Contents lists available at ScienceDirect

Experimental Gerontology

A prospective study on the association of sleep duration with grip strength among middle-aged and older Chinese

Tian Yu Wang, Yili Wu*, Tong Wang, Yujie Li, Dongfeng Zhang

Dept. of Epidemiology and Health Statistics, Medical College, Qingdao University, Qingdao, China

ARTICLE INFO

ABSTRACT

Background: Longitudinal studies on sleep duration and grip strength decline are limited. This study aimed to evaluate the associations of baseline sleep duration with follow-up grip strength and grip strength changeover time among a large sample of middle-aged and older Chinese.
Methods: Data from China Health and Retirement Longitudinal Study, CHARLS (2011–2015), were analyzed. Hand grip strength was measured by dynamometers twice with 4 years interval. Baseline self-reported nighttime sleep duration was collected by questionnaire. Basic demographics, life habits and health status were considered as potential confounders. *Multivariate* linear regression models with quadratic function and mixed-effects regression models were fitted.
Results: Inverted U-shaped associations occurred between baseline sleep duration and follow-up grip strength for both males ($\beta_{linear} = 1.011$, $p_{linear} = 0.002$; $\beta_{quadratic} = -0.061$, $p_{quadratic} = 0.014$) and females ($\beta_{linear} = 0.605$, $p_{linear} = 0.005$, $\beta_{quadratic} = -0.041$, $p_{quadratic} = 0.019$). Compared to the sleep duration of 7 h, significant interactions of < 5 hours-by-time ($\gamma = -0.966$ with SEE = 0.442, p = .029) in males as well as 5–7 hours-by-time ($\gamma = -0.717$ with SEE = 0.294, p = .015), 7–9 hours-by-time ($\gamma = -0.632$ with SEE = 0.311, p = .042) and > 9 hours-by-time ($\gamma = -1.567$ with SEE = 0.560, p = .005) in females were found.
Conclusion: For both males and females, compared to the intermediate sleep duration, shorter or longer sleep may predict the weaker follow-up grip strength and the faster rate of hand grip strength decline over time.

1. Introduction

Hand grip strength is a simple but well-established indicator of overall muscle strength. Cross-sectional and longitudinal studies have described the life course trajectory of grip strength: a period of increase from childhood to a peak in early adult life is obvious, followed by maintenance through to midlife, and finally decline from midlife onwards(Dodds et al., 2014; Nahhas et al., 2010). It has been proved that grip strength were associated with activities of daily living (Rantanen et al., 2002), cardiovascular diseases and all-cause mortality(Wu et al., 2017), and there is a considerable interest in its role in ageing (Sayer and Kirkwood, 2015). Thus, a better understanding of the influence factors on decline of grip strength with age would inform strategies for active and healthy ageing.
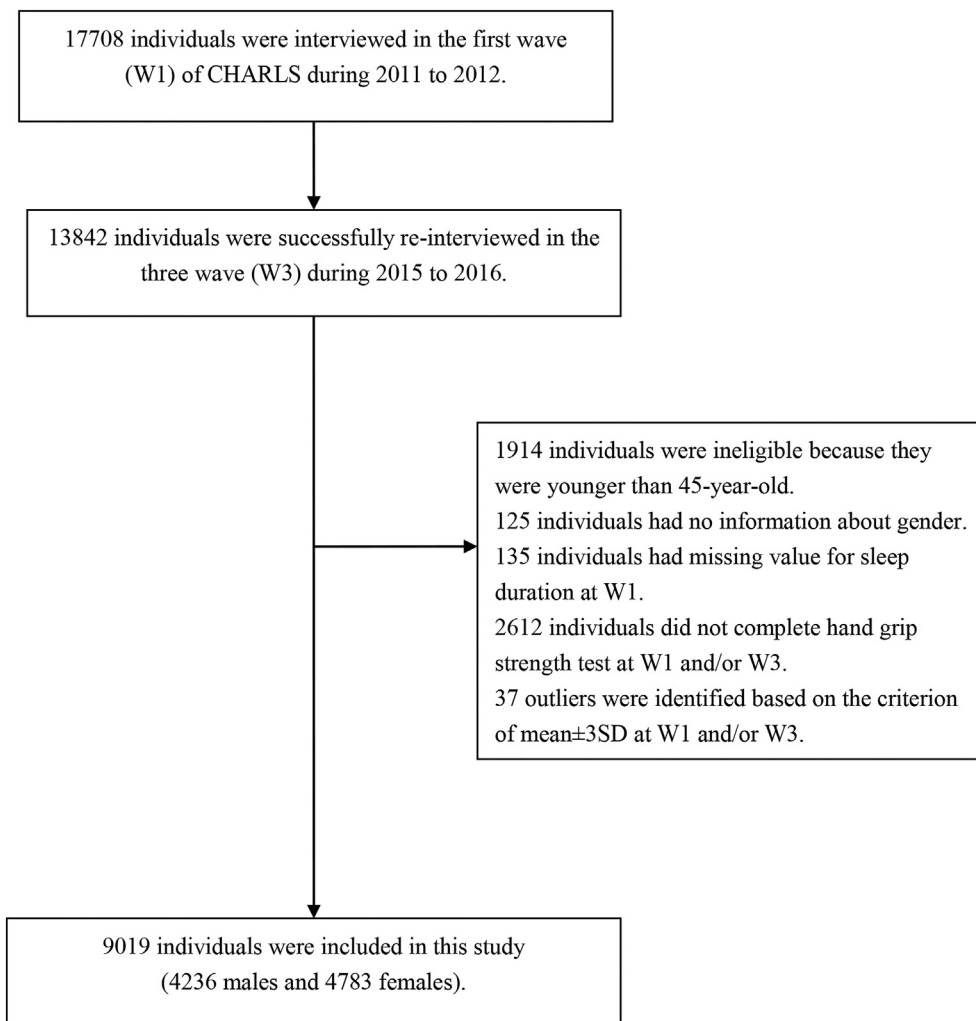
Sleep of adequate quantity and quality is essential for homeostatic regulation (Saper et al., 2005) and maintaining physical function. Over the past 30 years, several literatures have focused on the association between sleep duration and health outcomes (Leng et al., 2015; Cappuccio et al., 2011; Wang et al., 2012; Wu et al., 2014; Shan et al.,

2015; Lu et al., 2013). However, studies on the role of sleep duration in grip strength have been few in number and limited in scope. Furthermore, they have drawn conflicting conclusions. Some of them uncovered an inverted U-shaped relationship between sleep duration and muscle mass and function (Auyeung et al., 2015; Dam et al., 2008), while others suggested only short or long sleep duration had a risk effect on the grip strength (Chen et al., 2017; Fu et al., 2017) and few found no statistical association between them(Goldman et al., 2007). It is noted that most of the previous studies were cross-sectional design which give little information about the direction of causality. Besides, there is growing appreciation that sleep duration may have different relationships with grip strength in women and men (Chen et al., 2017, Fu et al., 2017).

Here we presented a prospective study by using a large, population-based sample derived from "China Health and Retirement Longitudinal Study (CHARLS)" to: (1) assess the gender-specific associations of baseline sleep duration with 4 years follow-up grip strength (2) explore the effect of sleep duration on the decline of grip strength over time.

* Corresponding author at: Dept. of Epidemiology and Health Statistics, Medical College, Qingdao University, NO. 38 Deng Zhou Street, Qingdao 266021, China.
 E-mail address: wuyili@qdu.edu.cn (Y. Wu).

```
┌─────────────────────────────────────────┐
│ 17708 individuals were interviewed in    │
│ the first wave (W1) of CHARLS during     │
│ 2011 to 2012.                            │
└─────────────────────────────────────────┘
                   │
                   ▼
┌─────────────────────────────────────────┐
│ 13842 individuals were successfully      │
│ re-interviewed in the three wave (W3)    │
│ during 2015 to 2016.                     │
└─────────────────────────────────────────┘
                   │
                   │        ┌──────────────────────────────────────────┐
                   │───────▶│ 1914 individuals were ineligible because │
                   │        │ they were younger than 45-year-old.      │
                   │        │ 125 individuals had no information about │
                   │        │ gender.                                  │
                   │        │ 135 individuals had missing value for    │
                   │        │ sleep duration at W1.                    │
                   │        │ 2612 individuals did not complete hand   │
                   │        │ grip strength test at W1 and/or W3.      │
                   │        │ 37 outliers were identified based on the │
                   │        │ criterion of mean±3SD at W1 and/or W3.   │
                   │        └──────────────────────────────────────────┘
                   ▼
┌─────────────────────────────────────────┐
│ 9019 individuals were included in this   │
│ study (4236 males and 4783 females).     │
└─────────────────────────────────────────┘
```

2. Methods

2.1. Study sample

The CHARLS is a nationally longitudinal survey in the middle-aged and older population (≥ 45 year) conducted by Peking University. The procedures concerning CHARLS and details of its multistage stratified sampling were described elsewhere (Zhao et al., 2014; Wang et al., 2017). Briefly, the survey covered 150 county-level units distributed in 28 provinces of China except Tibet and up to now, it included three waves. The baseline survey (wave 1, W1) was conducted in 2011–2012, and data for 17,708 participants were collected with the respondent rate above 80%. The second (wave 2, W2) and the third (wave 3, W3) wave survey successfully re-interviewed 15,770 and 13,842 of these individuals in 2013–2014 and 2015–2016, respectively. In all of waves, well-trained research assistants interviewed eligible participants face-to-face to pick-up information regarding participants' socio-demographic characteristics, lifestyles, health condition, as well as anthropometric and laboratory measurements. Considering that duration of two years was too short to measure grip strength change, we analyzed the data from W1 to W3 excluding W2 in the current study.

2.2. Hand grip strength and sleep duration

Hand grip strength (kilogram) was estimated by using a dynamometer (WCS-100, Nantong, China). Participants squeezed the handles as hard as possible in a standing position with their arms hanging naturally at their sides. The maximum of twice tests on two hands were adopted. Self-reported sleep duration was ascertained by one single question: "During the past month, how many hours of actual sleep did you get at night (average hours for one night)?" Then the quantitative variable of sleep duration was categorized as < 5 h, 5–7 h, 7 h, 7–9 h and > 9 h. Sleep duration of 7 h per night was chosen as the referent category (Lopez-Garcia et al., 2008; Patel et al., 2006; Li et al., 2016).

2.3. Other variables

Our covariates included age, educational level, alcohol drinking, cigarette smoking, body mass index (BMI), mental disorder, stroke, hypertension, type 2 diabetes and cardiovascular disease. Educational level was categorized as illiterate, primary education and above. Cigarette smoking was classed as 'never' (those who had never chewed tobacco, smoked a pipe, smoked self-rolled cigarettes, or smoked cigarettes/cigars), 'former' (those who had ever smoked, but has totally quit) or 'current' (those who still smoked). And alcohol drinking was classed as 'never' (those who had never drank alcoholic beverages such as beer, wine, or liquor or had never drank more than once a month), 'former' (those who had ever drank more than once a month, but has quit), 'current' (those who still drank more than once a month but less than twice a day) or 'frequent' (those who drank more than twice a day). BMI was derived by taking body weight (in kilogram) divided by height (in meter) squared and sorted as thin, normal, and overweight/obesity. Mental disorder, stroke, hypertension, type 2 diabetes and cardiovascular disease were dichotomized as "no" or "yes" based on the