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Prevalence of self-reported suboptimal sleep in Australia and receipt of sleep care: results from the 2017 National Social Survey

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ABSTRACT

Objectives: The National Sleep Foundation's (NSFs) sleep duration recommendations and quality indicators enable trichotomous classification of sleep parameters as 'appropriate', 'may be appropriate' or 'inappropriate', with the latter representing 'suboptimal' sleep. This study reports the prevalence of self-reported suboptimal sleep and associated demographics in a large sample of Australian adults. In addition, reported are rates of suboptimal sleep assessment by health-care clinicians/services and receipt of and desire for sleep care, and their associations with suboptimal sleep.
Design/Setting/Participants: A descriptive study (N = 1265) was undertaken using data derived from a cross-sectional telephone survey of Australian adults undertaken in 2017.
Measurement/Analysis: Descriptive statistics summarised the prevalence of suboptimal sleep, and chi-square and multivariable logistic regression analyses explored associations between suboptimal sleep, demographics and receipt of/interest in sleep care.
Results: Almost half of participants (42%) were considered to have suboptimal sleep: 19% met criteria on one parameter, 13% on 2, 11% on ≥3. The highest prevalence of suboptimal sleep was seen on measures of sleep duration (20%-23%). Participants who were single, female, middle-aged (26-64) and of low socioeconomic status were more likely to experience suboptimal sleep ($p<0.01$). Rates of assessment and treatment are currently suboptimal: 16% reported their sleep had been assessed and 10% received at least one element of sleep care, most commonly pharmacotherapy (43%).
Conclusions: Suboptimal sleep is prevalent in Australia, and rates of assessment and treatment are currently low. Finding supports the need for a coordinated population health strategy to improve the sleep health of Australians.

Introduction

Sleep of inadequate/excessive duration or poor quality, 'suboptimal sleep', is associated with significant preventable morbidity and mortality, worldwide.[1–4] A large literature identifies suboptimal sleep as a risk factor for preventable physical health conditions including obesity, cardiovascular disease, type 2 diabetes mellitus, hypertension and stroke[3,5–7]; and common mental disorders, such as depression.[8] Bidirectional relationships between suboptimal sleep and behaviours known to increase risk of chronic disease, such as physical inactivity, poor nutrition and risky alcohol consumption are also noted.[6] Australian data suggest in 2016-2017, *inadequate* sleep duration alone accounted for 228 162 disability adjusted life years (DALYs), including 162 598 years lived with a disability and 65 564 years of life lost,[9] as compared, for example, with 443 385 DALYs for all dietary risk factors in 2015.[10] A considerable economic burden was attributable to inadequate sleep duration in 2016-2017, with overall costs estimated at AUD 26.2 billion, comprising health systems costs (AUD 1.8 billion), productivity losses (AUD 17.9 billion), informal cost of care (AUD 0.6 billion) and other expenses (AUD 5.9 billion).[9] Further, in 2010 *diagnosed* sleep disorders in Australia accounted for 190 000 DALYs.[11] and were estimated to cost AUD 5.1 billion.[12] Owing to the significant health and economic burden, the Centers for Disease Control and Prevention has emphasised the need to conceptualise suboptimal sleep as a health risk behaviour and prioritise public-health investigations and interventions, internationally.[13]

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The United States' (US) National Sleep Foundation (NSF) published sleep duration recommendations in 2015 [14] and identified a number of indicators of sleep quality in 2017[15]; and the former has been endorsed by the Australasian Sleep Association. For adults (aged 26-64 years), sleep of less than 6 and greater than 10 hours is *not recommended*[14]; and self-reportable indicators of *inappropriate* sleep quality, include the following: sleep onset latency (>45 minutes); number of awakenings greater than five minutes (N >3); wake after sleep onset (>40 minutes); sleep efficiency (<75%), and number (N > 3) and duration (>100 minutes) of naps per 24-hour period.[15] Different criteria are specified for persons aged 18-25 years, 26-64 years and for persons aged 65+ years, reflecting changes to sleep that occur as a function of normal ageing.[14,15] The NSF sleep duration and quality criteria represent a consensus on signs of *suboptimal* (i.e. that which is not *recommended* or *inappropriate*) sleep, according to age, in the general population and suggest that 'sleep health' is more than merely the absence of a diagnosed 'sleep disorder'.[14,15]

A number of population-level studies, internationally, have assessed sleep duration and quality.[16–18] However, few have reported the prevalence of suboptimal sleep, classified as per NSF criteria. The most recent of such studies (N = 10, 967), using data collected as part of a series of nationally representative cross-sectional surveys in Canada between 2007 and 2013, reported the prevalence of self-reported suboptimal sleep duration.[18] For adults aged 18 to 64 years (n = 8 914), 65% reported sleep duration within the recommended range of 7 to 9 hours, with 32% and 3% reporting shorter and longer than recommended sleep duration, respectively.[18] Further, among older adults (aged 65+ years; n = 2 035), where the recommended range is 7 to 8 hours, 55% met recommendations, although 31% reported shorter than recommended duration and 15% longer.[18] Such figures closely reflect recent population-level studies undertaken in the US[19] and elsewhere.[20] To identify population subgroups at greatest risk of suboptimal sleep, associations between sleep duration and core demographics were explored. Among adults aged 18 to 64 years, those with lower levels of education (secondary school or less; 59%) were less likely than those with a bachelor's degree or higher (69%) to report recommended sleep duration. Further, for adults and older adults, household income was related to sleep duration, with a greater proportion of those earning > $80 000 (18 to 64 years: 68%; 65+ years: 63%) reporting recommended sleep duration, than those earning < $40 000 (18 to 64 years: 59%; 65+ years: 49%).[18]

No Australian research has reported the prevalence of suboptimal sleep, classified as per the NSF sleep duration and quality criteria.[14,15] Two population-level surveys of Australian adults[16,17] within the last decade, however, have reported on sleep duration and quality without reference to such criteria . The most recent survey , undertaken in 2016 on behalf of the Sleep Health Foundation, found that among 1 011 Australians, the mean sleep duration was 7 hours, with 12% sleeping for < 5 ½ hours and 8% for > 9 hours each night.[16] It was also reported that, at least a few times per week: 33% of participants had difficulty falling asleep, 42% woke a lot during the night, 34% woke too early and could not get back to sleep, 12% engaged in ≥ 4 naps per week and 20% took naps > 60 minutes in duration.[16] Exploration of associations between sleep parameters and demographics, including age and gender revealed difficulties with sleep maintenance increased with age and were more common among women than men.[16] However, younger adults reported shorter sleep duration and more daytime symptoms related to unrefreshing sleep.[16] It is noted that these data were collected in the context of a 'sleep' rather than general telephone survey, which may have led to reporting biases.

The second study, undertaken in the context of the 2013 Household, Income and Labour Dynamics in Australia panel survey (N = 14,571), found that 19% of participants slept < 6 hours each night and 22% for > 8 hours.[17] The authors also asked participants to subjectively rate their overall sleep quality, with 20% rating it as 'poor'.[17] Neither of the previous Australian studies[16,17] reported on all parameters identified in the NSF sleep duration and quality criteria, and the method of reporting on parameters that were assessed precluded direct comparison to such criteria, including considering different criteria for certain age groups.[14,15] In addition, exploration of factors associated with suboptimal sleep was limited to one study[16] and a small number of demographic variables. Consideration of a broader range of core demographic factors associated with suboptimal sleep, such as socioeconomic and marital status indicators,[18] in addition to gender and age,[16] would aid identification of population subgroups at greatest risk, and inform the targeting of future population health interventions.

Routine screening/assessment of chronic disease risk behaviours in health-care services increases the likelihood of detection and patient receipt of effective care.[21] In Australia,[22] and internationally,[7] there is a recognised need for routine assessment of sleep issues in health-care settings, yet few studies have explored rates of such assessment.[23–26] In 2015, a nationally representative cross-sectional survey of general practitioners (N = 1000) in Australia revealed insomnia management occurred 1.31 (95% confidence interval [CI] : 1.27 to 1.35) times per 100 patient encounters and that treatment comprised pharmacotherapy at 90% of such encounters, nonpharmacological advice at 20% and onward referral at 1%.[27] Rates of screening/assessment for broader sleep issues, however, were not reported. Further, in a US study, clinical record reviews of patients accessing support from general practitioners (N = 101) revealed evidence of limited sleep history taking in 25% of files, documentation of a sleep disorder in 9%, and referral to a sleep clinic and psychiatrist in 2% and 7%, respectively.[24] A case for routinely screening for suboptimal sleep is also strengthened by research suggesting many patients have a desire to receive sleep care.[26] For example, among ethnically diverse patients (N = 95) accessing primary care clinics in New York, 40% had a desire to receive sleep care during their upcoming appointment.[26] An indication of current rates of suboptimal sleep screening and assessment in health-care settings in Australia, and patient desire for receiving sleep care, is needed.

The present study aimed to address a lack of Australian data addressing these issues, by examining,

1. the prevalence of self-reported suboptimal sleep, categorised as per the recently published NSF sleep duration and quality criteria,[14,15] and associated demographics; and
2. rates of sleep assessment and receipt of and desire for sleep care, and their associations with suboptimal sleep.

It is expected that the highest prevalence of suboptimal sleep will be evident on measures of sleep duration, compared with other parameters [16]; women will report higher rates of suboptimal sleep[16]; and rates of sleep assessment and care receipt will be low.[23]

Participants and methods

Design

A descriptive study was undertaken using data derived from an Australian cross-sectional telephone survey: The National Social Survey (NSS). The NSS is undertaken annually by the Population Research Laboratory at Central Queensland University, Australia and comprises items assessing participant demographic information, health behaviours, chronic disease status, and quality of life. A portion of the survey is reserved for researchers affiliated with an Australian university to submit items of interest: the authors submitted items

regarding sleep duration, quality and care. The NSS incorporates quality assurance procedures, including pilot testing of all items.

The research protocol, including the process of obtaining informed consent, was approved by two Human Research Ethics Committees: The University of Newcastle (H-2017-0233) and Central Queensland University (H14/09-203).

Sample and recruitment procedure

For sampling purposes, Australia was delineated into state and territory areas. Dual frame (mobile and landline; 1:1 ratio) random digit dialling was used and random number selection approaches were used to ensure all respondents had an equal chance of being contacted.

Eligibility criteria for the survey were being: at least 18 years of age, an Australian resident, and contactable by landline or mobile telephone. When dialling mobile telephone numbers, the respondent was the person who received the phone call. For landline telephone numbers, a respondent within each household was selected using the following process to ensure an equal yet random selection of male and female participants: (1) each landline number was randomly pre-selected to target either a male or female, (2) the dwelling was confirmed to be the person's usual place of residence, (3) if there was more than one male/female in the household, then the person of the target gender with the most recent birthday was selected, and (4) if there was no-one of the targeted gender residing in the dwelling, it was designated 'not qualified'.

All respondents were briefed on the purpose and content of the survey. Verbal informed consent was obtained before commencement.

Data collection

Trained interviewers, supported by the computer-assisted telephone interviewing (CATI) system at Central Queensland University, administered the NSS. The interviews were undertaken between 17th July and 23rd August, 2017, at various times throughout the day, seven days per week. If the interviewers were unsuccessful in establishing contact on their first call, a minimum of five call back attempts were made. The average interview length was 38 minutes.

Measures

The survey items relevant to the present study were as follows: participant demographic information, suboptimal sleep parameters and desire for and receipt of sleep care.

Participant demographic information

Demographic information collected included the following items: marital status (single, widowed, divorced, separated not divorced, married, de facto), gender (male, female), age (years), Aboriginal and/or Torres Strait Islander origin (yes, no), highest level of education (pre-school, primary school, secondary school, technical or further educational institution, university or other higher education, none), paid employment (yes, no), employment status (full-time, part-time/casual, unemployed, retired/pensioner, student, home duties), state/territory of residence (selected one of the eight states/territories of Australia), and geographic distribution (city, town, rural area).

Suboptimal sleep parameters

Items were devised to directly align to NSF sleep duration recommendations and quality indicators [14,15] Separate items assessed sleep duration on weekdays and/or workdays (hours) and weekends and/or nonworkdays (hours). Measures of sleep quality included the following: sleep onset latency (minutes); number and duration (minutes) of awakenings throughout the night; frequency (days per week), number (per day) and duration (minutes) of naps; and sleep efficiency (%; calculated by combining data on sleep duration [as aforementioned] and total time in bed {[sleep duration/total time in bed] x 100}). All questions asked participants to consider their sleep and related behaviour on an average day or week.

Sleep assessment and receipt of and desire for sleep care

Three items were developed to examine rates of sleep assessment and receipt of and desire for sleep care. To examine rates of assessment (i.e. 'screening'), participants answered 'yes', 'no' or 'no contact with clinician or service' to the following question: 'In the past 12-months, have you been asked about the duration and/or quality of your sleep from a health-care clinician or service?' Receipt of care was assessed by the item: 'In the past 12-months, have you received any intervention or recommendations to improve the duration and/or quality of your sleep from a health-care clinician or service?' Response options included the following: yes, no, nil contact with a health-care clinician or service, and use of over-the-counter sleep aids without recommendation. If participants responded 'yes', the type of care provided or recommended was assessed: sleep medication, sleep aid such as continuous positive airway pressure machine or nasal strips, sleep hygiene education, psychosocial support such as cognitive behaviour therapy (CBT), or other support (such as referral to a specialist service).

Finally, to examine desire for sleep care, participants were asked to respond on a five-point Likert scale (ranging from strongly agree to strongly disagree, with an option to neither agree nor disagree) to the following statement: 'I would like to receive support to improve the duration and/or quality of my sleep from a health-care clinician or service'.

Variable transformation

In accordance with the NSF sleep duration and quality criteria,[14,15] data for sleep parameters were categorised as 'inappropriate'/'not recommended' (hereafter 'suboptimal'), 'may be appropriate' / 'uncertain' (henceforth 'may be appropriate') or 'appropriate'/ 'recommended' (hereafter 'appropriate'). Criteria for 'appropriate', 'may be appropriate' and 'suboptimal' categorisation, according to age, for each sleep parameter are outlined in Table 1.

The following variables were reduced to two or three levels for the purpose of association analyses: marital status (partnered, not partnered), age (18-25 years, 26-64 years, 65+ years),[14,15] identified to be Aboriginal and/or Torres Strait Islander (yes, no/no response), education (up to secondary school, technical/tertiary education), employment (paid employment, no paid employment), geographic distribution (city, town/rural area), sleep quality or duration assessed by health-care clinician/ service (yes, no), received intervention to improve the duration and/or quality of sleep from a health-care clinician or service (hereafter 'sleep care'; yes, no), and desire for sleep care (yes [strongly agree/agree], no [neither agree nor disagree/disagree/strongly disagree]).

For the purpose of association analyses, measures of sleep duration and quality were also reduced to two levels (suboptimal, appropriate/may be appropriate).[14,15]

Analyses

Analyses were conducted using IBM SPSS Statistics 24.

Descriptive statistics summarised participant demographic information, the prevalence and assessment of suboptimal sleep, and receipt of and desire for sleep care.

Table 1
NSF criteria for categorising sleep parameters as 'appropriate', 'may be appropriate' and 'suboptimal', according to age

Sleep parameter	Age	Appropriate	May be appropriate	Suboptimal
Sleep duration (hours)	18-25	7-9	6, 10-11	< 6, >11
	26-64	7-9	6, 10	< 6, >10
	65+	7-8	5-6, 9	<5, >9
Sleep onset latency (minutes)	18-25	≤30	>30 ≤45	>45
	26-64	≤30	>30 ≤45	>45
	65+	≤30	>30 ≤60	> 60
Awakenings (>5min)	18-25	≤1	>1 ≤3	>3
	26-64	≤1	>1 ≤3	>3
	65+	≤2	>2 ≤3	>3
Wake after sleep onset (minutes)	18-25	≤20	>20 ≤40	>40
	26-64	≤20	>20 ≤40	>40
	65+	≤30	>30	N/A
Sleep efficiency (%)	18-25	≥85	<85 ≥65	<65
	26-64	≥85	<85 ≥75	<75
	65+	≥85	<85 ≥75	<75
Naps per day (n)	18-25	0	1-2	>2
	26-64	N/A	0-3	>3
	65+	N/A	0-3	>3
Nap duration (minutes)	18-25	N/A	0-100	>100
	26-64	N/A	0-100	>100
	65+	N/A	0-100	>100
Nap frequency (days)	18-25	0	≥1	N/A
	26-64	N/A	N/A	N/A
	65+	N/A	N/A	N/A

N/A: not applicable; no: 'suboptimal' criteria.

Chi-square analyses explored univariate associations between sleep parameters and (1) all demographic variables, and (2) measures of sleep assessment and receipt of and desire for sleep care.

Demographic variables with a *p*-value of ≤ 0.25 in univariate associations were subsequently entered into multivariable logistic regression models, with both backward elimination and stepwise variable selection used. Separate models were developed for six dependent variables: sleep duration (weekdays/workdays and weekends/nonworkdays), sleep onset latency, sleep efficiency, and number and duration of awakenings. To account for multiple comparisons, the critical p-value was set at $p \leq 0.01$ for the inclusion of variables in the final models.

Results

Sample

Five thousand four hundred and fifty people were contacted and invited to participate, of which 1265 consented and completed the survey, with a response rate of 23%. Of the noncompleters, 2856 (68%) refused to participate, 804 (19%) could not be contacted, 18 (0%) commenced but did not finish the survey, and 507 (12%) did not participate for 'other' reasons. A response rate of 23% is comparable with other national telephone surveys,[28] including preceding NSS.[29]

Participant demographic data are summarised in Table 2. Comparison with the Australian Bureau of Statistics census data suggests the sample was overrepresented in terms of the number of people living outside major cities (47% versus 29%) and age (proportion ≥65 years: 35% versus 6%), and comparable in terms of the proportion who were female (53% versus 51%), had paid employment (54% versus 60%), identified to be of Aboriginal and/or Torres Strait Islander status (2% versus 3%), and lived in New South Wales, Victoria, Queensland or ACT (78% versus 80%).[30]

Prevalence of suboptimal sleep

Almost half of participants (42%) were considered to have suboptimal sleep: 19% met suboptimal criteria on one parameter, 13% on 2, 6% on 3 and 5% on ≥4 parameters, respectively. Approximately one-fifth of participants reported suboptimal sleep duration on weekdays/workdays (23%) and weekends/nonworkdays (20%) (Table 3). Of those reporting suboptimal sleep duration on the weekdays/workdays, 81% and 19% were categorised as having inadequate and excessive duration, respectively. In comparison, on weekends, fewer participants reporting suboptimal duration experienced inadequate sleep (71%), while a greater proportion had excessive sleep (29%). Fifteen percent of participants reported suboptimal sleep onset latency, and less than 10% reported suboptimal: number of awakenings per night (9%), wake after sleep onset (7%), sleep efficiency (6%), number of naps per day (1%), and nap duration (4%).

Demographic factors associated with parameters of suboptimal sleep

Variables with a p-value of ≤0.25 in the chi-square analyses and hence entered in the multivariable logistic regression models are noted in Table 2, with between four and five variables entered into each model. Significant findings are shown in Table 4 and summarised below.

Sleep duration (weekdays/workdays)

Participants without a partner were one and a half times more likely than those with a partner to report suboptimal sleep duration on weekdays/workdays ($OR = 1.50$, 95 % (CI): 1.13 to 1.99, $p = 0.01$), as were completers of up to secondary school compared with those

Table 2
Participant demographic information

	Number (%)
Marital status[1,2,3,4,5,6]	
Single (never married)	233 (18)
Widowed	106 (8)
Divorced	68 (5)
Separated not divorced	34 (3)
Married	713 (56)
De facto	104 (8)
No response	7 (1)
Gender[2,3,5,6]	
Male	598 (47)
Age, years[1,2,3,4,5,6]	
18-25	114 (9)
26-64	700 (55)
65+	443 (35)
No response	8 (1)
Identify to be Aboriginal and/or Torres Strait Islander[1,2,4,5]	
Yes	27 (2)
No	1232 (97)
Unsure/ no response	6 (1)
Highest level of education (complete or incomplete)[1,2,3,6]	
Pre-school	3 (0)
Infants/primary school	20 (2)
Secondary/high school	394 (31)
Technical or further educational institution (e.g. TAFE colleges)	243 (19)
University or other higher educational institution	598 (47)
No schooling/no response	7 (1)
Employment status[4,5,6,&]	
Employed full-time	435 (34)
Employed part-time/casual	255 (20)
Unemployed	55 (4)
Retired/pensioner	456 (36)
Student	29 (2)
Home duties	25 (2)
No response	10 (1)
State or Territory Residing[#]	
Australian Capital Territory (ACT)	19 (292)
New South Wales (NSW)	374 (30)
Northern Territory (NT)	12 (1)
Queensland (QLD)	282 (22)
South Australia (SA)	106 (8)
Tasmania (TAS)	34 (3)
Victoria (VIC)	307 (24)
Western Australia (WA)	127 (10)
No response	4 (0)
Geographic distribution[1]	
City	662 (52)
Town	278 (22)
Rural area	320 (25)
Unsure/ no response	5 (0)

Entered into multivariable regression analyses:
[1] Sleep duration (weekdays);
[2] Sleep duration (weekends);
[3] Sleep onset latency;
[4] Awakenings per night;
[5] Wake after sleep onset;
[6] Sleep efficiency.
[#] Not considered in association analyses – 'geographic distribution' deemed a more meaningful predictor.
[&] Primary employment status.

with technical/tertiary qualifications ($OR = 1.54$, 95 % CI: 1.16 to 2.05, $p < 0.001$) (Table 4). Those aged 25-64 years were 1.75 (95% CI: 1.29 to 2.38, $p < 0.001$) times more likely than those older than65+ years to report suboptimal sleep duration.

Sleep duration (weekends/nonworkdays)

Participants without a partner ($OR = 1.47$, 95 % CI: 1.09 to 1.98, $p = 0.01$), aged 26-64 ($OR = 1.63$, 95 % CI: 1.18 to 2.25, $p < 0.001$), and who completed up to secondary school ($OR = 1.74$, 95 % CI: 1.30 to 2.36, $p < 0.001$) were more likely to report suboptimal sleep duration on weekends/nonworkdays than those with a partner, older than 65+ years and completers of technical/tertiary qualifications, respectively.

Sleep onset latency

Suboptimal sleep onset latency was associated with not having a partner ($OR = 1.90$, 95 % CI: 1.35 to 2.67, $p < 0.001$), younger age (18-24: $OR = 2.70$, 95 % CI: 1.47 to 4.96, $p < 0.001$; 25-64: $OR = 2.94$, 95 % CI: 1.93 to 4.48, $p < 0.001$), lower levels of education ($OR = 1.55$, 95 % CI: 1.09 to 2.19, $p = 0.01$), and female gender ($OR = 1.65$, 95 % CI: 1.18 to 2.32, $p < 0.001$).

Awakenings per night

Participants aged 25-64 were 1.89 (95 % CI: 1.16 to 3.09, $p = 0.01$) times more likely to report suboptimal number of awakenings per night than those older than 65+ years.

Wake after sleep onset

No significant associations were found between wake after sleep onset and demographic variables considered.

Sleep efficiency

Unpaid/no employment ($OR = 1.94$, 95 % CI: 1.18 to 3.18, $p = 0.01$) was associated with an increased likelihood of suboptimal sleep efficiency.

Sleep assessment and receipt of and desire for sleep care

Sixteen percent (n = 203) of participants reported being asked about the duration and/or quality of their sleep and 10% (n = 131) received at least one element of sleep care (Table 3). The most common element of care received was medication (43%), followed by sleeping aids such as CPAP machine or nasal strips (32%), and other support (30%) (Table 3). Twenty-eight participants used over-the-counter sleep medications without prescription or recommendation, of which 10 (36%) had no contact with a service or clinician, 14 (50%) had contact but sleep care was not provided, and 4 (14%) used non-prescribed sleep medications in conjunction with care provided by a clinician or service.

One-fifth of participants (20%) indicated a desire to receive support from a health-care clinician or service to improve the duration and/or quality of their sleep (Table 3). A further 13% of participants neither had a desire nor a lack of desire for care, and the remainder (67%) had no desire to receive sleep care.

Association between suboptimal sleep and assessment receipt of and desire for sleep care

Of participants who had suboptimal sleep on at least one parameter (n = 534), 20% reported their sleep had been assessed, 14% had received at least one element of sleep care and 28% had a desire for care. In terms of sleep assessment according to specific sleep parameters, participants categorised as 'suboptimal' compared with 'appropriate' or 'may be appropriate', for sleep duration on weekdays, sleep onset latency and number of awakenings were more likely to have reported having their sleep assessed (all p-values < 0.01, Table 5). Whereas, there was no difference in assessment rates between those with and without suboptimal sleep in terms of sleep duration on weekends ($p = 0.29$), wake after sleep onset ($p = 0.06$), sleep efficiency ($p = 0.09$), number of naps ($p = 0.16$) and nap duration ($p = 0.32$). Across all sleep parameters, except nap duration and number of naps per day, those categorised as 'suboptimal' were significantly more likely than those categorised as 'appropriate or 'may be appropriate' to have received a form of sleep care (all p-values < 0.05; Table 5). With

Table 3
Prevalence of suboptimal sleep, and receipt of and desire for sleep care

	Number (%)
Sleep duration *(on weekdays/workdays)*[1]	
Appropriate	480 (39)
May be appropriate	480 (39)
Suboptimal	284 (23)
Inadequate	230 (81)
Excessive	54 (19)
Sleep duration *(on weekends/nonworkdays)*[1]	
Appropriate	575 (46)
May be appropriate	424 (34)
Suboptimal	245 (19)
Inadequate	175 (71)
Excessive	70 (29)
Sleep onset latency[2]	
Appropriate	992 (80)
May be appropriate	78 (6)
Suboptimal	177 (14)
Awakenings (> 5 minutes) per night[3]	
Appropriate	809 (65)
May be appropriate	327 (26)
Suboptimal	118 (9)
Wake after sleep onset[1]	
Appropriate	1024 (82)
May be appropriate	134 (11)
Suboptimal	86 (7)
Sleep efficiency[&,4]	
Appropriate	964 (76)
May be appropriate	141 (11)
Suboptimal	74 (6)
Nap frequency (days/week)[5]	
Appropriate	68 (5)
May be appropriate	1192 (95)
Suboptimal	N/A
Number of naps per day[6]	
Appropriate	68 (5)
May be appropriate	1181 (94)
Suboptimal	9 (1)
Nap duration[7]	
Appropriate	N/A
May be appropriate	1201 (96)
Suboptimal	52 (4)
In the past 12-months, have you been asked about the duration and/or quality of your sleep from a health-care clinician or service?	
Yes	203 (16)
No	187 (15)
Nil contact with a health-care clinician or service in the past 12-months	873 (69)
Unsure/no response	2 (0)
In the past 12-months, have you received any intervention or recommendations to improve the duration and/or quality of your sleep from a health-care clinician or service?	
No	261 (21)
Yes	131 (10)
Sleep medication recommended or prescribed[#]	56 (43)
Sleep aids such as CPAP machine or nasal strips recommended or prescribed[#]	32 (24)
Sleep hygiene education[#]	22 (17)
Psychosocial support such as cognitive behavioural therapy (CBT)[#]	9 (7)
Other support (referral to specialist service, medication advice, etc.)[#]	39 (30)
Nil contact with a health-care clinician or service in the past 12-months	873 (69)
"I would like to receive support to improve the duration and/or quality of my sleep from a health-care clinician or service."	
Strongly agree	68 (6)
Agree	172 (14)
Neither agree nor disagree	165 (13)
Disagree	588 (47)
Strongly disagree	254 (20)
Unsure/no response	18 (1)

CPAP: continuous positive airway pressure.
*p <0.05; **p <0.01; ***p <0.001.
[1] Missing: n = 21;
[2] Missing: n = 18;
[3] Missing: n = 11;
[4] Missing: n = 86;
[5] Missing: n = 5;
[6] Missing: n = 7;
[7] Missing: n = 12;
[&] Sleep efficiency on weekdays;
[#] Multiple responses permitted; N/A: not applicable.

Table 4
Association between participant demographics and suboptimal sleep across multiple parameters

Predictor	OR	95 % CI		*p*
		Lower	Upper	
Sleep duration				
(weekdays/workdays)[1]				
Marital status				
Not partnered	1.50	1.13	1.99	0.01
Partnered	1			
Age, years				
18-24	0.95	0.55	1.65	0.86
26-64	1.75	1.29	2.38	0.00
65+	1			
Education				
Up to secondary school	1.54	1.16	2.05	0.00
Technical/tertiary	1			
Sleep duration				
(weekends/nonworkdays)[1]				
Marital status				
Not partnered	1.47	1.09	1.98	0.01
Partnered	1			
Age, years				
18-24	1.55	0.91	2.62	0.11
26-64	1.63	1.18	2.25	0.00
65+	1			
Education				
Up to secondary school	1.75	1.30	2.36	0.00
Technical/tertiary	1			
Sleep onset latency[1]				
Marital status				
Not partnered	1.90	1.35	2.67	0.00
Partnered	1			
Age, years				
18-24	2.70	1.47	4.96	0.00
26-64	2.94	1.93	4.48	0.00
65+	1			
Education				
Up to secondary school	1.55	1.09	2.19	0.01
Technical/tertiary	1			
Gender				
Female	1.65	1.18	2.32	0.00
Male	1			
Awakenings per night[1]				
Age, years				
18-24	0.87	0.35	2.19	0.77
26-64	1.89	1.16	3.09	0.01
65+	1			
Sleep efficiency[1]				
Employment				
Unpaid/no employment	1.94	1.18	3.18	0.01
Paid	1			

Note. Logistic regression models were not developed for parameters regarding-naps because of either no specified 'suboptimal' category in quality recommendations or the sample categorised as such being insufficient to perform association analyses.
[1] (Reference category: Appropriate/May be appropriate).

the exception of numbers of naps per day and nap duration, participants categorised as 'suboptimal' across all parameters of suboptimal sleep were significantly more likely to desire sleep care (all *p*-values < 0.05; Table 5).

Discussion

This is the first study to report the prevalence of self-reported suboptimal sleep, as per the recently published NSF sleep duration and quality criteria,[14,15] in a large sample of Australian adults, and to explore associated demographic factors. It also provides an initial indication of current rates of assessment and care provision for sleep, and desire for such care. Nearly half of participants (42%) reported experiencing suboptimal sleep, as assessed on at least one parameter [14,15] and 24% on two or more parameters. Aligning to our hypotheses, the highest prevalence of suboptimal sleep was found to occur for measures of sleep duration; a higher proportion of women reported suboptimal sleep onset latency; and rates of care provision were low (10-16%). In addition, across multiple parameters, those that were single, middle-aged and had lower levels of education were most likely to report suboptimal sleep. One-fifth (20%) of all participants had a desire to receive sleep care from a health-care service or clinician, however, nearly twice the proportion (38%) of those with suboptimal sleep-desired care. Findings highlight the extent of suboptimal sleep in the Australian population and a need for population health interventions to address such.

In terms of the prevalence of suboptimal sleep, results from the present study are comparable with the previous surveys undertaken in Australia,[16,17] Canada[18] and elsewhere.[18] For example, nearly half of participants in the present study (42%) and those by Adams et al.[16] (33-45%)and Chaput et al.[18] (35-46%)experienced sleep of inadequate duration or quality. Further, the high prevalence of suboptimal sleep duration (23%: 18% inadequate, 4% excessive) found in the present study mirrors that of previous Australian research, where 19% of 14 571 individuals aged 15 or older reported sleeping < 6 hours each night in 2013,[17] and 12% and 8% of 1011 adults reported sleeping for < 5 ½ hours and > 9 hours, respectively, in 2016.[16] In addition, although the prevalence of suboptimal sleep duration was similar on workdays/weekdays and weekends/nonworkdays (23% compared with 20%), a higher proportion of excessive sleep duration on weekends was noted (7% compared with 4%). Such a trend, of similarly small magnitude, has been noted in previous research[16] and suggested to be related to attempts to 'catch up' on inadequate sleep duration throughout the working week on nonworkdays.

Smaller proportions of the study sample – ranging from 1% to 9% – reported suboptimal sleep with regard to most other parameters investigated. Fourteen percent, however, reported suboptimal sleep onset latency, which may suggest more adults experience difficulties with sleep initiation than maintenance. Adams et al.[16] found 33% and 24% of participants had 'difficulties falling asleep' and 'waking a lot during the night', respectively. Non-operationalisation of sleep onset latency and wake after sleep onset variables likely account for discrepancy between previous and present findings. In terms of nap duration and frequency parameters, broad criteria for what is considered to be 'appropriate' reflects a lack of consensus regarding their validity as sleep quality indicators [15] and may explain the low prevalence of suboptimal sleep with regard to these parameters.

In concordance with previous research exploring the relationship between poor sleep and sociodemographic factors, certain subgroups of the population were identified to be at higher risk, including those who were single,[31] female,[32] had lower levels of education[33] and unpaid/no employment.[33] As the present study accounted for age, such similarities suggest that accounting for normal changes to sleep that occur as a function of ageing does not appear to impact on subgroups identified to be at highest risk of suboptimal sleep. In addition, across 4 of 6 regression models, the likelihood of suboptimal sleep was higher among adults aged 26-64 than those who were older. Such findings support previous Australian research[16] challenging the notion that sleep issues are a feature of ageing and suggest that suboptimal sleep – defined as per the NSF duration and quality citeria[14,15] – is most common in middle-aged populations. To enable targeting of population health interventions, further Australian research, adopting longitudinal designs and objective sleep measures, is needed to confirm groups at highest risk of not obtaining the sleep duration and quality indicated for their age, and who therefore may be at highest risk of sleep-related morbidity and mortality.

Our findings support those of prior studies in suggesting suboptimal sleep is prevalent in Australia,[16] not routinely assessed[27]; and most commonly treated with pharmacotherapy recommendation or prescription.[27] In this study, 16% of participants reporting having

Table 5
Associations between suboptimal sleep and assessment, receipt of and desire for sleep care

Sleep parameter	Sleep assessed		Received sleep care		Desire for sleep care	
	Yes (%)		Yes (%)		Yes (%)	
Sleep duration (on weekdays/workdays)						
Appropriate/may be appropriate	15	X^2 (1) = 6.71	9	X^2 (1) = 15.1	15	X^2 (1) = 38.12
Suboptimal	21	p = 0.01	17	p = <.001	32	p < .001
		n = 1244		n = 1244		n = 1244
Sleep duration (on weekends/non-workdays)						
Appropriate/may be appropriate	16	X^2 (1) = 1.10	9	X^2 (1) = 7.35	16	X^2 (1) = 30.31
Suboptimal	18	p = 0.29	15	p = 0.01	31	p < .001
		n = 1244		n = 1244		n = 1246
Sleep onset latency						
Appropriate/may be appropriate	15	X^2 (1) = 10.20	7	X^2 (1) = 25.80	17	X^2 (1) = 25.76
Suboptimal	24	p = 0.001	21	p = <.001	33	p < .001
		n = 1247		n = 1247		n = 1247
Awakenings (> 5 minutes) per night						
Appropriate/may be appropriate	15	X^2 (1) = 13.79	9	X^2 (1) = 21.95	17	X^2 (1) = 21.06
Suboptimal	28	p = <.001	23	p = <.001	35	p < .001
		n = 1254		n = 1254		n = 1254
Wake after sleep onset						
Appropriate/may be appropriate	16	X^2 (1) = 3.62	10	X^2 (1) = 16.20	17	X^2 (1) = 25.42
Suboptimal	23	p = 0.06	23	p = <.001	40	p <.001
		n = 1244		n = 1244		n = 1244
Sleep efficiency						
Appropriate/may be appropriate	16	X^2 (1) = 2.91	10	X^2 (1) = 7.98	18	X^2 (1) = 23.81
Suboptimal	23	p = 0.09	20	p = 0.01	41	p <.001
		n = 1179		n = 1179		n = 1179
Number of naps per day						
Appropriate/may be appropriate	16	X^2 (1) = 1.98	10	X^2 (1) = 1.36	19	X^2 (1) = 0.06
Suboptimal	33	p = 0.16	22	p = 0.24	22	p =.81
		n = 1258		n = 1258		n = 1258
Nap duration						
Appropriate/may be appropriate	16	X^2 (1) = 0.98	10	X^2 (1) = 0.52	19	X^2 (1) = 2.17
Suboptimal	21	p = 0.32	14	p = 0.47	27	p =.141
		n = 1253		n = 1253		n = 1253

Note. Nap frequency (days/week) are not included due to absence of 'suboptimal' category.

their sleep assessed, with no significant difference in rates of assessment between those categorised as having 'suboptimal' sleep or otherwise across 5 of 8 parameters. With the exception of number of naps per day and nap duration, those with suboptimal sleep were more likely to have received a form of treatment ; however, this may be partially explained by such participants perhaps being more likely to raise concerns regarding sleep with their health provider. Nevertheless, notable proportions of people with suboptimal sleep on at least one parameter had not been assessed (80%) or treated (86%), representing an unmet need for care.

Improving provision of evidence-based care in health settings through the development and implementation of national clinical practice guidelines may be an important component of future population health interventions addressing suboptimal sleep in Australia.[7,34] Guidelines for other chronic disease risk behaviours such as smoking and physical inactivity stipulate that people should be made aware of guidelines and risk indicators, be proactively screened for risk by health-care clinicians, and offered evidence-based support where risk is identified.[35–37] A need for clinical practice guidelines for suboptimal sleep has been highlighted by experts in the field [7,38] and the American Heart Association.[7] Similar challenges to the implementation of guidelines as have been found for other chronic disease risk behaviours – such as a lack of clinician understanding of 'risk' and low confidence in providing assessment and treatment – will likely be encountered, and may then be addressed through evidence-based implementation strategies.[39]

The findings of the present study need be considered in the context of a number of methodological considerations. First, self-report data may have impacted our findings. Previous research suggests individuals with a history of sleep disturbance are likely to overestimate sleep disruptions and underestimate total sleep time.[40] In addition, correlations of moderate strength have been found between self-reported and objective sleep data,[41,42] however, are weaker when estimating the margins within which sleep parameters fall, perhaps resulting in an over/under estimation of the proportion of the sample categorised as having suboptimal sleep. Nevertheless, studies suggest that self-report data for sleep parameters, are, in some instances, equally predictive of sleep-related morbidity and mortality as more objective measures.[43–45] The self-report survey also precluded ability to report on sleep architecture indicators of sleep quality, though there is a poorer consensus regarding their validity,[15] and likely reduced the precision of the sleep efficiency measure (as a composite of two 'estimated' measures). Collection of objective data, at least for a subsample of participants to enable validation of self-report, would strengthen conclusions to be drawn from future population-level surveys.

Second, the validity of the NSF criteria have yet to be formally evaluated. However, they were developed via a rigorous process, including systematic reviews of relevant literature, expert input and use of quantitative techniques to synthesise findings.[14] In addition, the NSF criteria have been endorsed by numerous peak bodies related to sleep and health internationally, including the Australasian Sleep Association, and their use encouraged by individuals and clinicians when assessing sleep.[46]

Third, the cross-sectional study design limited capacity to identify antecedents to suboptimal sleep, and data for modifiable factors known to impact sleep such as work type and schedule were not collected and therefore could not be considered in regression models. Further, in 2018 Matricciani et al.[47] emphasised the need to consider sleep a multidimensional construct and to understand how sleep parameters, and their interactions, explain variance in health-related outcomes.[47] Four important facets of sleep were proposed:

duration, quality, timing and variability.[47] The present study offers only limited insight into the co-occurrence of suboptimal sleep across various duration, and quality parameters and did not consider their interaction. In addition, survey items assessed sleep parameters on an 'average' day or week, thereby collecting data on overall sleep patterns, precluding the ability to assess for variability in sleep timing, schedules or experiences. Future Australian longitudinal research may address further valuable questions, including exploration of modifiable factors that might precipitate and perpetuate suboptimal sleep, relationships between parameters and facets[47] of suboptimal sleep.

Fourth, compared with data from the Australian Bureau of Statistics, a higher proportion of the sample were older than 65 years and lived outside of major cities, which may reduce the generalisability of findings to the Australia population. However, nonsignificant differences between outcomes with raw data and data that were weighted to account for over/underrepresentation of the sample in terms of core demographics, suggest the impact on results of this study was minimal.

Conclusions

Findings suggest suboptimal sleep is prevalent in Australia, with nearly half of the sample meeting criteria on at least one sleep parameter, and the highest prevalence seen in terms of sleep duration. Adults who were female, single, middle-aged and had lower levels of education were more likely to experience suboptimal sleep. Rates of assessment and treatment currently appear to be suboptimal. To reduce the associated health and financial burden, a coordinated population health strategy to improve the sleep health of Australians may be warranted. Such a multicomponent strategy might comprise the following: continued public health surveillance, further identification of population subgroups who may experience higher rates of sleep-related morbidity and mortality, exploration of factors which precipitate and perpetuate suboptimal sleep, development of national clinical practice guidelines outlining screening and evidence-based treatment procedures, strategies to increase community awareness of what constitutes 'suboptimal' sleep and upskilling of relevant health-care staff. [7,34]

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Availability of supporting data

The datasets generated and analysed during the present study are not publicly available to preserve the privacy of participants, however are available from the corresponding author on reasonable request.

Authors' contributions

APM conceived the study, undertook the analyses and drafted the manuscript. JAB participated in study conception and drafting of the manuscript. Both authors critically revised and approved the final manuscript for publication.

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The authors declare no competing interests.

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