



Factors associated with short and long sleep

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ABSTRACT

Objective. Short (<7 h) and long sleep durations (≥9 h) have recently been linked with increased mortality in the US, Europe and Asia, but little is known about the sleep patterns of Australian adults. The present study examined the sleep habits of Australian adults and identified socio-demographic and health-related factors associated with short and long sleep.

Methods. This study analyzed cross-sectional and self-reported data from 49,405 Australian adults aged 45 to 65 years collected between 2006 and 2008. Socio-demographic and health-related factors were entered into multinomial logistic regression models predicting self-reported sleep duration.

Results. Short and long sleep were reported by 16.6% and 13.9% of participants respectively. Short sleep was associated with long working hours (odds ratio [OR] = 1.17, 95% confidence interval (CI): 1.08, 1.28) and obesity (OR = 1.29, 95% CI: 1.19, 1.41); long sleep was associated with recent treatment for cancer (OR = 1.64, 95% CI: 1.34, 2.02) and heart attack/angina (OR = 1.58, 95% CI: 1.19, 2.09).

Conclusions. Short and long sleep were common in this sample of middle aged Australian adults. The determinants of short sleep have potential public health implications and could be targeted to prevent morbidity and mortality associated with short sleep.

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Introduction

Prospective data from the US, Europe and Asia indicate that short sleep (<7 h sleep a night) could contribute to chronic health conditions such as diabetes, cardiovascular disease and obesity (Kripke et al., 2002; Heslop et al., 2003; Tamakoshi and Ohno, 2004; Ferrie et al., 2007; Hublin et al., 2007; Shankar et al., 2008). These findings are concerning because short sleep is increasingly common and is currently reported by approximately 30% of US adults (Kripke et al., 1979; Kripke et al., 2002; Nunes et al., 2008; Krueger and Friedman, 2009). Long sleep (≥9 h sleep a night) has also been associated with increased morbidity and mortality in adult populations (Tamakoshi and Ohno, 2004; Ferrie et al., 2007; Hublin et al., 2007; Shankar et al., 2008). Therefore, interventions targeting sleep duration may have implications for the prevention and management of chronic disease.

Krueger and Friedman (2009) recently examined sleep patterns in a nationally representative survey of 110,441 US adults. Short and long sleep were reported by 28.3% and 8.5% of respondents respectively, and were associated with low education levels, low income, alcohol consumption, depression and chronic health conditions such as cardiovascular disease and diabetes. Short sleep was also associated with being single and long working hours, whilst long

sleep was also associated with low physical activity levels, pregnancy and ethnicity. These findings extend on smaller scale and less comprehensive community based studies (Mallon et al., 2002; Heslop et al., 2003; Adams, 2006; Gottlieb et al., 2006; Patel et al., 2006a,b; Steptoe et al., 2006; Stranges et al., 2008) in identifying factors associated with short and long sleep.

Unfortunately, little is currently known about the sleep habits of Australian adults. Bartlett et al. (2008) recently found that 18.5% of Australian adults aged 18–64 years ($n = 3300$) reported sleep durations below 6.5 h a night, but potential predictors of short and long sleep were not examined. The purpose of the present study was to apply an analytic approach similar to Krueger and Friedman (2009) to investigate the sleep patterns of Australian adults and identify possible socio-demographic, behavioral and health determinants of short and long sleep.

Methods

Participants

The present paper utilized data collected between 2006 and 2008 as part of the 45 and Up Study (a survey study of adults aged 45 years and over residing in New South Wales [NSW], Australia). The majority of participants (99%) were randomly selected from the Medicare Australia enrollment database and were mailed a questionnaire (response rate: 17–18%) and a small proportion of individuals (<1%) independently volunteered to participate; informed consent was obtained from all participants. Ethics approval for the 45 and Up Study was provided by the University of NSW

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Human Research Ethics Committee; approval to use the data for this paper was obtained from the University of Wollongong Human Research Ethics Committee. The present paper only included participants aged 45–65 years given the differences in sleep structure and quality observed in elderly populations (Bliwise, 2005). The dataset included 62,317 people in this age range, but the present study included the 49,405 adults for whom complete data were available.

Materials

All variables included in the present study (except for area of residence) were derived from a self-report questionnaire. Sleep duration was determined from the question, “About how many hours in each 24 h day do you

usually spend sleeping (including at night and naps)?” and was coded as <6 h, 6 h (≥ 6 h, <7 h), 7 h (≥ 7 h, <8 h), 8 h (≥ 8 h, <9 h) and ≥ 9 h to be consistent with previous studies (Ferrie et al., 2007; Shankar et al., 2008; Krueger and Friedman, 2009). Also collected were age, gender, country of birth (Australia, other), highest level of education (<high school, high school, trade/diploma/certificate, university degree), marital status (single [includes divorced, separated, widowed individuals], married/de facto) and employment status (no paid work, part-time work [1–34 h/week], full time work [35–40 h/week] and more than full time work [>40 h/week]). The standard index of geographic remoteness in Australia (Accessibility/Remoteness Index of Australia) was used to categorize individuals as living in a major city (0.0–0.2), a regional area (>0.2 –5.92) or a remote area (>5.92) (Australian Bureau of Statistics, 2008).

Table 1

Descriptive statistics by self-reported sleep duration in 49,405 Australian adults aged 45–65 years (45 and up study, New South Wales Australia 2006–2008).

	<6 h		6 h		7 h		8 h		≥ 9 h		p value ^a
	n	%	n	%	n	%	n	%	n	%	
Total	1611	3.3	6570	13.3	14,012	28.4	20,339	41.2	6873	13.9	
Sex											<0.01
Male	683	42.4	3120	47.5	6495	46.4	8584	42.2	2795	40.7	
Female	928	57.6	3450	52.5	7517	53.6	11,788	57.8	4078	59.3	
Age (years) ^b	M = 55.4	SD = 5.3	M = 55.2	SD = 5.3	M = 54.9	SD = 5.2	M = 55.5	SD = 5.4	M = 56.2	SD = 5.5	<0.01
Country of origin											<0.01
Australia	1163	72.2	4813	73.3	10,435	74.5	15,749	77.4	5484	79.8	
Other	448	27.8	1757	26.7	3577	25.5	4590	22.6	1389	20.2	
Description of residence											<0.01
Major City	697	43.3	3078	46.8	6645	47.4	8182	40.2	2220	32.3	
Regional area	882	54.7	3381	51.5	7118	50.8	11,712	57.6	4474	65.1	
Remote area	32	2.0	111	1.7	249	1.8	445	2.2	179	2.6	
Education level											<0.01
Less than high school	272	16.9	621	9.5	767	5.5	1384	6.8	729	10.6	
High school	530	32.9	1927	29.3	3814	27.2	6083	29.9	2288	33.3	
Trade/diploma/certificate	492	30.5	2174	33.1	4574	32.6	6878	33.8	2314	33.6	
University	317	19.7	1848	28.1	4857	34.7	5994	29.5	1542	22.4	
Body size status											<0.01
Underweight	31	1.9	91	1.4	137	1.0	226	1.1	95	1.4	
Lean	515	32.0	2080	31.7	5303	37.8	7650	37.6	2380	34.6	
Overweight	542	33.6	2601	39.6	5634	40.2	7976	39.2	2538	36.9	
Obese	523	32.5	1798	27.4	2938	21.0	4487	22.1	1860	27.1	
Paid work hours											<0.01
No paid work	694	43.1	1854	28.2	3289	23.5	6591	32.4	3437	50.0	
1–34 h	336	20.9	1433	21.8	3510	25.0	5729	28.2	1873	27.3	
35–40 h	287	17.8	1540	23.4	3593	25.6	4494	22.1	939	13.7	
>40 h	294	18.2	1743	26.5	3620	25.8	3525	17.3	624	9.1	
Marital status											<0.01
Single	432	26.8	1608	24.5	2788	19.9	3812	18.7	1332	19.4	
Married/de facto	1179	73.2	4962	75.5	11,224	80.1	16,527	81.3	5541	80.6	
Smoking status											<0.01
Never smoker	782	48.5	3484	53.0	8271	59.0	11,587	57.0	3674	53.5	
Former smoker	546	33.9	2230	33.9	4618	33.0	7115	35.0	2497	36.3	
Current smoker	283	17.6	856	13.0	1123	8.0	1637	8.0	702	10.2	
Alcohol consumption											<0.01
0 drinks	661	41.0	2131	32.4	3708	26.5	5503	27.1	2150	31.3	
1–7 drinks (ref)	477	29.6	2472	37.6	5494	39.2	7533	37.0	2159	31.4	
8–14 drinks	219	13.6	1070	16.6	2734	19.5	4007	19.7	1216	17.7	
≥ 15 drinks	254	15.8	897	13.7	2076	14.8	3296	16.2	1348	19.6	
Moderate physical activity											<0.01
<30 min/day	1013	62.9	4250	64.7	8920	63.7	12,618	62.0	4157	60.5	
≥ 30 min/day	598	37.1	2320	35.3	5092	36.3	7721	38.0	2716	39.5	
Recently treated for											<0.01
Cancer	28	1.7	107	1.6	184	1.3	378	1.9	212	3.1	
Heart attack/angina	35	2.2	96	1.5	93	0.7	179	0.9	135	2.0	
High blood pressure	352	21.8	1239	18.9	2191	15.6	3499	17.2	1494	21.7	
High cholesterol	269	16.6	843	12.8	1480	10.6	2271	11.2	1060	15.4	
Asthma	112	7.0	312	4.7	498	3.5	757	3.7	317	4.6	
Osteoarthritis	139	8.6	385	5.9	612	4.4	939	4.6	440	6.4	
Osteoporosis	83	5.1	222	3.4	385	2.7	605	3.0	276	4.0	
Thyroid problems	87	5.4	273	4.2	522	3.7	832	4.1	362	5.3	
Depression and/or anxiety	262	16.3	600	9.1	886	6.3	1603	7.9	1188	17.3	
Self-rated health											<0.01
Poor	401	24.9	894	13.6	993	7.1	1736	8.5	1335	19.4	
Good	593	36.8	2217	33.7	4104	29.3	5956	29.3	2148	31.3	
Very good	617	38.3	3459	52.6	8915	63.6	12,647	62.2	3390	49.3	

^a p values refer to chi-square or ANOVA (age) tests conducted to compare the groups.

^b Data are continuous and presented as means and standard deviations.

Cigarette smoking (current smoker, former smoker, never smoker) and alcohol consumption (0 drinks/week, 1–7 drinks/week [$>0, \leq 7$], 7–14 drinks/week [$>7, \leq 14$], ≥ 15 drinks/week) were also assessed and included

in the analyses (National Health and Medical Research Council, 2009). The amount of moderate physical activity was assessed and coded as 'not meeting the current Australian guidelines' (<30 min a day) and 'meeting the current

Table 2

Odds ratios and 95% confidence intervals from the three nested multinomial logistic regression models predicting self-reported sleep duration in 49,405 Australian adults aged 45–65 years (45 and up study, New South Wales Australia 2006–2008).

	<6 vs. 7 h sleep		6 vs. 7 h sleep		8 vs. 7 h sleep		≥ 9 vs. 7 h sleep		p value ^a
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI	
Model 1									
Sex									<0.01
Male	1.08	0.97, 1.21	1.07	1.00, 1.14	0.99	0.94, 1.04	1.18*	1.10, 1.26	
Female (ref)	1.00		1.00						
Age (years)	0.99	0.98, 1.00	1.00	1.00, 1.01	1.01*	1.00, 1.01	1.00	1.00, 1.01	<0.01
Country of birth									<0.01
Australia (ref)	1.00		1.00		1.00		1.00		
Other	1.18*	1.05, 1.33	1.08	1.01, 1.15	0.89*	0.85, 0.94	0.82*	0.76, 0.88	
Description of residence									<0.01
Remote	1.03	0.71, 1.51	0.89	0.71, 1.13	1.38*	1.18, 1.62	1.88*	1.53, 2.31	
Regional	1.05	0.95, 1.17	0.99	0.93, 1.06	1.25*	1.19, 1.30	1.59*	1.50, 1.70	
Major city (ref)	1.00		1.00		1.00		1.00		
Education level									<0.01
Less than high school (ref)	1.00		1.00		1.00		1.00		
High school	0.45*	0.38, 0.53	0.65*	0.58, 0.73	0.94	0.85, 1.04	0.75*	0.67, 0.85	
Trade/diploma/certificate	0.37*	0.31, 0.44	0.61*	0.54, 0.69	0.95	0.86, 1.04	0.73*	0.65, 0.82	
University	0.24*	0.20, 0.28	0.49*	0.44, 0.55	0.84*	0.76, 0.93	0.56*	0.49, 0.63	
Paid work hours									<0.01
No paid work	2.41*	2.06, 2.81	1.23*	1.13, 1.35	1.49*	1.40, 1.59	3.65*	3.33, 4.01	
1–34 h	1.20	1.01, 1.42	0.95	0.87, 1.04	1.26*	1.18, 1.34	1.99*	1.82, 2.19	
35–40 h (ref)	1.00		1.00		1.00		1.00		
>40 h	1.07	0.90, 1.28	1.15*	1.06, 1.25	0.78*	0.73, 0.84	0.65*	0.57, 0.72	
Marital status									<0.01
Single	1.47*	1.31, 1.66	1.31*	1.22, 1.41	0.93*	0.88, 0.98	0.99	0.92, 1.07	
Married/de facto (ref)	1.00		1.00		1.00		1.00		
Model 2									
Smoking status									<0.01
Never smoker (ref)	1.00		1.00		1.00		1.00		
Former smoker	1.19*	1.05, 1.34	1.14*	1.07, 1.22	1.06	1.01, 1.11	1.09	1.02, 1.16	
Current smoker	1.95*	1.67, 2.28	1.66*	1.50, 1.83	0.97	0.89, 1.05	1.09	0.98, 1.21	
Alcohol consumption									<0.01
0 drinks	1.67*	1.47, 1.98	1.21*	1.13, 1.30	1.01	0.95, 1.07	1.22*	1.13, 1.32	
1–7 drinks (ref)	1.00		1.00		1.00		1.00		
8–14 drinks	0.92	0.78, 1.09	0.85*	0.78, 0.92	1.09*	1.03, 1.16	1.18*	1.08, 1.28	
≥ 15 drinks	1.25*	1.06, 1.48	0.84*	0.77, 0.93	1.20*	1.12, 1.29	1.70*	1.55, 1.86	
Moderate physical activity									<0.01
<30 min/day	1.09	0.98, 1.22	1.08	1.02, 1.15	1.05	1.00, 1.10	1.12*	1.05, 1.19	
≥ 30 min/day (ref)	1.00		1.00		1.00		1.00		
Model 3									
Body weight status									<0.01
Underweight	1.58	1.05, 2.39	1.49*	1.14, 1.96	1.10	0.88, 1.36	1.20	0.93, 1.60	
Lean (ref)	1.00		1.00		1.00		1.00		
Overweight	0.92	0.81, 1.05	1.13*	1.05, 1.21	0.99	0.94, 1.04	0.95	0.88, 1.02	
Obese	1.21*	1.05, 1.40	1.29*	1.19, 1.41	1.00	0.94, 1.06	1.04	0.95, 1.13	
Cancer ^b	0.92	0.61, 1.38	1.07	0.84, 1.36	1.31*	1.10, 1.57	1.64*	1.34, 2.02	<0.01
Heart attack/angina ^b	1.54	1.02, 2.32	1.55*	1.15, 2.08	1.17	0.90, 1.51	1.58*	1.19, 2.09	<0.01
High blood pressure ^b	0.96	0.83, 1.10	1.03	0.94, 1.12	1.03	0.97, 1.10	1.01	0.93, 1.10	0.74
High cholesterol ^b	1.22	1.04, 1.42	1.04	0.94, 1.15	0.99	0.92, 1.07	1.15*	1.04, 1.26	<0.01
Asthma ^b	1.28	1.02, 1.59	1.15	0.98, 1.32	0.98	0.87, 1.11	0.89	0.78, 1.04	<0.01
Osteoarthritis ^b	1.09	0.89, 1.34	1.06	0.93, 1.22	0.90	0.81, 1.00	0.81*	0.71, 0.93	<0.01
Osteoporosis ^b	1.20	0.93, 1.56	1.07	0.90, 1.27	0.94	0.83, 1.08	0.99	0.84, 1.16	0.31
Thyroid problems ^b	0.99	0.78, 1.26	0.97	0.83, 1.13	0.99	0.88, 1.11	1.01	0.88, 1.17	0.98
Depression/anxiety ^b	1.63*	1.39, 1.91	1.18*	1.05, 1.32	1.16*	1.06, 1.27	2.12*	1.92, 2.34	<0.01
Self-rated health									<0.01
Poor	3.02*	2.56, 3.56	1.68*	1.51, 1.88	1.07	0.98, 1.17	2.11*	1.90, 2.34	
Good	1.62*	1.43, 1.83	1.20*	1.12, 1.29	0.98	0.93, 1.03	1.16*	1.08, 1.24	
Very good (ref)	1.00		1.00		1.00		1.00		

ref, referent group.

Model 1: includes sex, age, country of birth, description of residence, education level, paid work hours and marital status. Model 2: includes all of the variables in Model 1 as well as smoking status, alcohol consumption and moderate physical activity. Model 3: includes all of the variables from Model 1 and Model 2 as well as body weight status, treatment for chronic disease and self-rated health.

* $p < 0.01$.

^a p value obtained from the log-likelihood test. Bonferroni adjustments to α were performed to prevent type 1 errors associated with multiple tests. Since four comparisons were performed, the odds ratios were tested against an α of .013 (2-tailed).

^b For these variables, the referent group is comprised of people who have not recently been treated for the condition.

Australian guidelines' (≥ 30 min a day) (Department of Health and Ageing, 2005). Body size (i.e. underweight, lean, overweight, obese) was determined on the basis of body mass index using recommended cut-off levels (World Health Organization, 2000).

Participants also indicated whether they had been treated for any of the following conditions in the past month: cancer, heart attack/angina, high blood pressure, elevated blood cholesterol, asthma, thyroid problems, osteoporosis, osteoarthritis and depression/anxiety. Self-rated health was determined from the question 'In general how would you rate your health?' which was assessed on a five point Likert scale and coded as poor health, good health, and very good health.

Statistical analysis

The data were analyzed using multinomial logistic regression where 7 h sleep, which has the lowest mortality risk, was used as the reference condition (Kripke et al., 2002; Patel et al., 2004; Shankar et al., 2008; Krueger and Friedman, 2009). We tested three nested models predicting sleep duration. Model 1 included socio-demographic factors (i.e. age, sex, geographic area of residence, marital status, education level, work hours), model 2 added health behaviors (i.e. alcohol consumption, moderate physical activity and smoking) and model 3 added body size status, recent treatment for depression/anxiety and chronic health conditions, and self-rated health.

Table 3
Odds ratios and 95% confidence intervals from the full multinomial logistic regression model predicting self-reported sleep duration in 49,405 Australian adults aged 45–65 years (45 and up study, New South Wales Australia 2006–2008).

	<6 vs. 7 h sleep		6 vs. 7 h sleep		8 vs. 7 h sleep		≥ 9 vs. 7 h sleep		p value ^a
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI	
Sex									0.03
Male	0.98	0.87, 1.11	1.05	0.98, 1.12	0.95	0.90, 1.00	0.98	0.91, 1.05	
Female (ref)	1.00		1.00		1.00		1.00		
Age (years)	1.00	0.99, 1.01	1.01	1.00, 1.01	1.01*	1.00, 1.01	1.01*	1.00, 1.01	<0.01
Country of birth									<0.01
Australia (ref)	1.00		1.00		1.00		1.00		
Other	1.16	1.04, 1.32	1.07	1.00, 1.15	0.90*	0.85, 0.94	0.83*	0.77, 0.89	
Description of residence									<0.01
Remote	0.98	0.67, 1.43	0.86	0.68, 1.08	1.38*	1.17, 1.62	1.85*	1.50, 2.27	
Regional	1.06	0.95, 1.18	0.99	0.93, 1.05	1.25*	1.19, 1.31	1.60*	1.50, 1.70	
Major city (ref)	1.00		1.00		1.00		1.00		
Education level									<0.01
Less than high school (ref)	1.00		1.00		1.00		1.00		
High school	0.56*	0.47, 0.66	0.74*	0.65, 0.83	0.94	0.85, 1.04	0.83*	0.74, 0.93	
Trade/diploma/certificate	0.48*	0.40, 0.57	0.71*	0.63, 0.80	0.95	0.86, 1.04	0.81*	0.72, 0.91	
University	0.35*	0.29, 0.43	0.61*	0.54, 0.69	0.84*	0.76, 0.93	0.65*	0.57, 0.73	
Paid work hours									<0.01
No paid work	1.74*	1.48, 2.04	1.09	1.00, 1.19	1.49*	1.39, 1.59	3.07*	2.79, 3.37	
1–34 h	1.15	0.97, 1.36	0.95	0.87, 1.03	1.26*	1.18, 1.34	1.93*	1.75, 2.12	
35–40 h (ref)	1.00		1.00		1.00		1.00		
>40 h	1.12	0.94, 1.33	1.17*	1.08, 1.28	0.78*	0.73, 0.83	0.65*	0.58, 0.73	
Marital status									<0.01
Single	1.27*	1.13, 1.44	1.24*	1.16, 1.33	0.92*	0.87, 0.97	0.90*	0.84, 0.97	
Married/de facto (ref)	1.00		1.00		1.00		1.00		
Smoking status									<0.01
Never smoker (ref)	1.00		1.00		1.00		1.00		
Former smoker	1.08	0.96, 1.22	1.09	1.02, 1.17	1.06	1.01, 1.11	1.02	0.96, 1.09	
Current smoker	1.58*	1.34, 1.86	1.53*	1.38, 1.70	0.96	0.88, 1.04	0.92	0.83, 1.04	
Alcohol consumption									<0.01
0 drinks	1.45*	1.28, 1.66	1.14*	1.06, 1.23	1.01	0.95, 1.06	1.12*	1.03, 1.20	
1–7 drinks (ref)	1.00		1.00		1.00		1.00		
8–14 drinks	0.97	0.82, 1.14	0.87*	0.79, 0.94	1.09*	1.03, 1.16	1.21*	1.11, 1.32	
≥ 15 drinks	1.26*	1.06, 1.49	0.84*	0.76, 0.93	1.20*	1.12, 1.29	1.72*	1.57, 1.89	
Moderate physical activity									0.34
<30 min/day	1.00	0.89, 1.11	1.04	0.97, 1.10	1.04	0.99, 1.09	1.06	0.99, 1.12	
≥ 30 min/day (ref)	1.00		1.00		1.00		1.00		
Body weight status									<0.01
Underweight	1.58	1.05, 2.39	1.49*	1.14, 1.96	1.10	0.88, 1.36	1.20	0.93, 1.60	
Lean (ref)	1.00		1.00		1.00		1.00		
Overweight	0.92	0.81, 1.05	1.13*	1.05, 1.21	0.99	0.94, 1.04	0.95	0.88, 1.02	
Obese	1.21*	1.05, 1.40	1.29*	1.19, 1.41	1.00	0.94, 1.06	1.04	0.95, 1.13	
Cancer ^b	0.92	0.61, 1.38	1.07	0.84, 1.36	1.31*	1.10, 1.57	1.64*	1.34, 2.02	<0.01
Heart attack/angina ^b	1.54	1.02, 2.32	1.55*	1.15, 2.08	1.17	0.90, 1.51	1.58*	1.19, 2.09	<0.01
High blood pressure ^b	0.96	0.83, 1.10	1.03	0.94, 1.12	1.03	0.97, 1.10	1.01	0.93, 1.10	0.74
High cholesterol ^b	1.22	1.04, 1.42	1.04	0.94, 1.15	0.99	0.92, 1.07	1.15*	1.04, 1.26	<0.01
Asthma ^b	1.28	1.02, 1.59	1.15	0.98, 1.32	0.98	0.87, 1.11	0.89	0.78, 1.04	<0.01
Osteoarthritis ^b	1.09	0.89, 1.34	1.06	0.93, 1.22	0.90	0.81, 1.00	0.81*	0.71, 0.93	<0.01
Osteoporosis ^b	1.20	0.93, 1.56	1.07	0.90, 1.27	0.94	0.83, 1.08	0.99	0.84, 1.16	0.31
Thyroid problems ^b	0.99	0.78, 1.26	0.97	0.83, 1.13	0.99	0.88, 1.11	1.01	0.88, 1.17	0.98
Depression/anxiety ^b	1.63*	1.39, 1.91	1.18*	1.05, 1.32	1.16*	1.06, 1.27	2.12*	1.92, 2.34	<0.01
Self-rated health									<0.01
Poor	3.02*	2.56, 3.56	1.68*	1.51, 1.88	1.07	0.98, 1.17	2.11*	1.90, 2.34	
Good	1.62*	1.43, 1.83	1.20*	1.12, 1.29	0.98	0.93, 1.03	1.16*	1.08, 1.24	
Very good (ref)	1.00		1.00		1.00		1.00		

ref, referent group.

* $p < 0.01$; ref, referent.

^a p value obtained from the log-likelihood test. Bonferroni adjustments to α were performed to prevent type 1 errors associated with multiple tests. Since four comparisons were performed, the odds ratios were tested against an α of .013 (2-tailed).

^b For these variables, the referent group is comprised of people who have not recently been treated for the condition.

The data were analyzed using SPSS version 15 (SPSS, Chicago, IL) and results are reported as odds ratios (with 95% confidence intervals). Bonferroni adjustments to α were performed to prevent type 1 errors associated with multiple tests. Since four comparisons were performed, the odds ratios were tested against an α of 0.013 (2-tailed) in all of the models. Log-likelihood tests were performed to identify the best fitting model.

Results

The characteristics of the present sample are summarized in Table 1 which shows that 16.6% of individuals reported short sleep (i.e. <7 h) and 13.9% reported long sleep (i.e. ≥ 9 h). Although the response rate was low (17–18%), the demographic characteristics of the present sample were comparable with the NSW population for the same age range (Australian Bureau of Statistics, 2006). For example, the proportion of people born in Australia (76.2% vs. 77.1%), in a married or de-facto relationship (79.8% vs. 74.1%), not employed (32.1% vs. 32.6%), employed in part-time work (26.1% vs. 18.5%) and employed in full time work (41.8% vs. 44.8%) was similar between the present sample and the NSW population. The proportion of females was slightly higher in the present study (56.2% vs. 50.4%) as was the proportion of people who indicated that they had completed high school (92.4% vs. 80.3%).

The results of the three nested models are presented in Table 2 and the results of the full model are shown in Table 3. The direction and magnitude of the parameter estimates for the socio-demographic and health behavior variables were similar in the nested models and the full model. The only notable changes were that country of birth (<6 h sleep), no paid work (6 h sleep) and gender (≥ 9 h sleep) were significantly associated with sleep duration in model 1, but not in the full model. Similarly, former smoking (<6 h and 6 h sleep) and physical activity (≥ 9 h sleep) were significantly associated with sleep in model 2 but not in the full model. Likelihood ratio tests indicated that model 2 had a better fit than model 1 ($\chi^2_{24} = 574.64, p < 0.001$), with the full model providing a better fit than model 2 ($\chi^2_{56} = 1158.98, p < 0.001$). As a consequence, the remainder of this paper focuses on the results from the full model (Table 3).

The full model indicates that individuals born overseas were less likely to report long sleep, whilst living in a remote or regional area was associated with long sleep (Table 3). Higher education was associated with reduced odds of both short and long sleep, whilst being single was associated with greater odds of short sleep and reduced odds of long sleep. Individuals not employed in paid work were more likely to report short and long sleep. Compared to full time workers, part-time workers were more likely to report 8 h (odds ratio [OR] = 1.26, 95% confidence interval [1.18–1.34]) and ≥ 9 h sleep (OR = 1.93 [1.75–2.12]). Individuals working >40 h a week were more likely to report 6 h sleep (OR = 1.17 [1.08–1.28]) and less likely to report 8 h (OR = 0.78 [0.73–0.83]) and ≥ 9 h sleep (OR = 0.65 [0.58–0.73]).

Compared to non-smokers, current smokers were more likely to report <6 h (OR = 1.58 [1.34–1.86]) and 6 h sleep (OR = 1.53 [1.38–1.70]). Relative to consuming 1–7 drinks/week, not consuming alcohol was associated with increased odds of <6 h (OR = 1.45 [1.28–1.66]) and 6 h sleep (OR = 1.14 [1.06–1.23]). Furthermore, consuming ≥ 15 drinks per week was associated with increased odds of <6 h (OR = 1.26 [1.06–1.49]), 8 h (OR = 1.20 [1.12–1.29]) and 9 h sleep (OR = 1.72 [1.57–1.89]). Relative to a lean body size, obesity was associated with increased odds of <6 h (OR = 1.21 [1.05–1.40]) and 6 h sleep (OR = 1.29 [1.19–1.41]). Individuals treated for cancer had increased odds of sleeping 8 h (OR = 1.31 [1.10–1.57]) and ≥ 9 h (OR = 1.64 [1.34–2.02]), whilst recent treatment for heart attack/angina was associated with elevated odds of 6 h (OR = 1.55 [1.15–2.08]) and ≥ 9 h sleep (OR = 1.58 [1.19–2.09]). Recent treatment for depression/anxiety and poorer self-reported health were also associated with increased odds of short and long sleep.

Table 4

Factors associated with short and long sleep in the present Australian sample (49,405 adults aged 45–65 years) compared with the results obtained from the US sample of Krueger and Friedman (2009) (110, 441 adults aged 18 years and over).

Krueger and Friedman (2009) (US sample)	Present study (Australian sample)
<i>Factors associated with short sleep (i.e. 6 h sleep^a)</i>	
Socio-demographic variables	Socio-demographic variables
Ethnicity ^b	
Marital status (single)	Marital status (single)
Long work hours	Long work hours
Education level	Education level
Number of children ^b	
Family income ^b	
Health-related behaviors	Health-related behaviors
Current smoker	
Binge drinking (alcohol) ^b	Current smoker No alcohol consumption
History of chronic health conditions	Recently treated for
Cardiovascular disease	Heart disease/angina
Acute respiratory conditions	
Diabetes ^b	
Pain ^b	
Other	Other
Obesity	Obesity Overweight Underweight
Depression	Depression and anxiety
Anxiety	Poorer self-rated health ^c
Activity limitations ^b	
<i>Factors associated with long sleep (≥ 9 h)</i>	
Socio-demographic variables	Socio-demographic variables
Ethnicity ^b	Country of birth ^c
Number of children ^b	Regional/remote area of residence ^c
Shorter work hours	Shorter work hours
Education level	Education level
Currently pregnant ^b	Marital status (single)
Health-related behaviors	Health-related behaviors
Physical activity	Excessive alcohol consumption
Current smoker	
Former smoker	
History of chronic health conditions	Recently treated for
Cardiovascular disease	Cancer Heart attack/angina Arthritis High cholesterol
Diabetes ^b	
Other	Other
Underweight	Depression and anxiety
Depression	Poorer self-rated health ^c
Anxiety	
Activity limitations ^b	

^a We chose to compare the results for 6 h sleep as opposed to <6 h sleep as the former is more common.

^b Indicates that the variable was assessed in the US sample, but not in the Australian sample.

^c Indicates that the variable was assessed in the Australian sample, but not in the US sample.

Table 4 demonstrates that the factors associated with short and long sleep in the present study are similar to those identified by Krueger and Friedman (2009) in a representative sample of US adults. A similar pattern of results was obtained when the analyses were replicated with 8 h sleep set as the reference condition. There were slight differences in the magnitude of the associations, but the parameter estimates were in the same direction and relevant variables remained significantly associated with short and long sleep.

Discussion

We believe that this is the first study to comprehensively examine sleep duration in a sample of Australian adults. Our results demonstrate that 16.6% of participants reported short sleep (<7 h sleep a night), which is similar to a recent study of 3300 Australian adults (Bartlett et al., 2008), and 13.9% reported long sleep (≥ 9 h sleep a night). Previous

studies conducted in the US (Kripke et al., 2002; Hale and Do, 2007; Gangwisch et al., 2008; Nunes et al., 2008; Krueger and Friedman, 2009), Europe (Ursin et al., 2005; Ferrie et al., 2007) and Asia (Shankar et al., 2008) have indicated that short and long sleep were common in adults. Although we observed a similar pattern, the precise figures for short sleep (16.6% vs. 28.3%) and long sleep (13.9% vs. 8.5%) were lower and higher respectively compared to a recent US study (Krueger and Friedman, 2009). Previous studies indicate that older adults are more likely to report longer sleep durations (Gangwisch et al., 2008). Therefore, the figures for short and long sleep observed in the present study could reflect the older age of the present sample.

Our results indicate that poorer self-rated health, current smoking status, being single, recent treatment for depression/anxiety, lower education level, recent treatment for heart attack/angina and consuming no alcohol were the strongest predictors of short sleep. These findings are consistent with those reported by Krueger and Friedman (2009) (see Table 4), and are supportive of several smaller scale and less comprehensive studies (Wetter and Young, 1994; Patel et al., 2006a,b; Ferrie et al., 2007; Nunes et al., 2008; Stranges et al., 2008; Krueger and Friedman, 2009).

The strongest predictors of long sleep included residing in a rural or remote area, excessive alcohol consumption, lower education level, recent treatment for cancer, recent treatment for depression/anxiety and poor self-reported health, which is consistent with findings from other countries (Patel et al., 2006a,b; Stranges et al., 2008; Krueger and Friedman, 2009). However, neither short nor long sleep durations were associated with factors such as age, sex and physical activity as has been reported in some previous studies (Adams, 2006; Driver and Taylor, 2000; Patel et al., 2006a,b; Stranges et al., 2008; Krueger and Friedman, 2009). It is possible that in the present sample, the associations between these factors and sleep were accounted for by other socio-demographic, behavioral or health factors.

The findings associated with short sleep have important implications for preventive medicine and public health, given that short sleep is associated with cardiovascular disease (Ayas et al., 2003; Gangwisch et al., 2006; Gottlieb et al., 2006; Shankar et al., 2008), depression (Krueger and Friedman, 2009), obesity (Gangwisch et al., 2005; Singh et al., 2005; Patel and Hu, 2008; van den Berg et al., 2008) and elevated mortality. These chronic health conditions could cause short sleep because of discomfort, pain and/or the side effects of medication (Moldofsky, 2001). Some longitudinal data also demonstrate that short sleep could contribute to these conditions (Ayas et al., 2003; Gangwisch et al., 2005; Gangwisch et al., 2006; Patel et al., 2006a,b; Chaput et al., 2008; Shankar et al., 2008) possibly by altering sympathetic nervous system activity, neuroendocrine function and/or hypothalamic–pituitary–adrenal axis activity (Leprout et al., 1997; Spiegel et al., 2004; Van Cauter et al., 2007). However, more research is required to investigate the role of short sleep as a risk factor for chronic disease.

The health implications of the association between long sleep and chronic disease observed in previous studies are less clear (Patel et al., 2006a,b; Gangwisch et al., 2008; Stranges et al., 2008). It is known that many health conditions such as depression and cancer and associated medications contribute to longer sleep durations. However, there are currently no data demonstrating that long sleep contributes to poor health (Patel et al., 2006a,b). Although more research is needed to understand the potential implications of long sleep, it is generally argued that long sleep is a consequence, rather than a cause, of poor health (Patel et al., 2006a,b; Gangwisch et al., 2008; Stranges et al., 2008).

Study limitations and strengths

The main strengths of the present study were the large sample size comprising adults living in NSW (the most populous state in Australia) and the number of factors and covariates included in the models. Although the response rate was low, the socio-demographic characteristics of the sample are comparable with the general NSW

population for the same age range. However, the present study was limited by the use of cross-sectional data, which do not allow for causation to be determined, and self-report measures, which are not always accurate or reliable. Lauderdale et al. (2008), for example, found that self-reported sleep duration correlated modestly with objectively measured sleep duration and was affected by factors such as race, education, income and health status. Therefore, some relationships observed in this paper could reflect an inability for some groups of people to accurately assess their sleep duration. Further limitations were that other sleep-related factors (e.g. daytime sleepiness, sleep disturbances) were not examined; health conditions were also assessed on the basis of recent treatment, which does not provide an objective measure of disease status. Finally, depression and anxiety could not be examined separately, which is potential problem because these factors could have different relationships with sleep.

Conclusions

The present study is the first to comprehensively examine short (i.e. ≤ 6 h) and long sleep durations (i.e. > 8 h) in Australian adults. The results demonstrate that many middle aged Australian adults report short sleep, and that short sleep was associated with poorer self-rated health, lower education levels, being single, current cigarette smoking, alcohol consumption, obesity and treatment for heart disease and depression/anxiety. These findings are important because short sleep may be a risk factor for chronic health conditions such as diabetes, cardiovascular disease and obesity. Therefore, the determinants of short sleep could potentially be targeted through interventions as a way to increase sleep duration in short sleepers. This could complement existing interventions targeting factors such as physical activity, diet and smoking, to aid the treatment and prevention of chronic disease. The present results also indicate that long sleep is common, but the health implications are not clear and require further investigation. At present it appears most likely that long sleep is a consequence, rather than a cause, of chronic health conditions.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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