considered overcrowded if it requires 1 or more additional bedrooms, given the size and composition of the household. Severely overcrowded is defined as requiring 4 or more additional bedrooms according to the Canadian National Occupancy Standard (CNOS). The ABS classifies this as a form of homelessness (ABS 2018; AIHW 2012).
Numerator	Number of people living in overcrowded houses. Number of people living in severely overcrowded homes.
Denominator	Total number of people in the estimated resident Australian population.
Possible disaggregation(s)	Age, sex, First Nations people, remoteness area, states and territories and geographical disaggregations at the smallest level possible (for example, SA4 and Local Government Area level).
Data source(s) and frequency	ABS Census of Population and Housing – data available every 5 years. For further information about the data source see 'Appendix D: Data sources'.
Issues	The 2021 Census was conducted during the COVID-19 pandemic and this affected data collected during this period. Further information about these impacts can be found on the ABS COVID-19 and the 2021 Census website (ABS 2022). The CNOS has some recognised limitations; further details about this can be found in AHURI (2022).
Interpretation	A low percentage/estimate for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 11.1: By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.
Related national government policies and/or strategies	National Agreement on Closing the Gap
See also	Indicator 17: Incidence of acute rhematic fever Indicator 21: First Nations households with access to functioning health hardware Indicator 30: Health burden of unsafe sanitation
References	ABS (2018) *Census of Population and Housing: Estimating Homelessness*, ABS website, accessed 25 August 2023.

	ABS (2022) *4. COVID-19 and the 2021 Census*, ABS website, accessed 8 February 2024. ABS (2023) *Estimating Homelessness: Census*, ABS website, accessed 22 February 2024. Australian Housing and Urban Research Institute (AHURI) (2022*) Examining how overcrowding in Australian households is measured*, AHURI, accessed 9 February 2024. Australian Institute of Health and Welfare (AIHW) (n.d.) *Canadian National Occupancy Standard*, AIHW METEOR online registry website, accessed 22 February 2024. AIHW (2023) *Housing assistance in Australia*, AIHW, Australian Government, accessed 22 February 2024. AIHW and NIAA (2023) *2.01 Housing,* AIHW and NIAA, Australian Government, accessed 24 August 2023. Baker MG, Goodyear R, Telfar Barnard L and Howden-Chapman P (2012) *The distribution of household crowding in New Zealand: an analysis based on 1991 to 2006 Census data,* University of Otago, accessed 12 January 2023. Baker MG, McDonald A, Zhang J and Howden-Chapman (2013) *Infectious diseases attributable to household crowding in New Zealand: a systematic review and burden of disease estimate*, University of Otago, accessed 13 January 2023. Dockery AM, Moskos M, Isherwood L and Harris M (2022) *How many in a crowd? Assessing overcrowding measures in Australian housing*, Australian Housing and Urban Research Institute Limited, Melbourne, accessed 12 January 2023. Jaine R, Baker M and Venugopal K (2011) 'Acute rheumatic fever associated with household crowding in a developed country', *The Pediatric Infectious Disease Journal*, 30(4):315–319, doi: 10.1097/INF.0b013e3181fbd85b. World Health Organization (WHO) (2018) *Housing and health guidelines*, WHO, accessed 12 January 2023.

17. Incidence of acute rhematic fever

Description	Annual rate of acute rhematic fever (ARF).
Indicator type	**Effect**
Rationale	Acute rhematic fever is a preventable disease and disproportionally affects First Nations people living in regional and remote areas (AIHW 2023). ARF can cause lasting damage to the heart and the risk of recurrence is high after the initial diagnosis; repeated episodes increase the likelihood of rheumatic heart disease (RHD) (Carapetis et al. 2016). ARF is associated with household crowding, socioeconomic deprivation, low levels of functioning 'health hardware' (for

	example, toilets, showers, taps) and lack of access to health care services (Sims et al. 2016; Webb et al. 2015). Improved living conditions and access to functional health hardware can reduce high rates of group A streptococcal disease associated with ARF (Katzenellenbogen et al. 2017). More detailed reporting on ARF is available in the Aboriginal and Torres Strait Islander Health Performance Framework (AIHW and NIAA 2023).
Definition	Diagnoses of ARF are reported by Australian rheumatic heart disease control programs. Data are collected about diagnoses' preventive treatment and episode type; level of confirmation; level of severity at diagnosis and when clinical monitoring activities or surgery are performed, where episode type relates to the number of initial reports of ARF in addition to number of recurrences (AIHW 2023).
Numerator	Number of ARF diagnoses by episode type (new and recurrent cases) by selected Australian states and territories. Refer to 'possible disaggregations'.
Denominator	Total number of people in the estimated resident Australian population by selected Australian states and territories. Refer to 'possible disaggregations'.
Possible disaggregation(s)	Selected Australian states and territories (New South Wales, Queensland, Western Australia, South Australia and the Northern Territory), First Nations people, sex, age and year.
Data source(s) and frequency	National Rheumatic Heart Disease Data Collection – data are available annually. For further information about the data source see 'Appendix D: Data sources'.
Issues	Comparison of ARF results between different time periods should use the data presented in the report being considered, and comparisons to the results in previous versions of reports is discouraged. In 2021, ARF and RHD were notifiable in 5 jurisdictions (New South Wales, Queensland, Western Australia, South Australia, and the Northern Territory), although these became notifiable at different times in different jurisdictions. In New South Wales, RHD cases are notifiable only in people aged under 35 (AIHW 2023).
Interpretation	A low percentage/estimate for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 3.4: By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being.

	SDG 6.2: By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and children and those in vulnerable situations. SDG 11.1: By 2030, ensure access for all to adequate, safe and affordable housing and basic services, and upgrade slums.
Related national government policies and/or strategies	The Rheumatic Fever Strategy
See also	Indicator 16: Prevalence of household overcrowding Indicator 21: First Nations households with access to functioning health hardware Indicator 30: Health burden of unsafe sanitation
References	AIHW (2023) *Acute rheumatic fever and rheumatic heart disease in Australia 2017-2021*, AIHW, Australian Government, accessed 25 August 2023. AIHW and NIAA (2023) *1.06 Acute rheumatic fever and rheumatic heart diseases – Aboriginal and Torres Strait Islander Health Performance Framework,* AIHW and NIAA, Australian Government, accessed 6 February 2024. Carapetis JR, Beaton A, Cunningham MW, Guilherme L, Karthikeyan G, Mayosi BM, Sable C, Steer A, Wilson N, Wyber R and Zühlke L (2016) 'Acute rheumatic fever and rheumatic heart disease', *Nature Reviews Disease Primers* 2(15084):84, doi:10.1038/nrdp.2015.84 . Katzenellenbogen JM, Ralph AP, Wyber R and Carapetis J (2017) 'Rheumatic heart disease: infectious disease origin, chronic care approach'*, BMC Health Services Research*, 17(1):793, doi:10.1186/s12913-017-2747-5. Sims SA, Colquhoun S, Wyber R and Carapetis JR (2016) 'Global disease burden of group A streptococcus', in: Ferretti JJ, Stevens DL, Fischetti VA (eds) *Streptococcus pyogenes: basic biology to clinical manifestations*, University of Oklahoma Health Sciences Centre, Oklahoma City USA. Webb RH, Grant C and Harnden A (2015) 'Acute rheumatic fever', *British Medical Journal*, 351(8017), doi: 10.1136/bmj.h3443.

Sub domain: Indoor temperatures

18. Cold indoor temperatures

Description	Proportion of people unable to keep comfortably warm in their home during winter.
Indicator type	**Exposure**
Rationale	The WHO recommends an indoor temperature of 18 degrees Celsius to protect people from the harmful effects of cold during winter. A higher minimum temperature (greater than 18C) may be required for priority populations such as the elderly and those with chronic illnesses (WHO 2018). Evidence suggests an association between cold indoor temperatures and adverse health outcomes (WHO 2018) as cold air prevents circulation in the body and can lead to cardiovascular conditions (for example, ischemic heart disease) and strokes. It can also inflame the lungs leading to an increased risk of respiratory conditions including asthma and chronic obstructive pulmonary disease (COPD) (WHO 2018). Singh et al. (2022) found that eradicating indoor cold temperatures led to around an additional 30 Health-Adjusted Life Years (HALYs) per 1,000 people in cold housing, or an average of one and a half weeks of additional HALYs relating to cardiovascular disease alone. The annual burden of disease due to cold housing exposure is estimated to be around 30% of excess winter deaths (Braubac et al. 2011).
Definition	The ability for houses to be kept warm is seasonally dependent, and the measure of self-reported thermal comfort level is captured in both housing conditions data sets.
Numerator	Number of people who were unable to keep comfortably warm during cold winter weather in owned housing (Australian Housing Conditions Dataset). Number of people who were unable to keep comfortably warm during cold winter weather in rental housing (Australian Rental Housing Conditions Dataset).
Denominator	Total number of people in the Australian Housing Conditions Dataset. Total number of people in the Australian Rental Housing Conditions Dataset.
Possible disaggregation(s)	Age, sex, Australian states and territories.
Data source(s) and frequency	Australian Rental Housing Conditions Dataset Australian Housing Conditions Dataset

	These 2 datasets will be merged. Surveys will be conducted in 2024, 2025 and 2026. Certainty of future iterations yet to be determined. For further information about the data sources see 'Appendix D: Data sources'.
Issues	The initial data collection of the Australian Housing Conditions Dataset had a smaller sample size (around 4,500 people) and was conducted in only 3 Australian states (New South Wales, Victoria and South Australia) compared with the subsequent Australian Rental Housing Conditions Dataset that was conducted with 15,000 people Australia wide.
Interpretation	A low percentage/estimate for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 11.1: By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.
Related national government policies and/or strategies	None identified.
See also	Indicator 12: Low outdoor temperatures Indicator 13: Injury hospitalisations due to extreme weather-related events Indicator 14: Deaths due to injuries caused by extreme weather-related events
References	Braubach M, Jacobs DE and Ormandy D (2011) *Environmental burden of disease associated with inadequate housing: a method guide to the quantification of health effects of selected housing risks in the WHO European Region,* WHO (World Health Organization), Geneva, accessed 25 August 2023. Singh A, Mizdrak A, Daniel L, Blakely T, Baker E, Fleitas Alfonzo L and Bentley R (2022) 'Estimating cardiovascular health gains from eradicating indoor cold in Australia', *Environmental Health* 21(1):1–12, doi:10.1186/s12940-022-00865-9. WHO (2018) *Housing and health guidelines*, WHO, Geneva, accessed 12 January 2023.

19. Hot indoor temperatures

Description	Proportion of people unable to keep comfortably cool in their home during summer.
Indicator type	**Exposure**
Rationale	High indoor temperatures can have adverse health outcomes, although this depends on the body's ability to cool itself against heat (WHO 2018). There is no specific threshold for high

	indoor temperatures, the WHO states: 'as people are acclimatised to different temperatures in different climate regions, the optimal indoor temperature range is dependent on the specific region' (WHO 2018). High temperatures can contribute to increased rates of all-cause cardiovascular mortality and emergency hospitalisation (WHO 2018). Additionally, evidence for the effects of high indoor temperatures on health is most strongly linked to respiratory health, diabetes management and symptoms of schizophrenia and dementia (Tham et al. 2020). Other factors, such as socioeconomic position, are also associated with indoor temperatures, as people with lower incomes are more likely to live in poorly insulated housing with limited shade and air conditioning (ACOSS 2023). Additionally, those with pre-existing health conditions, children and the elderly are more susceptible to negative impacts of high temperatures (WHO 2018).
Definition	The ability for houses to be kept cool is seasonally dependent, and the measure of thermal comfort level is captured in both housing conditions data sets.
Numerator	Number of people who were unable to keep comfortably cool in their home during hot summer weather in owned housing (Australian Housing Conditions Dataset). Number of people unable to keep comfortably cool in their home during hot summer weather in rental housing (Australian Rental Housing Conditions Dataset).
Denominator	Total number of people in the Australian Housing Conditions Dataset. Total number of people in the Australian Rental Housing Conditions Dataset.
Possible disaggregation(s)	Age, sex, Australian states and territories.
Data source(s) and frequency	Australian Rental Housing Conditions Dataset. Australian Housing Conditions Dataset. These 2 datasets will be merged. Surveys will be conducted in 2024, 2025 and 2026. Certainty of future iterations is yet to be determined. For further information about the data sources see 'Appendix D: Data sources'.
Issues	The initial data collection of the Australian Housing Conditions Dataset had a smaller sample size (4,500 people) and was conducted in only 3 Australian states (New South Wales, Victoria and South Australia) compared with the subsequent

	Australian Rental Housing Conditions Dataset that was conducted with 15,000 people Australia-wide.
Interpretation	A low percentage/estimate for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 11.1: By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.
Related national government policies and/or strategies	None identified.
See also	Indicator 11: High outdoor temperatures Indicator 13: Injury hospitalisations due to extreme weather-related events Indicator 14: Deaths due to injuries caused by extreme weather-related events Indicator 28: Gastrointestinal food-borne disease notifications.
References	ACOSS (Australian Council of Social Service) (2023) *ACOSS 2023 Heat survey. How hotter days affect people on lowest incomes first, worst and hardest*, Australian Council of Social Service website, accessed 25 August 2023. Tham S, Thompson R, Landeg O, Murray KA and Waite T (2020) 'Indoor temperature and health: a global systematic review', *Public Health* 179:9–17, doi: 10.1016/j.puhe.2019.09.005. WHO (2018) *Housing and health guidelines*, WHO, Geneva, accessed 12 January 2023.

Sub-domain: Environmental noise in/near the home (non-occupational)

20. Noise

Description	Proportion of people who experience environmental noise when at home.
Indicator type(s)	**Exposure**
Rationale	Noise is a significant environmental health issue and affects a large number of people in urban areas. The WHO (2011) estimates that traffic-related noise accounts for more than 1 million healthy years of life lost annually to ill health, disability or early death in western European countries. As a result, environmental noise is the second most significant environmental factor leading to disease burden in Europe (WHO 2011). Environmental noise has both a direct and a cumulative effect on health, leading to economic and wellbeing losses (Jariwala et al. 2017). Health conditions associated with environmental noise include cardiovascular disease (such as hypertension

	and ischaemic heart disease), impaired cognitive function in children, sleep disturbance, increased mental health symptoms, hearing loss and tinnitus (Jariwala et al. 2017; WHO 2011). The European Environment Agency (EEA) has found that per year environmental noise contributes towards: • 48,000 new cases of ischemic heart disease • 12,000 premature deaths • 22 million people suffering from chronic high annoyance • 6.5 million people suffering from chronic sleep disturbance (EEA 2023).
Definition	Non-occupational environmental noise is defined as 'unwanted or harmful outdoor sound created by human activities, including noise emitted by means of transport, road traffic, rail traffic, air traffic, and from sites of industrial activity' (EU 2002).
Numerator	Number of people who are bothered by environmental noise in owned housing (Australian Housing Conditions Dataset). Number of people who are bothered by environmental noise in rental housing (Australian Rental Housing Conditions Dataset).
Denominator	Total number of people in the Australian Housing Conditions Dataset. Total number of people in the Australian Rental Housing Conditions Dataset.
Possible disaggregation(s)	Age, sex, Australian states and territories.
Data source(s) and frequency	Australian Rental Housing Conditions Dataset. Australian Housing Conditions Dataset. These 2 datasets will be merged. Surveys will be conducted in 2024, 2025 and 2026. Certainty of future iterations is yet to be determined. For further information about the data sources see 'Appendix D: Data sources'.
Issues	The initial data collection of the Australian Housing Conditions Dataset had a smaller sample size (around 4,500 people) and was conducted in only 3 Australian states (New South Wales, Victoria and South Australia) compared with the subsequent Australian Rental Housing Conditions Dataset that was conducted with 15,000 people Australia-wide. The way noise data are collected in the Australian Rental Housing Conditions Dataset and Australian Housing Conditions Dataset differs. In the rental data set exposure to environmental noise is operationalised as those who experience 'noise coming from adjoining flats, apartments or

	neighbours and noise from outside, such as traffic or construction'. The housing conditions dataset collects information about the frequency of people being bothered by 'noise when situated in an indoor home environment'.
Interpretation	A low percentage/estimate for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	None identified.
Related national government policies and/or strategies	None identified.
See also	None identified.
References	EEA (European Environment Agency) (2023) *How does environmental noise pollution impact my health?*, EEA website, accessed 1 September 2023. EU (2002) Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise, *Official Journal of the European Communities*, L 189:12–25. Jariwala HJ, Syed HS, Pandya MJ and Gajera YM (2017) 'Noise pollution & human health: a review', *Indoor and Built Environment*, 1–4. WHO (2011) *Burden of disease from environmental noise – Quantification of healthy life years lost in Europe*, WHO, Geneva, accessed 13 January 2023.

Sub domain: Housing function and utilities

21. First Nations households with access to functioning health hardware

Description	Proportion of households living in dwellings with access to working facilities, by facility type.
Indicator type	**Exposure**
Rationale	Housing is an important environmental factor for health and wellbeing. Inadequate basic facilities, such as functioning 'health hardware' (that is, kitchen, bathroom and laundry facilities that enable water-based hygiene practices) can lead to the spread of infections, including gastrointestinal, skin, and ear infections (AIHW and NIAA 2022; Ali et al. 2018). Repeated exposure to some types of infections place people at greater risk for developing certain chronic diseases, such as chronic kidney diseases and rheumatic heart disease (Kerdemelidis et al. 2010; White et al. 2010).

	Maintenance of housing quality has been shown to reduce rates of infection (Department of the Prime Minister and Cabinet 2017). First Nations people are more likely than non-Indigenous people to live in poor quality housing, and prevalence of poor-quality housing is higher in remote and very remote areas (Brackertz and Wilkinson 2017). Appropriate, affordable housing that is aligned with the priorities and needs of First Nations people is one of the socio-economic outcome areas identified in the National Agreement on Closing the Gap.
Definition	Facilities in a household are considered to be of an acceptable standard if they have 4 working facilities (for washing people, washing clothes and bedding, storing /preparing food, and sewerage) to support healthy living practices (ABS 2019). The National Aboriginal and Torres Strait Islander Health Survey defines 'household' as an occupied private dwelling where at least one permanent resident identifies as being of Aboriginal and/or Torres Strait Islander origin (ABS 2019).
Numerator	Number of First Nations households living in dwellings with access to working facilities, by facility type (for washing people/washing clothes or bedding/storing and preparing food/sewerage facilities).
Denominator	Number of First Nations households.
Possible disaggregation(s)	State and territory and remoteness area.
Data source(s) and frequency	ABS National Aboriginal and Torres Strait Islander Health Survey (NATSIHS) - about every 6 years. For further information about the data source see 'Appendix D: Data sources'.
Issues	None applicable.
Interpretation	A high percentage/estimate for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 6.2: By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and children and those in vulnerable situations. SDG 11.1: By 2030, ensure access for all to adequate, safe and affordable housing and basic services, and upgrade slums.
Related national government policies and/or strategies	National Agreement on Closing the Gap National Housing and Homelessness Agreement

See also	Indicator 16: Prevalence of household overcrowding Indicator 17: Incidence of acute rhematic fever Indicator 28: Gastrointestinal food-borne disease notifications Indicator 30: Health burden of unsafe sanitation
References	ABS (2019) *National Aboriginal and Torres Strait Islander Health Survey*, ABS website, accessed 15 February 2024. AIHW and NIAA (2022) *2.02 Access to functional housing with utilities – Aboriginal and Torres Strait Islander Health Performance Framework,* AIHW and NIAA, Australian Government, accessed 9 February 2024. Ali SH, Foster T, Hall NL (2018) 'The relationship between infectious diseases and housing maintenance in Indigenous Australian households', *International Journal of Environmental Research and Public Health*, 15(12):2827, doi:10.3390/ijerph15122827. Brackertz, N. and Wilkinson, A. (2017) Research synthesis of social and economic outcomes of good housing for Aboriginal and Torres Strait Islander People, AHURI Professional Services for Department of Prime Minister and Cabinet, Australian Housing and Urban Research Institute, Melbourne. Department of the Prime Minister and Cabinet (2017), *Remote Housing Review: a review of the National Partnership Agreement on Remote Indigenous Housing and the Remote Housing Strategy (2008–2018)*; Department of the Prime Minister and Cabinet, Australian Government. Kerdemelidis M, Lennon D, Arroll B, Peat B. and Jarman J (2010) 'The primary prevention of rheumatic fever', *Journal of Paediatrics and Child Health*, 46(9):534–548, doi: 10.1111/j.1440-1754.2010.01854.x. White A., Wong W, Sureshkumur P and Singh G (2010) 'The burden of kidney disease in indigenous children of Australia and New Zealand, epidemiology, antecedent factors and progression to chronic kidney disease', *Journal of Paediatrics and Child Health*, 46(9):504-509, doi:10.1111/j.1440-1754.2010.01851.x.

Domain: Built environment

Sub domain: Commuting to work

22. Type of transport used to travel to work

Description	Proportion of people who use public transport, private vehicle or active transport to travel to work each day.

Indicator type	**Exposure**
Rationale	The majority of Australians use private vehicles to travel to work each day (ABS 2022). While cars allow for increased mobility and convenience, a high level of dependence on cars for transport has implications for human and environmental health (Infrastructure Australia 2019). Increased car dependence reduces time spent in physical activity such as walking, increasing the risk of associated chronic diseases such as type 2 diabetes, obesity and high blood pressure (Chandrabose et al. 2019). Using active forms of transport to commute has positive benefits to health. People who actively commute have a lower risk of mortality (8% reduction), cardiovascular disease (9% reduction) and a 30% reduced risk of diabetes (Dinu et al. 2019). Patterson et al. (2020) also found positive health benefits with active forms of commuting compared with commuting by private vehicle. Additionally, living in close proximity to a mix of destinations such as public transport stops and shops has been associated with higher levels of active transport across all age groups (Boulange et al. 2017; McCormack et al. 2008; Sallis et al. 2012). Transport accounts for 18% of all of Australia's carbon dioxide emissions, with cars being the largest contributor (National Transport Commission 2022). Car dependence has environmental impacts such as increased traffic congestion and air and noise pollution. Poor air quality due to traffic emissions can be harmful to both human health and the ecosystem and tends to concentrate around major road corridors (Infrastructure Australia 2019).
Definition	The Australian Urban Observatory uses 3 data sets in GIS analysis on public transport stops, pedestrian road networks and sample points to determine how people travel to work, with a focus on those using public transport as a key indicator of liveability.
Numerator	Number of employed people aged 15 and over who travel to their workplace by mode of transport (private vehicle(s)/public transport/active transport).
Denominator	Total number of people in the estimated resident Australian population aged 15 and over who travel to their workplace.
Possible disaggregation(s)	21 Australian cities (including 8 capital cities and 13 other major cities with a population of 80,000 or more). Data are disaggregated at either a Local Government Area, suburb or SA1 level.
Data source(s) and frequency	Australian Urban Observatory (AUO) – data are currently only available for 2 time points, 2018 and 2021.

	For further information about the data source see 'Appendix D: Data sources'.
Issues	None identified.
Interpretation	Low levels of private vehicle dependence and high levels of public transport and active commuting can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 11.2: By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.
Related national government policies and/or strategies	Urban Transport Strategy National Health and Climate Strategy National Preventive Health Strategy 2021–2030.
See also	Indicator 1: Annual and daily high ambient concentration of $PM_{2.5}$ across Australia Indicator 23: Total minutes walked to get to and from places Indicator 24: Health burden of insufficient physical activity Indicator 26: Injury hospitalisations due to road traffic accidents Indicator 27: Injury deaths due to road traffic accidents.
References	ABS (2022) *Australia's journey to work*, ABS website, accessed 25 August 2023. Boulange C, Gunn L, Giles-Corti B, Mavoa S, Pettit C and Badland H (2017) 'Examining associations between urban design attributes and transport mode choice for walking, cycling, public transport and private motor vehicle trips', *Journal of Transport and Health*, 6:155–166, doi:10.1016/j.jth.2017.07.007. Chandrabose M, Rachele JN, Gunn L, Kavanagh A, Owen N, Turrell G, Giles-Corti B and Sugiyama T (2019) 'Built environment and cardio-metabolic health: systematic review and meta-analysis of longitudinal studies', *Obesity Reviews*, 20(1):41–54, doi:10.1111/obr.12759. Dinu M, Pagliai G, Macchi C and Sofi F (2019) 'Active commuting and multiple health outcomes: a systematic review and meta-analysis', *Sports Medicine*, 49(3):437–52, doi: 10.1007/s40279-018-1023-0. Infrastructure Australia (2019) *An assessment of Australia's future infrastructure needs: the Australian infrastructure audit 2019*, Infrastructure Australia, Australian Government, accessed 13 January 2023.

	McCormack GR, Giles-Corti B and Bulsara M (2008) 'The relationship between destination proximity, destination mix and physical activity behaviors', *Preventive Medicine*, 46(1):33–40, doi:10.1016/j.ypmed.2007.01.013. National Transport Commission (2022) *Carbon dioxide emissions intensity for new Australia light vehicles 2021*, National Transport Commission website, accessed 19 February 2024. Patterson R, Panter J, Vamos EP, Cummins S, Millett C and Laverty AA (2020) 'Associations between commute mode and cardiovascular disease, cancer, and all-cause mortality, and cancer incidence, using linked Census data over 25 years in England and Wales: a cohort study', *The Lancet Planetary Health*, 4(5):e186–e194, doi:10.1016/S2542-5196(20)30079-6. Sallis JF, Floyd MF, Rodriguez DA and Saelens BE (2012) 'Role of built environments in physical activity, obesity, and cardiovascular disease', *Circulation*, 125:729–737, doi:10.1161/CIRCULATIONAHA.110.969022.

Sub domain: Walkability

23. Total minutes walked to get to and from places

Description	Average number of minutes walked in the last week to get to and from places per person.
Indicator type	**Exposure**
Rationale	Neighbourhood walkability is a measure of how 'friendly' an area is for pedestrian walking and can be used to determine levels of physical activity and active travel (Frank et al. 2005; Gebel et al. 2009; Owen et al. 2004; Sallis et al. 2004). People are more likely to walk for recreation or exercise if they live in neighbourhoods that are within a walkable distance of destinations (including public transport services), have well-connected streets and higher residential densities (Gebel et al. 2009; Kamruzzaman et al. 2016). Cities such as Melbourne have adopted the concept of the '20-minute neighbourhood' to facilitate walkability; that is, people are able to meet most of their daily needs within a 20-minute return walk from home (about 800m walk from home to a destination and back again), with access to safe cycling and local transport options to improve community liveability (State Government of Victoria 2021). Utilising this concept could facilitate less private vehicle usage and subsequently reduce traffic congestion, noise, and air pollution.
Definition	Physical activity can be measured in a variety of ways depending on type of exercise. Walking to get to and from

	places is defined as being carried out for at least 10 minutes continuously. Subsequently, it excludes activities such as walking around a shopping centre as people tend to frequently pause while shopping. Data are captured based on hours and minutes. Crude and age-standardised rates (directly age-standardised to the 2001 Australian population) will be reported.
Numerator	Total minutes walked in the last week per person to get to and from places by: • adults aged 18 and over • adolescents aged 15–17.
Denominator	Total population of: • adults aged 18 and over • adolescents aged 15–17.
Possible disaggregation(s)	Socioeconomic area, remoteness area, age, sex, state and territory, and geographical disaggregations at the smallest level possible (for example, SA4 and Local Government Area level).
Data source(s) and frequency	ABS National Health Survey – data are available every 3 years. For further information about the data source see 'Appendix D: Data sources'.
Issues	Due to COVID-19 the survey was completed online, which is likely to affect the results. Therefore, data for 2020–21 is a break in time series and should be used only for point-in-time analysis.
Interpretation	A low percentage/estimate for this indicator can be interpreted as a negative result.
Related SDG goal/target(s)	None identified.
Related national government policies and/or strategies	National Preventive Health Strategy 2021–2030 National Health and Climate Strategy
See also	Indicator 22: Type of transport used to travel to work Indicator 24: Health burden of insufficient physical activity Indicator 25: Proximity to public open spaces greater than 1.5 hectares

References	Frank LD, Schmid TL, Sallis JF, Chapman J and Saelens BE (2005) 'Linking objectively measured physical activity with objectively measured urban form: findings from SMARTRAQ', *American Journal of Preventive Medicine*, 28(2):117–125. Gebel K, Bauman A, Owen N, Foster S and Giles-Corti B (2009) *Position statement: the built environment and walking*, National Heart Foundation of Australia, accessed 13 January 2023. Kamruzzaman MD, Washington S, Baker D, Brown W, Giles-Corti B and Turrell G (2016) 'Built environment impacts on walking for transport in Brisbane, Australia', *Transportation*, 43:53–77, doi:10.1007/s11116-014-9563-0. Owen N, Humpel N, Leslie E, Bauman A and Sallis JF (2004) 'Understanding environmental influences on walking: review and research agenda', *American Journal of Preventive Medicine*, 27(1):67–76, doi:10.1016/j.amepre.2004.03.006. Sallis JF, Frank LD, Saelens BE and Kraft MK (2004) 'Active transportation and physical activity: opportunities for collaboration on transportation and public health research', *Transportation Research Part A: Policy and Practice*, 38(4):249–268, doi:10.1016/j.tra.2003.11.003. State Government of Victoria (2021) *20-minute neighbourhoods*, State Government of Victoria website, accessed 28 August 2023.

24. Health burden of insufficient physical activity

Description	Health burden of insufficient physical activity – attributable fatal (YLL), non-fatal burden (YLD) and deaths.
Indicator type	**Effect**
Rationale	Insufficient physical activity is the 9th leading preventable cause of ill health and premature death (AIHW 2021a). Low levels of physical activity are a major risk factor for chronic conditions. People who are not active enough have a greater risk of developing cardiovascular disease, type 2 diabetes, osteoporosis and dementia. Being physically active improves mental and musculoskeletal health and reduces other risk factors such as overweight and obesity, high blood pressure and high blood cholesterol. Physical activity can also improve symptoms, delay, or halt the progression of a number of conditions, or the onset of associated disease and complications (Pedersen and Saltin 2015).

	Many built environment factors have been associated with physical activity levels, such as: • neighbourhood walkability where walkable distance to destinations (including public transport services), street connectivity and higher residential densities have been associated with increased walking (Gebel et al. 2009; Kamruzzaman et al. 2016). • living in close proximity to parks (Mavoa et al. 2016; Sugiyama et al. 2010) • active travel (AIHW 2022) • car dependence (Chandrabose et al. 2019). In 2018, the proportion of total disease burden attributable to insufficient physical activity for the following linked diseases was: • 20% of type 2 diabetes • 16% of coronary heart disease • 16% of uterine cancer • 12% of bowel cancer • 12% of dementia • 9.2% of stroke • 3.2% of breast cancer (AIHW 2021a).
Definition	Attributable burden is the disease burden attributed to a particular factor. It is the reduction in fatal (YLL) and non-fatal (YLD) burden as well as deaths that would have occurred if exposure to the risk factor had been avoided (or more precisely had been at its theoretical minimum) (see Glossary). Physical inactivity was described based on the total activities per week including categories for leisure, transportation, occupational and household activity using the measure of Metabolic Equivalent of Task (METs). A higher MET was associated with greater energy expended. Prevalence was estimated from the proportion of people within each activity category once the METs were summed. See Australian Burden of Disease Study methods for more details (AIHW 2021b). Crude and age-standardised rates (directly age-standardised to the 2001 Australian population) will be reported.
Numerator	Number of YLD attributable to insufficient physical activity.

	Number of YLL attributable to insufficient physical activity. Number of deaths attributable to insufficient physical activity.
Denominator	Total population aged 20 and over.
Possible disaggregation(s)	Sex, age, socioeconomic area, remoteness area, state and territory.
Data source(s) and frequency	AIHW Australian Burden of Disease Study – data available about every 3 years. Specific related conditions include: • coronary heart disease • dementia • type 2 diabetes • bowel cancer • stroke • breast cancer • uterine cancer. For further information about the data source see 'Appendix D: Data sources'.
Issues	See Australian Burden of Disease methods report for more details (AIHW 2021b). Exposure to physical activity used in the calculation of attributable burden, was estimated in METs calculated from self-reported data in the National Health Survey 2017–18, for activity for leisure, transport and occupation. Activity from gardening, and strengthening and toning were from the Australian Health Survey 2011–12. Household chores data were obtained from the 2006 ABS Time Use Survey.
Interpretation	A lower value can be interpreted as a positive result.
Related SDG goal/target(s)	None identified.
Related national government policies and/or strategies	Physical activity and exercise guidelines for all Australians National Preventive Health Strategy 2021–2030 National Climate and Health Strategy
See also	Indicator 1: Annual and daily high ambient concentration of $PM_{2.5}$ across Australia Indicator 22: Type of transport used to travel to work

	Indicator 23: Total minutes walked to get to and from places Indicator 25: Proximity to public open spaces greater than 1.5 hectares.
References	AIHW (2021a) *Australian Burden of Disease Study 2018: Interactive data on risk factor burden*, AIHW, Australian Government, accessed 1 September 2023. AIHW (2021b) *Australian Burden of Disease Study: Methods and supplementary material 2018*, AIHW, Australian Government, accessed 22 February 2024. AIHW (2022) *Built environment and health*, AIHW, Australian Government, accessed 1 September 2023. Chandrabose M, Rachele JN, Gunn L, Kavanagh A, Owen N, Turrell G, Giles-Corti B and Sugiyama T (2019) 'Built environment and cardio-metabolic health: systematic review and meta-analysis of longitudinal studies', *Obesity Reviews*, 20(1):41–54, doi:10.1111/obr.12759. Gebel K, Bauman A, Owen N, Foster S and Giles-Corti B (2009) *Position statement: the built environment and walking*, National Heart Foundation of Australia, accessed 1 September 2023. Kamruzzaman MD, Washington S, Baker D, Brown W, Giles-Corti B and Turrell G (2016) 'Built environment impacts on walking for transport in Brisbane, Australia', *Transportation*, 43:53–77, doi:10.1007/s11116-014-9563-0. Mavoa S, Davern M, Breed M and Hahs A (2019) 'Higher levels of greenness and biodiversity associate with greater subjective wellbeing in adults living in Melbourne, Australia', *Health & Place*, 57:321–329, doi:10.1016/j.mehy.2011.02.040. Pedersen B and Saltin B (2015) 'Exercise as medicine – evidence for prescribing exercise as therapy in 26 different chronic diseases', *Scandinavian Journal of Medicine and Science in Sports,* 25:1–72, doi: 10.1111/sms.12581. Sugiyama T, Francis J, Middleton NJ, Owen N and Giles-Corti B (2010) 'Associations between recreational walking and attractiveness, size, and proximity of neighborhood open spaces', *American Journal of Public Health,* 100(9):1752–1757,doi:10.2105%2FAJPH.2009.182006.

Sub domain: Public open space

25. Proximity to public open spaces greater than 1.5 hectares

Description	Proportion of dwellings within 400m of a public open space larger than 1.5 hectares.
Indicator type	**Exposure**
Rationale	Having access to high-quality public open spaces is important as it encourages people to be physically active and has physical and mental health benefits (Rozek et al. n.d.). Spending time in public open spaces (including green space) has been linked to a variety of health outcomes and behaviours including: • improvements in mental health and lower psychological distress (Rozek et al. n.d.) • reduced likelihood of overweight or obesity (Rozek et al. n.d.) • reduced cardiovascular disease (Liu at al. 2022) • increased physical activity levels. For example, Sugiyama et al. (2010) found that adults who lived within 1.6 km of larger attractive public open spaces were more likely to walk for 150 minutes or more per week. In many local climates, particularly urban areas, heat is a key concern for environmental and human health. Green space, a significant feature in many public open spaces, mitigates excess heat through solar shading, modification of wind flow, and evapotranspiration (Gunawardena et al. 2017). On average, vegetated urban parks are estimated to be 0.94 degrees Celsius cooler during the day than their surrounding built or non-green environment (Bowler et al. 2010). Because of their cooling potential, increasing the proportion of green space has been considered a potential mitigation strategy against urban heat islands and extreme heat (Gunawardena et al. 2017). Urban heat islands are suggested to increase energy costs (for example, through air conditioning), air pollution levels and heat-related illness and mortality (US EPA 2023).
Definition	The Australian Urban Observatory defines public open spaces as ‘areas such as parks and recreational reserves, public gardens, nature reserves, civic areas and open promenades where everyone has the right to visit without being excluded due to economic or social conditions’ (AUO n.d.). Access to public open space will be measured by distance (within 400 m) and size of public open spaces (1.5 hectares) (AUO n.d.).

Numerator	Number of dwellings within 400 m of a public open space greater than 1.5 hectares in urban areas of each city.
Denominator	Number of dwellings in urban areas of each city.
Possible disaggregation(s)	21 Australian cities (including 8 capital cities and 13 other major cities with a population of 80,000 or more). Data are disaggregated at a Local Government Area, suburb or SA1 level.
Data source(s) and frequency	Australian Urban Observatory (AUO) – data are currently only available for only 2 time points, 2018 and 2021. For further information about the data source see 'Appendix D: Data sources'.
Issues	Public open space data capture access only and do not measure usability. Research has shown that the following factors are associated with people's use of public open spaces: • distance and quantity of spaces • well-connected and walkable street networks • quality and characteristics (for example, safety, maintenance, aesthetics • size • amenities (Rozek et al. n.d.). At present there are no ongoing data collections to measure factors associated with utilisation of public open spaces.
Interpretation	A high percentage can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 11.7: By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.
Related national government policies and/or strategies	National Preventive Health Strategy 2021–2030
See also	Indicator 23: Total minutes walked to get to and from places Indicator 24: Health burden of insufficient physical activity.
References	AUO (Australian Urban Observatory) (n.d.) *Public Open Space*, AUO website, accessed 28 August 2023. Bowler D, Buyung-Ali L, Knight TM and Pullin AS (2010) 'Urban greening to cool towns and cities: a systematic review of the empirical evidence', *Landscape and Urban Planning*, 97(3):147–155, doi:10.1016/j.landurbplan.2010.05.006. Gunawardena K, Wells M and Kershaw T (2017) 'Utilising green and blue space to mitigate urban heat island intensity',

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Sub domain: Road safety

26. Injury hospitalisations due to road traffic accidents

Description	Annual number of road traffic injury hospitalisations, by mode of transport.
Indicator type	**Effect**
Rationale	Transport accidents were the third highest cause of injury hospitalisations in Australia in 2021–2022 (AIHW 2023). While road safety depends on factors including driver characteristics, vehicle quality, legislation and behaviour, environmental factors are also significant contributors. These include: • Climate and weather – climate and weather conditions affect road users, for example, by reducing visibility and road friction, decreasing vehicle and/or driver performance, and increasing road traffic volume, which in turn can lead to increased motor vehicle accidents (Rowland et al. 2007; Theofilatos and Yannis 2014; Zou et al. 2020). • Remoteness – increasing remoteness is linked to higher rates of transport injury hospitalisations. In 2021–22, there were 205 hospitalisations per 100,000 in *Major cities*, compared with 465 and 482 hospitalisations per 100,000 people in *Remote* and *Very remote* areas respectively (AIHW 2023).

	• The built environment – The National Road Safety Strategy 2021–2030 recognises that achieving the goal of zero deaths due to road traffic accidents by 2050 requires a Movement and Place approach (Infrastructure and Transport Ministers 2021). This recognises the importance of safe road design in ensuring safety for all road users, including pedestrians and cyclists.
Definition	Hospitalisations due to injuries caused by road traffic accidents are collected in the National Hospital Morbidity Database (NHMD). The NHMD is a comprehensive data set that has records for all episodes of admitted patient care from all public and private hospitals in Australia. In the NHMD, records are presented by hospital cases (discharges, transfers, deaths, or changes in care type) by time period. For more detailed information on coding of hospitalisations data, see the *Injury in Australia* technical notes (AIHW 2023). Crude and age-standardised rates (directly age-standardised to the 2001 Australian population) will be reported.
Numerator	Number of hospitalised injury cases by mode of transport: • car occupants • motorcyclists • pedal cyclists • pedestrians • other or unspecified.
Denominator	Total number of people in the estimated resident Australian population.
Possible disaggregation(s)	Sex, age, remoteness area, state and territories, First Nations people.
Data source(s) and frequency	AIHW National Hospital Morbidity Database – data available annually. For further information about the data source see 'Appendix D: Data sources'.
Issues	Cases do not include episodes of non-admitted care provided in outpatient clinics or emergency departments. Refer to *Injury in Australia* technical notes for further details about injury hospitalisation data (AIHW 2023).
Interpretation	A low percentage/estimate (across all modes of transport) for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 3.6: By 2020, halve the number of global deaths and injuries from road traffic accidents.

	SDG 11.2: By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.
Related national government policies and/or strategies	National Road Safety Strategy 2021–2030 National Road Safety Action Plan 2023–2025
See also	Indicator 9: Annual declared natural disasters Indicator 11: High outdoor temperatures Indicator 12: Low outdoor temperatures Indicator 22: Type of transport used to travel to work Indicator 27: Injury deaths due to road traffic accidents
References	AIHW (2023) *Injury in Australia*, AIHW, Australian Government, accessed 16 February 2024. Infrastructure and Transport Ministers (2021) *National Road Safety Strategy 2021-2030*, Department of Infrastructure, Transport, Regional Development and Communications, Australian Government, accessed 23 February 2024. Rowland B, Davey J, Freeman J and Wishart D (2007) 'Road transport sensitivities to weather and climate change in Australia', 30th Australasian Transport Research Forum papers, Australian Government Department of Transport and Regional Services. Theofilatos A and Yannis G (2014) 'A review of the effect of traffic and weather characteristics on road safety', *Accident Analysis and Prevention*, 72:244–256, doi: 10.1016/j.aap.2014.06.017. Zou Y, Zhang Y and Kai C (2021) 'Exploring the impact of climate and extreme weather on fatal traffic accidents', *Sustainability*, 13:390.

27. Injury deaths due to road traffic accidents

Description	Annual number of road traffic injury deaths, by mode of transport.
Indicator type	**Effect**
Rationale	Transport accidents were the fourth highest cause of injury deaths in Australia in 2021–2022 (AIHW 2023b). While road safety depends on various factors including driver characteristics, vehicle quality, legislation and behavioural factors, environmental factors are also significant contributors. These include:

	• Climate and weather – climate and weather conditions affect road users, for example by reducing visibility and road friction, decreasing vehicle and/or driver performance, and more road traffic volume, which in turn can lead to increased motor vehicle accidents (Rowland et al. 2007; Theofilatos and Yannis 2014; Zou et al. 2020). • Remoteness – increasing remoteness is linked to higher rates of road deaths. In 2021–22, there were 2.8 deaths per 100,000 in *Major cities*, compared with 19 and 25 deaths per 100,000 people in *Remote* and *Very remote* areas respectively (AIHW 2023). • The built environment –The National Road Safety Strategy 2021–30 recognises that achieving the goal of zero deaths due to road traffic accidents by 2050 requires a Movement and Place approach (Infrastructure and Transport Ministers 2021). This recognises the importance of safe road design in ensuring the safety of all road users, including pedestrians and cyclists.
Definition	Deaths resulting from injuries due to traffic accidents are collected in the AIHW National Mortality Database (NMD). It is compulsory to register all deaths in Australia, and information about a person's death is recorded on a death certificate, certified either by a medical practitioner or by the Coroner. The Australian Bureau of Statistics (ABS) is the agency responsible for coding according to the ICD-10-AM and publishing deaths data. The National Coronial Information System provides additional details to the ABS about those deaths which required certification by a coroner. Most deaths resulting from injury require certification by a coroner. In these cases, additional information regarding external cause coding is required. For more detailed information on coding of deaths data, see the *Injury in Australia* technical notes (AIHW 2023). Crude and age-standardised rates (directly age-standardised to the 2001 Australian population) will be reported.
Numerator	Number of deaths resulting from injuries, by mode of transport: • car occupants • motorcyclists • pedal cyclists • pedestrians • other or unspecified.
Denominator	Total number of people in the estimated resident Australian population.

Possible disaggregation(s)	Sex, age, remoteness area, state and territories, First Nations people.
Data source(s) and frequency	AIHW National Mortality Database (NMD) – data available annually. For further information about the data source see 'Appendix D: Data sources'.
Issues	Refer to *Injury in Australia* technical notes for further details about injury deaths data (AIHW 2023).
Interpretation	A low percentage/estimate for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 3.6: By 2020, halve the number of global deaths and injuries from road traffic accidents. SDG 11.2: By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.
Related national government policies and/or strategies	National Road Safety Strategy 2021–2030 National Road Safety Action Plan 2023–2025.
See also	Indicator 9: Annual declared natural disasters Indicator 11: High outdoor temperatures Indicator 12: Low outdoor temperatures Indicator 22: Type of transport used to travel to work Indicator 26: Injury hospitalisations due to road traffic accidents
References	AIHW (2023) *Injury in Australia*, AIHW, Australian Government, accessed 16 February 2024. Infrastructure and Transport Ministers (2021) *National Road Safety Strategy 2021–2030*, Department of Infrastructure, Transport, Regional Development and Communications, Australian Government, accessed 23 February 2024. Rowland B, Davey J, Freeman J and Wishart D (2007) Road transport sensitivities to weather and climate change in Australia, 30th Australasian Transport Research Forum Papers, Australian Government Department of Transport and Regional Services. Theofilatos A and Yannis G (2014), 'A review of the effect of traffic and weather characteristics on road safety', *Accident Analysis and Prevention*, 72:244–256, doi:10.1016/j.aap.2014.06.017.

	Zou Y, Zhang Y and Kai C (2021) 'Exploring the impact of climate and extreme weather on fatal traffic accidents', *Sustainability*, 13:390.

Domain: Food environment

Sub domain: Food-borne diseases

28. Gastrointestinal food-borne disease notifications

Description	Notifications of gastrointestinal illnesses associated with food pathogens – campylobacteriosis and salmonellosis.
Indicator type	**Effect**
Rationale	Having access to safe and nutritious food is essential for good health. Each year in Australia 4.7 million cases of food poisoning are reported, resulting in around 47,900 hospitalisations and nearly 40 deaths (Food Safety Information Council 2023). *Campylobacter* is the most commonly notified case of gastroenteritis in Australia. However, over the last 20 years notifications of salmonella have also substantially increased (Food Regulation Standing Committee 2018). The WHO (n.d.) has indicated that the globalisation of food trade, increasing population, climate change and rapidly changing food systems can affect food safety and subsequent food-borne illness. Several environmental factors relating to the climate have been linked to exacerbating the frequency and severity of particular foodborne pathogens. These include increased and decreased temperature, rainfall and humidity as well as decreased pH and salinity (for example, in oceans) (Duchenne-Moutien and Neetoo 2021). There is also likely to be a dose-response relationship between temperature and food-borne illness, particularly relating to *Salmonella*. Bambrick et al. (2008) found that for each average degree increase in temperature, there was around a 5% increase in the number of notifications for salmonella in Perth and Sydney. This increased to 10% per degree in Brisbane. Changes in climatic factors are likely to affect food-borne illness by influencing: - sources and mode of transmission from pathogens - growth and survival - microbial ecology (FAO 2008). Research conducted by Zhang et al. (2012) also suggested that with rising temperature and demographic changes, YLD due to *Salmonella* infection is estimated to increase by 31%–87% in temperate Australian regions and 87%–143% in

	subtropical Australian regions by 2050, compared with YLD in 2000.
Definition	The National Notifiable Diseases Surveillance System (NNDSS) reports the number of case notifications of campylobacteriosis and salmonellosis in Australia. Refer to the NNDSS Dashboard for details on data availability by year for diseases.
Numerator	Annual number of notifications for campylobacteriosis. Annual number of notifications for salmonellosis.
Denominator	Not applicable.
Possible disaggregation(s)	State and territory, sex, age.
Data source(s) and frequency	National Notifiable Diseases Surveillance System (NNDSS) – data are continually available (fortnightly and annually). For further information about the data source see 'Appendix D: Data sources'.
Issues	States and territories report cases in different ways, which can affect the quality and completeness of information. Additionally, notifications for some high-volume conditions are uploaded only quarterly by some jurisdictions, which can result in apparent large variability over time. Notifications are based on laboratory confirmation from clinical specimens, and in some cases, notifications from clinicians based on symptoms. However, many people do not present to the health system when suffering from the disease, and so the NNDSS notification numbers are known to be an under-report of actual cases. It has been estimated that for every 100 campylobacteriosis notifications there are approximately 700 cases of salmonella and 1000 cases of campylobacteriosis in the community (Hall et al. 2008).
Interpretation	A low percentage/estimate for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	None identified.
Related national government policies and/or strategies	Australia's Foodborne Illness Reduction Strategy 2018–2021+
See also	Indicator 9: Annual declared natural disasters Indicator 11: High outdoor temperatures Indicator 19: Hot indoor temperatures

	Indicator 21: First Nations households with access to functioning health hardware Indicator 30: Health burden of unsafe sanitation.
References	Bambrick H, Dear K, Woodruff R, Hanigan I and McMichael A (2008) *The impacts of climate change on three health outcomes: temperature-related mortality and hospitalisations, salmonellosis and other bacterial gastroenteritis, and population at risk from dengue*, Garnaut Climate Change Review, Australian Government, accessed 28 August 2023. Duchenne-Moutien RA and Neetoo H (2021) 'Climate change and emerging food safety issues: a review', *Journal of Food Protection*, 84(11):1884–1897, doi: 10.4315/JFP-21-141. FAO (Food and Agriculture Organisation of the United Nations) (2008) *Climate change: Implications for food safety*, FAO website, accessed 8 September 2023. Food Regulation Standing Committee (2018) *Australia's foodborne illness reduction strategy 2018–2021+*, Food regulation website, accessed 28 August 2023. Food Safety Information Council (2023) *Australia's Food Safety Report Card released for UN World Food Safety Day 7 June 2023,* Food Safety Information Council website, accessed 19 February 2024. Hall G, Yohannes K, Raupach J, Becker N and Kirk M (2008) 'Estimating community incidence of salmonella, campylobacter, and Shiga toxin-producing Escherichia coli infections, Australia', *Emerging Infectious Diseases*, 14(10):1601–1609, doi: 10.3201/eid1410.071042. WHO (n.d.) *Food Safety*, WHO, Geneva, accessed 28 August 2023. Zhang Y, Bi P and Hiller JE (2012) 'Projected burden of disease for salmonella infection due to increased temperature in Australian temperate and subtropical regions', *Environment International*, *44:*26–30, doi: 10.1016/j.envint.2012.01.007.

Domain: Waste

Sub domain: Waste

29. Hazardous waste generation

Description	Hazardous waste generation, by tonnes of National Environment Protection Measure (NEPM), waste type broken down by: • lead and compounds • per- and polyfluoroalkyl substances (PFAS) contaminated material

	• pesticides • contaminated soil.
Indicator type	**Exposure**
Rationale	Hazardous waste can be a risk for public health and is generated from materials that are able to be ignited and are corrosive, reactive and toxic (ABS 2013). Examples of hazardous waste include household cleaning products, aerosol sprays, automotive supplies, paints and thinners, batteries, gas bottles and pesticides (ACT Government n.d.). Some hazardous wastes become problematic only when they break down (ACT Government n.d.). Data show that hazardous waste contributes 10% to all waste generated and has increased at a rate of 6.3% per year from 2014–15 to 2019–20 (Latimer 2021). Contaminated soil is the largest contributor (35%) (Latimer 2021). For hazardous waste to cause minimal impact to human health it must be disposed of appropriately. Otherwise, health effects can occur including: • behavioural abnormalities • cancer • genetic mutations • physiological malfunctions (such as reproductive impairment and kidney failure) • physical deformations • birth defects (US EPA 2023).
Definition	Hazardous waste is measured by the number of tonnes for each category of hazardous waste.
Numerator	Number of tonnes of hazardous waste produced, by waste type.
Denominator	Not applicable.
Possible disaggregation(s)	State and territory
Data source(s) and frequency	Department of Climate Change, Energy, the Environment and Water Hazardous Waste in Australia report – data are available every 2 years. For further information about the data source see ‘Appendix D: Data sources’.
Issues	Reported hazardous waste accounts only for those that are legally reported.

Interpretation	A low amount for this indicator can be interpreted as a positive result.
Related SDG goal/target(s)	SDG 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution contaminants. SDG 11.6: By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management. SDG 12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimise their adverse impacts on human health and the environment.
Related national government policies and/or strategies	National Waste Policy 2018 National Waste Policy Action Plan 2019
See also	None identified
References	ABS (2013) *Waste Account, Australia, Experimental Estimates, 2013*, ABS website, accessed 17 January 2023. ACT Government (n.d.) *Hazardous waste*, ACT Government, accessed 29 August 2023. Latimer G (2021) *Hazardous Waste in Australia 2021*, Department of Agriculture, Water and the Environment, Australian Government, accessed 17 January 2023. US EPA (United States Environmental Protection Agency) (2023) *Health and ecological hazards caused by hazardous substances*, US EPA website, accessed 17 January 2023.

30. Health burden of unsafe sanitation

Description	Health burden of unsafe sanitation – attributable fatal (YLL) and non-fatal burden (YLD) and deaths.
Indicator type	**Effect**
Rationale	Sanitation refers to being able to access facilities for safe disposal of human waste and the ability to maintain hygienic conditions (CDC 2021). Most Australians have access to safe water and sanitation. However, inadequate access disproportionally affects First Nations people living in remote areas (Hall et al. 2017). Investment and access to WASH (Water, Sanitation and Hygiene) services has improved sanitation for First Nations

	people, although many continue to experience inadequate services, including poor maintenance of wastewater treatment facilities (Hall 2018). Data from the ABS National Aboriginal and Torres Strait Islander Health Survey 2018–19 show that in First Nations households: • 1 in 11 (9.1%) had no access to working facilities for food preparation • 4.5% had no access to working facilities to wash clothes and bedding • 2.8% had no access to working facilities to wash household residents. This was increasingly apparent in remote areas when compared with non-remote areas (AIHW and NIAA 2022). Poor sanitation is associated with living in overcrowded housing and increases the spread of infectious diseases such as respiratory illness and infections that can lead to acute rheumatic fever as well as exacerbation of chronic conditions (AIHW 2023; Clifford et al. 2015). Unsafe sanitation has also been linked to disease burden of gastrointestinal infections (AIHW 2022).
Definition	Attributable burden is the disease burden attributed to a particular factor. It is the reduction in fatal (YLL) and non-fatal (YLD) burden as well as deaths that would have occurred if exposure to the risk factor had been avoided (or more precisely had been at its theoretical minimum) (see Glossary). Unsafe sanitation is based on the number of First Nations people who self-reported living in households without working sewerage facilities. Crude and age-standardised rates (directly age-standardised to the 2001 Australian population) will be reported.
Numerator	Number of YLD attributable to unsafe sanitation. Number of YLL attributable to unsafe sanitation. Number of deaths attributable to unsafe sanitation.
Denominator	Total population of First Nations people in Australia.
Possible disaggregation(s)	Sex, and age.
Data source(s) and frequency	AIHW Australian Burden of Disease Study among First Nations people – data available approximately every 3–6 years. Reports burden of disease from unsafe sanitation due linked gastrointestinal infections. For further information about the data source see ‘Appendix D: Data sources’.

Issues	Unsafe sanitation estimates are available only for 2011 and 2018 and First Nations people.
Related SDG goal/target(s)	SDG 6.2: By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations. SDG 6.b: Support and strengthen the participation of local communities in improving water and sanitation management. SDG 11.1: By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.
Related national government policies and/or strategies	National Agreement on Closing the Gap
See also	Indicator 16: Prevalence of household overcrowding Indicator 17: Incidence of acute rhematic fever Indicator 21: First Nations households with access to functioning health hardware
References	AIHW (2022) *Australian Burden of Disease Study 2018: Interactive data on risk factor burden among Aboriginal and Torres Strait Islander people*, AIHW, Australian Government, accessed 29 August 2023. AIHW (2023) *Acute rheumatic fever and rheumatic heart disease in Australia 2017–2021*, AIHW, Australian Government, accessed 29 August 2023. AIHW and NIAA (2022) *2.02 Access to functional housing with utilities – Aboriginal and Torres Strait Islander Health Performance Framework,* AIHW and NIAA, Australian Government, accessed 19 February 2024. CDC (Centers for Disease Control and Prevention) (2021) *Sanitation & Hygiene*, CDC, United States Department of Health & Human Services, accessed 29 August 2023. Clifford HD, Pearson G, Franklin P, Walker R and Zosky GR (2015) 'Environmental health challenges in remote Aboriginal Australian communities: clean air, clean water and safe housing', *Australian Indigenous Health Bulletin,* 15(2). Hall N, Barbosa MC, Currie D, Dean AJ, Head B, Hill PS, Naylor S, Reid S, Selvey L and Willis J (2017) *Water, sanitation and hygiene in remote Indigenous Australian communities: a scan of priorities*, Global Change Institute discussion paper: Water for equity and wellbeing series, The University of Queensland, Brisbane. Hall N (2018) 'Australian Indigenous remote communities & water, sanitation & hygiene', *Water e-journal*, *3*(2):1–9.

Appendix D: Data sources

ABS Census of Population and Housing

The Australian Census of Population and housing is conducted every 5 years and most recently conducted in 2021. The survey counts every person and household in Australia including from small geographic areas and population groups. As a result, it is the most comprehensive snapshot of Australia and provides information about the economic, social and cultural make-up of the country.

More information on the Census can be found at the ABS website: https://www.abs.gov.au/census.

The data quality statement for the Census can be found on the ABS website: https://www.abs.gov.au/census/guide-census-data/census-methodology/2021/quality-declaration.

ABS National Aboriginal and Torres Strait Islander Health Survey (NATSIHS)

The NATSIHS is a household survey and collects information from First Nations people of all ages in non-remote and remote areas of Australia, including discrete First Nations communities. The survey has collected data about long-term health conditions, disability, lifestyle factors, physical harm and use of health services. The latest available data are for 2018–19 and surveys are run every 6–8 years. Previous surveys have been conducted in 2012–13 and 2004–05. The overall coverage of the 2018–19 NATSIHS was about 33% of First Nations people in Australia.

Further information on the NATSIHS can be found on the ABS website: https://www.abs.gov.au/statistics/people/aboriginal-and-torres-strait-islander-peoples/national-aboriginal-and-torres-strait-islander-health-survey/latest-release.

The data quality statement for the NATSIHS can be found on the ABS website:

https://www.abs.gov.au/methodologies/national-aboriginal-and-torres-strait-islander-health-survey-methodology/2018-19.

ABS National Health Survey (NHS)

The NHS is a household survey that is a key source of information on the health of Australians, with a sample size of around 21,300 people. The survey provides data such as prevalence of long-term health conditions; health risk factors such as smoking, measured height weight and blood pressure, diet, exercise and alcohol consumption and demographic and socioeconomic characteristics. Surveys are usually conducted every 3 years; the latest survey used in this report was 2022–23. Surveys have been conducted in 1989–90, 1995, 2001, 2004–05, 2007–08, 2011–12 (as part of the Australian Health Survey), 2014–15, 2017–18, 2020–21 and 2022. Health surveys conducted by the ABS in 1977–78 and 1983, while not part of the NHS series, collected similar information. The NHS does not include Very remote areas of Australia, so gaps exist in the availability and coverage of health data in Very remote areas, and in information available at local level. It also excludes non-private dwellings such as hotels, motels, hospitals, nursing

homes and short-stay caravan parks and this may affect estimates for older people and those with long-term conditions that require periods of hospitalisation or long-term care.

Further information on the NHS 2022 can be found at the ABS website:

https://www.abs.gov.au/statistics/health/health-conditions-and-risks/national-health-survey-first-results/latest-release.

The data quality statement for the NHS can be found at the ABS website: https://www.abs.gov.au/methodologies/national-health-survey-methodology/2022.

AIHW Australian Burden of Disease Study (ABDS)

The ABDS provides Australian-specific burden of disease estimates for the Australian population. It currently includes national estimates of disease burden for 2003, 2011, 2015, 2018 and 2022, and risk factor attribution for 2003, 2011, 2015 and 2018. The study aims to measure the combined impact of dying prematurely, as well as living with disease. More than merely counting deaths or disease incidence and prevalence, burden of disease analysis takes into account age at death and severity of disease for all diseases, conditions and injuries, in a consistent and comparable way. The ABDS uses and adapts the methods of global studies to produce estimates that are more relevant to the Australian health policy context.

Burden of disease estimates for First Nations people are available for 2018, 2011 and 2003. Note that results cannot be compared across studies due to changes in methodology and data sources.

Further information on the ABDS can be found at the AIHW website:

https://www.aihw.gov.au/about-our-data/our-data-collections/australian-burden-of-disease.

Further information on the ABDS methodology and quality framework can be found at the AIHW website:

https://www.aihw.gov.au/reports/burden-of-disease/abds-methods-supplementary-material-2018/contents/about.

AIHW National Hospital Morbidity Database (NHMD)

The NHMD is a compilation of episode-level records from admitted patient morbidity data collection systems in Australian public and private hospitals. The scope of the NHMD is episodes of care for admitted patients in all public and private acute and psychiatric hospitals, free-standing day hospital facilities and alcohol and drug treatment centres in Australia. Hospitals operated by the Australian Defence Force, correctional authorities National Strategic Framework for Chronic Conditions: reporting framework 109 and in Australia's offshore territories may also be included. The hospital data do not include episodes of non-admitted patient care provided in outpatient clinics or emergency departments. Patients in these settings may be admitted subsequently, with the care provided to them as admitted patients being included in the NHMD.

Further information on the NHMD can be found at the AIHW website:

https://www.aihw.gov.au/about-our-data/our-data-collections/national-hospitals.

Further information relating to notes and technical appendices including data quality statements are available on the AIHW website: https://www.aihw.gov.au/reports-data/myhospitals/content/about-the-data.

AIHW National Mortality Database (NMD)

The AIHW NMD contains cause of death information provided by the registries of births, deaths and marriages and the National Coronial Information System, and coded by the ABS, for deaths since 1964. Registration of deaths is the responsibility of each state and territory's Registry of Births, Deaths and Marriages. These data are then collated and coded by the ABS and are maintained at the AIHW in the NMD.
The AIHW uses these data in various reporting activities to monitor the health of Australians and to inform policy and planning. Summaries of causes of death, including trends and deaths among different population groups, can be derived from this long-term data set.

Further information on the NMD can be found at the AIHW website:

https://www.aihw.gov.au/about-our-data/our-data-collections/national-mortalitydatabase.

The data quality statements underpinning the AIHW National Mortality Database can be found in the following Australian Bureau of Statistics (ABS) publications:

- https://www.abs.gov.au/methodologies/deaths-australia-methodology/2021
- https://www.abs.gov.au/methodologies/causes-death-australia-methodology/2021.

Australian Bureau of Meteorology Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT)

The ACORN-SAT is a data set used by the Bureau of Meteorology to monitor long-term temperature trends in Australia. It contains daily maximum and minimum temperatures from 112 weather stations across Australia which have been selected based on the quality and length of their available temperature data. Data from 60 stations contain data from 1910 to the present and 110 stations have at least 50 years of available data, with the remaining 2 stations having between 40 and 50 years of data.

Further information about the ACORN-SAT can be found on the Australian Bureau of Meteorology website: http://www.bom.gov.au/climate/data/acorn-sat/.

Australian Housing Conditions Dataset

The initial wave of the Australian Housing Conditions Survey collected data in 2016 from 4,501 participants, stratified by a sample size of 1,500 across 3 Australian states: South Australia, Victoria and New South Wales. Three states were selected for the data set to provide sufficient depth, and the set has been designed as a baseline set made available to researchers and policy stakeholders to use and build upon.

The survey collected information on topics including:

- dwelling tenure and accommodation
- construction and maintenance

- energy, indoor environment and safety
- quality and satisfaction
- health status
- demographics
- contact information.

Further information about the Australian Housing Conditions Survey can be found on the ADA Dataverse website: https://dataverse.ada.edu.au/dataset.xhtml?persistentId=doi:10.26193/RDMRD3.

Australian Rental Housing Conditions Dataset

The Australian Rental Housing Conditions Survey has been built upon the 2016 Australian Housing Conditions Dataset and in 2020 collected data on the housing conditions of 15,000 rental households across all Australian states and territories. The survey built on infrastructure of tenant households collecting information on demographic characteristics, finances and health as well as characteristics of lease arrangements: for example, dwelling condition and quality, affordability and presence of major building problems.

Further information about the Australian Rental Housing Conditions Survey can be found on the ADA Dataverse website https://dataverse.ada.edu.au/dataset.xhtml?persistentId=doi:10.26193/IBL7PZ.

Australian Urban Observatory (AUO)

The AUO collates data on urban liveability in maps across Australia's 21 largest cities and has been developed by RMIT university. Nine domains of liveability are proposed by the AUO due to their association with health and wellbeing including walkability, social infrastructure, transport, food, alcohol, public open space, employment, housing and people. Data for these indicators are available for 2018 and 2021.

Further information about the data and methods used can be found on the AUO website: https://auo.org.au/portal/metadata/.

Clean Air health Research Data and Analysis Technology (CARDAT)

The CARDAT platform collates a wide range of population, health and environmental data sets enabling environmental exposure assessment and integration with health outcomes data. The data include air pollution, weather and the built environment data in Australia and internationally. Specifically, data on air pollution are sourced directly from all government air quality monitoring stations around Australia.

Further information can be found on the CARDAT website: https://cardat.github.io/.

Department of Climate Change, Energy, the Environment and Water (DCCEEW) Hazardous Waste in Australia

The DCCEEW provides an authoritative and current snapshot of hazardous waste generation and management in Australia that includes sources, amounts, trends, types, pathways and fates of hazardous waste every 2 years.

Further information can be found on the DCCEEW website: https://www.dcceew.gov.au/environment/protection/publications/hazardous-waste-australia-2021.

Department of Home Affairs Disaster Assist

The Department of Home Affairs Disaster Assist provides information on a list of disaster - declarations in Australia for all types of hazards, such as cyclones, bushfires and floods. It also provides information on declared disasters outside Australia.

Further information can be found on the Department of Home Affairs website: https://www.disasterassist.gov.au.

Medicare Benefits Schedule data collection

The Medicare Benefits Schedule (MBS) data collection contains information on services that qualify for a benefit under the Health Insurance Act 1973 and for which a claim has been processed. The database comprises information about MBS claims (including benefits paid), patients and service providers.

MBS claims data is an administrative by-product of Services Australia administration of the Medicare fee-for-service payment system.

Further information about the MBS data collection can be found on the AIHW website: https://www.aihw.gov.au/about-our-data/our-data-collections/medicare-benefits-schedule-mbs.

National Notifiable Diseases Surveillance System (NNDSS)

The NNDSS coordinates a national surveillance data set for more than 70 diseases that pose a risk to public health in Australia, particularly if there is an outbreak. De-identified data are supplied daily from state and territory health authorities about new cases of notifiable diseases.

Further information and a full list of nationally notifiable disease can be found on the Department of Health and Aged Care website: https://www.health.gov.au/our-work/nndss.

National Rheumatic Heart Disease Data Collection

The National Rheumatic Heart Disease data collection, held by the AIHW, contains data on diagnoses of acute rheumatic fever (ARF) and rheumatic heart disease (RHD) in Australia from jurisdictional registers of notified cases. It is a collation of data from ARF/RHD clinical

registers held by certain states and territories in which ARF and/or RHD are notifiable diseases. In 2018, ARF was notifiable to state health departments in 5 Australian jurisdictions (Queensland, Western Australia, South Australia, the Northern Territory and New South Wales), while RHD was notifiable in 3 (New South Wales, Western Australia and South Australia). In New South Wales, RHD cases are notifiable only for people aged under 35 . Diagnoses of notifiable diseases are required by law to be reported to state and territory health authorities, to enable ongoing monitoring and to support public health responses.

Further information on the National Rheumatic Heart Disease Data Collection can be found on the AIHW website: https://meteor.aihw.gov.au/content/742130.

A data quality statement for the National Rheumatic Heart Disease Data Collection can be found on page 42 of the *Acute rheumatic fever and rheumatic heart disease in Australia 2017–2021* report on the AIHW website: https://www.aihw.gov.au/reports/indigenous-australians/arf-rhd/summary.

State/territory health departments sourcing data from state/territory water authorities

Agencies at all levels of government have a role in the management of Australia's water resources and engagement on water. More specifically, state and territory governments are primarily responsible for managing water within their jurisdictions.

Further information on the national and state and territory water agencies are listed on the DCCEEW website: https://www.dcceew.gov.au/water/policy/policy/water-agencies.

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See 'Appendix B: Expert consultation and feedback' for a full list of contributors.

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- Burden of Disease, First Nations Health and Welfare Group
- Burden of Disease and Mortality, Population Health Group
- Chronic Conditions
- Cancer Data and Monitoring
- Disability
- Housing and Homelessness Reporting and Development
- Injuries and System Surveillance
- Mental Health Analytics and Reporting Service
- Mental Health Information and Evidence Refinement and Evaluation
- Primary Health Care Data Development
- Specialist Capabilities
- Website and Publishing

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Abbreviations

ABS	Australian Bureau of Statistics
ABDS	Australian Burden of Disease Study
ACORN-SAT	Australian Climate Observations Reference Network – Surface Air Temperature

AIHW	Australian Institute of Health and Welfare
ARF	Acute rheumatic fever
AUO	Australian Urban Observatory
CAR	Centre for Air pollution, energy and health Research (CAR)
CARDAT	Clean Air and health Research Data and Analysis Technology
CNOS	Canadian National Occupancy Standard
COPD	Chronic obstructive pulmonary disease
DALY	Disability-adjusted life year
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DPSEEA	Driving force, Pressure, State, Exposure, Effect, Action
EHEAG	Environmental Health Expert Advisory Group
HALY	Health-adjusted life years
ICD-10	International Classification of Diseases 10th Revision
ICD-10-AM	International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification
IPCC	Intergovernmental Panel on Climate Change
JEV	Japanese encephalitis virus
MBS	Medicare Benefits Schedule
METEOR	Metadata Online Registry
NATSIHS	National Aboriginal and Torres Strait Islander Health Survey
NEPM	National Environment Protection Measure (NEPM)
NHMD	National Hospital Morbidity Database
NHMRC	National Health and Medical Research Council
NHS	National Health Survey
NMD	National Mortality Database
NNDSS	National Notifiable Diseases Surveillance System
OECD	Organisation for Economic Co-operation and Development
PAF	Population attributable fraction
PBS	Pharmaceutical Benefits Scheme
PFAS	Per- and polyfluorinated substances
$PM_{2.5}$	Particulate matter with diameters that are 2.5 micrometres (μm) or smaller
RHD	Rheumatic heart disease
RPBS	Repatriation Pharmaceutical Benefits Scheme

SDG	Sustainable development goal
UV	Ultraviolet
WHO	World Health Organization
YLD	Years lived with disability
YLL	Years of life lost

Symbols

$\mu g/m^3$	millionths of a gram of matter per cubic metre
km	kilometre
%	per cent
>	greater than

Glossary

Aboriginal and/or Torres Strait Islander people: People who have identified themselves, or have been identified by a representative (for example, their parent or guardian), as being of Aboriginal and/or Torres Strait Islander origin. See also **First Nations people.**

active travel: The process of being physically active to make a journey. Common forms of active travel are walking and cycling.

acute: A term used to describe something that comes on sharply and is often brief, intense and severe.

aeroallergen: An airborne substance or inhalant that causes allergic reactions – includes pollen, spores and non-biological airborne particles (Aung 2019).

age-standardised rates: are incidence, or prevalence rates that enable comparisons to be made between populations that have different age structures. The age structures of the different populations are converted to the same 'standard' structure, and then the rates that would have occurred with that structure are calculated and compared. Rates can be expressed in many ways, for example, per 100,000 per population years, per 100,000 population and per 1,000 population.

air pollutants: Pollutants that include ozone (O3), nitrogen dioxide (NO2), particulate matter (PM10 or 2.5), carbon monoxide (CO), sulfur dioxide (SO2) and biological allergens.

attributable burden: The amount of burden that could be reduced if exposure to the risk factor had been avoided.

Australian Statistical Geography Standard (**ASGS**): Common framework defined by the Australian Bureau of Statistics for collecting and disseminating geographically classified statistics.

built environment: The human-made surroundings where people live, work and recreate. It includes buildings and parks as well as supporting infrastructure such as transport, water and energy networks (Coleman 2017).

burden of disease: The quantified impact of a disease or injury on a population, using the **disability-adjusted life years (DALY)** measure. Referred to as 'health burden' in this report.

causal: A relationship between 2 events, where one event is the result of the occurrence of the other event (ABS n.d.a.).

chronic: Persistent and long-lasting.

communicable disease: An **infectious disease** or illness that may be passed directly or indirectly from one person to another.

conceptual framework: A way to organise concepts and ideas on a specific subject matter. For the purposes of this report, a conceptual framework assists with interpreting and determining the relationship between the environment and health (Hambling et al. 2011).

crude rate: A rate derived from the number of events recorded in a population during a specified time period, without adjustments for other factors such as age (see **age-standardised rates**).

dwelling: A structure or discrete space within a structure intended for people to live in, or where a person or group of people live.

effect: Health effects induced due to exposure to environmental hazards. This can vary by type, intensity and magnitude of **exposure** (WHO 1999).

excess mortality: Typically defined as the difference between the total number of deaths in a specified period and the expected numbers of deaths in that same period (ABS 2023a).

exposure: Interaction/contact between people and hazards in the environment; for example, inhalation, ingestion or skin absorption of environmental pollution (WHO 1999).

extreme weather event: An unusual weather event or phenomenon at the extreme of a 'typical' historical distribution, such as a violent storm, exceptionally high levels of rainfall, or a heatwave or drought that is longer or hotter than normal.

fatal burden: Quantified impact on a population of premature death due to disease or injury. Measured as years of life lost **(YLL)**.

First Nations people: People who have identified themselves, or have been identified by a representative (for example, their parent or guardian), as being of Aboriginal and/or Torres Strait Islander origin.

green space: Urban land covered by vegetation of any kind. This covers vegetation on private and public land, irrespective of size and function, and can also include small water bodies such as ponds, lakes or streams (blue spaces).

health: A term relating to whether the body (including the mind) is in a well or ill state. With good health, the state of the body and mind are such that a person feels and functions well and can continue to do so for as long as possible.

health outcome: A change in the health of an individual or population due wholly or partly to a preventive or clinical intervention.

heatwave: A heatwave is defined as 3 or more consecutive days of high maximum and minimum temperatures that are unusual for a location (Bureau of Meteorology n.d.).

incidence: The number of new cases (of an illness or event, and so on) occurring during a given period. Compare with **prevalence**.

Index of Relative Socio-Economic Disadvantage (**IRSD**): One of the sets of Socio-Economic Indexes for Areas for ranking the average socioeconomic conditions of the population in an area. It summarises attributes of the population such as low income, low educational attainment, high unemployment and jobs in relatively unskilled occupations.

indicator: A key statistical measure selected to help describe (indicate) a situation concisely so as to track change, progress and performance; and to act as a guide for decision making.

Indigenous status: A term used to describe whether or not a person identifies as being of **First Nation** origin.

infectious disease: A disease or illness caused by an infectious agent (bacteria, viruses, parasites and fungi and their toxic products). Many infectious diseases are also **communicable diseases**.

Medicare-subsidised services: Services listed in the Medicare Benefits Schedule that result in a payment of Medicare benefit.

mental health: A state of wellbeing in which the person realises their own abilities, can cope with normal stresses of life, can work productively and can contribute to the community. Mental health is the capacity of individuals and groups to interact with one another and their

environment in ways that promote subjective wellbeing, optimal development and the use of cognitive, affective and relational abilities.

monitoring (of public health): A process of keeping a regular and close watch over important aspects of the public's health and health services through various measurements, and then regularly reporting on the situation, so that the health system and society more generally can plan and respond accordingly. The term is often used interchangeably with surveillance, although surveillance may imply more urgent watching and reporting, such as the surveillance of infectious diseases and their epidemics.

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

mortality: The number or rate of deaths in a population during a given time period.

natural environment: A setting that includes all vegetation and animal species (including micro-organisms), habitats and landscapes on Earth, but excludes aspects of the environment that result from human activities. The natural environment includes air, water and climate.

non-fatal burden: The quantified impact on a population of ill health due to disease or injury. Measured as years lived with disability **(YLD)**, which is also sometimes referred to as years of healthy life lost due to disability.

notifiable disease: A group of communicable diseases that are reported to state and territory health departments, as required by legislation. The information enables public health responses and the monitoring of disease activity.

occupational exposures and hazards: Chemical, biological, psychosocial, physical and other factors in the workplace that can potentially cause harm.

$PM_{2.5}$: Atmospheric particulate matter (PM) that have a diameter of 2.5 micrometres (0.0025 millimetres) or less.

prevalence: The number or proportion (of cases, instances, and so forth) in a population at a given time. For example, in relation to cancer, refers to the number of people alive who had been diagnosed with cancer in a prescribed period (usually 1, 5, 10 or 26 years). Compare with **incidence**.

remoteness areas: these regions are defined by the **Australian Statistical Geography Standard (ASGS)** and based on the Accessibility/Remoteness Index of Australia which uses the road distance to goods and services (such as general practitioners, hospitals and specialist care) to measure relative accessibility of regions around Australia.

social determinants of health: The circumstances in which people are born, grow up, live, work and age, and the systems put in place to deal with illness. These circumstances are in turn shaped by a wider set of forces: economics, social policies and politics.

socioeconomic areas: Based on the **Index of Relative Socio-Economic Disadvantage**, part of the **Socio-Economic Indexes for Areas (SEIFA)** created from Census data, which aims to represent the socioeconomic position of Australian communities and reflect the overall or average level of disadvantage of the population in an area.

Socio-Economic Indexes for Areas (**SEIFA**): A set of indexes, created from Census data, that aim to represent the socioeconomic position of Australian communities and identify areas of advantage and disadvantage. The index value reflects the overall or average level of disadvantage of the population of an area; it does not show how individuals living in the same area differ from each other in their socioeconomic group.

thunderstorm asthma: The triggering of an asthma attack by environmental conditions directly caused by a local thunderstorm.

trachoma: An infectious disease of the eye caused by *Chlamydia trachomatis* bacteria. If left untreated, follicles (small groups of cells) form on the upper eyelids and grow larger until they invade the cornea, eventually causing blindness.

µg/m^3: Millionths of a gram of matter per cubic metre of air, water or other fluid.

ultraviolet (**UV**) **radiation**: Part of the electromagnetic spectrum emitted by the sun. It has major importance to human health, particularly in relation to vitamin D production, the functioning of the immune system, and the formation of skin cancers and cataracts.

urban heat islands: Urban areas that are significantly warmer than surrounding rural or natural areas due to human activities and land uses.

vector-borne disease: Human illnesses caused by parasites, viruses and bacteria that are transmitted by vectors (WHO 2020).

walkability: A measure of how conducive an area is to walking.

wider determinants: A diverse range of social, economic and environmental factors which influence people's mental and physical health (Public Health England 2018).

years lived with disability (**YLD**): A measure calculated as the prevalence of a condition, multiplied by a disability weight for that condition. YLD represent **non-fatal burden**. Sometimes referred to as years of healthy life lost due to disability (YLD).

years of life lost (**YLL**): For each new case, years of life lost equals the number of years between premature death and the standard life expectancy for the individual.

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Related publications

The following AIHW reports might be of interest:

- AIHW (2024) *Geography and time-specific health data for environmental analysis*, AIHW, Australian Government, accessed 8 March 2024.
- AIHW (2022) *Australian Burden of Disease Study 2018: Interactive data on risk factor burden among Aboriginal and Torres Strait Islander people*, AIHW, Australian Government, accessed 10 October 2023.
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Climate change and environmental health indicators: reporting framework was developed to meet identified gaps in both the National Preventive Health Strategy and the National Health and Climate Strategy. This report describes a framework and 30 indicators for measuring and monitoring how climate change and the environment (both natural and built) impact on the Australian population's health. This report details the methods used in developing the framework, indicator specifications and data gaps.

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