Ageing & Society (2022), **42**, 2206–2223
doi:10.1017/S0144686X21000015

ARTICLE

Socio-demographic and behavioural factors associated with status change of sleep quality and duration among Chinese older adults

Yen-Han Lee[1]*, Yen-Chang Chang[2], Po-Ju Chang[3] and Mack Shelley[4]

[1]Department of Applied Health Sciences, Indiana University School of Public Health, Bloomington, IN, USA,, [2]Center for General Education, National Tsing Hua University, Hsinchu City, Taiwan,, [3]Department of Horticulture and Landscape Architecture, National Taiwan University, Taipei City, Taiwan and [4]Department of Political Science and Department of Statistics, Iowa State University, Ames, IA, USA
*Corresponding author. Email: yil5050@bu.edu

(Accepted 23 December 2020; first published online 17 February 2021)

Abstract

China has faced challenges related to the rapid growth of its ageing population, and sleep is one of the public health challenges to this demographic group. This study examines the socio-demographic and behavioural factors associated with status change of sleeping patterns among Chinese older adults, using longitudinal data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS). Socio-demographic factors were selected from the 2012 wave of the CLHLS to examine the sleep status change in the 2014 wave. Multivariable logistic and multinomial regressions were used to study older adults' changes of sleep quality and daily sleep duration. Older adults, 65 years old or above, were selected as study participants. A higher level of education was negatively associated with poor sleep quality and longer sleep duration (>8 hours). Increasing age was positively associated with both shorter and longer sleep duration. Being female was negatively associated with longer sleep duration. However, exercise status, smoking behaviour and alcohol use all were neither positively nor negatively associated with status change of sleeping patterns. Participants' education, age and gender might be important factors associated with sleep status change. However, the effects of behavioural factors should be studied further. Policy implications and further research directions are discussed based on empirical results.

Keywords: older adults; sleep quality; sleep duration; longitudinal analysis; quantitative research

Introduction

Sleep problems have become common complaints of older adults. Nearly 50 per cent of older adults complain about their sleeping difficulty in the United States of America (USA), and poor sleep quality could significantly increase mortality and morbidity (Neikrug and Ancoli-Israel, 2010). With decreased slow-wave sleep, older adults had higher chances of problems associated with early awakening

and fragmented sleep as compared with younger individuals (Suzuki *et al*., 2017). Also, the prevalence of sleeping difficulty among older adults is higher than among younger people due to the decline of biological functions such as circadian rhythm (Schmidt *et al*., 2012). Therefore, it is imperative to help address older adults' sleeping patterns.

China is a country with rapid growth of the elderly population, together with skyrocketing prevalence of non-communicable diseases (Zheng *et al*., 2016). With the public health challenges related to non-communicable diseases in the older adult population (Wu *et al*., 2013), the prevalence of Chinese older adults reporting sleep problems also is high. For example, a regional study conducted in Hunan province found that 27 per cent of adolescents and older adults reported insomnia (Tang *et al*., 2017). In Shanghai, one of the mega cities in China, approximately 42 per cent of older adults reported poor sleep quality (Luo *et al*., 2013). On the other hand, a published report of the National Sleep Foundation suggests that older adults' recommended sleep duration should be 7–8 hours daily (Hirshkowitz *et al*., 2015). Nevertheless, only 39 per cent of Chinese older adults sleep within this range (Lee *et al*., 2019).

Several key determinants are associated with poor quality of sleep among Chinese older adults in different studies. Socio-demographic factors associated with poor quality of sleep included being female and having chronic conditions (Wang *et al*., 2020; Zhang *et al*., 2020). Having more than two kinds of chronic conditions was an important contributing factor associated with poor sleep among Chinese older adults, according to a cross-sectional study targeting Chinese older adults in nursing homes (Zhu *et al*., 2020). In the same study, as older adults aged, the risks of having poor quality of sleep also increased. Besides, residing in rural areas might be associated with poorer quality of sleep due to residents' physical and health problems (Zhang *et al*., 2020).

Targeting Chinese older adults, previous studies investigated the determinants associated with sleeping patterns, including socio-demographic and health factors (Gu *et al*., 2010; Wang *et al*., 2020), dietary behaviours (Lee *et al*., 2018a, 2019), living arrangements (Lee *et al*., 2020a) and health consequences related to poor sleeping patterns such as falls among older adults (Essien *et al*., 2018). However, several studies targeting Chinese older adults (Gu *et al*., 2010; Lee *et al*., 2018a; Wang *et al*., 2020) were based on cross-sectional design. Adopting the cross-sectional research design, the authors can make conclusive claims only at a certain time-point because the participants were interviewed once (Sedgwick, 2014). These results from such a study design might be temporal. Providing a perspective on changes in sleep quality or duration would not be available from cross-sectional data. The study by Lee *et al*. (2020a) used a panel analytic approach to tease out the effects of living arrangements on Chinese older adults' sleeping patterns, but the focus of the research discussed only the importance of living arrangements among older adults. Therefore, knowledge regarding socio-demographic and health behavioural factors associated with Chinese older adults' status change of sleeping patterns using longitudinal data remains limited.

Such a study, targeting older adults, is needed for several reasons. First, it is a common perception that people have more difficulties with sleep as they age, and sleep architecture changes with age, such as time spent awake at night

https://doi.org/10.1017/S0144686X21000015 Published online by Cambridge University Press

(Gooneratne and Vitiello, 2014). Second, in a regional study conducted in the Shih-Pai area of Taipei City, Taiwan (Chen and Chou, 2017), follow-up surveys showed that only 45.9 per cent of older adults remained in the same sleep duration when they were recruited in both surveys. Additionally, in the same study, the authors observed that long sleepers had the lowest consistency rate, 27.6 per cent at baseline (Chen and Chou, 2017). Therefore, with escalating sleep-related problems among Chinese older adults, it is imperative to use longitudinal data investigating Chinese older adults' status change of sleeping patterns.

We conducted secondary analyses with a large dataset, the Chinese Longitudinal Healthy Longevity Survey (CLHLS), to investigate the socio-demographic and behavioural factors associated with Chinese older adults' status change of sleeping patterns. We selected older adults who reported good quality of sleep in the earlier wave, and examined their sleep quality in the next wave (whether or not their sleep quality became worse). In the same vein, we followed the same procedure for the daily sleep duration: we selected older adults who slept within the recommended range of sleep (7–8 hours daily; Hirshkowitz *et al.*, 2015) in the earlier wave, and examined if they did not sleep within this recommended range in the next wave. With the aforementioned literature gaps and the need to address problems related to Chinese older adults' sleep, health practitioners and health scholars might use the study results from this research to identify the determinants and provide assistance or interventions as needed. Further policy implications are discussed.

Materials and methods

Data source and study population

Longitudinal data were extracted from the 2012 (collected between 2011 and 2012) and 2014 waves of CLHLS for statistical analyses. CLHLS is a currently ongoing open cohort targeting Chinese older adults. This is an internationally collaborative database including investigators from the Centre for the Study of Ageing and Human Development at Duke University, Peking University and others. This is the first longitudinal dataset ever targeting the oldest-old in a developing country at the national level. The study population of CLHLS includes centenarians, nonagenarians, octogenarians, younger older adults between 65 and 79 years old, and some middle-age adults. In the latest wave (2014), older adults from 23 provinces and mega cities were surveyed and half of the total number of these counties and cities were randomly selected. The surveyed regions covered nearly 85 per cent of the total population in China. CLHLS has a wide range of topics including mental health, cognitive function, dietary behaviour, chronic disease, social welfare (such as social insurance coverage), substance use (including tobacco use and alcohol consumption) and other lifestyle matters. Face-to-face interviews were conducted for data collection. Further information regarding this dataset can be found in Zeng (2012). As this research used only de-identified and secondary data in the public domain without personal information, Institutional Review Board approvals were not required at the authors' institutions. All participants provided informed consent to the CLHLS data collectors.

https://doi.org/10.1017/S0144686X21000015 Published online by Cambridge University Press

Measurements

Two outcome variables describe older adults' sleeping patterns. The first measurement is participants' quality of sleep ('How do you rate your current sleep quality?'). The original responses included 'very bad', 'bad', 'neutral', 'good' and 'very good'. To correct for the skewed distribution of these responses, participants who answered 'good' and 'very good' for quality of sleep were categorised as 'good' and those who answered 'neutral', 'bad' and 'very bad' were classified as 'not good'. This dichotomisation has been used in other sleep-related research (Gu *et al.*, 2010; Lee *et al.*, 2019; Lee *et al.*, 2020a). We considered older adults' good quality of sleep in the 2012 wave and estimated the status change of sleep quality in the 2014 wave. The second question is about participants' average daily hours of sleep ('How many hours on average do you sleep daily?'). The original measurement was in continuous form. We followed the recommendation by Hirshkowitz *et al.* (2015) that older adults should sleep between 7 and 8 hours daily. This measurement was coded as a categorical variable. The reference group included participants who slept between 7 and 8 hours daily. The other two categories included older adults who slept less than 7 hours daily (< 7 hours) and those who slept more than 8 hours daily (> 8 hours). We considered those who slept within the recommended range of sleep hours in the 2012 wave (between 7 and 8 hours daily) and estimated the change of duration in the 2014 wave (either more than 8 hours daily or less than 7 hours daily). The outcome variables were selected from the 2014 wave.

Two variables represent older adults' biological characteristics: age (65–80, 81–95 and above 95 years; an ordinal variable) and gender (male, female; a binary variable). Variables representing participants' socio-economic status included marital status (married, other – including those who were widowed, divorced, separated or never married; a binary variable), household income (⩽10,000, 10,001–30,000, 30,001–50,000, 50,001–70,000, > 70,001 RMB, and do not know; a categorical variable) and years of formal education (none, 1–5, 6–10 and 11 years and above; an ordinal variable). The current Chinese currency, renminbi (RMB), was used as the currency unit. In addition, we selected community of residence (urban, rural; a binary variable) and province (North, North-East, East, Central-South and West; a categorical variable) for regional information.

Furthermore, variables describing Chinese older adults' health condition, well-being and health-related behaviours were selected to explore their potential associations with sleeping patterns: exercise status (no, yes; a binary variable), suffering from chronic conditions that required inpatient treatments in the past two years (no, yes; a binary variable), life satisfaction (good, neutral and bad; a categorical variable), disability (not limited, limited and strongly limited; a categorical variable), smoking status (none, former and current; a categorical variable) and alcohol-use status (none, former and current; a categorical variable). We selected all predictors from the 2012 wave.

Statistical analyses

To carry out the statistical analyses, two groups of participants were created to investigate the status change of sleeping patterns among older adults without missing responses and who answered all questions of interest. First, participants who

https://doi.org/10.1017/S0144686X21000015 Published online by Cambridge University Press

reported good quality of sleep in the 2012 wave were followed up to examine status change of quality of sleep in the 2014 wave (whether or not their sleep quality changed during this time period). This study sample regarding older adults' quality of sleep included 3,277 participants. Second, for individuals who slept within the recommended duration of between 7 and 8 hours daily in the 2012 wave, their change of sleep duration in the 2014 wave was examined. This study sample included 2,032 participants. Figure 1 shows the sample selection procedure.

A multivariable logistic regression model was estimated to investigate the sociodemographic and behavioural variables associated with the potential change of sleep quality. A multinomial logistic regression model was estimated for sleep duration, given that the outcome measurement had more than two categories. Adjusted odds ratios (AORs) and 95 per cent confidence intervals (95% CIs) were reported for both regression models. All statistical tests were two-tailed with level of significance at 0.05 ($p < 0.05$). All statistical analyses were conducted using the free and publicly available statistical software R (version 3.4.3); the package 'nnet' was used for multinomial logistic regression (Ripley and Venables, 2016).

Results

Table 1 provides the sample characteristics of the two study samples. The results were based on the study participants who reported good quality of sleep and those who slept within the recommended daily sleep duration in the 2012 wave and their status changes in the 2014 wave. In both samples, a majority of participants were above 80 years old and male. More than 50 per cent of older adults were not married in the first study sample, but nearly 53 per cent of the participants were married in the second study sample. Most older adults had lower household income (less than 30,000 RMB), did not have formal education, lived in rural communities, and resided in East and Central-South provinces (Table 1).

Some discrepancies in health behaviours, health conditions and wellbeing were observed between the two study samples. First, for the first study sample regarding quality of sleep, 17 per cent suffered from chronic diseases that required inpatient treatments in the past two years, 68 per cent felt good with their life, 23 per cent were current smokers and 23 per cent were current alcohol users. In the second study sample, 19 per cent of participants suffered from chronic conditions that required inpatient treatments in the past two years, 62 per cent felt good with their life, 22 per cent were current smokers and 20 per cent were current alcohol users. However, nearly 41 per cent exercised and only 6 per cent were strongly limited with basic activities of daily living (ADLs) in both study samples.

For the change of quality of sleep between the 2012 and 2014 waves, approximately 52 per cent of female older adults did not report good quality of sleep. Non-married participants, older adults without formal education and those with the lowest level of income all reported greater frequency of poorer sleep quality as compared with other categories. Nearly 63 per cent of older adults who did not exercise reported poorer quality of sleep. Interestingly, the majority of older adults who did not report good quality of sleep did not suffer from chronic conditions, did not have a disability, did not smoke and did not consume alcohol. These

https://doi.org/10.1017/S0144686X21000015 Published online by Cambridge University Press

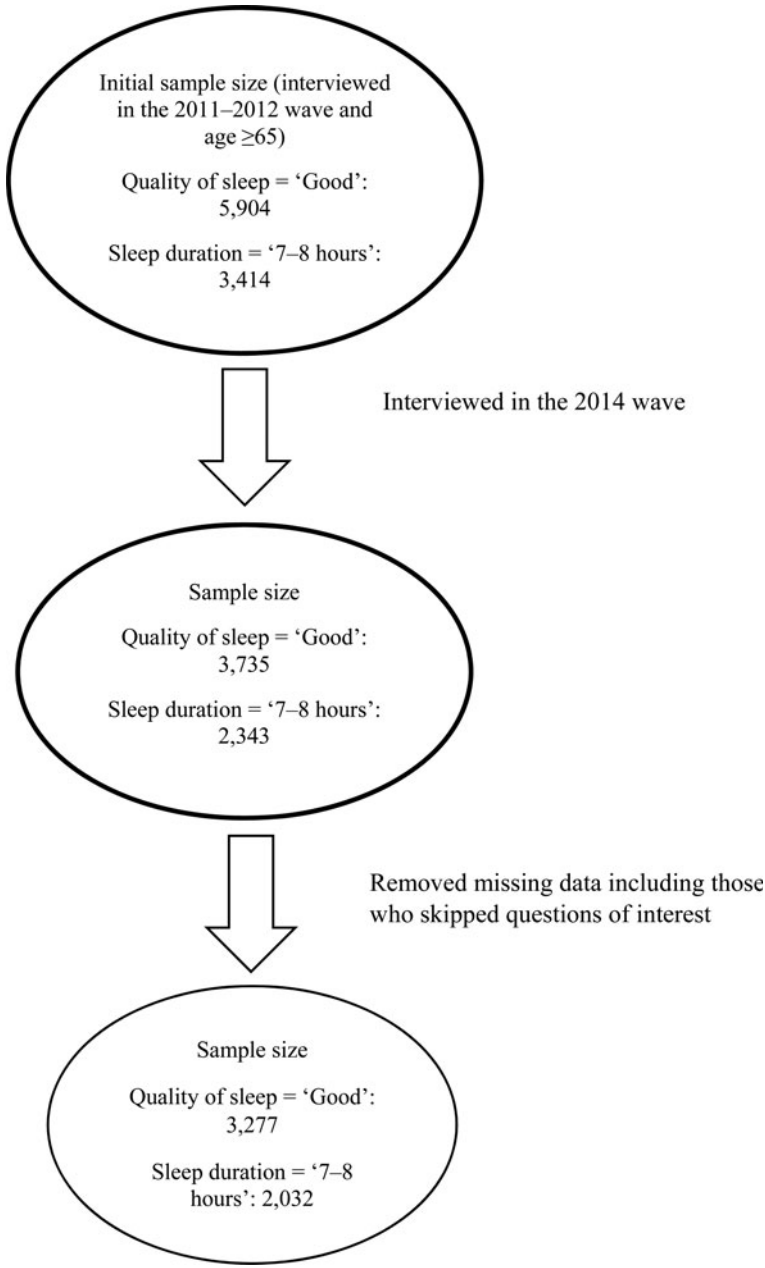

Figure 1. Flowchart of the study sample selection procedure.

observations may be due to the fact that most older adults did not engage in such behavioural activities or conditions.

For the change of daily sleep duration between the 2012 and 2014 waves, approximately 54 per cent of female participants reported shorter sleep duration

https://doi.org/10.1017/S0144686X21000015 Published online by Cambridge University Press

Table 1. Sample characteristics of older adults who reported good quality of sleep and those who slept within the recommended daily sleep duration in the 2012 wave and their status changes in the 2014 wave

	2014 wave: quality of sleep (N = 3,277)[1]						2014 wave: daily sleep duration (N = 2,032)							
	Good		Not good		Overall		7–8 hours		< 7 hours		> 8 hours		Overall	
2012 wave	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Age:														
65–80	1,126	49.3	469	47.23	1,595	48.67	561	62.06	314	52.42	243	45.94	1,118	55.02
81–95	896	39.23	412	41.49	1,308	39.91	273	30.2	225	37.56	210	39.7	708	34.84
> 95	262	11.47	112	11.28	374	11.41	70	7.74	60	10.02	76	14.37	206	10.14
Gender:														
Male	1,218	53.33	477	48.04	1,695	51.72	477	52.77	276	46.08	292	55.2	1,045	51.43
Female	1,066	46.67	516	51.96	1,582	48.28	427	47.23	323	53.92	237	44.8	987	48.57
Marital status:														
Married	1,152	50.44	462	46.53	1,614	49.25	513	56.75	306	51.09	263	49.72	1,082	53.25
Other	1,132	49.56	531	53.47	1,663	50.75	391	43.25	293	48.91	266	50.28	950	46.75
Household income (RMB):														
⩽10,000	889	38.92	425	42.8	1,314	40.1	366	40.49	253	42.24	209	39.51	828	40.75
10,001–30,000	667	29.2	259	26.08	926	28.26	258	28.54	165	27.55	155	29.3	578	28.44
30,001–50,000	304	13.31	114	11.48	418	12.76	125	13.83	82	13.69	80	15.12	287	14.12
50,001–70,000	116	5.08	44	4.43	160	4.88	47	5.2	18	3.01	20	3.78	85	4.18
> 70,000	170	7.44	77	7.75	247	7.54	68	7.52	42	7.01	34	6.43	144	7.09
Do not know	138	6.04	74	7.45	212	6.47	40	4.42	39	6.51	31	5.86	110	5.41

Years of formal education:														
None	1,115	48.82	561	56.5	1,676	51.14	391	43.25	313	52.25	273	51.61	977	48.08
1–5	607	26.58	263	26.49	870	26.55	272	30.09	154	25.71	124	23.44	550	27.07
6–10	462	20.23	123	12.39	585	17.85	191	21.13	97	16.19	120	22.68	408	20.08
⩾11	100	4.38	46	4.63	146	4.46	50	5.53	35	5.84	12	2.27	97	4.77
Residence:														
Urban	1,085	47.5	474	47.73	1,559	47.57	448	49.56	292	48.75	233	44.05	973	47.88
Rural	1,199	52.5	519	52.27	1,718	52.43	456	50.44	307	51.25	296	55.95	1,059	52.12
Province:														
North	106	4.64	34	3.42	140	4.27	36	3.98	22	3.67	19	3.59	77	3.79
North-East	137	6	58	5.84	195	5.95	59	6.53	38	6.34	23	4.35	120	5.91
East	1,017	44.53	372	37.46	1,389	42.39	346	38.27	238	39.73	221	41.78	805	39.62
Central-South	760	33.27	424	42.7	1,184	36.13	377	41.7	224	37.4	202	38.19	803	39.52
West	264	11.56	105	10.57	369	11.26	86	9.51	77	12.85	64	12.1	227	11.17
Exercise status:														
No	1,314	57.53	621	62.54	1,935	59.05	527	58.3	363	60.6	316	59.74	1,206	59.35
Yes	970	42.47	372	37.46	1,342	40.95	377	41.7	236	39.4	213	40.26	826	40.65
Chronic conditions:[2]														
No	1,904	83.36	807	81.27	2,711	82.73	739	81.75	463	77.3	437	82.61	1,639	80.66
Yes	380	16.64	186	18.73	566	17.27	165	18.25	136	22.7	92	17.39	393	19.34
Life satisfaction:														
Good	1,586	69.44	653	65.76	2,239	68.32	568	62.83	350	58.43	342	64.65	1,260	62.01

(*Continued*)

Table 1. (*Continued.*)

	2014 wave: quality of sleep (N = 3,277)[1]						2014 wave: daily sleep duration (N = 2,032)							
	Good		Not good		Overall		7–8 hours		< 7 hours		> 8 hours		Overall	
2012 wave	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Neutral	650	28.46	291	29.31	941	28.72	310	34.29	220	36.73	176	33.27	706	34.74
Bad	48	2.1	49	4.93	97	2.96	26	2.88	29	4.84	11	2.08	66	3.25
Disability:														
Not limited	1,779	77.89	730	73.51	2,509	76.56	718	79.42	428	71.45	398	75.24	1,544	75.98
Limited	390	17.08	197	19.84	587	17.91	150	16.59	131	21.87	93	17.58	374	18.41
Strong limited	115	5.04	66	6.65	181	5.52	36	3.98	40	6.68	38	7.18	114	5.61
Smoking status:														
None	1,353	59.24	647	65.16	2,000	61.03	552	61.06	394	65.78	314	59.36	1,260	62.01
Former	371	16.24	155	15.61	526	16.05	137	15.15	94	15.69	85	16.07	316	15.55
Current	560	24.52	191	19.23	751	22.92	215	23.78	111	18.53	130	24.57	456	22.44
Alcohol use status:														
None	1,416	62	657	66.16	2,073	63.26	583	64.49	403	67.28	346	65.41	1,332	65.55
Former	315	13.79	148	14.9	463	14.13	129	14.27	88	14.69	74	13.99	291	14.32
Current	553	24.21	188	18.93	741	22.61	192	21.24	108	18.03	109	20.6	409	20.13

Notes: 1. The distributions of quality of sleep and sleep duration were based on the changes between 2012 and 2014. 2. Suffering from chronic conditions that required inpatient treatments in the past two years.
Source: Chinese Longitudinal Healthy Longevity Survey.

(less than 7 hours daily) and only 44.8 per cent of female older adults reported longer sleep duration (more than 8 hours daily). A majority of married older adults reported shorter sleep duration (51%), but most non-married participants reported longer sleep duration (50.3%). Individuals with the lowest level of income or education had higher percentages of reporting either shorter or longer sleep duration daily compared with other categories. A majority of those who did not sleep within the recommended average sleep hours daily did not suffer from chronic conditions, did not have a disability, did not smoke and did not consume alcohol. Again, these observations may be because most of the older adults did not engage in such behavioural activities or conditions.

Table 2 shows the results of multivariable logistic and multinomial regression models with outcomes of changes of sleep quality and daily sleep duration. Participants who had received 6–10 years of formal education had lower odds of reporting poorer quality of sleep (AOR = 0.56, 95% CI = 0.43, 0.72; $p < 0.01$), compared with those who received no formal education. Compared with participants from northern regions, residents from central and southern areas had lower odds of reporting poor quality of sleep (AOR = 1.61, 95% CI = 1.06, 2.45; $p < 0.05$). Bad life satisfaction was associated with poorer quality of sleep (AOR = 2.01, 95% CI = 1.32, 3.07; $p < 0.01$). However, exercise, smoking behaviour and alcohol consumption were not associated with quality of sleep.

In the second model estimating daily sleep duration, older participants had higher odds of longer sleep duration (> 8 hours; all p values < 0.01), compared with younger individuals. Older participants also had higher odds of shorter sleep duration, compared with younger counterparts (AOR = 1.33, 95% CI = 1.04, 1.71; $p < 0.05$). Being female was negatively associated with longer sleep duration (AOR = 0.72, 95% CI = 0.53, 0.96; $p < 0.05$). Household income between 50,001 and 70,000 RMB was negatively associated with shorter sleep duration (< 7 hours). A higher level of education was negatively associated with longer sleep duration ($p < 0.05$), with the exception of older adults who received 6–10 years of formal education. Older adults who were strongly limited with ADLs had higher odds of longer sleep duration (AOR = 1.72, 95% CI = 1.05, 2.83; $p < 0.05$), compared with those who were not limited with ADLs. Exercise status, smoking behaviour and alcohol consumption were not associated with daily sleep duration.

Discussion

We used a large study sample with longitudinal data to investigate the socio-demographic and behavioural traits associated with Chinese older adults' status change of sleeping patterns. The use of longitudinal data made it possible to capture older adults' change of sleep status at two different time-points. Among all socio-economic and regional variables, only education and province were associated with quality of sleep. In terms of health and wellbeing predictors, only older adults who were unsatisfied with their life satisfaction were more likely to report poor quality of sleep. In the second multinomial regression model regarding daily sleep duration, increasing age was positively associated with both longer and shorter sleep duration, and being female was negatively associated with longer sleep duration. Again, older adults with higher levels of education (between 1 and 5 years

https://doi.org/10.1017/S0144686X21000015 Published online by Cambridge University Press

Table 2. Multivariable logistic and multinomial regression models examining the socio-demographic factors associated with status change of quality of sleep and daily sleep duration

	Model 1: Quality of sleep (2014)[1]		Model 2: Daily sleep duration (2014)[2]			
	Not good		< 7 hours		> 8 hours	
	AOR	95% CI	AOR	95% CI	AOR	95% CI
Age:[3]						
65–80						
81–95	0.94	0.79, 1.13	1.33*	1.04, 1.71	1.73**	1.33, 2.25
> 95	0.77	0.58, 1.02	1.28	0.84, 1.94	2.35**	1.56, 3.54
Gender:						
Male						
Female	0.99	0.80, 1.21	1.09	0.82, 1.43	0.72*	0.53, 0.96
Marital status:						
Married						
Other	1.07	0.90, 1.28	1.02	0.80, 1.30	1.06	0.81, 1.37
Household income (RMB):						
⩽10,000						
10,001–30,000	0.87	0.71, 1.05	0.94	0.72, 1.23	1.11	0.84, 1.46
30,001–50,000	0.90	0.70, 1.17	0.96	0.68, 1.35	1.24	0.87, 1.76
50,001–70,000	0.86	0.59, 1.26	0.53*	0.29, 0.95	0.82	0.46, 1.45
> 70,000	1.05	0.77, 1.43	0.86	0.55, 1.35	0.98	0.61, 1.58
Do not know	1.04	0.76, 1.42	1.36	0.84, 2.22	1.40	0.83, 2.35
Years of formal education:						
None						
1–5	0.88	0.72, 1.07	0.81	0.62, 1.07	0.69*	0.52, 0.93
6–10	0.56**	0.43, 0.72	0.80	0.58, 1.12	1.05	0.76, 1.46
⩾11	1.00	0.67, 1.49	1.14	0.69, 1.90	0.39**	0.20, 0.78
Residence:						
Urban						
Rural	0.90	0.76, 1.06	1.06	0.84, 1.33	1.25	0.99, 1.60
Province:						
North						
North-East	1.37	0.83, 2.27	1.08	0.54, 2.13	0.77	0.36, 1.64
East	1.05	0.70, 1.60	1.08	0.61, 1.93	1.16	0.63, 2.13

(*Continued*)

https://doi.org/10.1017/S0144686X21000015 Published online by Cambridge University Press

Table 2. (*Continued.*)

	Model 1: Quality of sleep (2014)[1]		Model 2: Daily sleep duration (2014)[2]			
	Not good		< 7 hours		> 8 hours	
	AOR	95% CI	AOR	95% CI	AOR	95% CI
Central-South	1.61*	1.06, 2.45	0.86	0.48, 1.53	0.90	0.49, 1.66
West	1.15	0.72, 1.81	1.31	0.70, 2.47	1.36	0.70, 2.65
Exercise status:						
No						
Yes	0.85	0.72, 1.00	0.98	0.78, 1.24	1.11	0.87, 1.42
Chronic conditions:[4]						
None						
Yes	1.09	0.89, 1.33	1.23	0.94, 1.60	0.96	0.72, 1.29
Life satisfaction:						
Good						
Neutral	1.00	0.84, 1.18	1.11	0.88, 1.39	0.94	0.74, 1.20
Bad	2.01**	1.32, 3.07	1.62	0.92, 2.86	0.71	0.34, 1.48
Disability:						
Not limited						
Limited	1.16	0.95, 1.42	1.31	1.00, 1.73	1.05	0.78, 1.42
Strongly limited	1.24	0.89, 1.72	1.52	0.94, 2.48	1.72*	1.05, 2.83
Smoking status:						
None						
Former	0.97	0.76, 1.24	0.99	0.7, 1.39	1.02	0.71, 1.46
Current	0.81	0.64, 1.01	0.82	0.6, 1.13	1.11	0.81, 1.52
Alcohol use status:						
None						
Former	1.16	0.91, 1.47	1.05	0.75, 1.47	0.87	0.60, 1.24
Current	0.86	0.70, 1.07	0.98	0.72, 1.33	0.89	0.66, 1.21

Notes: All models were controlled for the same set of variables. 1. Multivariable logistic regression (quality of sleep); reference group: 'good'. 2. Multinomial regression (daily sleep duration); reference group: '7–8 hours'. 3. All predictors were selected from the 2012 wave. 4. Suffering from chronic conditions that required inpatient treatments in the past two years. AOR: adjusted odds ratio. 95% CI: 95% confidence interval.
Significance levels: * $p < 0.05$, ** $p < 0.01$.

https://doi.org/10.1017/S0144686X21000015 Published online by Cambridge University Press

of formal education and 11 years and above) had lower odds of reporting longer sleep duration, compared with participants who did not have any formal education. Older adults who were strongly limited with ADLs had higher odds of reporting longer sleep duration, compared with those who did not have such challenges.

However, one of the most surprising findings is that older adults' health-related behaviours, including exercise status, smoking behaviour and alcohol consumption, were neither positively nor negatively associated with any sleeping measurements. Previous studies (Gu *et al.*, 2010; Lee *et al.*, 2018a), using cross-sectional CLHLS datasets (2005 and 2014), have found somewhat paradoxical findings that older smokers and alcohol users had higher odds of reporting good quality of sleep, compared with non-smokers and non-alcohol users. Nevertheless, it also has been observed previously that smoking was associated with challenges in initiating sleep, insomnia-like sleep problems and other sleep disturbance (Wetter and Young, 1994; Jaehne *et al.*, 2012; Costa and Esteves, 2018). In the same vein, heavy alcohol use may affect length of sleep or reduce quality of sleep (Martindale *et al.*, 2017; Devenney *et al.*, 2019), although it is known that mild standard drinks before bedtime could increase the quality of sleep (Stein and Friedmann, 2005). These interesting discrepancies can be explained in different ways.

First, the majority of the participants included in our analyses were healthy. More than 80 per cent of these older adults claimed that they did not have any chronic conditions that required inpatient treatments in the past two years. In fact, chronic conditions are associated with sleep problems (Koyanagi *et al.*, 2014), which might also be the reason why we did not find any associations between older adults' chronic conditions and sleep-related measurements because only 17 per cent of participants had chronic conditions in our study samples. Second, in China, cigarette and alcohol products are used as symbols of celebration and relationship, and people always share and exchange these products as gifts (Xu *et al.*, 2016; Lee *et al.*, 2020b). Chinese older adults may not be aware of the harmful effects of these products. Further research or clinical experiments might be needed to examine the impacts of smoking and alcohol consumption behaviours on older adults' sleep-related measurements. Third, as previous research has observed the paradoxical effects of smoking and alcohol consumption behaviours on sleeping patterns with cross-sectional data (Gu *et al.*, 2010; Lee *et al.*, 2018a), this study employed longitudinal data to examine Chinese older adults' status change of sleep at two time-points. Previous paradoxical observations might be relevant only to a single time-point. Other research should continue to use longitudinal data to examine this topic of interest.

Moderate physical activity is associated with better quality of sleep, and poor sleep and physical inactivity are public health priorities (Kline, 2014; Wang and Boros, 2021). Exercise is well-documented as an intervention to improve quality of sleep (Youngstedt and Kline, 2006). In one meta-analysis, the authors observed that exercise has modest effects on improving quality of sleep among middle-aged and older adults with challenges to sleep (Yang *et al.*, 2012). However, this study did not reveal such associations. One major explanation of this discrepancy is that exercise status may not continue to affect older adults who already slept well, given that we recruited participants who already reported good quality of

https://doi.org/10.1017/S0144686X21000015 Published online by Cambridge University Press

sleep and slept within the recommended range of daily sleep duration. The long-term effect of exercise on maintaining sleep quality also should be investigated further with longitudinal data or clinical trials.

The positive findings between poorer life satisfaction and poorer sleep quality and between strongly limited status of ADLs and longer sleep duration were not as surprising. These observations were consistent with previous research studies (Paunio *et al*., 2009; Gu *et al*., 2010). In fact, poor sleep may have effects on emotions and the brain (Paunio *et al*., 2009), so it is not surprising to observe the associations between quality of sleep and life satisfaction among older adults. This could imply that life satisfaction and sleep quality might go hand-in-hand. For disability status, lower levels of muscle strength and balance function were associated with longer sleep duration among Chinese men (Fu *et al*., 2017). In this study, targeting older adults, participants who were strongly limited with ADLs may not have sufficient physical function or good muscle strength to perform basic activities. Therefore, they could spend more time with sedentary behaviour, which might lead to a higher level of sleepiness. Further assistance might be needed to support older adults who were strongly limited with ADLs to have a reasonable amount of sleep duration, 7–8 hours per day for older adults (Hirshkowitz *et al*., 2015).

Two biological factors, age and gender, were not associated with quality of sleep, but were associated with sleep duration. Observing increasing age on both longer and shorter daily sleep duration was not surprising, as ageing is associated with changes of circadian rhythms (Cooke and Ancoli-Israel, 2011; Duffy *et al*., 2015). Both short and long sleep duration were associated with a higher level of mortality (Hublin *et al*., 2007). However, when the biological function of circadian rhythms changes among older adults, it is more difficult for them to maintain the same level of sleep hygiene as in their younger adulthood. Therefore, it has become more critical for older adults to sleep within the recommended daily average time, which is 7–8 hours. Providing assistance and helping older adults to sleep within a reasonable duration become keys to geriatric health. Changes in daily habits might be able to increase the odds of sleeping within the recommended average hours of sleep daily as they age. For example, it has been suggested previously that more frequent consumption of vegetables and fruits might help older adults to sleep within the recommended duration (Lee *et al*., 2018a).

Some gender gaps were observed between this present research and other research. Although it has been found previously that men reported better sleep than women (Gu *et al*., 2010), such an association was not present in this research. Furthermore, women tend to sleep more than men in the USA at the same life-course stage (Burgard and Ailshire, 2013). Compared with the results in the USA (Burgard and Ailshire, 2013), we speculate that this discrepancy could be the result of cultural variation. Interestingly, in one study targeting middle-aged Chinese men and women, Chen *et al*. (2018) observed that women had shorter sleep duration and more symptoms of insomnia, especially for those who were more than 50 years old. To some extent, our research findings were more consistent with the observations by Chen *et al*. (2018) regarding Chinese middle-aged women.

However, some discrepancies between the US and Chinese study samples should be noted. In China, women take most of the role at home (including housework) while men usually take the responsibility of work and become the major source

https://doi.org/10.1017/S0144686X21000015 Published online by Cambridge University Press

of family income. According to the National Bureau of Statistics (*The Straits Times*, 2019), Chinese women spend approximately 2.1 hours on housework daily, which is three times that of men. In addition, most Chinese women are responsible for taking care of their family members at home. The long-term family burden of Chinese women might make them sleep less than men. Further research should investigate gender gaps in sleeping patterns, especially for the cross-cultural differences.

Education is another important variable for human health, and higher education could be a good indicator of better health (Winkleby *et al.*, 1992; Zajacova and Lawrence, 2018). In our research, a higher level of education was negatively associated with poor quality of sleep, although the statistically significant association was observed only between participants with 6–10 years and those without any formal education. A higher level of education also was negatively associated with longer sleep duration (> 8 hours), holding all other variables constant. In China, people with a higher level of education are more likely to make healthier choices, including the use of preventive care services, and report lower odds of alcohol related problems (Lee *et al.*, 2018b, 2020b). Similarly, individuals with higher levels of education tend to make better health decisions and long-term health choices in the USA, compared with those with a lower level of education (Fletcher and Frisvold, 2009). Highly educated individuals might care more about their health condition (Lee *et al.*, 2018b), which could be associated with better sleeping patterns in general. The effect of education also could be more evident among older adults, given that most of them have experienced drastic social changes in their earlier life, including the Chinese Civil War and the Cultural Revolution. These two social changes, on the other hand, might have hindered their opportunities to receive formal education.

A few research limitations should be stated as caveats. First, one major weakness is that the CLHLS questionnaire did not include an instrument such as the Pittsburgh Sleep Quality Index to assess older adults' sleeping patterns. Therefore, we did not have sufficient information to identify whether an older adult had insomnia. Second, all health-related measurements, including sleep-related measurements, were self-reported. Therefore, the results might reflect self-report bias. However, previous research has shown that self-rated health measurements are actually consistent with objective health status (Wu *et al.*, 2013). Besides, this is a common limitation for survey-based research and should not be a major concern to this research. Third, observational data, rather than clinical data, were used for our analyses. We can provide only evidence of associations of each socio-demographic variable, not 'impact'. Thus, further research should attempt to resolve this study limitation by conducting clinical trials. Lastly, some categories were relatively small among variables. We should be careful not to make a conclusive claim for those measurements.

Conclusion

In spite of these limitations, this study adds to the body of literature examining the socio-demographic and behavioural factors associated with Chinese older adults' status change of sleeping patterns. The advantages of this study include a

https://doi.org/10.1017/S0144686X21000015 Published online by Cambridge University Press

substantial amount of oldest-old respondents, the use of a large dataset and investigating older adults' sleeping status change between two time-points. Taken together, the results of this research may help public health practitioners and care providers assist older adults with their sleep-related challenges.

Data. Data used for this research were provided by the Chinese Longitudinal Healthy Longevity Survey (CLHLS) managed by the Center for Healthy Aging and Development Studies, Peking University. CLHLS is supported by funds from the US National Institutes on Aging (NIA), China Natural Science Foundation, China Social Science Foundation and the United Nations Population Fund.

Acknowledgements. We thank research participants and researchers for their efforts in collecting the Chinese Longitudinal Healthy Longevity Survey data.

Financial support. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. The authors declare no conflicts of interest.

Ethical standards. The authors used only secondary datasets for this present study and data analyses. Thus, approvals from the Institutional Review Board were not required.

References

Burgard SA and Ailshire JA (2013) Gender and time for sleep among U.S. adults. *American Sociological Review* **78**, 51–69.

Chen HC and Chou P (2017) Predictors of change in self-reported sleep duration in community-dwelling older adults: the Shih-Pai Sleep Study, Taiwan. *Scientific Reports* **7**, 4729.

Chen Y, Kartsonaki C, Clarke R, Guo Y, Yu C, Bian Z, Jiang Q, Li S, Chen J, Li L, Chen Z and China Kadoorie Biobank Study (2018) Characteristics and correlates of sleep duration, daytime napping, snoring and insomnia symptoms among 0.5 million Chinese men and women. *Sleep Medicine* **44**, 67–75.

Cooke JR and Ancoli-Israel S (2011) Normal and abnormal sleep in the elderly. *Handbook of Clinical Neurology* **98**, 653–665.

Costa M and Esteves M (2018) Cigarette smoking and sleep disturbance. *Addictive Disorders & Their Treatment* **17**, 40–48.

Devenney LE, Coyle KB, Roth T and Verster JC (2019) Sleep after heavy alcohol consumption and physical activity levels during alcohol hangover. *Journal of Clinical Medicine* **8**, 752.

Duffy JF, Zitting KM and Chinoy ED (2015) Aging and circadian rhythms. *Sleep Medicine Clinics* **10**, 423–434.

Essien SK, Feng CX, Sun W, Farag M, Li L and Gao Y (2018) Sleep duration and sleep disturbances in association with falls among the middle-aged and older adults in China: a population-based nationwide study. *BMC Geriatrics* **18**, 196.

Fletcher JM and Frisvold DE (2009) Higher education and health investments: does more schooling affect preventive health care use? *Journal of Human Capital* **3**, 144–176.

Fu L, Jia L, Zhang W, Han P, Kang L, Ma Y, Yu H, Zhai T, Chen X and Guo Q (2017) The association between sleep duration and physical performance in Chinese community-dwelling elderly. *PLOS ONE* **12**, e0174832.

Gooneratne NS and Vitiello MV (2014) Sleep in older adults: normative changes, sleep disorders, and treatment options. *Clinics in Geriatric Medicine* **30**, 591–627.

Gu D, Sautter J, Pipkin R and Zeng Y (2010) Sociodemographic and health correlates of sleep quality and duration among very old Chinese. *Sleep* **33**, 601–610.

Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, DonCarlos L, Hazen N, Herman J, Katz ES, Kheirandish-Gozal L, Neubauer DN, O'Donnell AE, Ohayon M, Peever J, Rawding R, Sachdeva RC, Setters B, Vitiello MV, Ware JC and Adams Hillard PJ (2015) National Sleep Foundation's sleep time duration recommendations: methodology and results summary. *Sleep Health* **1**, 40–43.

https://doi.org/10.1017/S0144686X21000015 Published online by Cambridge University Press

Hublin C, Partinen M, Koskenvuo M and Kaprio J (2007) Sleep and mortality: a population-based 22-year follow-up study. *Sleep* **30**, 1245–1253.

Jaehne A, Unbehaun T, Feige B, Lutz UC, Batra A and Riemann D (2012) How smoking affects sleep: a polysomnographical analysis. *Sleep Medicine* **13**, 1286–1292.

Kline CE (2014) The bidirectional relationship between exercise and sleep: implications for exercise adherence and sleep improvement. *American Journal of Lifestyle Medicine* **8**, 375–379.

Koyanagi A, Garin N, Olaya B, Ayuso-Mateos JL, Chatterji S, Leonardi M, Koskinen S, Tobiasz-Adamczyk B and Haro JM (2014) Chronic conditions and sleep problems among adults aged 50 years or over in nine countries: a multi-country study. *PLOS ONE* **9**, e114742.

Lee Y-H, Chang Y-C, Lee Y-T, Shelley M and Liu CT (2018a) Dietary patterns with fresh fruits and vegetables consumption and quality of sleep among older adults in mainland China. *Sleep and Biological Rhythms* **16**, 293–305.

Lee Y-H, Chiang T and Liu C-T (2018b) Residents' educational attainment and preventive care utilization in China. *International Journal of Health Care Quality Assurance* **31**, 41–51.

Lee Y-H, Chang Y-C, Liu C-T and Shelley M (2019) Evaluating the associations of consumption of non-red meat protein sources and flavor preferences on sleeping patterns among older adults in China. *Sleep & Biological Rhythms* **17**, 79–92.

Lee Y-H, Chang Y-C, Chiang T, Liu C-T and Shelley M (2020a) Living arrangements and sleep-related outcomes among older adults in China: a panel analytic approach. *International Journal of Aging and Human Development* **91**, 111–126.

Lee Y-H, Chang Y-C, Liu C-T and Shelley M (2020b) Correlates of alcohol consumption and alcohol dependence among older adults in contemporary China: results from the Chinese Longitudinal Healthy Longevity Survey. *Journal of Ethnicity in Substance Abuse* **19**, 70–85.

Luo J, Zhu G, Zhao Q, Guo Q, Meng H, Hong Z and Ding D (2013) Prevalence and risk factors of poor sleep quality among Chinese elderly in an urban community: results from the Shanghai aging study. *PLOS ONE* **8**, e81261.

Martindale SL, Hurley RA and Taber KH (2017) Chronic alcohol use and sleep homeostasis: risk factors and neuroimaging of recovery. *Journal of Neuropsychiatry and Clinical Neurosciences* **29**, A6–5.

Neikrug AB and Ancoli-Israel S (2010) Sleep disorders in the older adult – a mini-review. *Gerontology* **56**, 181–189.

Paunio T, Korhonen T, Hublin C, Partinen M, Kivimaki M, Koskenvuo M and Kaprio J (2009) Longitudinal study on poor sleep and life dissatisfaction in a nationwide cohort of twins. *American Journal of Epidemiology* **169**, 206–213.

Ripley B and Venables W (2016) *Package 'nnet'*. Available at https://cran.r-project.org/web/packages/nnet/nnet.pdf.

Schmidt C, Peigneux P and Cajochen C (2012) Age-related changes in sleep and circadian rhythms: impact on cognitive performance and underlying neuroanatomical networks. *Frontiers in Neurology* **3**, 118.

Sedgwick P (2014) Cross sectional studies: advantages and disadvantages. *BMJ* **348**, g2276.

Stein MD and Friedmann PD (2005) Disturbed sleep and its relationship to alcohol use. *Substance Abuse* **26**, 1–13.

Suzuki K, Miyamoto M and Hirata K (2017) Sleep disorders in the elderly: diagnosis and management. *Journal of General and Family Medicine* **18**, 61–71.

Tang J, Liao Y, Kelly BC, Xie L, Xiang YT, Qi C, Pan C, Hao W, Liu T, Zhang F and Chen X (2017) Gender and regional differences in sleep quality and insomnia: a general population-based study in Hunan Province of China. *Scientific Reports* **7**, 43690.

The Straits Times (2019) Being a woman in China means working a sixth of your life unpaid. *The Straits Times*. Available at https://www.straitstimes.com/asia/east-asia/being-a-woman-in-china-means-working-a-sixth-of-your-life-unpaid.

Wang F and Boros S (2021) The effect of physical activity on sleep quality: a systematic review. *European Journal of Physiotherapy* **23**, 11–18.

Wang P, Song L, Wang K, Han X, Cong L, Wang Y, Zhang L, Yan Z, Tang S and Du Y (2020) Prevalence and associated factors of poor sleep quality among Chinese older adults living in a rural area: a population-based study. *Aging Clinical and Experimental Research* **32**, 125–131.

Wetter D and Young T (1994) The relation between cigarette smoking and sleep disturbance. *Preventive Medicine* **23**, 328–334.

Winkleby MA, Jatulis DE, Frank E and Fortmann SP (1992) Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease. *American Journal of Public Health* **82**, 816–820.

Wu F, Guo Y, Kowal P, Jiang Y, Yu M, Li X, Zheng Y and Xu J (2013) Prevalence of major chronic conditions among older Chinese adults: the Study on Global AGEing and adult health (SAGE) wave 1. *PLOS ONE* **8**, e74176.

Wu S, Wang R, Zhao Y, Ma X, Wu M, Yan X and He J (2013) The relationship between self-rated health and objective health status: a population-based study. *BMC Public Health* **13**, 320.

Xu Y, Xu S, Wu Q and Guo Y (2016) Association between secondhand smoke exposure at home and cigarette gifting and sharing in Zhejiang, China: a repeat cross-sectional study. *BMJ Open* **6**, e010058.

Yang P-Y, Ho K-H, Chen H-C and Chien M-Y (2012) Exercise training improves sleep quality in middle-aged and older adults with sleep problems: a systematic review. *Journal of Physiotherapy* **58**, 157–163.

Youngstedt SD and Kline CE (2006) Epidemiology of exercise and sleep. *Sleep & Biological Rhythms* **4**, 215–221.

Zajacova A and Lawrence EM (2018) The relationship between education and health: reducing disparities through a contextual approach. *Annual Review of Public Health* **39**, 273–289.

Zeng Y (2012) Towards deeper research and better policy for healthy aging – using the unique data of Chinese Longitudinal Healthy Longevity Survey. *China Economic Journal* **5**, 131–149.

Zhang YS, Jin Y, Rao WW, Jiang YY, Cui LJ, Li JF, Li L, Ungvari GS, Ng CH, Li KQ and Xiang YT (2020) Prevalence and socio-demographic correlates of poor sleep quality among older adults in Hebei province, China. *Scientific Reports* **10**, 12266.

Zheng X, Pang L, Chen G, Huang C, Liu L and Zhang L (2016) Challenge of population aging on health. In Islam MdN (ed.), *Public Health Challenges in Contemporary China*. Berlin: Springer.

Zhu X, Hu Z, Nie Y, Zhu T, Chiwanda Kaminga A, Yu Y and Xu H (2020) The prevalence of poor sleep quality and associated risk factors among Chinese elderly adults in nursing homes: a cross-sectional study. *PLOS ONE* **15**, e0232834.

Cite this article: Lee Y-H, Chang Y-C, Chang P-J, Shelley M (2022). Socio-demographic and behavioural factors associated with status change of sleep quality and duration among Chinese older adults. *Ageing & Society* **42**, 2206–2223. https://doi.org/10.1017/S0144686X21000015