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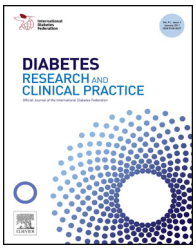

The influence of sex and age on the relationship between sleep duration and metabolic syndrome in Korean adults

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ABSTRACT

Aims: To investigate the influence of sex and age on the relationship between sleep duration and metabolic syndrome in a nationally representative population.
Methods: We used data from the Korea National Health and Nutrition Examination Survey (2001–2010) and enrolled 24,511 participants aged 20–79 years. Sleep duration was categorized into five groups: ≤5, 6, 7 (referent), 8, and ≥9 h/day. Age was categorized into three groups: younger (20–39 y), middle-aged (40–59 y), and older (60–79 y). The association between sleep duration and metabolic syndrome was assessed in the total, separately in men and women, then in six groups based on sex and age.
Results: The prevalence of metabolic syndrome by sleep category demonstrated a U-shaped pattern in the total population. However, after adjusting for age, education, occupation, exercise, smoking, alcohol, and body mass index, the prevalence of metabolic syndrome increased in long sleepers (OR 1.31; 95% CI 1.14–1.51) but not in short sleepers (OR 1.00; 95% CI 0.89–1.11). The relationship between sleep duration and metabolic syndrome varied by sex and age–long sleep (≥9 h/day) was positively associated with metabolic syndrome only in younger (OR 2.13; 95% CI 1.38–3.28) and middle-aged (OR 1.63; 95% CI 1.21–2.21) women. Short sleep (≤5 h/day) was not associated with metabolic syndrome in any sex and age groups. However, extremely short sleep (≤4 h/day) was associated with metabolic syndrome in middle-aged men (OR 1.76, 95% CI 1.05–2.96).
Conclusion: These data suggest that sex and age significantly modify the relationship between sleep duration and metabolic syndrome.

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1. Introduction

A growing number of epidemiological studies have indicated that short and long sleep duration are associated with an increased risk for cardiovascular disease [1]. Previous studies have indicated that abnormal sleep duration is associated with metabolic syndrome [2–6] and the individual components that make up the syndrome [7–25]; however, the relationship has been reported to vary between studies. A U-shaped relationship between sleep duration and metabolic syndrome has been reported in two Korean studies [2,3] as well as a US study [4]. In Korea, one study found a U-shaped relationship in women only [2], and the other reported different relationships by age [3]. However, the influence of age and sex on this relationship has not been thoroughly investigated.

Age and sex have been found to influence the quantity and quality of sleep in adults. Among young adults studied in a sleep laboratory, women reported better overall sleep quality compared to men [26]. By contrast, elderly women were twice as likely to report difficulty with sleep initiation compared to elderly men in the Cardiovascular Health Study [27]. Moreover, gender differences are further impacted by hormonal changes. A community survey and longitudinal study of women at middle-age revealed that menopausal status is significantly associated with difficulty sleeping [28,29]. The Sleep Heart Study suggested that aging results in a decrease in the quantity and quality of sleep [30]; however, a meta-analysis by Floyd et al. [31] found sleep duration to increase with age while waking frequency also increased.

For the components of metabolic syndrome, previous studies have found significant relationships between sleep duration and hypertension [7–11], obesity [32,33], and insulin resistance [15,18–21,25]. Age and gender have been reported to modify only the relationship between sleep duration and hypertension [8–11]. For example, short sleep duration of ≤5 h/day was found to be associated with an increased risk of hypertension for young and middle-aged adults only [8,10] and striking associations between short sleep and hypertension were found in only females when sex-specific analyses were performed [9,11].

Based on this evidence, the relationship between sleep duration and cardiovascular risk could be further analyzed by not only looking at the relationship between sleep duration and metabolic syndrome, but also the possibly significant influence that age and sex have on modifying this relationship. Therefore, we hypothesized that both short and long sleep duration would be associated with an increased prevalence of metabolic syndrome and that age and sex would significantly influence this relationship.

2. Methods

2.1. Study population

Data for this study were derived from the 2001 (phase 2), 2005 (phase 3), 2007–2009 (phase 4) and 2010 (phase 5) Korea National Health and Nutrition Survey (KNHANES) performed by the Korea Ministry of Health and Welfare. The KNHANES uses a stratified multistage probability sampling design to obtain a nationally representative sample of non-institutionalized civilian Koreans for each data collection year. A detailed description of the KNHANES has been published elsewhere [34,35].

In order to obtain the largest, most nationally representative group of Korean adults, all participants who participated in the health examination and survey portions of the KNHANES phases 2–5 (6 data collection years) were combined together and analyzed (n = 43,129). Participants younger than 20 years old and older than 79 years old were initially excluded from the study (n = 8625) leaving 34,504 participants. This age range was chosen due to the differences in diagnostic criteria for metabolic syndrome for children and adolescents. Additionally, older adults have a higher likelihood of systemic disorders and often experience changes in their sleep structure – specifically in their sleep initiation and maintenance [8].

Additional participants (n = 8150) were excluded because they were missing sleep duration data (n = 960), covariate data (n = 5793), and/or not fasting for at least 8 h before blood sampling (n = 1397). Those who reported receiving a diagnosis of stroke, myocardial infarction, angina, renal failure, liver cirrhosis, and any cancers were also excluded from the analysis (n = 1674). Lastly, females who reported being pregnant at the time of the survey were removed (n = 169) leaving a final study population of 24,511 participants (9997 men and 14,514 women).

2.2. Sleep

Trained interviewers recorded sleep duration during the health interview. Participants were asked, ‘‘On average, how long do you sleep each day?’’ Responses were collected in hours per day (h/day) as whole numbers in most participants; however, in a small number of participants (n = 15), responses were collected to the half hour (i.e., 7.5 h/day) and these values were rounded up to the nearest integer. Self-reported sleep duration was categorized into five categories: ≤5 h/day, 6 h/day, 7 h/day (referent), 8 h/day, and ≥9 h/day.

2.3. Metabolic syndrome

Metabolic syndrome was defined according to the joint interim statement of 2009 ‘‘harmonizing the metabolic syndrome’’ as the presence of three or more of the following: (1) elevated waist circumference as ≥90 cm in men or ≥80 cm in women – modified for the recommended cutoff for the Asia-Pacific region; (2) elevated triglycerides of ≥150 mg/dL, or on drug treatment for elevated triglyceride; (3) reduced HDL cholesterol for <40 mg/dL in males and <50 mg/dL in females, or on drug treatment for reduced HDL cholesterol; (4) elevated blood pressure as ≥130 mmHg systolic blood pressure or ≥85 mmHg diastolic blood pressure, or on drug treatment for hypertension; (5) elevated fasting glucose as ≥100 mg/dL, or on drug treatment for elevated glucose [36].

The components of metabolic syndrome requiring blood extraction were assessed after an overnight fast of at least 8 h. Body weight and height were measured while participants wore light clothing and no shoes. Waist circumference was