The Association of Sleep Duration with Visual Impairment in Middle-aged and Elderly Adults: The China Health and Retirement Longitudinal Baseline

Mengsha Sun
Shanghai Jiaotong University First People's Hospital
Qiyu Bo
Shanghai Jiaotong University First People's Hospital
Bing Lu
Shanghai Jiaotong University First People's Hospital
Xiaodong Sun
Shanghai Jiaotong University First People's Hospital
minwen zhou (zmw8008@163.com)
Shanghai General Hospital https://orcid.org/0000-0002-3746-2300

Research

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Abstract

Background

Sleep disorders may heighten the risk of visual impairment to further impact health outcomes. Little is known regarding the association of visual impairment with sleep disorders in China. Our objective was to examine the association of visual impairment with sleep disorders.

Methods

This cross-sectional study used the data from 13264 respondents to the 2011 survey of the China Health and Retirement Longitudinal Study, a nationally representative survey of adults aged 45 years or older. Visual impairment (VI) and sleep duration were examined using self-reported questionnaires. Respondents were identified as having VI if they reported blindness or partial blindness. With regards to sleep duration, participants were categorized into three groups: 1) those reporting short sleep duration (≤ 6 hours/night), 2) those reporting long sleep duration (> 8 hours/night), and 3) those reporting 6 to 8 hours of sleep per night (used as the reference group). Weighted multilevel logistic regression models, adjusting for sociodemographic characteristics, health behaviors, and medical history, were used.

Results

Of 13,264 respondents, 6,880 (51.9%) were women. The mean, standard deviation (SD) age was 59.39 (9.71) years. A total of 842 (6.3%) of respondents reported VI. The prevalence of short and long sleep duration was significantly higher among respondents with VI than those without VI ($P < 0.001$). The associations also persisted after stratifying the sample by age or sex. Multilevel logistic regression models showed that compared with 6–8 h/night of sleep, sleep duration of ≤ 6h/night was associated with a 1.19-fold (95% confidence interval (CI) = 1.02–1.40) higher VI risk, and sleep duration of > 8 h/night was associated with a 1.36-fold (95% CI = 1.05–1.75) higher VI risk. Higher risk of VI was associated with short (odds ratio [OR] = 1.34, 95% CI: 1.04–1.73) and long (OR = 1.60, 95% CI: 1.04–2.44) sleep durations in middle-aged respondents, as well as short sleep duration (OR = 1.27, 95% CI: 1.05–1.55) in elderly respondents. However, the association between VI and long sleep duration (OR = 1.34, 95% CI = 0.97–1.84) was absent in elderly respondents.

Conclusion

In this study, both short and long sleep durations were associated with VI. More comprehensive and integrated health care and rehabilitation systems covering vision and sleep are needed to address age-related VI.

Background

Visual impairment (VI) is a major global public health problem. According to a published report in Lancet Global Health, the number of people affected by VI has increased substantially, attributable to population growth and aging. Cataract and uncorrected refractive error combined contributed to 55% of blindness and 77% of vision impairment in adults aged 50 years and older in 2015 [1]. In China, the prevalence of low bilateral vision was 5.1%, and the prevalence of blindness was 1.0% based on the World Health Organization (WHO) best corrected visual acuity (BCVA) criteria in the Taizhou Eye Study [2]. The analysis further revealed that VI was associated with a higher rate of cognitive impairment, depression, and lower quality of life [3–5]. A few studies based on the US population concluded that older adults with VI experienced increased sleep disturbance [6, 7].

In vision impairment, sleep is one of the aspects of functioning that may be underestimated because attention is focused on establishing visual functions. Sleep is vital for optimal physical and mental health. There is growing evidence that both short and long-duration sleep may be associated with adverse health outcomes [8–10]. Several epidemiologic studies have reported an increased risk of all-cause mortality among those with self-reported short or long duration of sleep, as well as stroke and cardiovascular disease mortality [11–13]. Recent findings have also uncovered differences in sleep health based on racial/ethnic and socioeconomic position differences. Understanding the underlying causes of disparities in sleep health is only beginning to emerge [14]. Recently, additional studies have reported a statistically significant association between sleep disorders and ocular diseases, such as glaucoma, optic nerve dysfunction, and dry eye syndrome [15–17]. However, sleep data has not yet been considered an essential element in many epidemiologic studies of VI.

To our knowledge, there have been few large-scale population-based studies on the association between sleep duration and VI in an Asian population. This study aimed to evaluate the associations between sleep duration and prevalence of VI in a nationally representative survey of the Chinese adult population aged 45 years or older, using data from the 2011 survey of the China Health and Retirement Longitudinal Study (CHARLS).

Methods

Data and Study Sampling

The CHARLS is a nationally representative survey of Chinese adults aged 45 years or older and their spouses. The CHARLS was conducted between June 2011 and March 2012 and included 17,708 respondents in 150 counties or districts and 450 villages or urban communities throughout China [18]. The CHARLS protocol followed the tenets of the Declaration of Helsinki [19] and received ethical approval from the Peking University institutional review board [18]. Informed consent was obtained from all participants when CHARLS was administered consistent with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines [20].

Visual Impairment

The presence of VI was identified using a self-reported assessment of visual functions. CHARLS collected self-reported data on visual functions by asking, “Do you have vision problems (blind or partial blind)?” We identified respondents as having VI if they reported yes. We then categorized those responses as “VI” or “no VI”.

Sleep Duration

Sleep duration was assessed by asking participants the following question: “During the past month, how many hours of actual sleep did you get at night (average hours for one night)? (This may be shorter than the number of hours you spend in bed).” Concerning sleep duration, participant responses were categorized into three groups: 1) those reporting short sleep duration (≤ 6 hours), b) those reporting long sleep duration (> 8 hours), and 3) those reporting 6 to 8 hours of sleep (used as the reference group) [21, 22].

Covariates

Participants’ sociodemographic data, health behavior, and medical history included age, sex, marital status (married or partnered vs. otherwise), smoking status (yes or no), drinking status (more than once a month, less than once a month, none), and presence of certain chronic diseases. Chronic diseases and comorbidities were documented based on self-reported hypertension, dyslipidemia, diabetes, tumor, lung disease, liver disease, stroke, or heart problems.

Statistical Analysis

Because CHARLS has a complex sampling design, sampling weights were considered in the analyses. Continuous variables were presented using mean ± SD. Categorical variables were presented using numbers and percentages. Characteristics of the study sample were compared using the $\chi 2$ test for categorical variables and an independent-sample t-test or Mann-Whitney U test for continuous variables. The subjects were divided into two groups according to the median age: middle age and elderly. The prevalence of VI was calculated based on the complex survey design and non-response rate.

The PROC SURVEYFREQ procedure was used to calculate the overall age and gender-specific prevalence of VI using the inverse probability weighting method. Weighted multilevel logistic regression models were performed to evaluate the OR at a 95% CI. They modeled the association between self-reported sleep duration and VI adjusting for sociodemographic data (age, sex), lifestyle factors (marital status, smoking status, and drinking status), and health conditions (hypertension, dyslipidemia, diabetes, tumor, lung disease, liver disease, stroke, and heart problems). Statistical analysis was carried out using the Statistical Analysis System (SAS) (version 9.4, SAS Institute, Cary, NC, USA) for windows. All reported P values were two-tailed, and values less than 0.05 were considered statistically significant.

Results

Among the participants, subjects under 45 or those with incomplete demographic or health status data were excluded. Thus, 13,264 individuals, including 6,384 males (48.1%) and 6,880 (51.9%) females, were included in the final analysis. Figure 1 shows the schematic flow of the study sampling process. The characteristics of the included subjects in the CHARLS 2011–2012 are shown in Table 1. Of the study subjects, 842 (6.3%) reported VI. Those who reported VI were older and more likely to be not married or not partnered. In addition, subjects with VI were more likely to have hypertension, diabetes, tumor, lung disease, liver disease, stroke, and heart problems. Interestingly, subjects with short or long sleep durations were more likely to suffer VI.

Table 1

Demographic Characteristics of middle-aged and elderly Chinese with and without suffering vision impairment (CHARLS 2011–2012).

Variables		Vision impairment	No Vision impairment	*P*
Total 13264		842	12422	
Age 59.39 ± 9.7		63.87 ± 10.47	59.09 ± 9.58	< 0.001
Sex, n (%)	Male	385 (45.7)	5999 (48.3)	0.149
	Female	457 (54.3)	6423 (51.7)	
≥ 45 and ≤ 58 years	Male	138 (48.1)	2952 (45.8)	0.441
	Female	149 (51.9)	3498 (54.2)	
> 58 years	Male	247 (44.5)	3047 (51.0)	0.003
	Female	308 (55.5)	2925 (49.0)	
Marital status, n (%)	Married or Partnered	648 (77.0)	10957 (88.2)	< 0.001
	Otherwise	194 (23.0)	1465 (11.8)	
Smoking status, n (%)	Yes	346 (41.1)	4876 (39.3)	0.290
	No	496 (58.9)	7546 (60.7)	
Drinking status, n (%)	> once a month	203 (24.1)	3148 (25.3)	0.126
	≤ once a month	52 (6.2)	969 (7.8)	
	None	587 (69.7)	8305 (66.9)	
Hypertension, n (%)	Yes	259 (30.8)	2999 (24.1)	< 0.001
	No	583 (69.2)	9423 (75.9)	
Dyslipidemia, n (%)	Yes	80 (9.5)	1170 (9.4)	0.937
	No	762 (90.5)	11252 (90.6)	
Diabetes, n (%)	Yes	80 (9.5)	706 (5.7)	< 0.001
	No	762 (90.5)	11716 (94.3)	
Tumor, n (%)	Yes	14 (1.7)	108 (0.9)	0.020
	No	828 (98.3)	12314 (99.1)	
Lung disease, n (%)	Yes	144 (17.1)	1190 (9.6)	< 0.001
	No	698 (82.9)	11232 (90.4)	

Variables		Vision impairment	No Vision impairment	*P*
Liver disease, n (%)	Yes	47 (5.6)	466 (3.8)	0.008
	No	795 (94.4)	11956 (96.2)	
Stroke, n (%)	Yes	41 (4.9)	257 (2.0)	< 0.001
	No	801 (95.1)	12165 (98.0)	
Heart Problems, n (%)	Yes	140 (16.6)	1453 (11.7)	< 0.001
	No	702 (83.4)	10969 (88.3)	
Sleep duration, n (%)	≤ 6 h	483 (57.4)	6155 (49.5)	< 0.001
	6–8 h	272 (32.3)	5235 (42.1)	
	> 8 h	87 (10.3)	1032 (8.3)	

Weighted VI prevalence in middle-aged and elderly Chinese based on sleep duration are shown in Table 2. VI was more pronounced among respondents having short or long sleep durations than those with 6 to 8 hours of sleep in age and gender categories.

Table 2
Vision impairment prevalence in middle-aged and elderly Chinese according to Sleep duration (CHARLS 2011–2012)

		Sleep duration groups (hours/night)			*P*
	Overall	**≤ 6 h**	**6–8 h**	**> 8 h**	
All	n = 13264	n = 6638	n = 5507	n = 1119	
Vision impairment, n (%)	842 (6.0)	483 (6.5)	272 (5.2)	87 (7.2)	< 0.001
Age					
≥ 45 and ≤ 58 years	n = 6737	n = 3105	n = 3103	n = 529	
Vision impairment, n (%)	287 (3.8)	153 (4.1)	105 (3.2)	29 (5.8)	< 0.001
> 58 years	n = 6527	n = 3533	n = 2404	n = 590	
Vision impairment, n (%)	555 (7.9)	330 (8.3)	167 (7.4)	58 (8.4)	< 0.001
Sex					
Male	n = 6384	n = 3070	n = 2784	n = 530	
Vision impairment, n (%)	385 (5.6)	203 (5.8)	141 (5.0)	41 (7.1)	< 0.001
Female	n = 6880	n = 3568	n = 2723	n = 589	
Vision impairment, n (%)	457 (6.4)	280 (7.1)	131 (5.3)	46 (7.2)	< 0.001

The associations between sleep duration and VI in weighted logistic regression models are shown in Table 3. These associations were resilient to covariate adjustments for age, sex, marital status, smoking status, drinking status, hypertension, dyslipidemia, diabetes, tumor, lung disease, liver disease, stroke, and heart problems. Even after adjusting for these sociodemographic factors, a greater risk of VI was found in the ≤ 6 h/night (OR = 1.19, 95% CI: 1.02–1.40) and > 8 h/night (OR = 1.36, 95% CI: 1.05–1.75) groups, compared to the 6–8 h/night group.

Table 3
Associations between sleep duration and risk of vision impairment in middle-aged and elderly Chinese (CHARLS 2011–2012).

	Sleep duration groups (hours/night)		
	≤ 6 h	6–8 h	> 8 h
	OR (95%CI)	OR (95%CI)	OR (95%CI)
All	n = 6638	n = 5507	n = 1119
Model 1	1.37 (1.18–1.60)*	1.00 (Ref.)	1.44 (1.12–1.86) *
Model 2	1.31 (1.13–1.54) *	1.00 (Ref.)	1.34 (1.04–1.73) *
Model 3	1.19 (1.02–1.40) *	1.00 (Ref.)	1.36 (1.05–1.75) *
Age			
≥ 45 and ≤ 58 years	n = 3105	n = 3103	n = 529
Model 1	1.42 (1.10–1.83) *	1.00 (Ref.)	1.65 (1.09–2.53) *
Model 2	1.41 (1.09–1.82) *	1.00 (Ref.)	1.65 (1.08–2.52) *
Model 3	1.34 (1.04–1.73) *	1.00 (Ref.)	1.60 (1.04–2.44) *
> 58 years	n = 3533	n = 2404	n = 590
Model 1	1.31 (1.08–1.60) *	1.00 (Ref.)	1.34 (0.97–1.83)
Model 2	1.32 (1.08–1.60) *	1.00 (Ref.)	1.32 (0.97–1.82)
Model 3	1.27 (1.05–1.55) *	1.00 (Ref.)	1.34 (0.97–1.84)
Model 1 adjusted for age and sex.			
Model 2 adjusted for covariates in model 1 plus marital status, smoking status, and drinking status.			
Model 3 adjusted for covariates in model 2 plus, hypertension, dyslipidemia, diabetes, tumor, lung disease, liver disease, stroke, and heart problems.			
* significant			

In a stratified analysis of age categories, short and long sleep durations was associated with VI in middle-aged respondents. However, in elderly respondents, only the association between short sleep duration and VI was detected (Table 3).

Discussion

This study examined the association between sleep duration and VI in a nationally representative sample of older adults in China. Using large-scale population-based data, this study reached several findings. First, self-reported VI was highly prevalent among middle-aged and elderly adults in China. Second, short (≤ 6 h/night) and long (> 8 h/night) sleep durations were significantly associated with VI risks after adjusting for internal and external factors. In addition, we found a stronger association between VI and self-reported short and long sleep durations in middle age (≥ 45 and ≤ 58 years) respondents than the elderly. Our findings suggest that both short and long sleep durations could be a predictor of VI.

The prevalence of VI in China was demonstrated to be higher than that in the US or Asia [23]. The rapidly aging Chinese population may account for it. Chen et al.[24] reported that cataracts were the leading cause of bilateral or monocular VI among adults 50 years and older in the Binhu District of Wuxi City, China, followed by high myopic macular degeneration, age-related macular degeneration, and eye loss/atrophy. Bourne et al.[25] reported that leading causes worldwide were cataracts for blindness and uncorrected refractive error for moderate and severe VI. Moreover, more women were blind or having moderate and severe VI than men due to cataracts and macular degeneration worldwide and in all regions [25]. Our results revealed that the prevalence of VI in women was higher than that in men in the elderly (> 58 years), which was consistent with prior studies to some extent. Still, there was no significant difference in the middle-aged (≥ 45 and ≤ 58 years) group. Therefore, sociodemographic disparities exist in the prevalence of VI, and more targeted efforts are required for preventing and treating low vision and blindness in high-risk groups.

The mechanism of sleep duration has not been fully explained. Short sleep duration may be attributed to difficulty falling asleep, sleep fragmentation, and early awakenings. Long sleep duration may be due to poor circadian entrainment, compensation for fragmented sleep, and lower sleep efficiency [10, 26]. Sleep deterioration and related VI may result from several diseases [27]. In turn, VI may further increase mood disturbance and even worse sleep disorders. Further, respondents with VI tend to exhibit a shortened photoperiod and reduced circadian entrainment [8]. The decline or loss of light perception leads to circadian misalignment, further contributing to abnormal sleep duration. Therefore, ophthalmologists must recognize the possibility of sleep disturbance in subjects with VI and participate in effective management accordingly.

In particular, long sleep duration had more significant potential for VI than short sleep duration in multilevel logistic regression models. The result was similar in subset analyses of middle-aged respondents. However, this association was not significant in subset analyses of elderly respondents. It suggests that those who sleep for a long duration may require greater amounts of sleep, reflecting worse sleep conditions, and have a greater risk of VI, especially in the middle-aged group. Additional studies examining the causal relationship between sleep durations and VI are needed.

To our knowledge, this study is the first large-scale population-based study to explore the associations between self-reported sleep duration and VI among Chinese. Self-reported sleep duration and the prevalence of VI are known to reflect ethnic differences [28, 29]. Therefore, it is essential to investigate the

association between VI and sleep duration among older adults in China. Such research would be more convincing if adjusted for sociodemographic characteristics, health behavior, and medical history. All may affect the relationship between self-reported sleep duration and VI.

However, this study is not without limitations.

1. Due to the cross-sectional nature of the study, causality could not be established.
2. Sleep duration and visual function were subjectively assessed through self-reported questionnaires. Details outlining the severity of VI through visual acuity were not recorded. Moreover, an objective assessment of sleep quality using polysomnography or actigraphy was not conducted. However, according to previous studies [30], self-reported sleep duration is sufficiently consistent with objective methods such as actigraphy. In large-scale studies, the evaluation of sleep duration through self-reported questionnaires is a fast, simple, and widely accepted method [31].
3. The correlation between the severity of VI and the severity of sleep difficulties was not explained.
4. Though the study was adjusted for sociodemographic characteristics, health behavior, and medical history, it was not adjusted for mood, medication, and exposure to artificial light at night, affecting sleep duration [32, 33].

Conclusion

In summary, based on large-scale population-based data in China, this study concluded that both short and long sleep duration was associated with VI. However, the cause-and-effect relationship is unclear. The relationship of VI to sleep in the elderly requires more attention because of a lack of epidemiological studies in China. Furthermore, a more comprehensive and integrated healthcare and rehabilitation system that addresses vision and sleep is needed to address age-related VI.

Abbreviations

VI
Visual impairment
OR
odds ratio
CI
confidence interval
CHARLS
China Health and Retirement Longitudinal Study

Declarations

Ethics approval and consent to participate

The CHARLS program protocol followed the tenets of the Declaration of Helsinki and was ethically approved by the Peking University institutional review board. Informed consent was obtained from all participants when CHARLS was administered in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline. The present study involved a secondary analysis of established data sets and was not subject to ethical approval according to the London School of Economics and Political Science research ethics policy and procedures.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Competing interests

The authors declare no competing interests.

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Authors' contributions

MS and MZ contributed to the conception and design of the study. MS performed the statistical analysis and drafted the manuscript. QB and BL interpreted the data and critically reviewed the manuscript. XS and MZ supervised the whole study process. All authors read and approved the final manuscript.

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Figures

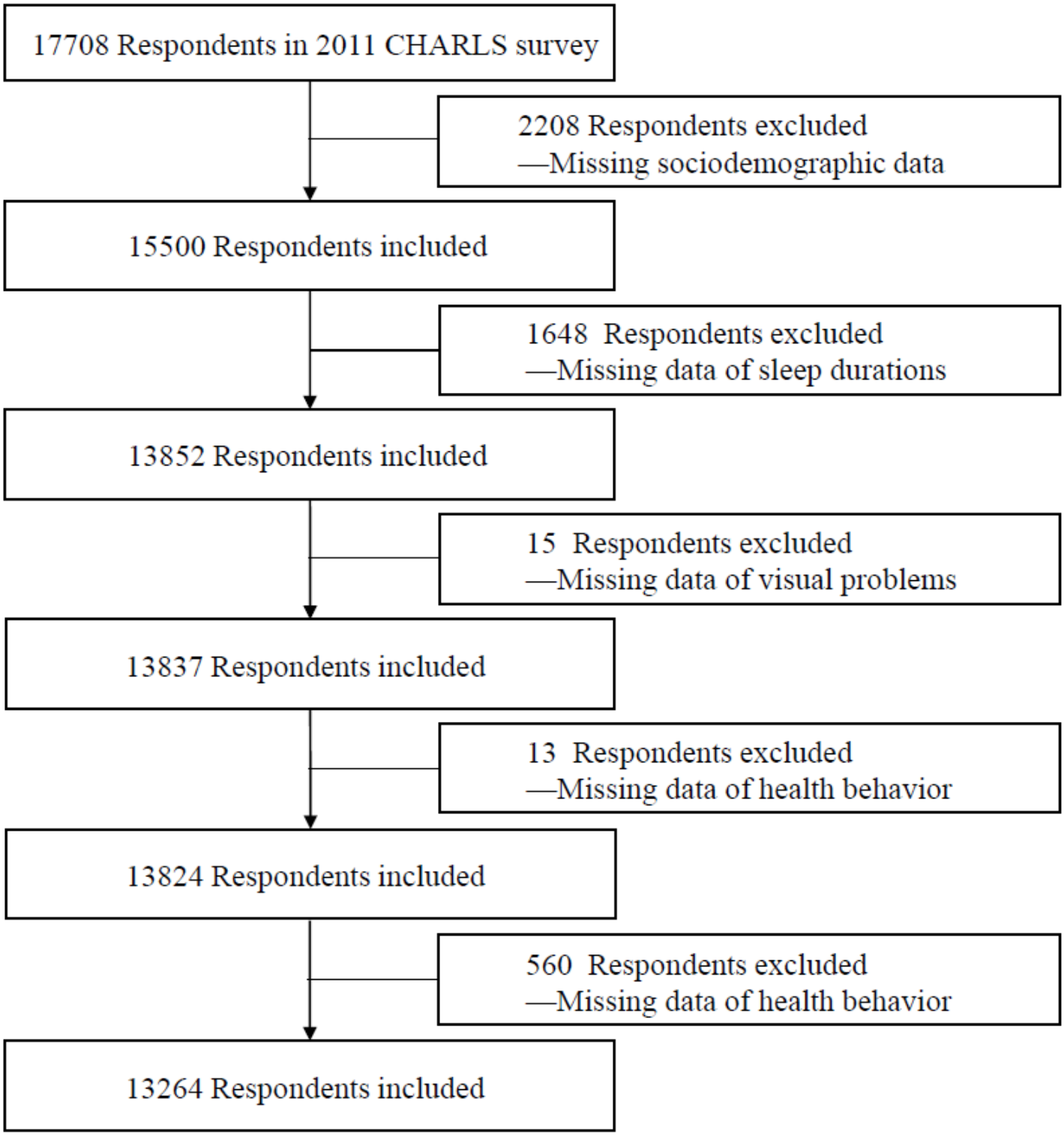

Figure 1

Flow Chart of the Study Sample From the 2011 China Health and Retirement Longitudinal Study (CHARLS)