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# Sleep problems as a risk factor for chronic conditions

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Getting enough sleep is crucial for our overall health and wellbeing. While most Australians are meeting national recommendations for how much sleep is required each night, many still experience some form of sleep problem.

Poor sleep can seriously affect a person's quality of life and increase the risk of developing chronic health conditions. It also has a substantial impact on the Australian economy.

This report summarises available national and international evidence on sleep problems as a risk factor for chronic conditions. It presents data on sleep in Australia, including the prevalence of sleep problems. It also highlights the limitations of existing data and identifies potential new data sources for monitoring sleep in Australia.

## Why is sleep important?

Sleep is essential to support good health. Getting enough sleep can help with regulating appetite, metabolism and mood, as well as immune, hormonal and cardiovascular functioning (Consensus Conference Panel et al. 2015).

Sleep is also essential for healthy growth, learning and development in children, and for cognitive functioning and workplace performance in adults (Adams et al. 2017a; Astill et al. 2012; Chaput et al. 2016). Both the length and quality of sleep are associated with self-reported life satisfaction (Wilkins 2016). For most Australian adults, getting 7 to 9 hours of uninterrupted sleep is recommended.

In 2016, it was estimated that **nearly half (48%)** of all Australian adults had at least **2 sleep-related problems**



In 2018, **one-quarter of 12-13 year olds (27%)** and half of 16-17 year olds (52%) were not meeting sleep guidelines on school nights



Getting too much or too little sleep is associated with an **increased risk** of type 2 diabetes, cardiovascular disease, coronary heart disease, obesity, and death



**Women** are more likely to have **insomnia** while **men** are more likely to have **obstructive sleep apnoea**



AIHW

There is evidence to suggest that poor sleep and other sleep problems increase the risk of developing and/or aggravating some chronic conditions, including hypertension, heart disease, type 2 diabetes, stroke, and mental health conditions (Itani et al. 2017; Jike et al. 2018; Magee et al. 2009; Senaratna et al. 2016). Poor sleep is also associated with risk factors for chronic conditions, such as obesity, smoking, low physical activity, frequent consumption of fast food and excessive alcohol consumption (Gordon et al. 2019; Magee et al. 2009; Magee et al. 2012).

Sleep problems increase the risk of motor vehicle and workplace accidents (Adams et al. 2017b), and a 2017 report by Deloitte suggested that inadequate sleep contributed to more than 3,000 deaths in Australia in 2016–17 (Deloitte Access Economics 2017).

In terms of financial costs, a 2021 report by Deloitte suggested that the annual combined direct and indirect cost to the national economy from sleep disorders was \$51 billion in 2019–20 (Deloitte Access Economics 2021).

## How much sleep do we need?

How much sleep an individual needs each night may vary, as different people can have different sleep needs to support their general health and functioning. There are some broad recommendations for children and adults.

### Adults

As people age, they tend to need less sleep to support their health (Sleep Health Foundation 2015). There are no formal guidelines on sleep for adults in Australia’s Physical Activity and Sedentary Behaviour Guidelines (Department of Health 2017, 2019a). However, based on international guidelines (Hirshkowitz et al. 2015), Australia’s Sleep Health Foundation (2015) recommends the following for adults:

- 7–9 hours for 18–64 year olds;
- 7–8 hours for people aged 65 and over.

### Children and young people

According to the 24-Hour Movement Guidelines (Department of Health 2017, 2019a), children and young people need 8 to 17 hours of sleep a day, depending on their age (see Table 1).

**Table 1: Australian sleep guidelines for children and young people**

Age group	Hours of sleep recommended
Infants (under 1 year)	14 to 17 hours (for those aged 0–3 months) and 12 to 16 hours (for those aged 4–11 months) of good quality sleep, including naps during the 24-hour period
Toddlers (aged 1–2 years)	11 to 14 hours of good quality sleep, including naps during the 24-hour period, with consistent sleep and wake-up times
Pre-schoolers (aged 3–5 years)	10 to 13 hours of good quality sleep, which may include a nap, with consistent sleep and wake-up times
5–13 years	9 to 11 hours of uninterrupted sleep per night
14–17 years	8 to 10 hours of uninterrupted sleep per night

Source: Department of Health 2017, 2019a.

## What are sleep problems?

Sleep difficulties tend to be considered a problem when they occur a few times a week or more (Adams et al. 2017b). Sleep problems fall into 4 key areas (see Box 1):

- short sleep: getting less sleep than recommended for your age group;
- long sleep: sleeping longer than recommended for your age group;
- poor sleep quality, which includes taking too long to fall asleep, waking frequently or for long periods, and poor sleep efficiency;
- doctor-diagnosed sleep disorders, such as insomnia, restless leg syndrome, or obstructive sleep apnoea.

'Sleep problems' encompass a wide range of sleeping difficulties and disturbances, including trouble falling asleep, waking frequently during the night, snoring, and waking feeling unrefreshed (Adams et al. 2017b). Sleep problems can also include daytime symptoms of poor sleep such as sleepiness, fatigue, irritability, or moodiness (Adams et al. 2017b), and sleep disorders such as obstructive sleep apnoea (OSA)—where a person's breathing stops during sleep (see Box 1).

### Box 1: How much sleep is too little, and how much is too much?

While definitions of 'short' and 'long' sleep have varied over time, **short sleep** is now generally considered less than 6 hours for adults aged 18–64, and less than 5 hours for adults aged 65 and over. **Long sleep** is considered more than 11 hours for adults aged 18–25, more than 10 hours for adults aged 26–64, and more than 9 hours for adults aged 65 and over.

#### What about the quality of sleep?

While there is not yet consensus on what defines 'good quality' versus 'poor quality' sleep, several broad markers are commonly used to assess the quality of an individual's sleep. These include the time taken transitioning from being awake to falling asleep (**sleep latency**), the total time spent awake after having fallen asleep (**wakes after sleep onset**), the number of episodes awoken per night (**awakenings**), and the ratio of sleep duration to time spent in bed (**sleep efficiency**).

#### What about sleep disorders?

There are several kinds of sleep disorder, such as insomnia, restless leg syndrome, and sleep apnoea. **Insomnia** refers to a chronic difficulty initiating or maintaining sleep that leads to distress and daytime symptoms of poor sleep. **Restless leg syndrome** is a condition that causes unpleasant or uncomfortable sensations in the legs and an irresistible urge to move them that often occurs at night and can disrupt sleep. **Sleep apnoea** is a type of sleep-related breathing disorder in which breathing repeatedly stops and starts during sleep. **Obstructive sleep apnoea (OSA)** is a form of sleep apnoea caused by obstruction of the upper airway during sleep. The term sleep apnoea is used in this report when research findings have not differentiated the type of sleep apnoea, whereas the term OSA is used when findings have explicitly reported on OSA.

For more information on OSA and other sleep-related breathing disorders, see the AIHW report [Sleep-related breathing disorders with a focus on obstructive sleep apnoea](#) (AIHW 2021).

Sources: AIHW 2021; Harvey & Tang 2012; Hirshkowitz et al. 2015; Ohayon et al. 2017; Sleep Health Foundation 2015.

# How common are sleep problems in Australia?

## Adults commonly report at least 1 sleep problem

Australian adults report sleeping, on average, 7–8 hours a day (AIHW analysis of ABS 2013; Adams et al. 2017a; Wilkins 2016). This is within the recommendations outlined in Australia’s Sleep Health Foundation guidelines (2015). Despite this, 2 in 3 (66%) adults report at least 1 sleep problem and almost half (48%) of all adults report at least 2 sleep related problems (Adams et al. 2017b).

The proportion of Australian adults who experience short and long sleep varies depending on the definitions used (see Box 1). Estimates of the prevalence of short sleep vary from 12% to 18% (Adams et al. 2017a; Metse & Bowman 2020; Wilkins 2016), while estimates of long sleep vary from 3.4% to 8.0% (Adams et al. 2017a; Wilkins 2016).

Doctor-diagnosed sleep disorders occur in about 1 in 5 adults (22%) when the prevalence of OSA, restless leg syndrome, and insomnia are combined (Deloitte 2017).

Sleep problems often occur together. Short sleep is more likely in those with either OSA or insomnia, and nearly one-third (31%) of people with OSA also have symptoms of insomnia (Appleton et al. 2018).

## Sleep varies with age

According to several national surveys (see Table 2):

- There are relatively minimal differences across age groups in the average time spent sleeping (Adams et al. 2017b).
- Short sleep is more common for those aged 26–64 (Metse & Bowman 2020).
- Long sleep is more common in older age groups (65 and over) (Wilkins 2016).
- OSA is more common in middle to older age groups (45 and over) (Adams et al. 2017b).

**Table 2: Average sleep duration and prevalence of sleep problems by age**

Age (years)	Sleep time (hrs)	Short sleep	Long sleep	Poor quality sleep	OSA	Insomnia	Restless legs
18–24 <sup>(a)</sup>	7.2	13%	1.9%	22%	5.0%	26%	20%
25–34	7.1	14%	2.0%	24%	4.9%	18%	16%
35–44	7.1	20%	1.3%	26%	3.6%	16%	15%
45–54	6.8	22%	1.6%	29%	12%	21%	22%
55–64	6.9	24%	2.1%	25%	13%	23%	17%
65–74 <sup>(b)</sup>	7.0	9.2%	8.5%	20%	12%	18%	17%
75+	—	11%	15%	19%	—	—	—

OSA = obstructive sleep apnoea.

(a) Age category is 15–24 for short sleep, long sleep and poor quality sleep.

(b) Sleep time, OSA, insomnia and restless legs are reported for those aged 65 and over. The dash for those aged 75+ reflects that this data has been captured within the 65–74+ age category.

Note: Sleep time refers to average sleep duration for working nights.

Source: Adams et al. 2017b; Wilkins 2016.

## Sleep problems vary between men and women

Women are more likely than men to report short sleep, poor sleep quality, and daytime symptoms associated with poor sleep, and insomnia is up to 1.4 times more common in women than men (Adams et al. 2017b; Metse & Bowman 2020; Wilkins 2016).

Frequent and loud snoring (a key indicator and symptom of OSA) is more common in men than women, and OSA is up to 3.5 times more common in men than women (Adams et al. 2017b; Cunningham et al. 2021).

## Children and young people sleep about 10 hours a night

Children aged 5–17 sleep, on average, 9.8 hours per night (AIHW analysis of ABS 2013). This is within the recommendations outlined in Australia's sleep guidelines for children and young people, and is consistent with findings from the Longitudinal Study of Australian Children (LSAC) that most children (88%) between the ages of 6 and 11 were getting the required amount of sleep (Evans-Whipp & Gasser 2019).

There is a lack of data on doctor-diagnosed sleep disorders in Australian children. According to international data, the prevalence of OSA in children ranges from 0% to 5.7% (Marcus et al. 2012). According to Australian studies, the prevalence of habitual snoring is 11% in children aged 2–5 (Lu et al. 2003) and 15% in children aged 4–12 (Zhang et al. 2004).

There are some noteworthy age and sex differences in children and young people. These include that:

- One-quarter (27%) of 12–13 year olds were not meeting the minimum sleep guidelines on school nights.
- Over half (52%) of 16–17 year olds were not meeting the minimum sleep guidelines on school nights.
- Younger children (aged 6–11) were less likely to meet sleep requirements on non-school nights, whereas older children (aged 12–17) were less likely to meet sleep requirements on school nights.
- For children aged 12–17, more girls (13–35%) than boys (9.2–22%) reported that they did not get enough sleep.
- Boys (aged 16–17) were more likely to report that they got enough sleep when they did not meet the minimum sleep guidelines (38%), compared with girls (27%) (Evans-Whipp & Gasser 2019).

## Do sleep patterns vary for Aboriginal and Torres Strait Islander Australians?

The sleep of Aboriginal and Torres Strait Islander adults has not been extensively studied. The data available suggest Indigenous adults sleep, on average, 8 hours per night (AIHW analysis of ABS 2016). This is within the recommendations outlined in Australia's Sleep Health Foundation guidelines (2015).

The prevalence of short sleep for Indigenous adults is similar to all Australians (16%) (Deacon-Crouch et al. 2020). Long sleep is more common in Indigenous adults compared with non-Indigenous adults. For example, 41% of Indigenous adults in a national sample reported 9 hours or more sleep per night, compared with 26% of non-Indigenous adults (Deacon-Crouch et al. 2020).

Analysis of sleep problems in Indigenous adults by age and sex is lacking, as are data on doctor-diagnosed sleep disorders. One community-based study of sleep clinic patients reported that the odds of Indigenous patients having a positive diagnosis for a sleep-related breathing disorder (such as OSA) were 1.8 times as high as that of non-Indigenous patients (Woods et al. 2015; Yiallourou et al. 2019).

Aboriginal and Torres Strait Islander children (aged 5–12) sleep, on average, 10 hours per night (Deacon-Crouch et al. 2019), although there is some variability in the average amount of sleep Indigenous children get based on the consistency in their overall sleep schedule (Blunden et al. 2018; Fatima et al. 2020). Short sleep for Indigenous children has been reported at 11% (Blunden et al. 2021), while long sleep is between 4.5% and 12% (Blunden et al. 2018; Fatima et al. 2020).

The prevalence of sleep difficulties and poor quality sleep among Indigenous children ranges from 15% to 35% (Amarasena & Lalloo 2015; Priest et al. 2020). There is a lack of data on sleep disorders, however, snoring occurs in 14% of children according to 1 community-based study (Valery et al. 2004), and OSA was reported in half (51%) of the Indigenous paediatric patients in 1 sleep clinic study (Gentin 2020).

There is little difference in sleep duration based on age and sex among Indigenous children (AIHW analysis of ABS 2014; AIHW analysis of ABS 2016; Fatima et al. 2020). However, Indigenous children experience fewer sleep difficulties with age—dropping from 30% at age 1 to 17% at age 8 (Department of Social Services 2015). For Indigenous children aged 6–18 months, nearly 1 in 3 (29%) were reported to have trouble falling or staying asleep. This fell to nearly 1 in 5 (18%) for Indigenous children aged 3.5 to 4.5 years (Department of Families, Housing, Community Services and Indigenous Affairs 2009).

## What factors are associated with sleep problems?

### Adult sleep problems are linked to common sociodemographic and health factors

Several risk factors have been associated with sleep problems, such as weight, socioeconomic disadvantage, and education. These include that:

- Adults who are obese (body mass index (BMI)  $\geq 30$ ) are at greater risk of short sleep and lower sleep quality than those with a normal BMI (Astell-Burt et al. 2013; Gordon et al. 2019; Wilkins 2016).
- Adults who completed up to secondary schooling have up to 1.7 times higher odds of reporting short or long sleep and/or poor sleep quality as those who completed a technical or tertiary degree (Metse & Bowman 2020).
- Adults with depression or anxiety are at greater risk of short or long sleep (Magee et al. 2009), and are almost twice as likely to report 2 or more sleep problems as those without depression or anxiety (Adams et al. 2017b).
- Adults without a partner have 1.5 to 1.9 times higher odds of reporting short or long sleep or poor sleep quality as those with a partner (Metse & Bowman 2020).
- Adults aged 45 and over living in remote areas or the most disadvantaged neighbourhoods are more likely to report short sleep than those living in urban areas or the most advantaged neighbourhoods (Astell-Burt et al. 2013).

Employment status is also associated with sleep problems. Both short and long sleep are more common among people who are not employed, compared with those who are employed (Lallukka et al. 2018). Compared with those in paid employment, the odds of poor sleep quality are almost twice as high in those not in paid employment (Metse & Bowman 2020). Among people who are employed, each extra hour of paid work (beyond 30 hours per week) is associated with a reduction in sleep duration (Wilkins 2016).

In terms of occupation, the least hours of sleep are reported by labourers, followed by machinery operators and drivers, community and personal service workers, technicians and trades workers, and clerical and administrative workers (Wilkins 2016). The timing of work can be particularly problematic for sleep, as those who are employed in shift work are at higher risk for sleep problems than people who work 'regular' hours (e.g., 9:00 am to 5:00 pm) (see Box 2).

### **Box 2: What is shift work sleep disorder?**

Shift work is when a portion of the work occurs between 7:00 pm and 6:00 am (Wickwire et al. 2017). In 2019, around 1 in 6 people (16% of the Australian working population, or around 1.5 million people), were shift workers (ABS 2020). People who work shifts are at higher risk of sleep problems than people who work regular hours (Ohayon et al. 2009). Shift work can interrupt important physiological mechanisms, such as those responsible for hormone balance and chemical control (Jehan et al. 2017). These disturbances can have poor outcomes for health.

Shift work sleep disorder is caused by a disruption to the body's circadian rhythm (its schedule for sleep and wakefulness) due to working long or irregular hours. It is characterised by impaired alertness, insomnia, and/or excessive sleepiness (Rajaratnam et al. 2013; Wickwire et al. 2017).

Estimates from 2013 showed that about 1 in 3 (32%) Australians who worked at night suffered from shift work sleep disorder, about 1 in 11 (9.1%) of whom reported severe symptoms (Di Milia et al. 2013). Falling asleep at work occurred at least once a week for around 1 in 3 (32–36%) Australian shift workers, and the risk of accidents for shift workers was at least 60% higher than for non-shift workers (Rajaratnam et al. 2013). Shift workers are also at a heightened risk of insomnia, with prevalence estimates between 26% (Drake et al. 2004) and 45% (Chatterjee & Ambekar 2017), compared with 20% in the Australian population (Adams et al. 2017a).

Shift work sleep disorder has been associated with an increased risk of a range of illnesses, injuries, and diseases, including peptic ulcer disease, depression, type 2 diabetes, obesity, hypertension, metabolic syndrome, coronary heart disease, stroke, certain cancers, acute respiratory infections, gastrointestinal tract problems, back pain and headaches, and workplace and road accidents (Brown et al. 2009; Drake et al. 2004; Jehan et al. 2017; Jia et al. 2013; Knutsson 2003; Kubo et al. 2006; Monk & Buysse 2013; Wickwire et al. 2017).

### **Australian lifestyles may pose a risk to adequate sleep**

Australian lifestyles may not be conducive to sufficient sleep, as nearly one-quarter (23%) of Australian adults report that their typical weekday routine does not allow them to get enough sleep (Adams et al. 2017b). This is reflected in the amount of sleep adults are getting on different days of the week: sufficient sleep duration is higher on weekends (46%) than weekdays (39%), whereas short sleep is greater on weekdays (23%) than weekends (19%) (Metse & Bowman 2020).

Attempting to remedy sleep difficulties through caffeine consumption leads to further sleep problems, as those who consume higher amounts of caffeine are more likely to report sleep problems than those with lower caffeine consumption (Adams et al. 2017b).

Activities done in the hour before bed are also linked with sleep problems. Seven in 10 (70%) people who report doing work related to their job in the hour before bed at least a few nights of the week report 2 or more sleep problems—significantly more than those who do not do work related to their job before bed (37%). Moreover, about 1 in 4 (26%) adults who use the internet most nights of the week before bed report 2 or more sleep difficulties, compared with 1 in 20 (5.7%) who do not use the internet before bed (Adams et al. 2017b).

Artificial lighting (such as blue light from electronic devices), bedroom temperature, and industrial and urban noise may also interfere with people getting adequate sleep (Parliament of Australia 2019). More than one-quarter (27%) of Australians self-report sleep issues related to being woken during the night due to light, and half (50%) are woken during the night due to noise, with a slightly higher occurrence of the latter in women (55%) than men (45%) (Adams et al. 2017b).

Other lifestyle factors that increase the risk of sleep problems include frequent or excessive alcohol consumption, long work hours, sitting for extended periods of time, smoking, low physical activity, stress, and frequent consumption of fast food (Adams et al. 2017b; Astell-Burt et al. 2013; Duncan et al. 2020; Gordon et al. 2019; Liu et al. 2013; Magee et al. 2009; Magee et al. 2012; Piccolo et al. 2013; Von Reusten et al. 2012; Wilkins 2016).

## Children's sleep is influenced by weight, socioeconomic group, and birth order

Factors that increase the risk of poor sleep in children and young people are similar to those in adults:

- Children (aged 12–13) who are obese are less likely to meet sleep recommendations (63%) than those with a normal BMI (75%) (Evans-Whipp & Gasser 2019).
- Children in low socioeconomic groups are less likely to meet sleep recommendations on non-school nights (64%) than those in high socioeconomic groups (71%) (Hardy et al. 2016).

Unique risk factors in children (aged 12–13) include that youngest-born children are less likely to meet sleep guidelines (69%) than first-borns (77%) (Evans-Whipp & Gasser 2019), and children from English-speaking backgrounds are less likely to meet sleep recommendations (75%) than children and adolescents from Asian cultural backgrounds (82%) (Hardy et al. 2016).

## Children may be at risk of 'yo-yo sleeping'

The routines associated with school and development mean that children and young people may be at risk of 'yo-yo sleeping', characterised by cyclical states of sleep deprivation on school days followed by catch-up sleep on weekends. Results from the LSAC (Evans-Whipp & Gasser 2019) show that:

- Children aged 12–17 are more likely to meet the minimum sleep guidelines on non-school nights than school nights.
- A greater proportion of 12–13 year olds do not meet the minimum sleep guidelines in families whose parents do not enforce regular bedtimes (45%) compared with children with regular bedtimes (21%).

Despite these findings, earlier research showed that failure to meet minimum sleep guidelines was most pronounced on Sundays (27%), compared with the rest of the week (15–19%) (Olds et al. 2010).

Technology use and school activities are further related to sleep issues in children (Evans-Whipp & Gasser 2019). Meeting the minimum sleep guidelines is less likely in:

- children aged 12–15 with internet access in their bedroom, compared with those with no internet access in their bedroom;
- 12–17 year olds who spend more than 5 hours a week on homework, compared with those who spend between 1 and 3 hours a week on homework;
- 14–17 year olds who had been absent from school 3 or more times without permission, compared with those who had never been absent from school, in the preceding 6 months;
- 14–17 year olds who had been late to school 3 or more times, compared with those who had never been late to school, in the preceding 6 months.

Similar to Australian adults, caffeine use may exacerbate sleep difficulties in children, as the likelihood of not meeting the minimum sleep guidelines in 14–15 year olds is increased from 24% with no caffeine intake to 33% with caffeine consumption (Evans-Whipp & Gasser 2019).



# What factors are associated with sleep problems for Aboriginal and Torres Strait Islander Australians?

There is a lack of analysis of risk factors for sleep problems in Aboriginal and Torres Strait Islander adults. A recent report found that Indigenous adults who were overweight or obese had higher odds of short sleep, however this association was not statistically significant (Deacon-Crouch et al. 2020).

Aboriginal and Torres Strait Islander children are faced with some unique risk factors compared with other groups. After controlling for age, sex, household income, and socioeconomic group, Indigenous status is associated with less sleep on average when compared with non-Indigenous status among children (Deacon-Crouch et al. 2019). Children who experience racial discrimination or with primary carers who experience racial discrimination have around 2 times the odds of persistent sleep difficulties, compared with those who had reported not experiencing racial discrimination (Shepherd et al. 2017).

Similar to non-Indigenous children:

- Sleep decreases with age, with 12-year-old Indigenous children sleeping less than 6-year-old Indigenous children (Blunden et al. 2021; Deacon-Crouch et al. 2018).
- Indigenous boys are more likely to snore than Indigenous girls (Valery et al. 2004).
- Compared with Indigenous children with a normal BMI, Indigenous children who are obese get less sleep on average (21 minutes less on average per night for boys, and 12 minutes less on average per night for girls) (Deacon-Crouch et al. 2018).
- Remoteness is associated with sleep difficulties. The proportion of Indigenous children (7.5–9 years old) who report less than 10 hours of sleep is 3.4 times as high in those living in extreme geographic isolation as those living in urban areas (Department of Social Services 2015).

The types of sleep difficulties experienced by Indigenous children vary with age. For example, teething and illness or pain are common reasons for sleep difficulties for those aged 6–30 months, while for those 42 months and over, overexcitement and nightmares are the most common reasons for sleep difficulties (Department of Families, Housing, Community Services and Indigenous Affairs 2009).

## What is the relationship between sleep problems and chronic conditions?

### Adults with chronic conditions commonly report sleep problems

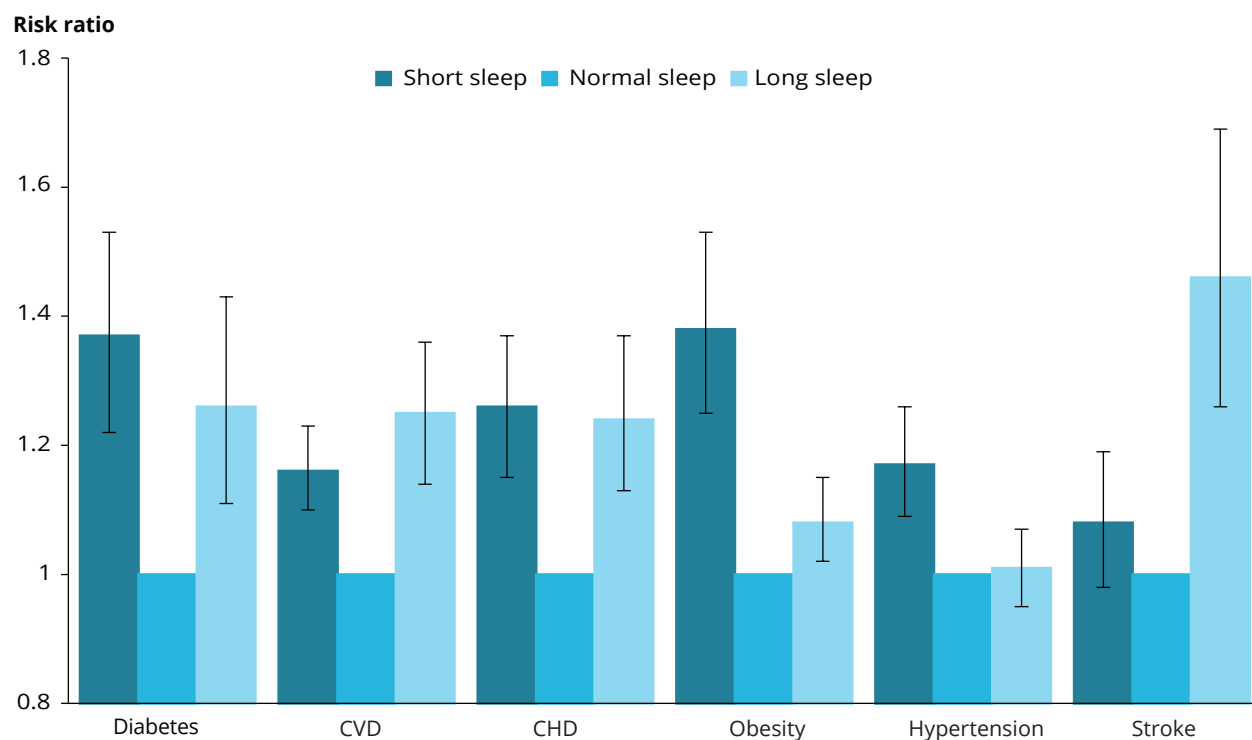
Sleep problems and chronic conditions frequently occur together. About two-thirds of Australians aged 18 and over with diabetes, heart disease, hypertension, arthritis, or any cardio-metabolic or mental health condition, report at least 1 sleep difficulty or problem (Appleton et al. 2018). When compared with adults with no chronic conditions, the likelihood of any self-reported sleep problem increases as the number of chronic conditions increases (Adams et al. 2017b).

### Short and long sleep increase the risk of chronic conditions

National and international longitudinal studies suggest that poor sleep—based on either short or long duration, or through sleep disorders—contributes to the development of chronic conditions.

Results from more than 100 prospective cohort studies (Chen et al. 2018; Itani et al. 2017; Jike et al. 2018), and cross-sectional data from Australia (Magee et al. 2012), provide evidence of an increase in the incidence of different conditions based on sleep duration (see Figure 1). The pattern reflects a ‘U-shape’—when compared with normal sleep duration, sleep of either short or long duration leads to an increased risk of 8–46% for a variety of conditions (Itani et al. 2017; Jike et al. 2018).

**Figure 1: Increased incidence (risk ratios) of conditions based on sleep duration**



**Notes:**

1. Numbers reflect risk ratios for incident condition outcomes. 1 reflects baseline risk (normal sleep). Numbers greater than 1 indicate an increased risk of incidence.
2. Error bars reflect 95% confidence intervals. We can be 95% confident that the confidence interval contains the true value.
3. CVD refers to cardiovascular disease. CHD refers to coronary heart disease.

Source: Chen et al. 2018; Itani et al. 2017; Jike et al. 2018; see Table S1 for data.

Exceptions include that there is insufficient evidence to suggest a significant association between short sleep and stroke (Itani et al. 2017), between long sleep and hypertension (Jike et al. 2018), and between sleep duration and cancer (Chen et al. 2018). The only Australian study to have examined the link between sleep duration and cancer examined breast cancer in women aged 18–80 and found no significant association (Girschik et al. 2013).

Evidence suggests there may be differences in these associations based on age and sex:

- The increased risk of cardiovascular disease with short sleep was significant only in those aged 65 and under (Itani et al. 2017).
- The increased risk of cardiovascular disease with long sleep was significant only in those aged 65 and over (Jike et al. 2018).
- The increased risk of coronary heart disease with long sleep was not significant in those aged 65 and under (Jike et al. 2018).
- The increased risk of diabetes with short sleep was significant only in men (Itani et al. 2017).
- The increased risk of hypertension with short sleep was significant only in women (Itani et al. 2017).
- The increased risk of obesity with long sleep was significant only in women (Jike et al. 2018).

Sleep duration is also associated with an increased incidence of death. Compared with normal sleep, the risk of death is increased by 12% from short sleep and 39% from long sleep (Itani et al. 2017; Jike et al. 2018).

## Sleep disorders are associated with risk factors for chronic conditions

Sleep disorders, including sleep apnoea and insomnia, have been linked to chronic conditions and their risk factors.

### Sleep apnoea is linked to obesity

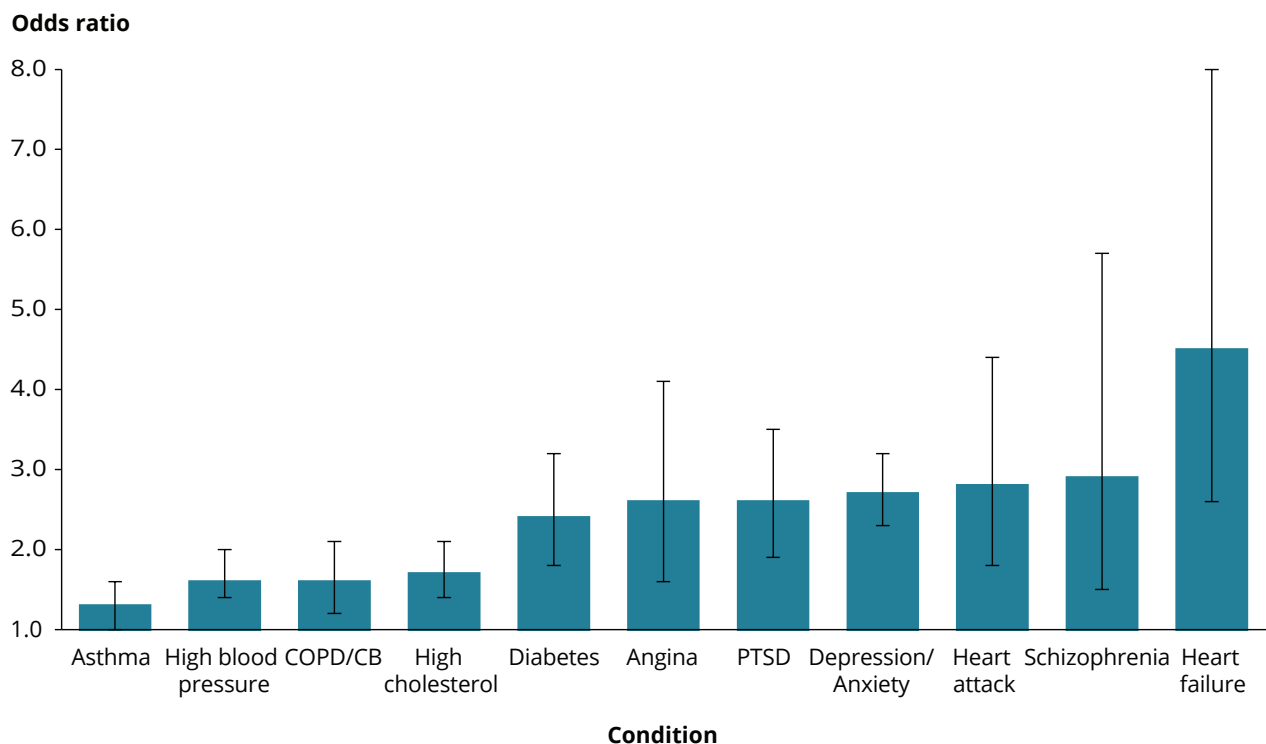
Sleep apnoea has been associated with risk factors for chronic conditions and with chronic conditions more directly. After controlling for age, sex, BMI, smoking, and daytime sleepiness, the odds of having 2 or more chronic conditions are 8.8 times higher in Australian adults with OSA compared with those without OSA (Appleton et al. 2018).

Obesity is commonly associated with OSA (Senaratna et al. 2017). Findings from 12 international studies that measured OSA with polysomnography—a sleep study used to diagnose sleep disorders—showed a higher prevalence of obesity in those with OSA (Dong et al. 2020). In Australian men, the strength of the association increases with a person’s BMI—compared with those with a normal or underweight BMI, the odds of sleep apnoea increase from 1.7 for those who are overweight, to 10.3 for those in the highest obesity category (a BMI of 40 or over), after adjusting for age and country of birth (Senaratna et al. 2016).

According to data from Ten to Men—a national study of men’s health—after controlling for age, country of birth, and BMI, men with sleep apnoea are at increased odds of several chronic conditions and risk factors, when compared with men without sleep apnoea (Senaratna et al. 2016) (see Figure 2). Similar data for Australian women with sleep apnoea is currently lacking.

Available evidence suggests that the association between sleep apnoea and cancer in men is not significant after controlling for age, country of birth and BMI (Senaratna et al. 2016).

**Figure 2: Increased odds (ORs) of chronic conditions and other risk factors in men with sleep apnoea**



**Notes:**

1. Numbers reflect odds ratios for the association between condition and sleep apnoea after adjusting for age, country of birth, and BMI.
2. Numbers greater than 1 indicate increased odds of association.
3. Error bars reflect 95% confidence intervals. We can be 95% confident that the confidence interval contains the true value.
4. COPD/CB refers to chronic obstructive pulmonary disease or chronic bronchitis. PTSD refers to post-traumatic stress disorder.

Source: Senaratna et al. 2016; see Table S1 for data.

## Insomnia is linked to depression

Australian adults with a chronic condition are no more likely to have insomnia than those without a chronic condition, however the odds of having 2 or more health conditions are 3.6 times higher in those with insomnia compared with those without insomnia (Appleton et al. 2018). The presence of at least 1 mental health condition is associated with a 4.3 times higher prevalence of insomnia (Appleton et al. 2018). Some international data also suggest that symptoms of insomnia may be related to type 2 diabetes (Cappucio et al. 2010; Johnson et al. 2021; Koopman et al. 2020).

The mental health condition most closely associated with insomnia is depression. International longitudinal studies have reported that insomnia is associated with more than twice the risk of depression, with 26 studies suggesting an association (Li et al. 2016). Of the 2 Australian studies that examined this link, both reported an association between symptoms of insomnia and onset of depression and anxiety. One study found that women aged 22–27 with self-reported sleep difficulties had more than 4 times the odds of developing depression, and almost 3 times the odds of developing anxiety, when followed up 9 years later (Jackson et al. 2014). The other study found that men aged 70–90 who self-reported difficulties falling asleep had almost twice the risk of developing depression when followed up, on average, 6 years later (Almeida et al. 2011).

Recent evidence also suggests a link between insomnia and suicidality, with international longitudinal studies showing that insomnia is a weak but significant predictor of suicide ideation, suicide attempts, and suicide deaths (Harris et al. 2020; Liu et al. 2020).

## More data is needed on children and young people

Comparatively little Australian data have examined the link between sleep problems and chronic conditions in children and young people. The LSAC found that whether children met the minimum sleep requirements did not vary based on the presence of a medical condition (Evans-Whipp & Gasser 2019), with the exception that children (aged 12–17 years) who did not meet the minimum sleep guidelines were more likely to be obese and were more likely to show symptoms of depression, anxiety and unhappiness. Data from the Western Australian Raine study also found that sleep problems at 8 years old were significantly associated with anxiety (Uren et al. 2019; Wang et al. 2016).

## Potential new data sources

A number of research groups and institutions have called for increased monitoring of sleep and sleep behaviours in Australia (Appleton et al. 2018; Parliament of Australia 2019). This section describes some new sources of data that may contribute to filling this gap.

### Information on sleep medications and pharmaceuticals may be valuable

The use of doctor-prescribed sleep medications may provide a valuable source of data on sleep. For example, data from the 2017–18 National Healthy Survey showed that about 1.0% of men and 1.2% of women in the Australian population had taken hypnotics or sedatives in the 2 weeks before the survey (AIHW analysis of ABS 2018), while results from the 2016 Sleep Health Foundation survey showed that 31% of people reporting symptoms consistent with undiagnosed OSA reported using sleep medications 3 or more nights a week (Appleton et al. 2018).

The Medicare Benefits Schedule and the Pharmaceutical Benefits Scheme (PBS) are other potential data sources for sleep monitoring in Australia. Medicare provides a number of items for general practitioners to bill sleep treatments (AIHW 2021), including referrals for diagnostic home or laboratory-based sleep studies for OSA if screening criteria are met (Department of Health 2019b). The PBS also provides some data on doctor-prescribed sleep medications.

Non-prescription and over-the-counter sleep remedies, such as herbal teas, could also provide data for sleep monitoring. Over-the-counter sleep aids are used by 1 in 8 (12%) Australians at least a few nights per month, although they are 1 of the last approaches respondents consider for sleep problems (Adams et al. 2017b).

An important limitation of any data on sleep medications is that they will likely only capture people with more serious sleep problems.

## Wearable devices can track sleep

Some consumer wearable devices, such as smart watches and fitness bands, can provide estimates of sleep time and quality. These devices use an actigraph—a sensor that measures sleep through physical movement. Actigraph devices have been found to be accurate around 82% of the time when identifying if someone is awake or asleep (Conley et al. 2019). Some of the newer generation wristband devices have been found to perform particularly well at tracking sleep time and efficiency, with more recent devices showing better performance (Haghighyegh et al. 2019).

Several factors may limit the application of this data to the broader population. Because of their cost, devices are likely to be worn by people in a higher socioeconomic group or higher income bracket. They are also likely to be used more by people who are more physically active. Wearables may also be prone to error in some populations, for example those with medical conditions that alter body movement (Conley et al. 2019).

## What are the limitations of sleep data?

While an in-depth assessment of the quality of sleep research data is beyond the scope of this report, there are several data limitations worth highlighting.

### Data rely on self-reporting

The majority of data on sleep are based on self-report. This may be a problem as people may find it difficult to estimate when they fall asleep and for how long they slept. When sleep is measured with actigraphy, self-reported sleep duration has been found to underestimate sleep time by 30 minutes (Jackson et al. 2020). Some populations may be more likely to provide skewed estimates than others. For example, insomnia can lead to overestimation of sleep latency (the transition time from wake to sleep) and underestimation of total sleep duration (Harvey & Tang 2012; Jackson et al. 2020).

It is also likely that sleep disorders are underestimated in self-reported data. For example, only 1 in 6 (16%) respondents in 1 survey had been asked about the duration or quality of their sleep when visiting a health-care clinician over the past 12 months (Metse & Bowman 2020). Of those who reported at least 1 sleep problem, only 1 in 5 (20%) had been medically assessed for the problem, and fewer than 1 in 3 (28%) had a desire for care from a health-care clinician to improve their sleep.

Sleep problems might also be underreported and underdiagnosed in certain populations, either due to the respondents' lack of knowledge or because they misjudge the adequacy of their own sleep. For example, while 2 in 3 (66%) adults have been reported to have at least 1 sleep problem, only 1 in 4 (24%) reported thinking they had a sleep problem (Adams et al. 2017b). Similarly, data from the LSAC showed that almost half (48%) of those 16–17 year olds who self-reported good sleep quality did not meet the minimum guidelines for sleep on school nights (Evans-Whipp & Gasser 2019).

## Studies measure sleep differently

There are some differences in how sleep is measured between surveys that may lead to issues with comparing results. Not all surveys account for time spent napping (e.g., the Australian Health Survey). Some surveys ask respondents about their sleep duration over a 24-hour period (e.g., the 45 and Up Study), while others ask about their sleep duration over a 30-day period (e.g., the National Social Survey).

These differences may be the source of some discrepancies in prevalence estimates between data sources. For example, self-reported estimates of insomnia range from 5.4% when queried with the question 'I slept in short bursts only and was awake most the night' (Bin et al. 2012) to 33% when measured based on self-reported difficulty initiating and maintaining sleep (Bartlett et al. 2008). Nevertheless, estimates of sleep duration and prevalence of sleep problems are, overall, relatively consistent across different surveys.

## Lack of data on the relationship between sleep problems and chronic conditions

There are not a great deal of Australian data on the relationship between sleep problems and chronic conditions. The data that have been published are dated and limited in scope. For example, a number of the Australian findings on the relationship between sleep problems and chronic conditions are based on data from the 45 and Up Study, which only looks at people from New South Wales aged 45 and over. Only 1 dataset was identified that includes data on the relationship between sleep problems and chronic conditions in a nationally representative sample (the Sleep Health Foundation Survey, Adams et al. 2017b).

Additional data for tracking the development of sleep problems and chronic conditions over time would be valuable. Some of the existing data sources are ongoing and so could be used to examine the relationship between sleep and chronic conditions if they were to collect the relevant data. Chronic disease management plans could also be an area where sleep questionnaires (Senaratna et al. 2019) might be included to provide data on those with chronic conditions. For a list of data sources on sleep, refer to Table 3.

**Table 3: Data sources for sleep in Australia**

Data source	Example of where data have been referenced
Australian Health Survey	Deacon-Crouch et al. 2020
Household, Income and Labour Dynamics in Australia Survey	Wilkins 2016
Sleep Health Foundation Survey	Adams et al. 2017a
National Social Survey	Metse & Bowman 2020
Philips Sleep Survey	Philips 2018
Tasmanian Longitudinal Health Study	Senaratna et al. 2019
West Australian Sleep Health Study	Mukherjee et al. 2012
National Mental Health and Wellbeing Survey	ABS 2008
West Australian Pregnancy Cohort (Raine) Study	Uren et al. 2019
North West Adelaide Health Survey	Adelaide Health 2020
Busselton Health Study	Busselton Population Medical Research Institute 2021
45 and Up	Magee et al. 2012
Australian Breakthrough Cancer Study	Cancer Council Victoria n.d.
West Australian Cancer Registry	Girschik et al. 2013
Australian Longitudinal Study on Women's Health	Department of Health 2015
Australian Longitudinal Study on Male's Health (Ten to Men)	BioMed Central Public Health 2021
National Aboriginal and Torres Strait Islander Nutrition and Physical Activity Survey	Blunden et al. 2021
National Aboriginal and Torres Strait Islander Health Survey	Blunden et al. 2021
Australian Health and Fitness Survey	Eisenmann et al. 2006
School Physical Activity and Nutrition Survey	Hardy et al. 2016
Longitudinal Study of Australian Children (Growing up in Australia)	Evans-Whipp & Gasser 2019
Great South Coast Childhood Obesity Monitoring Study/Goulbourn Valley Health Behaviours Monitoring Study	No published data to date
Longitudinal Study of Indigenous Children (Footprints in Time)	Fatima et al. 2020
Speak Out Against Racism Survey	Priest et al. 2020
Better Indigenous Risk Stratification for Cardiac Health (BIRCH)	Rémond et al. 2017
Sydney Sleep BioBank	Sutherland et al. 2019

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