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Original Article

Association between sleep disturbances and falls among the elderly: results from the German Cooperative Health Research in the Region of Augsburg-Age study

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ABSTRACT

Objective: We aimed to examine the association between various sleep disturbances and falls among older individuals from the general population while considering the influence of age and dizziness.
Methods: Data were derived from the population-based cross-sectional KORA (Cooperative Health Research in the Region of Augsburg)-Age study, whereby information was conducted in standardized telephone interviews with 4127 men and women aged ⩾65 years in 2008 and 2009. Unstratified and stratified (by age and dizziness) multivariable logistic regression model analyses were performed.
Results: The multivariable analysis showed a marginally significant association between trouble staying asleep and ⩾1 fall in the previous year (odds ratio [OR], 1.23 [95% confidence interval (CI), 1.01–1.50]). This association was more pronounced in participants older than the age of 75 years (OR, 1.58 [95% CI, 1.16–2.16]) and in individuals without dizziness (OR, 1.35 [95% CI, 1.04–1.76]). There was no association between daytime sleepiness and falls in the fully-adjusted models, but the odds of falls in the previous year in individuals older than the age of 75 years were significantly higher for individuals with difficulty falling asleep. Although sleep duration was not associated with falls in multivariable analyses when stratified by dizziness, sleep duration of 9 h daily was significantly associated with higher odds of experiencing at least one fall in the previous year.
Conclusions: Our study suggested that the positive relationship between a trend towards longer sleep duration, trouble falling and staying asleep, and falls is strongest in older individuals and in individuals who did not experience dizziness in the previous year.

1. Introduction

Falls pose an important health risk in the elderly and are known to be associated with morbidity and mortality. Negative physical and mental consequences from falls also can lead to an impaired quality of life, loss of independence, or a premature admission into a nursing home [1,2]. Furthermore, falls can be the cause of high health care costs. For Germany, Heinrich et al. [3] estimated overall costs attributable to falls of elderly individuals between 2.1 and 3.8 billion euro per year. Therefore, the occurrence of falls in older populations has great public health relevance. Because approximately one-third of all individuals over the age of 65 years fall at least once every year [4], it can be assumed that this topic will become increasingly important in view of demographic changes.

Although sleep patterns change across the lifespan [5], sleep disorders are not part of normal aging. Because sleep problems often are associated with chronic medical conditions, they are highly prevalent at an advanced age [6]. In a large study with over 9000 participants aged 65 years and older, more than half of the participants reported having chronic sleep disturbances such as difficulty falling asleep or staying asleep [7]. According to a review from Ancoli-Israel et al. [6], chronic sleeping difficulties can lead to worsened attention, slower reaction times, and memory problems [6], which in combination may foster stumbling e.g., if one forgets that he or she changed the environment and trips over a new rug on the way to the bathroom.

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Furthermore, sleep deprivation can induce a modification in the posterior parietal cortex [8,9], which is important for the processing of vestibular information regarding space representation [9]. In addition, sleep loss is associated with elevated tumor necrosis factor α levels, though extended sleep durations are related to increasing C-reactive protein and IL-6 levels [10]. Long-term increases in the levels of these inflammation markers are associated with weak muscle strength and slower gait speed [11,12]. All of these factors could be linked to falls, especially during the night and in individuals whose physical abilities for compensation are already poor. Hence it could be hypothesized that sleep disturbances and falls may be associated in elderly individuals.

Up to now, comparatively few large studies have investigated the independent relationship between various sleep disturbances and falls among community-dwelling elderly individuals [2,13–17]. In addition, only one of these studies [16] investigated the reciprocal effect between sleep duration and age, and none of these studies explored if there was an interaction between dizziness and disturbed sleep. In elderly individuals, dizziness may be related to age and polypharmacy, and therefore may be considered as a geriatric syndrome with accumulated impairments in multiple domains such as neuromuscular or functioning [18]. Thus it is conceivable that the effect of sleep disturbances could vary due to the presence or absence of dizziness.

Therefore, the purpose of our study was to examine the association between various forms of sleep disturbances (difficulty falling asleep, trouble staying asleep, inadequate sleep duration, and daytime sleepiness) and falls in older men and women from the general population. Furthermore, the objective of our investigation was to determine if disturbed sleep in this regard has different effects on falls in various age groups and in individuals with and without dizziness. Because sleep disturbances are partly modifiable risk factors, knowing if there is an association between disturbed sleep and falls in the elderly could have important clinical implications.

2. Material and methods

2.1. Study design and participants

Data were derived from the cross-sectional KORA (Cooperative Health Research in the Region of Augsburg)-Age study conducted in 2008 and 2009, which investigated the long-term determinants and consequences of multimorbidity in later life and examined reasons for "successful" aging (for further details see [19,20]).

In brief the KORA-Age study is a follow-up of all participants aged 65 years and older in the year 2008 who took part in at least one of the four previous MONICA (Monitoring trends and determinants in cardiovascular diseases)/KORA (Cooperative Health Research in the Region of Augsburg) surveys conducted between 1984 and 2001 in the Region of Augsburg, Southern Germany ($N = 9197$) (details are described elsewhere [21,22]).

For our analysis, data from the telephone interview from 4127 participants, complemented with additional information about these individuals regarding sociodemographic aspects, chronic diseases, smoking status, and medication use from the postal survey [19,20], formed the database. Data from 252 participants were excluded. In 185 participants, proxy interviews with relatives, friends, or caregivers were performed when the physical or mental status of a participant was poor; however, these proxies did not provide data about the sleep behavior of the subject, and 67 participants had missing data on required variables. Thus the final dataset consisted of 3875 participants (1998 women and 1877 men) aged 65–93 years.

Written informed consent was obtained from the study participants. The KORA-Age study was approved by the Ethics Committee of the Bavarian Medical Association ("Bayerische Landesärztekammer") and all investigations were conducted in accordance with the Declaration of Helsinki.

2.2. Measures

2.2.1. Outcome definition

According to the Consensus of the Prevention of Falls Network Europe, a fall is defined as "an unexpected event in which the participant comes to rest on the ground, floor, or lower level" [23]. History of falls was assessed with the question "Did you fall in the previous 12 months?" which was derived from the National Health and Nutrition Examination Survey questionnaire [24]. The participants were not given a specific definition of falls. Possible answers were (1) yes, once; (2) yes, more than once; and (3) no. For the analyses, the variable was dichotomized in at least one fall and no fall in the previous year.

2.2.2. Sleep habits and sleep duration

Analogue to former MONICA/KORA studies [19], including trouble falling asleep ("Did you have trouble falling asleep [often, sometimes, or almost never]?") and difficulty staying asleep ("Did you have problems with sleeping through the night [often, sometimes, or almost never]?"), were assessed by self-report. Daytime sleepiness was assessed by the question, "Do you feel tired or exhausted during the day because of your sleep problems in the night [often, sometimes or almost never]?" All variables were binary coded. Participants were categorized as having problems in a certain area or complaint if they chose often and as no difficulties if they chose sometimes or almost never as their response.

Sleep duration was assessed with the question "How many hours a day do you usually sleep? Please also think of nap habits." Participants were invited to answer in integer hours. Following the literature [16] but also to enhance statistical power, sleep duration was categorized in $\leqslant$5, 6, 7–8 (reference), 9, or $\geqslant$10 h per day.

2.2.3. Covariables

We collected information on sociodemographic characteristics and lifestyle behavior of the participants. Body mass index was computed as current weight in kilograms according to self-reporting in the postal survey divided by the square of height in meters, as measured at baseline examination during former MONICA/KORA studies. Educational level was estimated by years of education, $\leqslant$11 years being categorized as low educational level and >11 years as high. Marital status was defined as married or not, and living situation was categorized as living alone or living with someone. Frequent alcohol consumption was rated as drinking alcohol two or more times per week during the past 12 months. Participants were classified into individuals who had never smoked and participants who had smoked at some time in their lives. Leisure time physical activity was assessed with two separate questions concerning leisure time sport activity in winter and in summer (cycling included) [25]. In both questions, answer categories were rated on a Likert scale that ranged from 1 (no sports) to 4 (more than 2 h per week) in winter and summer, respectively. An individual was rated as active, if the sum of these two responses was $\geqslant$5.

Further, information about medical history (depression, anxiety, hypertension, neurologic diseases, eye diseases, multimorbidity) and medication was gathered. Depression was measured with the 15-item short form of the Geriatric Depression Scale. Values ranged from 0 to 15, whereby values >10 were judged as depressed mood [26]. Anxiety was obtained with the Generalized Anxiety Disorder Score. Values ranged from 0 to 21 and participants with