

# Relationship between sedentary time and central obesity in adult Korean men: Korean National Health and Nutrition Examination Survey, 2014

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## ABSTRACT

**Background.** We aimed to examine the association between sedentary time and central obesity in a nationally representative sample of adult Korean men.

**Methods.** We included 1269 participants from the Korean National Health and Nutrition Examination Survey. Central obesity was defined as having a waist circumference (WC)  $\geq 90$  cm. The ORs and 95% CIs for central obesity were calculated using multiple logistic regression analysis.

**Results.** The mean values of WC tended to increase proportionally with increasing sedentary time quartiles. The prevalence of central obesity increased significantly in accordance with sedentary time quartiles. Compared to individuals in the lowest sedentary time quartile ( $\leq 4$  hours for a day), the OR for central obesity for individuals in the highest quartile ( $\geq 11$  hours for a day) was 1.81 after adjusting for confounding variables.

**Conclusion.** We confirmed a relationship between sedentary time and the risk prevalence of central obesity in a representative sample of adult Korean men. A public health intervention to reduce sedentary time is needed to prevent central obesity.

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## INTRODUCTION

Obesity is related to multiple morbid conditions such as hypertension,<sup>1</sup> dyslipidaemia,<sup>2</sup> type 2 diabetes,<sup>3</sup> cardiovascular disease,<sup>4</sup> cerebrovascular disease,<sup>5</sup> liver disease,<sup>6</sup> neurodegenerative disease,<sup>7</sup> osteoarthritis,<sup>8</sup> asthma,<sup>9</sup> depressive disorder<sup>10</sup> and certain cancers,<sup>11</sup> as well as increased mortality.<sup>12</sup> As the prevalence of obesity has reached alarming levels and become an epidemic during the past few decades, public health concerns about obesity have also increased.<sup>13,14</sup> Moreover, central obesity has been recognized as a stronger predictor of the risk of cardiovascular diseases and metabolic comorbid conditions than the body mass index (BMI).<sup>15–17</sup>

Multifactorial interactions between genetic background and

environmental factors such as a high calorie intake and low physical activity are considered to be the causes of central obesity.<sup>18</sup> Because environmental factors can be controlled, the appropriate modification of environmental factors aimed at reducing central obesity may be important from a public health perspective. Sedentary behaviours are ubiquitous in developed economies, and the rapid socioeconomic growth of South Korea has resulted in substantial lifestyle changes such as westernized diets and prolonged sedentary time.

Although previous studies have reported a positive association between excessive time engaged in sedentary behaviours and an increased risk of cardiometabolic diseases,<sup>19,20</sup> a few studies in Korea have used large-scale, randomly sampled, population-based data. Therefore, we examined the relationships between sedentary time and the risk prevalence of central obesity in a nationally representative sample of adult Korean men.

## METHODS

### *Survey overview and study population*

This cross-sectional study used data obtained from the 2014 Korean National Health and Nutrition Examination Survey (KNHANES), which was conducted by the Korea Centers for Disease Control and Prevention. The KNHANES is a nationwide, representative, population-based survey performed to evaluate the health and nutritional status of Koreans. The survey consists of a health interview survey, a nutrition survey and a health examination survey. The target population of the survey was non-institutionalized civilians in South Korea. The sampling units consisted of households that were selected through a stratified, multistage probability sampling design based on geographical location, sex distribution and age. Sampling weights that were representative of the probability of being sampled were assigned to each participant to ensure that the results represented the overall South Korean population.

A total of 7550 participants were included in the KNHANES conducted in 2014, and this survey included data from 1621 adult men aged 20–59 years. Of these 1621 adult men, we excluded those whose sedentary time and/or waist circumference (WC) data were missing ( $n=330$ ). Participants who had a history of cancer were also excluded from the study ( $n=22$ ). Therefore, 1269 participants were included in the final analysis. The KNHANES was approved by the Institutional Review Board of the Korea Centers for Disease Control and Prevention (approval number: 2013-12EXP-03-5C). In addition, this study was performed in accordance with the ethical principles of the Declaration of Helsinki.

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### Measurement of anthropometric and laboratory data

At the time of the 2014 KNHANES, citizens were informed that their household had been randomly selected to voluntarily participate in a nationwide representative survey performed by the Korea Centers for Disease Control and Prevention, and that they had the right to withdraw at any time in accordance with the National Health Enhancement Act supported by the National Statistics Law of Korea. Written informed consent was obtained from all citizens who agreed to participate. Blood tests were performed for participants aged 10 years or older, and consent was obtained to use the blood samples in further studies.

Trained medical staff performed the anthropometric measurements following a standardized procedure. Height and body weight were measured to the nearest 0.1 cm and 0.1 kg, respectively, while participants wore light clothing without shoes. BMI was calculated as weight (kg) divided by the square of height (m<sup>2</sup>). WC was measured to the nearest 0.1 cm at the midpoint between the lower border of the rib cage and the iliac crest at the end stage of normal expiration.

### Definition of each term

In the health interview survey, there was a question that was used to assess sedentary time: 'on average how many hours per day do you sit down?' We defined sedentary time as the time spent sitting down in a day. According to the International Diabetes Federation recommendations for Asians,<sup>21</sup> central obesity was defined as having a WC  $\geq 90$  cm. Exercise status was assessed via a 7-day recall method using the Korean version of the short form of the International Physical Activity Questionnaire.<sup>22</sup> From the questionnaire, we defined a regular exerciser as an individual who participated in vigorous-intensity physical activity lasting  $\geq 20$  minutes per session more than three times per week or took part in moderate-intensity physical activity lasting  $\geq 30$  minutes per session more than five times per week. A current smoker was defined as one who answered affirmatively to the question in the survey that asked whether a participant was currently smoking. A regular drinker was

defined as someone who drank alcoholic beverages at least twice per week. Those whose education duration was  $\leq 9$  years were considered to have a 'low education' level.

### Statistical analysis

Sampling weights were used to account for the complex survey design of the KNHANES; therefore, we obtained valid estimates that represented the overall South Korean population and avoided biased estimates. The sedentary time quartiles were categorized as follows: Q1  $\leq 4$  hours; Q2, 5–7 hours; Q3, 8–10 hours and Q4,  $\geq 11$  hours. The characteristics of the study participants were assessed using a weighted one-way analysis of variance for continuous variables and a weighted chi-square test for categorical variables. The age-adjusted mean WC was calculated with a weighted analysis of covariance. The ORs and 95% CIs for central obesity were determined using multiple logistic regression analysis after adjusting for confounding variables (age, daily calorie intake, exercise status, smoking status, alcohol intake, residence area, education level and income). All statistical analyses were performed using SPSS statistical software version 24.0 (SPSS Inc., Chicago, IL, USA). A p value of  $< 0.05$  was considered statistically significant.

### RESULTS

Table I presents the characteristics of the study participants according to the sedentary time quartiles. The mean WC values tended to increase proportionally with sedentary time quartiles.

Figure 1 shows the prevalence of central obesity according to the sedentary time quartiles. The prevalence of central obesity increased with increasing sedentary time quartiles as follows: 19.5%, 24.2%, 27.5% and 32.3% ( $p=0.017$ ).

Table II shows the risk prevalence of central obesity according to the sedentary time quartiles. Compared with the lowest quartile, the ORs (95% CIs) for central obesity in the highest quartiles of sedentary time were 1.81 (1.15–2.86) after adjusting for age, daily calorie intake, exercise status, smoking status, alcohol intake, residence area, education level and income.

TABLE I. Characteristics of study participants according to sedentary time quartiles (ST-Q)\*

Characteristic	All	ST-Q1 ( $\leq 4$ hours)	ST-Q2 (5–7 hours)	ST-Q3 (8–10 hours)	ST-Q4 ( $\geq 11$ hours)	p value†
Unweighted, <i>n</i>	1269	307	324	365	273	
Age (years)	39.6 (0.4)	42.4 (0.8)	39.1 (0.7)	39.0 (0.7)	38.1 (0.7)	0.001
Body mass index (kg/m <sup>2</sup> )	24.4 (0.1)	23.8 (0.2)	24.5 (0.2)	24.6 (0.2)	24.7 (0.2)	0.008
Waist circumference (cm)	84.5 (0.3)	83.0 (0.6)	84.1 (0.6)	85.0 (0.5)	85.8 (0.6)	0.016
Calorie intake (kcal/day)	2561 (36)	2549 (68)	2521 (64)	2572 (68)	2603 (76)	0.871
Regular exercise‡ (%)	19.1 (1.2)	23.2 (2.6)	24.0 (2.9)	15.7 (2.2)	13.5 (2.2)	0.006
Current smoker (%)	47.2 (1.6)	52.5 (3.2)	47.9 (3.3)	43.6 (2.6)	45.1 (3.2)	0.175
Regular drinker (%)	36.3 (1.7)	40.9 (2.8)	33.1 (3.1)	38.1 (2.9)	32.7 (3.6)	0.188
Residence in rural area (%)	15.0 (2.8)	22.2 (4.7)	15.8 (3.6)	11.9 (2.9)	10.4 (3.1)	0.018
Low education (%)	11.8 (1.1)	18.9 (2.4)	12.0 (1.9)	8.8 (1.6)	7.9 (1.9)	0.001
<i>Income</i>						0.085
4th quartile (lowest)	24.1 (1.7)	30.6 (3.3)	23.8 (2.6)	20.2 (2.3)	22.4 (3.2)	–
3rd quartile	26.0 (1.6)	26.3 (2.9)	29.1 (2.8)	25.6 (2.9)	22.8 (3.2)	–
2nd quartile	25.0 (1.5)	24.7 (2.9)	23.4 (2.9)	24.2 (2.6)	28.3 (3.2)	–
1st quartile (highest)	24.8 (1.9)	18.4 (3.1)	23.6 (2.6)	30.0 (3.1)	26.5 (3.9)	–

\*ST-Q represents sedentary time divided into quartiles for a day (ST-Q1 0–4 hours, ST-Q2 5–7 hours, ST-Q3 8–10 hours and ST-Q4  $\geq 11$  hours). Data are presented as mean (standard error) or percentage (standard error).

†p values were obtained using weighted one-way ANOVA tests for continuous variables and weighted chi-squared tests for categorical variables.

‡Regular exercise was defined as participating in vigorous-intensity physical activity lasting  $\geq 20$  minutes per session  $> 3$  times per week or taking part in moderate-intensity physical activity lasting  $\geq 30$  minutes per session  $> 5$  times per week.

TABLE II. ORs and 95% CIs for central obesity according to sedentary time quartiles (ST-Q)

Detail	ST-Q1 (≤4 hours)	ST-Q2 (5–7 hours)	ST-Q3 (8–10 hours)	ST-Q4 (≥11 hours)
Unadjusted	1	1.24 (0.81–1.89)	1.38 (0.93–2.03)	1.67 (1.08–2.56)
Model 1	1	1.31 (0.86–2.00)	1.47 (0.99–2.17)	1.81 (1.18–2.76)
Model 2	1	1.41 (0.88–2.25)	1.59 (1.01–2.48)	1.76 (1.11–2.80)
Model 3	1	1.32 (0.86–2.01)	1.39 (0.9–2.08)	1.75 (1.13–2.71)
Model 4	1	1.43 (0.90–2.30)	1.66 (1.06–2.62)	1.81 (1.15–2.86)

Model 1: adjusted for age      Model 2: adjusted for age, smoking status, alcohol intake, residence area, education level and income  
 Model 3: adjusted for age, daily calorie intake, smoking status, alcohol intake, residence area, education level and income  
 Model 4: adjusted for age, daily calorie intake, exercise status, smoking status, alcohol intake, residence area, education level and income

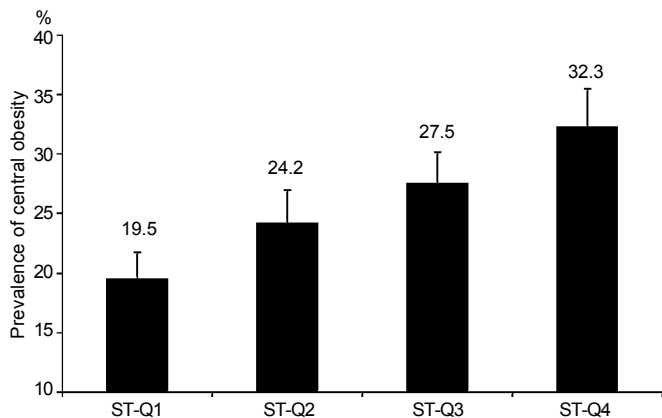


FIG 1. Prevalence of central obesity according to the sedentary time quartiles. Error bars represent standard errors

DISCUSSION

In this nationally representative cross-sectional study, we found that sedentary time was positively related to central obesity in adult Korean men. This positive association was maintained after controlling for potential confounding variables including physical activity. Our findings are in agreement with the results of previous studies showing that sedentary time is associated with increased cardiometabolic risk factors, and suggest that prolonged sedentary time is independently related to central obesity regardless of physical activity in Korean adult men. Central obesity is a key component of metabolic syndrome, and studies have shown that the prevalence of metabolic syndrome (and related central obesity) is higher in men than in women in Korea. In 2014, the prevalence of metabolic syndrome was 24.2% in men, whereas in women, it was 14.4%.<sup>23</sup>

Weekly physical activity of at least 150 minutes is advised for adults.<sup>24,25</sup> The key feature of primary and secondary prevention has been known to be the intensity of such habitual physical activity, with an established preventive role in obesity,<sup>26</sup> type 2 diabetes,<sup>27</sup> cardiovascular disease,<sup>28</sup> cerebrovascular disease<sup>29</sup> and certain cancers.<sup>30,31</sup> According to a population-based study, more than one-half of an average person’s waking day include sedentary activities, which are universally associated with prolonged sitting, such as watching television and using the computer.<sup>32</sup> Considering the studies suggesting that prolonged sitting has detrimental health effects in adults, this lifestyle trend is prominently risky and serious.<sup>33–35</sup> Furthermore, it is likely that physical activity and sedentary behaviours are mutually exclusive. For example, some people who have achieved their recommended physical activity targets

may seem to be highly sedentary throughout the remainder of their waking hours, whereas others who might not regularly participate in physical activity may be non-sedentary due to their involvement in leisure activities, workplace environments or both.<sup>36</sup> Thus, for promoting public health, it is essential to stress on the importance of reducing sedentary time regardless of the level of physical activity. In addition, high levels of moderate intensity physical activity may be important. A latest meta-analysis showed that vigorous activity for 60–75 minutes/day could mitigate the harmful effects of sitting for 8 hours or more a day.<sup>37</sup>

Lifestyle behaviours, including daily calorie and alcohol intake as well as exercise and smoking status, influence central obesity.<sup>38–41</sup> In addition, several studies have reported that education level and household income are associated with the risk of central obesity, supporting the influence of socioeconomic status.<sup>42,43</sup> Our study included both lifestyle behaviours and socioeconomic status as confounding variables in the multiple regression analysis to control for potential confounding.

Our study has certain limitations that should be considered when interpreting the findings. First, we used a cross-sectional design, making it difficult to establish a causal relationship between sedentary time and central obesity in Korean men. Second, we could not fully exclude the effect of information bias because the study was based on a questionnaire survey. Self-reported sedentary time may be less accurate than objectively measured sedentary time. Third, the questions did not distinguish between sedentary leisure time, such as time spent watching television or playing video games, and productive sedentary time, such as working on the computer. Because physical activity could be differentially associated with different types of sedentary pursuits,<sup>44</sup> the measurement of total sedentary time without distinguishing between sedentary leisure time and productive sedentary time could affect the results regarding the risk of central obesity. Despite these potential limitations, to the best of our knowledge, this is the first population-based study to show a relationship between sedentary time and central obesity in adult Korean men, which strengthens the validity of its findings.

Conclusion

We confirmed a clear and significant relationship between sedentary time and the prevalence risk of central obesity in a representative sample of adult Korean men. Public health intervention to reduce sedentary time is needed to prevent central obesity in Korea.

Conflicts of interest. None declared

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