Behavioral Medicine

ISSN: 0896-4289 (Print) 1940-4026 (Online) Journal homepage: http://www.tandfonline.com/loi/vbmd20

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To cite this article: Minsung Sohn MPH, Kyung-Hwan Cho MD, PhD, Kyung-Do Han MS, Mankyu Choi MPH,PhD & Yang-Hyun Kim MD, PhD (2016): Sitting Time and Obesity or Abdominal Obesity in Elderly South Koreans: Korean National Health and Nutrition Examination Survey 2013, Behavioral Medicine, DOI: 10.1080/08964289.2015.1135101

To link to this article: http://dx.doi.org/10.1080/08964289.2015.1135101

Sitting Time and Obesity or Abdominal Obesity in Elderly South Koreans: Korean National Health and Nutrition Examination Survey 2013

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Abstract

We examined relationships between sitting time and obesity or abdominal obesity according to sex and socioeconomic status in the elderly. We analyzed data from the Korean National Health and Nutrition Examination Survey 2013, and 1,565 participants were included in the study. Multivariate logistic regression analysis was used to examine relationships between sitting time and obesity or abdominal obesity according to sex and socioeconomic status. **S**itting time was positively correlated with body mass index in men and women and waist circumference in men.

When considering socioeconomic factors, men who sat for ≥ 5 h and fell within the lowest income were more likely to have obesity and abdominal obesity relative to men who sat for < 5 h and earned higher incomes (odds ratio [95% confidence interval] = 1.80 [1.14--2.84] and 1.63 [1.02--2.61] respectively), and women who sat for ≥ 5 h and fell within the lowest educational level were more likely to have abdominal obesity relative to women who sat for < 5 h and were educated to a higher level (1.24 [1.01--1.85]). Strategies to reduce sedentary behavior would help to prevent obesity in elderly men who earn low incomes, women with lower levels of educational attainment.

Keywords

Sitting time; Obesity; Abdominal obesity; Socioeconomic status; Elderly

Introduction

Obesity is defined as excessive fat accumulation and a body mass index (BMI) of > 25 kg/m^2 in Asian individuals.[1] Obesity and abdominal obesity are major risk factors for many chronic diseases, such as diabetes mellitus, hypertension, cardiovascular disease, and some types of cancer, and have been associated with decreased overall quality of life.[2-4] The prevalence of overweight and obesity are increasing worldwide.[5-8] In South Korea, the prevalence of obesity in those older than 70 years has increased from 29.3% in 2008 to 33.8% in 2013;[9] as a result, obesity in the elderly has become an important health and social problem in South Korea.

The risk factors for obesity include increased caloric intake, decreased physical activity, endocrine disorders such as Cushing's syndrome and polycystic ovary disease, genetic predisposition,[10] and low socioeconomic status (SES).[11-13] Increases in the prevalence of obesity during the 2000s are mainly attributable to reduced physical activity rather than high caloric intake.[14,15] Habitats that encourage physical activity help to reduce unhealthy body weight and may be beneficial, because in particular older people are at risk for functional decline.[14] According to a research on association between employment status and obesity in a Korean elderly population, unemployment appears to be significantly related to a high risk of obesity, which showed the characteristic to less exercise despite low caloric intake.[16] Many previous studies have focused on increases in physical activity to prevent weight gain or loss;[17-19] however, recent studies have revealed that sedentary behavior, such as television viewing, was also associated with various health risks including obesity.[20-26] Moreover, some prospective studies have reported relationships between sedentary time and television viewing and

mortality.[27-29] Gómez-Cabello et al. found that sitting time increased the risk of obesity, particularly in elderly individuals, independently of walking time,[30] and other studies reported differences according to sex,[20,24,30-32] employment status,[33] and SES[13] in the relationship between sitting time and obesity.

Most of the aforementioned studies included Caucasian participants; however, there is insufficient evidence involving Asian participants, particularly from South Korea, where the prevalence of aging and obesity have increased rapidly. To determine whether hypotheses supported by studies involving Caucasian participants would be supported with South Korean participants, we examined the relationships between sitting time and obesity according to sex and SES in the elderly using data from the entire elderly Korean population.

Methods

Survey overview and participants

The data for this study were taken from the Korean National Health and Nutrition Examination Survey 2013, which was conducted by the Korea Center for Disease Control and Prevention. This survey was a nationwide representative study that used stratified, multistage probability sampling to select household units. The overall response rate was reportedly 82.7%. In total, 8,018 respondents from these sampling frames were included in the survey. Of these, 6,148 were excluded, as they were aged 60 years or younger. A further 305 participants were excluded due to missing values or lack of responses regarding the main study variables. The final sample consisted of 1,565 participants (656 men and 906 women). All study participants provided

written informed consent, and the institutional review board of the Korea Center for Disease Control and Prevention approved the study protocol.

Anthropometric measurements

A trained examiner measured participants' height (cm) and weight (kg), in light clothing, to the nearest 0.1 cm and 0.1 kg, respectively. Waist circumference (WC) at the end of normal expiration was measured, to the nearest 0.1 cm, on a horizontal plane at the midpoint between the iliac crest and costal margin.

Sitting time and general health behavior

To assess sitting time, participants reported the amount of time that they spent sitting during a typical day. Participants were asked to include time spent sitting at work and home, during transportation, with friends, reading, playing cards, watching television, and using a computer, but they excluded time spent sleeping. Participants were asked, "During the last 7 days, how much time have you spent sitting on a typical day?" The International Physical Activity Questionnaire contains a similar question concerning sitting time ("During the last 7 days, how much time did you spend sitting during a day?"), and has demonstrated acceptable reliability and validity.[34,35] Regarding general health behaviors, current smokers were defined as those who smoked at the time of data collection. To define the heavy drinking, we converted the amount of alcohol consumed per drinking day and the frequency of drinking in the past month into the mean daily alcohol consumption (g/day). According to the WHO classification[36], heavy drinking was defined as alcohol consumption ≥20 g/day in women and ≥40 g/day in men. In this study, we defined heavy drinkers those who had heavy drinking more than once per week. The physical

activity group was defined as those who exercised more than once per week at an intense level of exercise for more than 30 min.

Sociodemographic variables and nutritional assessment

Participants completed a self-administered questionnaire containing items concerning age, sex, educational attainment, and household income. Household income was adjusted for number of family members and divided into quartiles. Daily food intake was also reported via self-administered questionnaire, and total caloric intake was calculated using the processed food database developed for the Korean National Health and Nutrition Examination Survey and the food composition table published by the National Rural Living Science Institute under the Rural Development Administration.

Definitions of obesity and abdominal obesity

The outcome variables were obesity and abdominal obesity. BMI is a crude population measure of obesity, which is calculated by dividing an individual's weight (kg) by the square of his or her height (m^2). In Asian populations including South Koreans, the BMI cut-off values for obesity ($\geq$ 25 kg/m^2) are lower than the BMI cut-off values for obesity in Americans ($\geq$ 30 kg/m^2).[37] Abdominal obesity was calculated using waist circumference, to the nearest 0.1 cm, measured at the superior border of the iliac crest. The WC cut-off values for abdominal obesity were $\geq$ 90 cm for men and $\geq$ 85 cm for women.[38]

Statistical analysis

Participants' general characteristics, according to sex, are presented as mean ± standard error (SE) or proportion (SE), examined via t test or Chi-square tests. Multivariate logistic regression

analysis was used to determine odds ratio (OR) and 95% confidence interval (CI) for obesity and abdominal obesity according to sitting time in men and women. Model 1 was not adjusted, and Model 2 was adjusted for age, smoking, alcohol intake, and physical activity. In addition to these factors, Model 3 was adjusted for household income, educational attainment, and daily food intake based on the covariates of Model 2. Subgroup analysis was used to examine mean differences in sitting time, BMI, and WC, stratified according to SES quartile (household income and educational attainment), between men and women. We also analyzed the OR and 95% CI for obesity and abdominal obesity subsequent to categorizing participants into two groups according to sitting time and SES: sitting time of ≥ 5 h and the lowest income and educational levels (Q1) and sitting time of < 5 h and higher income and education levels (Q2--Q4). Statistical analyses were performed using STATA v. 12.0 (STATA, College Station, TX) and two-sided p values of < 0.05 were considered statistically significant.

Results

General sample characteristics

Table 1 shows the participants' general characteristics. The mean age was 69.4 in men and 70.0 in women. WC and the proportions of current smokers, heavy drinkers, and regular exercisers were higher in men relative to those observed in women (all p values < 0.001). Regarding educational attainment, the proportion of participants educated to elementary school level or lower was higher in women relative to that of men (73.3% and 41.4% respectively). With respect to household income, the proportion of participants in the lowest quartile was higher in women relative to that of men (48.3% and 38.4% respectively). BMI and the prevalence of obesity and abdominal obesity were higher in women relative to those observed in men (all p values <

0.001). Sitting time was normally distributed in both men and women (data not shown), and mean sitting time was higher in men relative to that of women; however, this difference was nonsignificant (5.41 h/day and 5.32 h/day, respectively; p = 0.515).

(Table 1 near here)

Associations between sitting time and BMI or WC in men and women

Supplement Table 1 shows multivariate linear regression analysis between sitting time and BMI or WC by sex. Sitting time was positively related with BMI and WC in men after adjusting for all covariates (β = 0.105 and 0.109, respectively). Sitting time was also positively related with BMI in women (β = 0.100).

(Supplement table 1 near here)

Associations between sitting time and obesity or abdominal obesity in men and women

Multivariate logistic regression analysis between sitting time and obesity or abdominal obesity by sex is shown in Table 2. Men who reported sitting for ≥ 5 h/day were 1.54 times (CI: 1.09--2.16) more likely to be obese relative to those who reported sitting for < 5 h/day after adjusting for all covariates, but this finding was not observed in women. Sitting time was not significantly associated with the prevalence of abdominal obesity after adjusting for all covariates in men and women.

(Table 2 near here)

Sitting time, BMI and WC according to SES (household income and educational attainment) in men and women

Figure 1 shows the associations between sitting time and BMI and WC according to SES in men and women. Across household incomes, sitting time was most consistently associated with BMI and WC in men in the lowest household income quartile. Sitting time was consistently associated with BMI in women educated to a level lower than that of elementary school, but this finding was not observed in men. WC did not differ significantly according to sitting time or educational level in men or women.

Table 3 shows the effects of the interaction between SES factors on the relationships between sitting time and obesity or abdominal obesity. Men who sat for ≥ 5 h/day and fell within the lowest household income quartile (Q1) were 1.80 (95% CI: 1.14--2.84) and 1.63 (95% CI: 1.02--2.61) times more likely to have obesity and abdominal obesity, respectively, relative to those who sat for < 5 h/day and fell within the highest household income quartile (Q2-4) after adjusting for age, smoking, alcohol, physical activity, and daily food intake. Women who sat for ≥ 5 h/day and were educated to elementary school level or lower were 1.24 (95% CI: 1.01--1.85) times more likely to be obese relative to those who sat for < 5 h/day and were educated to middle school to associate, high school to associate, or college degree or higher levels.

(Figure 1 and Table 3 near here)

Discussion

In this study, sitting time was positively correlated with WC in men and BMI in both sexes. Sitting for ≥ 5 h was associated with increased obesity prevalence in men, but this finding was

not observed in women. Men who sat for ≥ 5 h and fell within the lowest household income quartile were more likely to have obesity and abdominal obesity relative to men who sat for < 5 h and earned higher incomes, and women who sat for ≥ 5 h and fell within the lowest educational level quartile were more likely to display abdominal obesity relative to women who sat for < 5 h and were educated to a higher level.

Sedentary behavior is defined as waking behavior that it distinguished by energy expenditure of less than 1.5 metabolic equivalents in a reclining or sitting posture[39]. Many studies have demonstrated relationships between sedentary behaviors and obesity[13,20,23-26,29-33,40-42] and metabolic syndrome and its components including high WC.[43-47] In studies involving adults, sitting time has been independently associated with obesity[30,40,41] and television viewing, which is the most frequently investigated sitting behavior was also associated with obesity.[13,20,23,24,27,33,42] The association between sitting time and obesity has been found to be bidirectional in some cohort studies. The Nurses' Health Study showed an increase of 5% in obesity for each increase of 2 h of sitting time in the workplace;[42] however, some studies, including an Australian cohort study, have shown that obese individuals sit for longer periods relative to nonobese individuals.[48-50] In contrast, some studies found no association between sitting time and obesity.[51-53]

The mechanisms underlying the contribution of increased sitting time to obesity are not fully understood. Increased sitting time could reduce physical activity, resulting in a decrease in total energy expenditure.[54] Using transportation, performing domestic tasks in the workplace, and pursuing leisure activities in the sitting position, including television viewing or gaming, have

been found to result in decreased physical activity.[43,55-57] Some studies have found that increased television viewing time was associated with increased energy intake via snacking.[58-60] Obesity also induces increased sitting time, as shown in previous cohort studies;[48-50] however, this was not observed in this cross-sectional study. Some studies, including the current research, have reported an association between sitting time and obesity, particularly in men;[31,42,61] however, other studies have reported this association solely in women.[29,62,63] Therefore, the sex difference observed in the relationship between sitting time and obesity is controversial. Some studies explained these sex differences by increased television viewing time[55,62,63] and sedentary leisure time[64] in men or women. Further studies are required to examine the effects of occupational status, leisure time activity, and domestic environment on the prevalence of obesity.

SES is another important confounder in the association between sitting time and obesity. The effect of SES on the relationship between sitting time and obesity could be explained by findings indicating that participants with low SES tended to eat more unhealthy diets involving high caloric and fat intake and participated in outdoor leisure activities less frequently relative to those with high SES. [26,65-69]

This study was subject to some limitations. It was a cross-sectional study; therefore, we could not elucidate a causal relationship between sitting time and obesity. In addition, there was a lack of dietary data in the study, but dietary intake is an important factor in obesity prevalence. Further, sitting time data were collected via self-report questionnaire; therefore, results may have been subject to some degree of recall-bias. Moreover, there was no information available regarding the location at which sitting time was measured.

Despite these limitations, this study had some strengths. First, we analyzed data representative of the entire elderly Korean population. Second, to the best of our knowledge, no studies had previously been conducted to examine the relationship between sitting time and obesity in South Korean participants; therefore, this was the first study to report an association between sitting time and obesity in elderly South Korean adults. Moreover, we investigated this association in consideration of SES. We also examined the relationship between abdominal obesity and sitting time and adjusted for various covariates that may affect obesity prevalence.

Conclusion

In conclusion, elderly men with low SES were likely to show high BMI and WC, and sitting times of ≥ 5 h were associated with increased obesity prevalence in men but not women. Obesity and abdominal obesity were more prevalent in men who sat for ≥ 5 h and earned low incomes, and abdominal obesity was more prevalent in women who sat for ≥ 5 h and were educated to a low level. Strategies to increase physical activity and reduce sedentary behavior would help to prevent obesity in elderly men who earn low incomes and elderly women with lower levels of educational attainment. Further prospective studies are needed to reveal the causal relationship between sitting time and obesity using more precise sitting time measurement and information about exercise and diet.

Acknowledgements

We wish to thank the study participants for their dedication and there was no funding for this study.

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Table 1. General characteristics, mean ± SE or proportion (N = 1,565)

	Men	Women	p value*
Unweighted number	656	906	
Age (y)	69.4 ± 6.7	70.0 ± 7.0	0.193
60--69	50.1	45.9	
70--79	39.6	41.6	
≥80	10.3	12.5	
BMI (kg/m^2)	23.5 ± 2.9	24.4 ± 3.3	< **0.001**
Waist circumference (cm)	84.6 ± 8.9	82.8 ± 9.4	< **0.001**
Current smoker (yes, %)	25.2	3.8	< **0.001**
Heavy drinker (yes, %)	20.5	1.5	< **0.001**
Physical activity (yes, %)	49.5	50.6	0.355
Daily food intake (g)	1463.2 ± 722.7	1146.4 ± 596.5	< **0.001**
Educational attainment			< **0.001**
Elementary school or lower	41.4	73.3	
Middle school to associate	18.4	11.8	
High school to associate	26.9	11.0	
College degree or higher	13.4	3.9	
Household income			< **0.001**
1st quartile (lowest)	38.4	48.3	

2st quartile	26.9	26.7	
3st quartile	19.3	14.2	
4st quartile (highest)	15.5	10.7	
Obese (yes, %)	36.6	45.4	< **0.001**
Abdominal obesity (yes, %)	28.8	42.3	< **0.001**
Sitting time (h)	5.4 ± 3.2	5.3 ± 3.1	0.515

Data are presented as mean ± SE or proportion.

*Obtained using t and chi-square tests.

BMI: body mass index

Boldface indicates statistical significance ($p < 0.05$).

Table 2. Multivariate logistic regression models of odds ratio of obesity or abdominal obesity associated with sitting time by sex

	Model 1		Model 2		Model 3	
Sitting time	< 5h	≥ 5h	< 5h	≥ 5h	< 5h	≥ 5h
Obesity						
Men	1	**1.51 (1.09--2.08)****	1	**1.53 (1.10--2.11)****	1	**1.54 (1.09--2.16)***
Women	1	1.19 (0.89--1.50)	1	1.17 (0.89--1.52)	1	1.19 (0.86--1.51)
Abdominal obesity						
Men	1	1.39 (0.99--1.95)	1	1.39 (0.98--1.95)	1	1.38 (0.88--1.81)
Women	1	1.18 (0.91--1.54)	1	1.17 (0.89--1.53)	1	1.19 (0.87--1.53)

Data are presented as odds ratio (OR) and confidence interval (CI) and obtained by multivariate logistic regression analysis.

Model 1 was not adjusted.

Model 2 was adjusted for age, smoking, alcohol intake, and physical activity

Model 3 was adjusted for the factors adjusted for in Model 2, household income, educational attainment, and daily food intake based on the covariates of Model 2.

Boldface indicates statistical significance ($p < 0.05$); * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3. Sitting time, obesity, and abdominal obesity by interaction with socioeconomic factors in men and women

	Income (Q2--4)	Income (Q1)	Education (Q2--4)	Education (Q1)
Sitting time	< 5h	≥ 5h	< 5h	≥ 5h
Obesity				
Men	1	**1.80 (1.14--2.84)****	1	0.96 (0.61--1.52)
Women	1	0.99 (0.68--1.45)	1	**1.24 (1.01--1.85)***
Abdominal obesity				
Men	1	**1.63 (1.02--2.61)***	1	0.88 (0.54--1.42)
Women	1	1.26 (0.86--1.84)	1	1.08 (0.77--1.52)

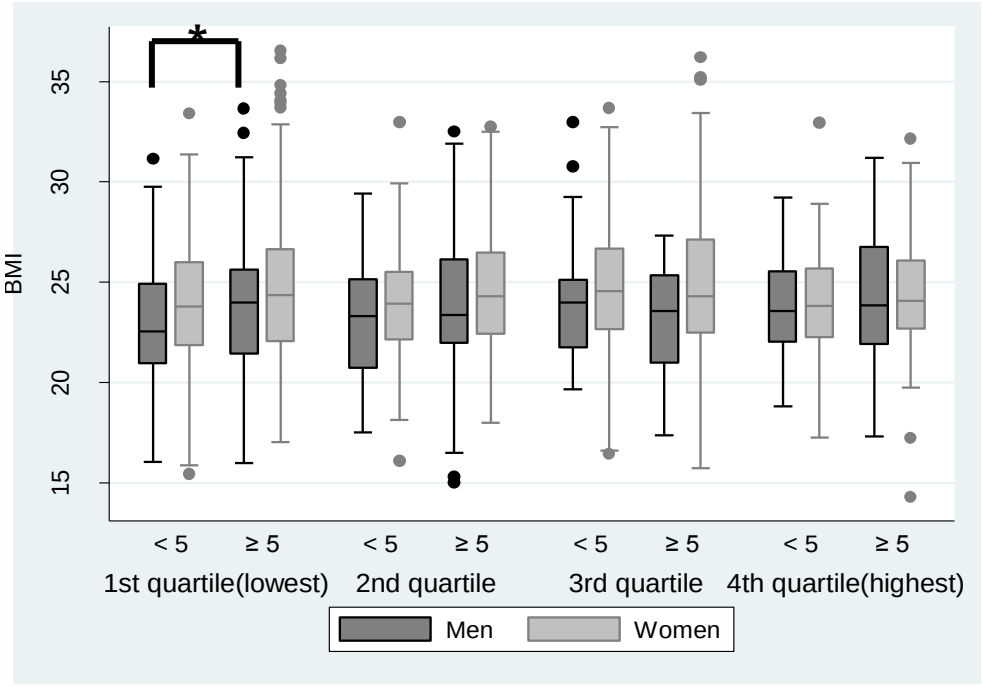
Data are presented as odds ratio (OR) and confidence interval (CI) and were obtained via multivariate logistic regression.

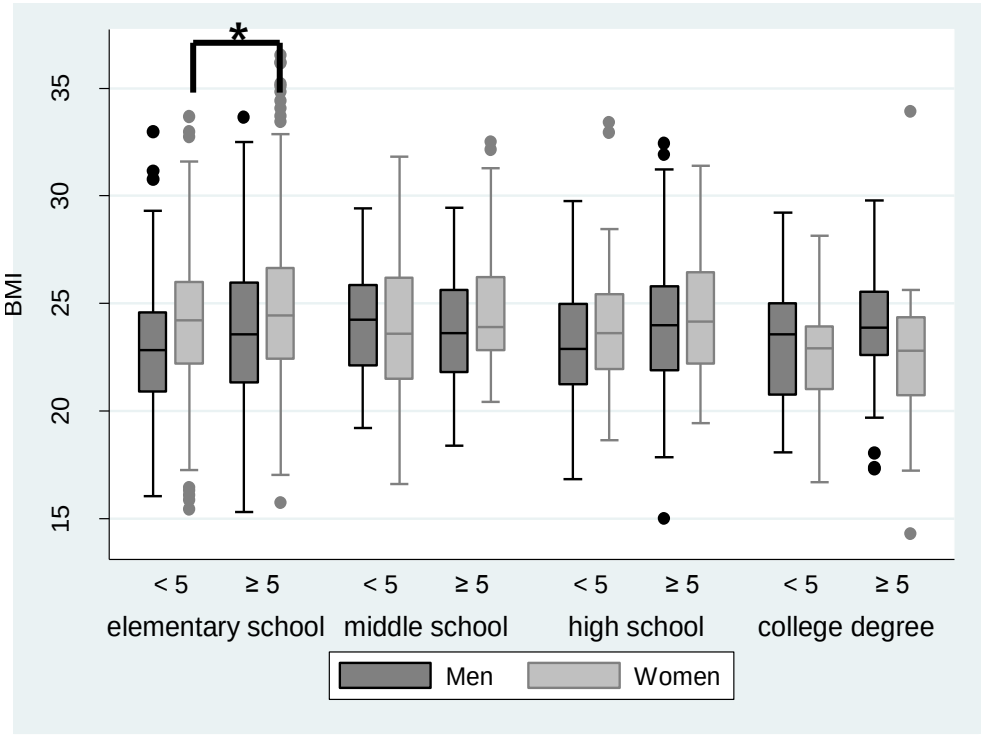
Adjusted for age, smoking, alcohol, physical activity, and daily food intake

Income (Q1): 1stquartile (lowest); income (Q2--4): 2nd quartile, 3rd quartile, and 4th quartile (highest); education (Q1): elementary school or lower; education (Q2--4): middle school to associate, high school to associate, and college degree or higher

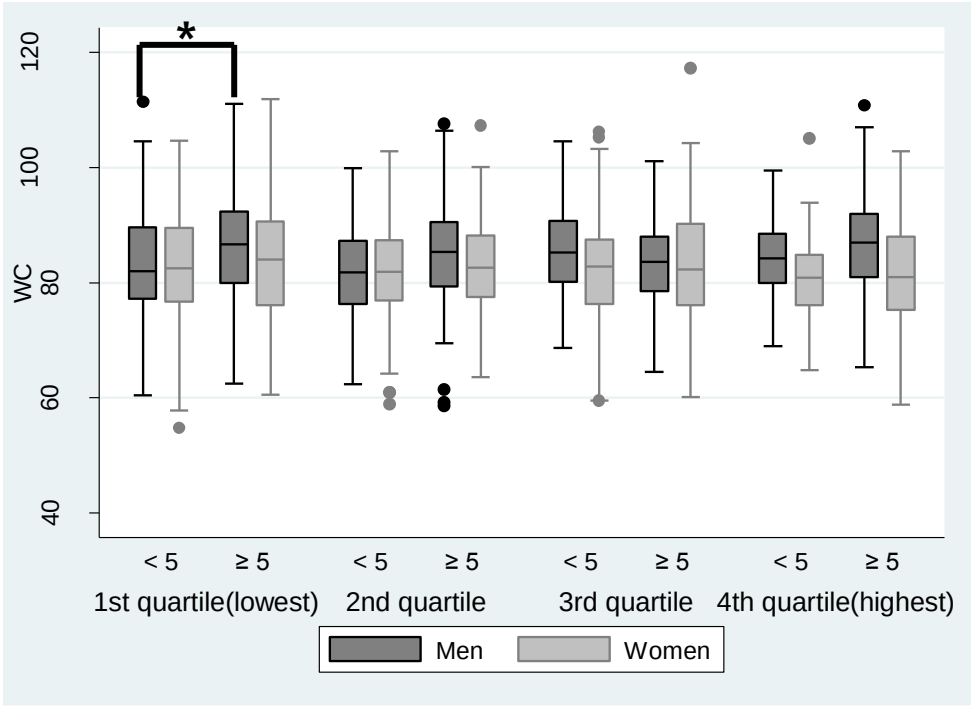
Boldface indicates statistical significance ($p < 0.05$); * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

a. Household income





b. Educational level



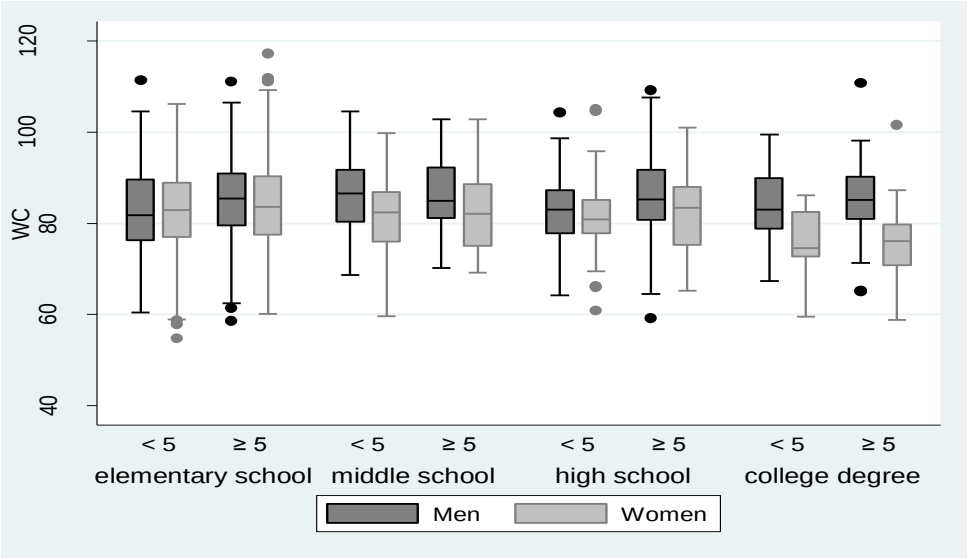


Figure 1. Sitting time and body mass index and waist circumference according to SES (household income and educational level) in men and women