Nutrition, Metabolism & Cardiovascular Diseases (2014) 24, 65–71

Available online at www.sciencedirect.com

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journal homepage: www.elsevier.com/locate/nmcd

Nutrition, Metabolism & Cardiovascular Diseases

Relation between sleep duration, overweight, and metabolic syndrome in Korean adolescents

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Received 14 November 2012; received in revised form 11 June 2013; accepted 11 June 2013
Available online 1 November 2013

KEYWORDS
Overweight;
Metabolic syndrome;
Sleep duration;
Adolescents

Abstract *Background and aims:* The increasing prevalence of obesity has been paralleled by a trend of reduced sleep duration. Sleep is considered a modulator of neuroendocrine function. The aim of this study was to determine the relation between sleep duration, overweight, and metabolic syndrome in Korean adolescents.
Methods and results: This study was based on data from the Korean National Health and Nutrition Examination Survey (KNHANES) IV. Data from 1187 adolescents aged 12–18 years were included in the analysis. Subjects were classified according to self-reported sleep duration: ≤5 h, 6–7 h, 8–9 h, and ≥10 h. We analysed the association between sleep duration, overweight, and metabolic syndrome after adjustment for potential confounding variables. Body mass index (BMI), waist circumference (WC), and diastolic blood pressure (DBP) were higher in subjects who slept ≤5 h, and triglyceride level was higher in subjects who slept ≥10 h. According to logistic regression analysis, subjects who slept ≤5 h had a higher risk of overweight (odds ratio (OR) 2.04, 95% confidence interval (CI) 1.17–3.57) and elevated blood pressure (BP) (OR 2.11, 95% CI 1.22–3.65). We did not find any association between sleep duration and metabolic syndrome. Subjects who slept ≥10 h had a higher risk of hypertriglyceridemia (OR 2.17, 95% CI 1.14–4.13).
Conclusion: Short sleep duration was associated with overweight in adolescents. Although there was no association between sleep duration and metabolic syndrome, short sleep duration was associated with elevated BP and long sleep duration was associated with hypertriglyceridemia.

Abbreviations: BMI, body mass index; CI, confidence interval; BP, blood pressure; DBP, diastolic blood pressure; HDL, high-density lipoprotein; KNHANES, Korean National Health and Nutrition Examination Survey; OR, odds ratio; SBP, systolic blood pressure; WC, waist circumference.

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http://dx.doi.org/10.1016/j.numecd.2013.06.004

Introduction

Obesity in children and adolescents is a major public health problem worldwide [1]. As the prevalence of obesity has increased, that of metabolic syndrome has also increased. Obesity in children and adolescents often continues into adulthood, and disrupts multiple organ systems. Prevention of childhood and adolescent obesity is an important issue for public health, not only in industrialised countries but also in some developing countries [1].

The recent epidemic of obesity has been paralleled by a trend of reduced sleep duration in adults and children [1,2]. Laboratory studies demonstrate that sleep loss results in metabolic and endocrine alterations that may ultimately lead to weight gain [3,4], and evidence from epidemiological studies in adults suggests that short sleep duration is a risk factor for the development of obesity and its complications [2]. However, the relation between sleep duration and metabolic syndrome in adults is not clear, with some studies reporting a U-shape pattern between sleep hours and metabolic syndrome [5,6] and another study reporting that long sleep duration is associated with metabolic syndrome [7].

Sleep, like nutrition and physical activity, might play an essential role in the growth, development, maturation, and health status of children and adolescents by controlling the diurnal rhythm of hormones related to energy homeostasis [2,4]. Previous studies indicate that sleep restriction results in changes in the levels of several hormones, including ghrelin, leptin, insulin, cortisol, and growth hormone [3]. These hormonal changes may contribute to energy dysregulation that leads to weight gain and obesity. Several epidemiological studies have evaluated the association between sleep duration and obesity in children and adolescents. There is a clear association between short sleep duration and obesity in children [8]; however, there is limited evidence to suggest a similar association in adolescents. Studies in Asian populations are particularly rare.

South Korea has experienced rapid socioeconomic growth over the past several decades and this has led to a substantial transformation of lifestyles in the country. As a result of such transformation, the prevalence of pediatric and adolescent overweight has significantly increased [9]. Sleep duration and patterns during adolescence differ between countries [10]. Asian adolescents are more likely to go to bed late than adolescents from Western countries, resulting in less total sleep time [10]. In adolescents, shorter sleep duration is associated with multiple indicators of adverse health status and a lower likelihood of reporting better self-rated health [11]. However, the association between sleep duration and metabolic syndrome in adolescents has rarely been determined. The aim of this study was to analyse the relation between sleep duration, overweight, and metabolic syndrome in Korean adolescents.

Methods

Study population

This study was based on data from the Korean National Health and Nutrition Examination Survey (KNHANES) IV (of 2007, and 2008), a national, cross-sectional survey conducted periodically since 1998 by the Korean Ministry of Health and Welfare [12]. For the KNHANES 2007–2008 survey, 300 units (100 units investigated from July to December, 2007, 200 units investigated from January to December, 2008) were selected by randomly considering the 2005 Population and Housing Census of South Korea and selecting 20 households from each unit. Written informed consent was obtained from all participants and the parents of subjects that were $<$16 years of age. All subjects agreed to respond to each part of survey and take part in all examinations. A total of 14 338 people participated in the KNHANES 2007–2008 survey (4594 in 2007, and 9744 in 2008) and the response rates were 71.2% in 2007 and 77.8% in 2008 [12]. In total, 1315 adolescents between the ages of 12 and 18 years were included to take part in this study. Of the 1315 adolescents, 128 (9.7%) did not report sleep duration and/or anthropometric measures and so were excluded. The remaining 1187 subjects were included in the analysis. All experimental procedures were performed in accordance with the ethical guidelines set down in the Declaration of Helsinki.

Sleep duration and lifestyle factors

The survey was conducted by trained interviewers who stayed in each sampling unit for 3 days. Demographic data was obtained through direct interviews using standardised questionnaires. Household income was evaluated by equivalised gross household income per month, calculated by total household income per month/$\sqrt{\text{number of family members}}$ [12]. A single 24 h dietary recall was used to assess dietary intake. Subjects filled out a questionnaire, which asked questions about the levels of physical activity and sleep duration. The level of physical activity was estimated using the short International Physical Activity Questionnaire (IPAQ) [13] and was classified as 'high' (at least 3 days/week of vigorous-intensity activity or 7 days of any combination of walking, moderate- or vigorous-intensity activities); 'moderate' (5 or more days/week of moderate-intensity activity or walking at least 30 min/day); or 'low' (all others). Sleep duration was self-reported and assessed using the single question: 'for how long do you usually sleep?' Sleep duration was classified into four categories: $\geq$10 h; 8–9 h; 6–7 h; and $\leq$5 h. The reference category was 8–9 h [14].

Anthropometric and metabolic risk factors

Anthropometric measurements and blood sampling were performed in a mobile screening bus 1 week before the interviewers visited the participant's home. Height, body weight, and waist circumference (WC) were measured by standardised methods. Body mass index (BMI) was calculated as (weight in kilograms)/(height in metres)^2. WC was measured to the nearest 0.1 cm at the narrowest point between the lowest rib and the uppermost lateral border of the right iliac crest. Blood pressure (BP) was measured with a mercury manometer after a 10 min rest in the sitting position. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded twice within a 5 min interval and were averaged for analysis. Blood samples were collected from the antecubital vein after 10–12 h of fasting. Fasting glucose, triglycerides, and high-density lipoprotein (HDL)