Sleep Duration and Functional Disability among Chinese Older Adults: A Cross-Sectional Study

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Abstract

Background: The elderly demographic in China is undergoing a consistent increase, with a concomitant increase proportion of elderly in self-care functional disability. Among older people, the duration of sleep is a significant factor associated to health status, however, findings from previous researches have not been entirely consistent about the correlation between sleep duration and functional disability.

Objective: To investigate the association between sleep duration and functional disability among the elderly aged 65 years and older in China.

Methods: This is a nationally representative across-section study. Participants were aged 65 and above Chinese adults drawn from the 2018 survey of the China Health and Retirement Longitudinal Study (CHARLS). The duration of sleep per night obtained from face-to-face interviews. Functional disability was defined as a difficulty in performing activities of daily living (ADL) or instrumental activities of daily living (IADL). The association between sleep duration and functional disability was assessed by multivariable generalized linear model. The dose?response relationship between sleep duration and functional disability was analyzed using restricted cubic spline function.

Results: Of the 19 816 respondents, a total of 5 519 subjects were included in this study. The age of the subjects was (73.67±0.09) years, including 3 048 (55.23%) females. The prevalence of functional disability was 50.73% (2 800/5 519). After adjusted for potential confounders, individuals reporting shorter sleep durations (? 4, 5, 6 hours) or longer sleep durations (8, 9, ? 10 hours) per night exhibited a notably elevated risk of functional disability compared to the reference group (7 hours) ($P < 0.05$). Further analysis suggested a U-shaped association between sleep duration and functional disability. When sleep duration fell below 7 hours, increased sleep duration was associated with a significantly lower risk of functional disability (OR, 0.85; 95% CI, 0.79–0.91; $P < 0.001$), and the risk of functional disability would increase facing prolonged sleep duration (OR, 0.85; 95% CI, 0.79–0.91; $P < 0.001$).

Conclusions: Shorter and longer duration was associated with a higher risk of functional disability among the aged 65 and above Chinese adults. Future studies are needed to explore intervention strategies about sleep duration especially focus on functional disability.

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Sleep Duration and Functional Disability among Chinese Older Adults: A Cross-Sectional Study

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Abstract:

Background: Duration of sleep has a crucial role in the development of physiological functions that impact health. Little is known about the associations between sleep duration and functional disability among the older adults in China.

Objective: This study aims to explore the associations between sleep duration and functional disabilities in the older population aged 65 years and above in China.

Methods: The data for this cross-sectional study were gathered from respondents aged 65 years and above who participated in the 2018 survey of China Health and Retirement Longitudinal Study, an ongoing nationwide longitudinal investigation of Chinese adults. The duration of sleep per night was obtained through face-to-face interviews. Functional disability was assessed using activities of daily living (ADL) and instrumental activities of daily living (IADL). The association between sleep duration and functional disability was assessed by multivariable generalized linear model. Restricted cubic spline model was used to explore the dose-response relationship between sleep duration and functional disability.

Results: In total, 5 519 participants [Male: 2 471 (44.77%)] were included in this study with a mean age of 73.67 years old, containing 2 800 (50.73%) functional disabled, 1 978 (35.83%) ADL disabled, and 2 299 (41.66%) IADL disabled older adults. After adjusted for potential confounders, individuals reported shorter sleep durations (≤ 4, 5, 6 hours) or longer sleep durations (8, 9, ≥ 10 hours) per night exhibited a notably increased risk of functional disability compared to those who with 7 hours (P < 0.05), which revealed a U-shape association between sleep duration and dysfunction. When sleep duration fell below 7 h, increased sleep duration was associated with a significantly lower risk of functional disability (odds ratio [OR], 0.85; 95% confidence interval [CI], 0.79–0.91; P < 0.001). When sleep duration exceeded 7 h, the risk of functional disability (OR, 1.16; 95% CI, 1.05–1.29; P < 0.001) would increase facing prolonged sleep duration.

Conclusion: Shorter and longer sleep duration was associated with a higher risk of functional

disability among the aged 65 and above Chinese adults. Future studies are needed to explore intervention strategies about sleep duration especially focus on functional disability.

Keywords: sleep duration, functional disability, activity of daily living disability, instrumental activity of daily living, older population

Introduction

The issue of disability in older population has garnered significant attention and interest in recent decades[1-3]. Disability, as defined by the International Classification of Functioning, Disability, and Health (ICF), encompasses the combined effects of impairments, activity limitations, or participation restrictions[4]. Functional disability is a significant measure of restrictions in activities, specifically referring to challenges in performing basic activities of daily living (ADL) and/or instrumental activities of daily living (IADL)[5,6]. ADL are widely recognized as essential tasks for

maintaining independence in one's own residence, such as dressing, bathing, and eating. IADL refers to more complex tasks that require a higher level of independence and cognitive ability, such as managing financial matters, engaging in shopping activities, and preparing meals[7].

According to the World Health Organization (WHO) survey in 2022, 46.1% of those aged 60 and above worldwide have disability, and this figure is increasing in tandem with the rapid global aging phenomenon[8]. China, as one of the nations with the highest proportion of older citizens globally, has a population of over 14 percent individuals who are classified as older people[8], and is expected to increase to 30 percent in 2050 with an elderly support ratio [the number of 'working age' people (15–64) divided by those aged 65+] plummet from 9 in 2010 to 3, comparable to that of the US and Germany[9]. A previous meta-analysis conducted in 2022 reported the cumulative prevalence of functional disability in China exceeds 20%[10]. Moreover, WHO projects that by 2050, the number of functional disabled older adults in China will increase to 66 million[11]. With the high prevalence of functional disabilities among the growing older adult population, exploring the vital influence factors in functional disabilities process becomes crucial due to their potential amenability in preventions and interventions.

Duration of sleep has a crucial role in the development of physiological functions that impact health. It has been proposed to correlated with the increasing risk of cognitive decline, depression, cardiovascular diseases, osteoporosis, and stroke[12-17]. However, a consensus has yet to be reached about the association between the duration of sleep and the potential risk of functional disability. In 2016, the National Survey of Midlife Development in the United States presented evidence that insufficient sleep has been identified as an independent and important factor for physiological function disability[18]. A cohort study conducted in China with 1 798 individuals aged 90 years or older demonstrated that sleep duration of 8 to 10 hours was associated with the lowest risk of experiencing an ADL disability while a sleep duration exceeding 12 hours was associated with a heightened risk of experiencing ADL disability[19]. Regarding IADL disability, there is limited knowledge known about its correlations with the duration of sleep. A study with 136 participants, predominantly comprising older black individuals aged 65 years or above from low-income households, revealed a significant correlation between extended sleep duration surpassing 7.5 hours and worse IADL performance[20]. Similarly, evidence from the National Health Interview Survey spanning the years 2000 to 2015 showed that extended sleep duration (≥9 hours) was associated with a higher risk of IADL disability[21]. In addition, affected by historical, ethnic, economic, and socio-cultural factors, the association between sleep duration and functional disability may be heterogeneous for different countries[22,23]. Therefore, this study aims to examine the association between sleep duration and

functional disability in t China using a nationally representative sample of adults aged 65 years and above.

Methods:

Design and study population

This study used data from the China Health and Retirement Longitudinal Study (CHARLS), a comprehensive longitudinal data set designed to provide a representative sample of individuals aged 45 and above residing in mainland China[3]. The baseline survey of the CHARLS conducted a multistage stratified probability proportional to sampling method to recruit participants across 150 counties or districts and 450 villages or urban areas throughout the country. Face-to-face interviews were used to obtain the data. An older adult's closest relative or caregiver was asked to complete the survey on their behalf if the older adult was unable to do so. Additional details regarding the CHARLS dataset are available in previous published paper[3].The current study used the most recent wave of the CHARLS in 2018, with a sample size of 19 816 participants, to investigate the potential correlation between sleep duration and functional disability. We included only observations without missing values from Chinese older adults, aged 65 years or above. The schematic flow of the study sample is depicted in Figure 1. The total sample consisted of 5 519 individuals, both with and without functional disability.

[Figure 1 insert here]

The protocols followed in the CHARLS study were aligned with the principles of the Declaration of Helsinki[24]. The study obtained ethical approval from the Institutional Review Board at Peking University (IRB00001052-11015; IRB00001052-11014)[3]. All participants in the CHARLS provided written informed consent. The present cross-sectional study followed to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline[25].

Sleep duration

The self-reported data on sleep duration were obtained from a question about the average number of hours participants slept per night over the course of the previous month. Based on previous research experience of CHARLS study on sleep[26,27], we divided respondents into seven sleep duration groups (≤ 4, 5, 6, 7, 8, 9, and ≥ 10 h per night) in the analyses. In addition to assessing sleep duration, the study also explored daytime napping habits and established four distinct groups based on napping duration: 0 minutes, less than 30 minutes, 30 to 90 minutes, and over 90 minutes[28].

Functional disability

Functional disability was evaluated by asking participants about their ability to perform several domains of routine tasks in the ADL and IADL questionnaires without special equipment. The response of each item was categorized into four levels, including “No, I do not encounter any problem”, “I experience difficulty but am still able to perform the task”, “Yes, I encounter trouble and require assistance”, and “I am unable to perform the task”. According to the previous studies[29-31], respondents were recorded as having functional disability if they reported any challenge in any of the six ADLs (dressing, bathing, eating, getting in and out of bed, using the toilet, and managing urination and defecation) or the five IADLs (household chores, cooking, shopping, paying bills or managing assets, and taking medications)[32,33].

Covariates

The CHARLS structured questionnaire employed in-person interviews to gather participants' demographic characteristics. Covariates including age (years), gender (men and women), tobacco usage (never and current usage), alcohol consumption (never and current use), education level (illiterate, primary or middle school, and high school or higher), residential location (urban or rural areas), marital status (married or cohabited and other statuses), afternoon napping habits , chronic disease status, the incorporation of sampling weights, the depression status,. The 10-item Center for Epidemiological Studies Depression Scale (CES-D-10) was suggested to differentiate between individuals with and without depression with a cut-off value of 10 score[34-36]. The chronic illness condition of participants was assessed using self-reported non-communicable diseases (NCDs), including hypertension, diabetes, dyslipidemia, heart issues, stroke, liver diseases, renal diseases, lung diseases, arthritis, and stomach disorders. Based on a recent CHARLS study on sleep duration[37], individuals were divided into three chronic disease groups: “none” (no NCD), “mild” (1–2 NCDs), or “severe” (more than 3 NCDs). Regarding sampling weights, we used sets of cross-sectional individual weights that incorporated adjustments for non-response by individuals and households.

Statistical Analysis

Participants’ characteristics were presented as numbers and percentages for categorical variables and mean values and standard deviations (SDs) for continuous variables according to their functional disability status (including ADL and IADL disability). Missing baseline data was handled by multiple imputation method, which was widely used to compensate for the missing data via generating predictions for each missing value multiple times resulting in a dataset contained no missing values. Multivariable generalized linear models (GLM) were conducted, using a binomial family and log links, to investigate the associations between sleep duration and diverse functional disability statuses. Restricted cubic splines analyses with four specific knots located at the 5th, 25th,

75th, and 95th centiles of the exposure distribution were conducted to assess dose–response relationships between sleep duration and functional disability. The GLM and restricted cubic spline models were adjusted for these potential confounders including age, gender, education, marital status, tobacco and alcohol use, afternoon napping, residential location, depression status, chronic disease condition, and sampling weights. All analyses were accounted for the complex survey design of CHARLS conducted using Stata version 14.0 by Stata Corp. Statistically significant findings were defined by a two-sided *P*-value below 0.05. All data analyses were conducted utilizing Stata version 14.0 by Stata Corp.

Results

Sample Characteristics

A total of 5 519 participants (2 471 men and 3 048 women) were included in this analysis with a mean age of 73.67 years containing 2 800 (50.73%) functional disabled, 1 978 (35.83%) ADL disabled and 2 299 (41.66%) IADL disabled older adults. Table 1 provide descriptions of baseline characteristics. The data showed that the average sleep duration was 6.04 hours, and it was noticeable that most individuals had sleep durations less than 7 hours. Moreover, individuals with functional disability exhibited an average reduction in sleep duration, in comparison to those without functional disability (5.80 vs. 6.28 hours). A similar pattern emerged among individuals with ADL and IADL disabilities. Notably, older participants, women, non-smokers, abstainers, singles, rural inhabitants, as well as those with lower educational attainment, depression and a higher burden of chronic illnesses had greater rates of functional disability.

Table 1. Baseline characteristics of participants by functional disability status[a].

teris	Participants, no. (%)							
	Total sample (N = 5 519)	Functional Disability		ADL Disability		IADL Disability		
		Yes (n =2 800)	No (n =2 719)	Yes (n =1 978)	No (n =3 541)	Yes (n =2 299)	No (n =3 220)	
on ight, ±	6.04 ± 2.41	5.80 ± 2.64	6.28 ± 2.12	5.73 ± 2.72	6.21 ± 2.20	5.78 ± 2.71	6.23 ± 2.15	
on night rs, n								

1 418(25.69)	900(32.14)	518(19.05)	678(34.28)	740(20.90)	755(32.84)	663(20.59)
792(14.35)	411(14.68)	381(14.01)	273(13.80)	519(14.66)	345(15.01)	447(13.88)
995(18.03)	450(16.07)	545(20.04)	302(15.27)	693(19.57)	364(15.83)	631(19.60)
695(12.59)	259(9.25)	436(16.04)	182(9.20)	513(14.49)	199(8.66)	496(15.40)
885(16.04)	392(14.00)	493(18.13)	268(13.55)	617(17.42)	311(13.53)	574(17.83)
315(5.71)	145(5.18)	170(6.25)	109(5.51)	206(5.82)	111(4.83)	204(6.34)
419(7.59)	243(8.68)	176(6.47)	166(8.39)	253(7.14)	214(9.31)	205(6.37)
mean 73.67 ± 6.41	74.79 ± 6.79	72.53 ± 5.76	74.83 ± 6.87	73.03 ± 6.04	75.16 ± 6.93	72.62 ± 5.78
y er, n						
2 471(44.77)	1 099(39.25)	1 372(50.46)	790(39.94)	1 681(47.47)	883(38.41)	1 588(49.32)
n 3 048(55.23)	1 701(60.75)	1 347(49.54)	1 188(60.06)	1 860(52.53)	1 416(61.59)	1 632(50.68)
tion,						
2 067(37.45)	1 230(43.93)	837(30.78)	857(43.33)	1 210(34.17)	1 058(46.02)	1 009(31.34)
te y or 3 132(56.75)	1 464(52.29)	1 668(61.35)	1 050(53.08)	2 082(58.80)	1 156(50.28)	1 976(61.37)
chool ve 320(5.80)	106(3.79)	214(7.87)	71(3.59)	249(7.03)	85(3.70)	235(7.30)
co (%)						
3 158(57.93)	1 677(60.61)	1 481(55.18)	1 163(59.58)	1 995(57.02)	1 379(60.62)	1 779(56.01)
t 2 293(42.07)	1 090(39.39)	1 203(44.82)	789(40.42)	1 504(42 98)	896(39.38)	1 397(43.99)
ol (%)						
3 959(71.73)	2 120(75.71)	1 839(67.64)	1 479(74.77)	2 480(70.04)	1 787(77.73)	2 172(67.45)
t 1 560(28.27)	680(24.29)	880(32.36)	499(25.23)	1 061(29.96)	512(22.27)	1 048(32.55)

ed or ited, ence)	3 754(68.02)	1 780(63.57)	1 974(72.60)	1 248(63.09)	2 506(70.77)	1 434(62.37)	2 320(72.05)
	4 337(78.65)	2 304(82.34)	2 033(74.85)	1 635(82.70)	2 702(76.39)	1 901(82.72)	2 436(75.75)
	1 177(21.35)	494(17.66)	683(25.15)	342(17.30)	835(23.61)	397(17.28)	780(24.25)
ssio %) me ng in es, n	2 131(38.61)	1 312(46.86)	819(30.12)	968(48.94)	1 163(32.84)	1 083(47.11)	1 048(32.55)
	1 972(35.73)	1 016(36.29)	956(35.16)	713(36.05)	1 259(35.55)	1,576(39.51)	1 126(34.97)
	417(9.22)	244(8.71)	227(8.35)	167(8.44)	304(8.59)	359(9.00)	259(8.04)
	2 058(37.29)	995(35.54)	1 063(39.10)	706(35.69)	1 352(38.18)	1,385(34.72)	1 271(39.47)
	1 018(18.45)	545(19.46)	473(17.40)	392(19.82)	626(17.68)	669(16.77)	564(17.52)
ic se ion, (%)							
	2 679(48.54)	1 174(41.93)	1 505(55.35)	805(40.70)	1 874(52.92)	945(41.10)	1 734(53.85)
	2 389(43.29)	1 333(47.61)	1 056(38.84)	951(48.08)	1 438(40.61)	1 099(47.80)	1 290(40.06)
	451(8.17)	293(10.46)	158(5.81)	222(11.22)	229(6.47)	255(11.09)	196(6.09)

ADL, activity of daily living; IADL, instrumental activity of daily living.

[a]Missing data for the following characteristics: tobacco use (139 [1.11%]), and residence (17 [0.14%]).

[b]Defined as a score of 10 or greater on the 10-item Center for Epidemiologic Studies Depression scale.

Trajectories for Sleep Duration Across Functional Disability Status

The trajectories of sleep duration for different functional disabled groups are depicted in Figure 2. The sleep duration of respondents with no functional disability followed a flat curve, while there was a U-shaped association between sleep duration and age among respondents with functional disability (Figure 2A). Individuals with any functional disability had a substantially shorter level of sleep duration between the ages of 65 and 75 years (mean [SD] score at 65 vs 75 years: 6.11 [2.22] vs 5.98 [2.43]). Respondents with functional disability showed an increase trend in sleep duration after the age of 75 years (mean hour per 1–age point later in life, 0.09h). Respondents with ADL disability showed a rapid decline in sleep duration between the ages of 65–75 years, and increased after the age of 75 (Figure 2B). Similar patterns are illustrated in Figure 2C that for respondents with IADL disability, the sleep duration trajectories took a U-shape with age, and the shortest sleep duration happened at around the age of 75 years.

[Figure 2 insert here]

Graphs display analog values (lines) of the sleep duration with 95% CIs (shaded areas) for any functional disability (A), activity of daily living disability (B), and instrumental activity of daily living disability (C).

Associations Between Sleep Duration and Functional Disability

Table 2 presents the association between sleep duration and various functional disability groups. In the unadjusted model (Model 1), both individuals reporting shorter sleep durations (≤ 4, 5, 6 hours) or longer sleep durations (8, 9, ≥ 10 hours) per night exhibited a notably increased risk of functional disability compared to the reference group (7 hours) (All $P < 0.05$). The same trend was observed in the relationship between different sleep durations and IADL (All $P < 0.05$). Correspondingly, participants reporting shorter sleep durations (≤ 4, 5 h) or longer sleep durations (9, ≥10 h) demonstrated a significantly higher odd of ADL disability compared to the reference group (All $P < 0.05$).

After adjusted for other potential confounding factors (Model 2), the associations between shorter sleep durations (≤ 4, 5, 6 hours) or longer sleep durations (8, 9, ≥ 10 hours) and functional disability persisted (All $P < 0.05$), while those linking longer sleep duration (9 hours) to IADL disability dissipated (OR [odds ratio], 1.37; 95% CI, 0.96–1.96; $P = 0.085$) and longer sleep duration

(8 hours) to ADL disability emergent (OR, 1.33; 95% CI, 1.02–1.74; *P* = 0.037).

Table 2. Associations between sleep duration and functional disability status in participants from the 2018 China Health and Retirement Longitudinal Study.

Sleep duration per night, h	Functional Disability		ADL Disability		IADL Disability	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Model 1[a]						
≤4	2.92(2.42-3.52)	<0.001	2.58(2.12-3.14)	<0.001	2.84(2.34-3.44)	<0.001
5	1.81(1.48-2.23)	<0.001	1.48(1.19-1.85)	0.001	1.92(1.55-2.38)	<0.001
6	1.39(1.14-1.69)	0.001	1.23(0.98-1.52)	0.063	1.44(1.16-1.77)	0.001
7	[Reference]	NA	[Reference]	NA	[Reference]	NA
8	1.34(1.09-1.63)	0.005	1.22(0.98-1.52)	0.074	1.35(1.09-1.67)	0.006
9	1.43(1.09-1.88)	0.009	1.49(1.12-1.98)	0.006	1.36(1.02-1.80)	0.035
≥10	2.32(1.81-2.97)	<0.001	1.85(1.43-2.39)	<0.001	2.60(2.02-3.34)	<0.001
Model 2[b]						
≤4	2.65(2.08-3.38)	<0.001	2.16(1.68-2.78)	<0.001	2.48(1.94-3.19)	<0.001
5	1.78(1.34-2.37)	<0.001	1.39(1.04-1.88)	0.029	1.82(1.36-2.46)	<0.001
6	1.67(1.29-2.15)	<0.001	1.26(0.96-1.66)	0.091	1.69(1.29-2.20)	<0.001
7	[Reference]	NA	[Reference]	NA	[Reference]	NA
8	1.51(1.18-1.94)	0.001	1.33(1.02-1.74)	0.037	1.48(1.14-1.93)	0.003
9	1.57(1.12-2.21)	0.010	1.66(1.16-2.38)	0.006	1.37(0.96-1.96)	0.085
≥10	2.23(1.60-3.09)	<0.001	1.64(1.17-2.29)	0.004	1.91(1.57-2.32)	<0.001

ADL, activity of daily living; IADL, instrumental activity of daily living; OR, odds ratio; CI, confidence interval.

[a]Model 1 was unadjusted.

[b]Model 2 was adjusted for age, gender, education, marital status, tobacco use, alcohol use, afternoon napping, residence, depression, chronic diseases conditions, and sampling weights.

Subgroup Analyses

The findings of subgroup analyses by age and gender are shown in Figures 3–4, where significant effects specific to gender and age were noted. Compared to men, women who slept for shorter sleep durations (≤ 4, 5, 6 hours) or longer sleep durations (8, 9, ≥ 10 hours) per night were more likely to experience functional disability (Figure 3). Regarding age-specific effects, older adults (75 years and older) who slept for fewer than 6 hours or more than 8 hours were more likely than younger adults (75 years and younger) to develop functional disability (Figure 4).

[Figure 3 insert here]

[Figure 4 insert here]

A Non-linear Pattern for Relationship Between Sleep Duration and Functional Disability

Restricted cubic splines analyses were conducted to visually represent the associations between the duration of sleep and functional disability. There exists a U-shaped relationship between sleep duration and functional disability, even after accounting for any confounding factors. According to the data presented in Figure 3, the risk of functional disability was negatively correlated with sleep duration until it bottomed out at 7 h (OR, 0.85; 95% CI, 0.79–0.91; $P < 0.001$). Nevertheless, it was observed that there was a substantial increase in the risk of functional disability when the duration of sleep exceeded 7 hours (OR, 1.16; 95% CI, 1.05–1.29; $P < 0.001$).

[Figure 5 insert here]

Discussion

Principal Results

Our findings obtained from the nationally representative sample of 5 519 participants aged 65 years and older in China, indicated that shorter or longer sleep durations are more likely to experience higher risk of functional disability, including limitations in ADL and IADL. In the case of older population, it has been observed that a minimum risk of 7 hours of sleep duration is associated with a reduced likelihood of experiencing functional disability. Based on the previous studies that had shown functional disability as a notable risk factor for the sleep disorders in older population[38], the findings in this study suggest that the association between sleep and functional disability can exhibit a bidirectional nature.

Limitations

Our study have several limitations. First, the data of sleep duration and functional disability assessment was collecting via self-report by participants which could be subject to potential presence of information bias. Second, the sample for this study comprised individuals from China who were 65 years of age or older. This particular demographic characteristic may limit the generalizability of the findings to different age cohorts, geographical areas, or ethnic backgrounds. Third, this study adopts a cross-sectional design, which limits its ability to show a causal association. It is plausible to consider that older adults with functional disability may require prolonged periods of sleep, and a

reduced duration of sleep could potentially serve as an initial indication of dysfunction. Therefore, it is necessary to conduct further comprehensive cohort studies in order to validate these findings.

Comparison with Prior Work

Functional ability refers to an individual's capacity to engage in daily living and social activities according to their own intentions and preference. However, it is unoptimistiv that the prevalence of functional disability was found to be 41% across the entire sample in China[39]. The aging process is commonly accompanied with disturbances in sleep patterns, which have been linked to notable alterations in brain function and a decline in overall quality of life[40]. Besides, various population-based researches[41-43], both cross-sectional and longitudinal studies, have demonstrated that the prevalence of cognitive decline may be linked to an increased risk of experiencing functional disability. Moreover, some epidemiological research have documented a U-shaped association between sleep duration and cognitive decline, indicated a significant trend in the association between sleep duration and functional disability[44-46]. Nevertheless, a definitive consensus has not yet been attained, there is still a dearth of studies examining the association between sleep duration and functional disability.

Previous research has also investigated the association between sleep duration and self-care function. However, the majority of these studies have primarily concentrated on a single form of functional disability. A study involved night shift workers in the United States found that the prevalence of shorter sleep duration (< 7 hours/day) was the highest sleep problems among night shift workers (61.8%) with the highest prevalence of impaired ADL score (24.8%)[47], which revealed a correlation between shoter sleep duration and higher risk of ADL disability. Another study focused on dementia patients discovered that longer sleep duration was associated with ADL disability[48]. Similarly, a cross-sectional study recruited 1 798 participants aged older than 90 years resulted that long sleep duration (≥ 12 hours) may be associated with an increased risk of ADL disability among the older population[19]. Besides, Peng and his colleagues found that after accounting for potential confounders such as age and gender, both longer and shorter duration of sleep were linked to a heightened risk of IADL[49], which was consistent with the results of this study. Furthermore, instead of solely focused on the relationship between shorter sleep duration or longer sleep duration and functional disability among different sample sets, we simultaneously explored the impact of both shorter and longer sleep duration on functional disability within the same sample group. Additionally, concerning functional disability, we separately explored the associations between sleep duration and ADL and IADL, found that both shorter and longer sleep durations have an influence on functional health among the older population.

Implications and Contribution

The mechanism that accounts for the association between sleep duration and functional disability has yet to be fully explained, however there are several hypotheses. A study has demonstrated that inadequate and excessive sleep durations have been associated with an increased likelihood of hypertension among Chinese individuals[50]. The increased susceptibility to cardiovascular illnesses associated with this elevated risk can have a direct influence on the overall well-being and functional abilities of older adults. A recent study has revealed that both insufficient and excessive sleep durations are associated with an increased risk of late-life dementia, a condition that significantly impairs the ability of older individuals to perform their everyday duties[51]. Besides, relevant studies indicated that sleep was correlated with changes in epigenetic mechanisms like DNA methylation and histone modifications, which can also lead to cognitive dysfunctions such as learning and memory disruption[52-54]. This provided a new avenue for exploring the mechanism underlying the relationship between sleep duration and functional disability. Interventions aimed at good sleep hygiene may possess the capacity to yield favorable outcomes in terms of imporving physiology function among older adults. As evidenced by the empirical fundings of this study, the maintenance of recommended sleep duration (7 hours) might paly a crucial role in the health of older population.

Our subgroup analyses suggested that women and the older adults aged 75 years and above with for shorter sleep durations (≤ 4, 5, 6 hours) or longer sleep durations (8, 9, ≥ 10 hours) per night were more likely to experience functional disability. Gender differences in sleep duration among the aged population cannot be ignored. With the changes in the biological life cycles and the extreme hormonal change and with advancing age, women are at an increased risk for sleep disturbances (including insomnia and hypersomnia)[55]. Further, the sleep disturbances during menopause can be an independent risk associated with arterial stiffness and can result into higher incidence of steoarthritis that were highly related to dysfunction[56]. As for age-specific effects, changes in sleep sleep duration are a part of the normal aging process and meanwhile, may enhance cellular ageing in the later years of life[57]. According to the previous findings from an umbrella review[58], extreme sleep durations (including shorter and longer sleep duration) were more likely to be associated with an elevated risk of all-cause mortality, cognitive disorders, and diabetes mellitus type 2 in general population. The circadian oscillations that alter body functions including sleep become less pronounced during old age that increase the risk of functional disability[59]. The results emphasize on the importance of addressing the complex needs of dysfunctional population, particularly among women and the older adults.

Conclusions

In conclusion, more attention should be paid to older individuals with shorter or longer sleep duration. The precise mechanisms underlying the association between sleep duration and functional disability in the older population require further investigation.

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Data availability statement

The datasets presented in this study can be found in online repositories: China Health and Retirement Longitudinal Study. https://charls.charlsdata.com/index/en.html. The data sets generated during and analyzed during this study are available from the corresponding author on reasonable request.

Ethics statement

The studies involving human participants were reviewed and approved by the Peking University Institutional Review Board. The patients/participants provided their written informed consent to participate in this study.

Author contributions

HR and YF had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. ML, YD, BF and XZ contributed to the hypothesis and study design and interpreted the result. HL and CL analyzed the data. ML wrote the manuscript. HR and YF revised the manuscript. All authors contributed to the article and approved the submitted version.

Conflicts of interest

We declare no competing interests.

Generative AI statement

We declare no generative AI tool was used in any portion of the manuscript writing.

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Abbreviations

ADL activities of daily living

CES-D-10 10-item Center for Epidemiological Studies Depression Scale

CHARLS China Health and Retirement Longitudinal Study

ELSA English Longitudinal Study of Aging

IADL instrumental activities of daily living

NCD non-communicable disease

OR odds ratio

SD standard deviation

STROBE Strengthening the Reporting of Observational Studies in Epidemiology

Figure legends:

Figure 1. Flowchart of the study sample cleaning process.

Figure 2. Trajectories of sleep duration across individuals with various functional disability statuses.

Graphs display analog values (lines) of the sleep duration with 95% CIs (shaded areas) for any functional disability (A), activity of daily living disability (B), and instrumental activity of daily living disability (C).

Figure 3. Gender-specific effect of sleep duration on functional disability.

Figure 4. Age-specific effect of sleep duration on functional disability.

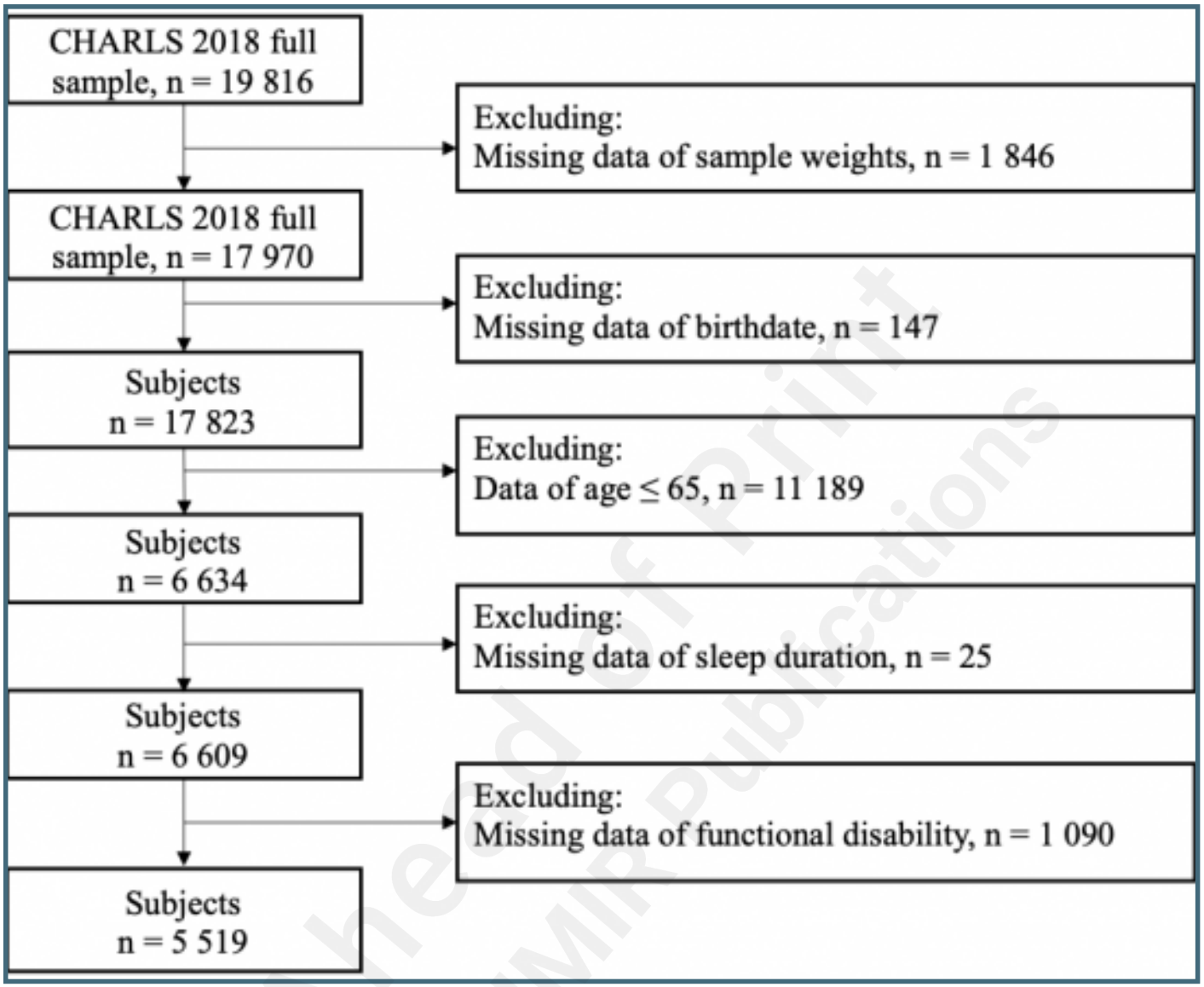
Figure 5. Non-linear relationship of sleep duration and functional disability status.

Graphs display adjusted OR for confounding factors (solid lines) of sleep duration with 95% CIs (dotted lines) for functional disability.

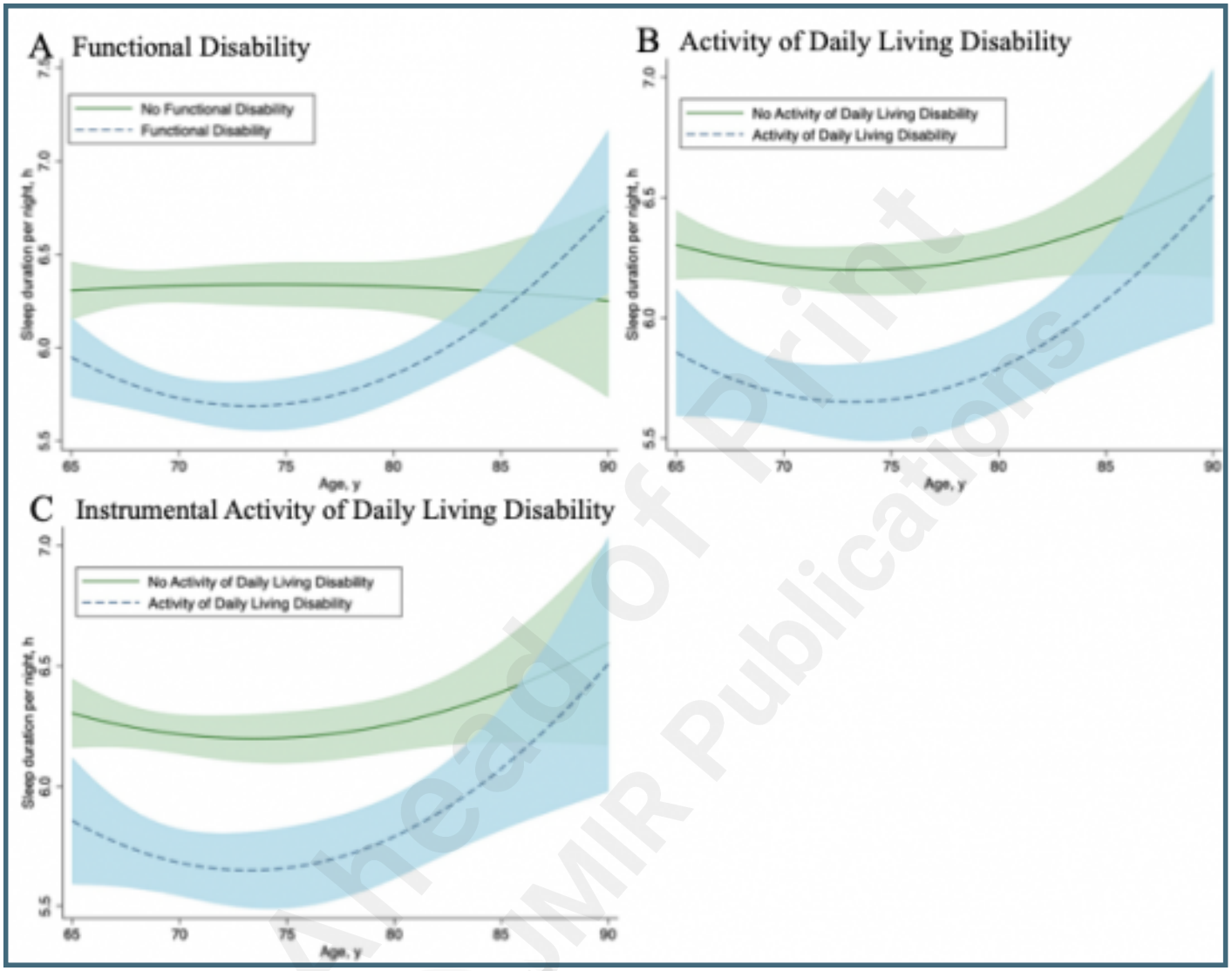
Supplementary Files

Figures

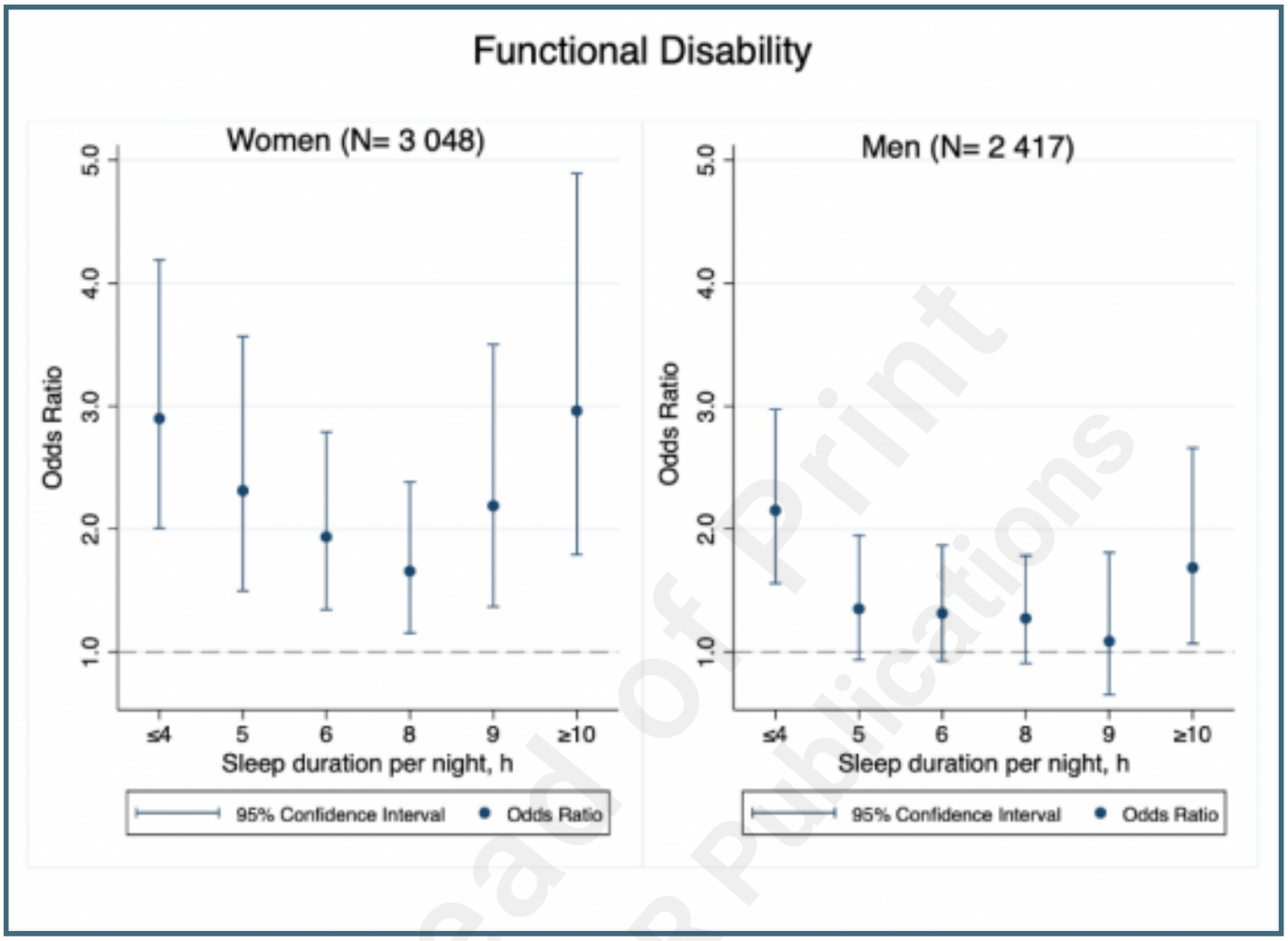
Flowchart of the study sample cleaning process.



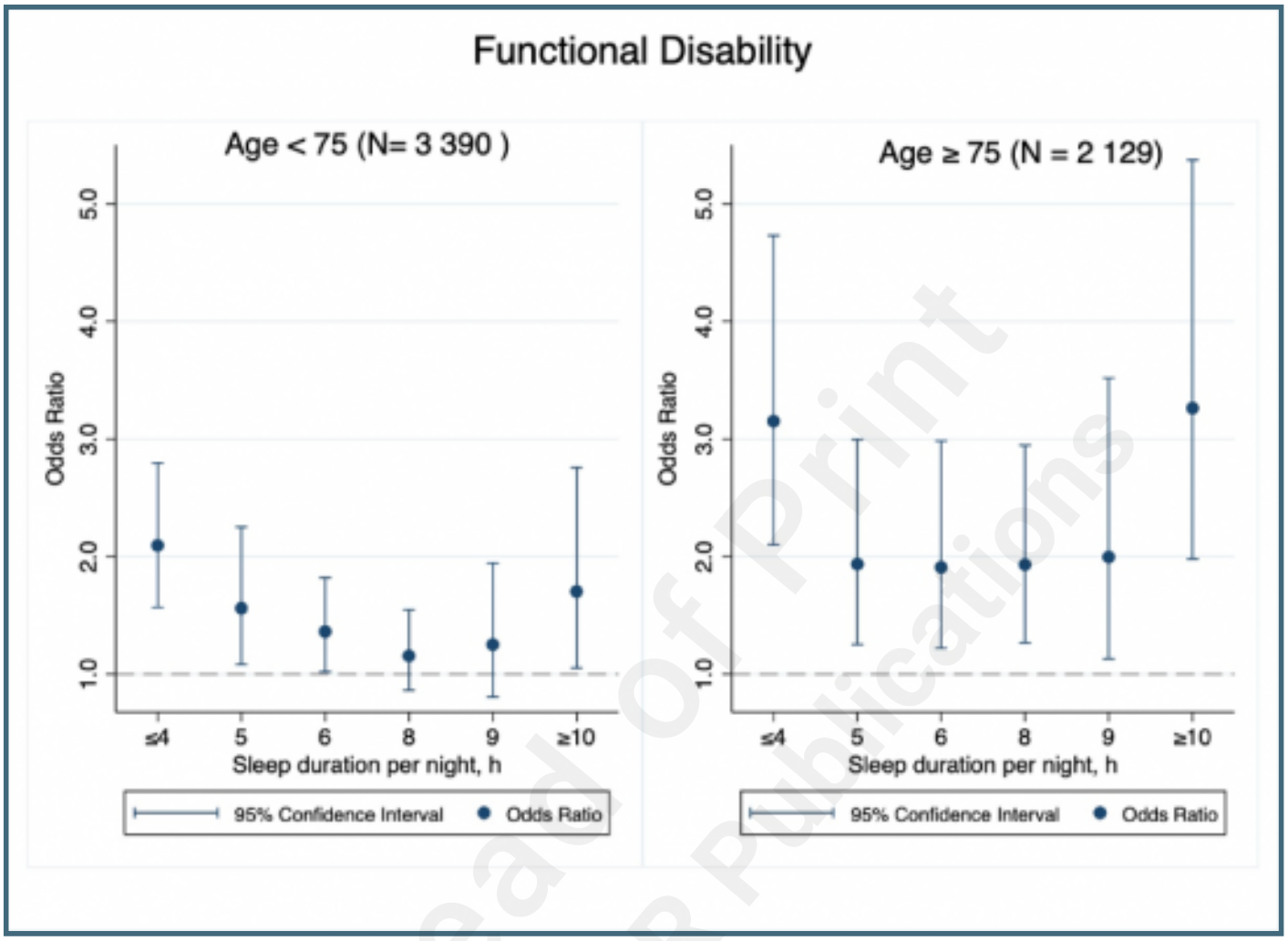
Trajectories of sleep duration across individuals with various functional disability statuses. Graphs display analog values (lines) of the sleep duration with 95% CIs (shaded areas) for any functional disability (A), activity of daily living disability (B), and instrumental activity of daily living disability (C).



Gender-specific effect of sleep duration on functional disability.



Age-specific effect of sleep duration on functional disability.



Non-linear relationship of sleep duration and functional disability status. Graphs display adjusted OR for confounding factors (solid lines) of sleep duration with 95% CIs (dotted lines) for functional disability.