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Association Between Socioeconomic Status and Obesity in Adults: Evidence From the 2001 to 2009 Korea National Health and Nutrition Examination Survey

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Objectives: The present study examined relationships between socioeconomic status (SES) and obesity and body mass index (BMI) as well as the effects of health-related behavioral and psychological factors on the relationships.

Methods: A cross-sectional population-based study was conducted on Korean adults aged 20 to 79 years using data from the 2001, 2005, and 2007 to 2009 Korea National Health and Nutrition Examination Survey. Multivariate logistic and linear regression models were used to estimate odds ratios of obesity and mean differences in BMI, respectively, across SES levels after controlling for health-related behavioral and psychological factors.

Results: We observed significant gender-specific relationships of SES with obesity and BMI after adjusting for all covariates. In men, income, but not education, showed a slightly positive association with BMI ($p<0.05$ in 2001 and 2005). In women, education, but not income, was inversely associated with both obesity and BMI ($p<0.0001$ in all datasets). These relationships were attenuated with adjusting for health-related behavioral factors, not for psychological factors.

Conclusions: Results confirmed gender-specific disparities in the associations of SES with obesity and BMI among adult Korean population. Focusing on intervention for health-related behaviors may be effective to reduce social inequalities in obesity.

Key words: Socioeconomic status, Obesity, Body mass index, Sex, Behavioral factors, Psychological factors

INTRODUCTION

Obesity is closely associated with a variety of diseases such as cardiovascular diseases, type 2 diabetes, hypertension, hepatitis, osteoarthritis, and some types of cancer [1-3]. Being overweight or obese has been a serious health problem in Western countries. Moreover, developing countries have had a growing prevalence of obesity and Korea is no exception [4-6]. With rapid industrialization and economic development in Korea over the past several decades, the overall prevalence of obesity and mean body mass index (BMI) is increasing steadily [7]. Evidence from a large birth cohort study in Korea showed that the prevalence of obesity increased 2.5-fold in men and 2.3-fold in women between 1992 and 2000 [8]. A study using the Korea National Health and Nutrition Examination Survey (KNHANES) from 1998 through 2007 revealed that BMI and waist circumference tended to increase, but in men only [9].

Socioeconomic status (SES) has been shown to be a significant predictor of obesity [4]. Numerous studies from Western

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countries found a strong inverse relationship between SES and obesity and some of them observed gender-specific associations [1,10]. Rathmann et al. [11] found that SES indicators (including income, education, and occupation) were inversely associated with BMI in women; however, these associations were weak or absent in men. The association between SES and obesity is inconsistent in other than Western countries. Studies in developing countries showed a strong positive relationship between SES and obesity in both men and women [4,12]. Yoo et al. [13] reported a gender-specific association between SES and obesity in Korea using the 1998 to 2007 KNHANES; the relationship was positive in men and was negative in women.

Health-related lifestyle factors and psychological factors have been investigated with the relationship between SES and obesity to understand the mechanisms underlying the relationship. Evidence from previous studies has been inconsistent on whether the relationship of SES and obesity was explained by these factors [14-16]. Molarius [16] found that alcohol use and physical inactivity mainly contributed to the association between education and obesity while smoking and dietary intake had almost no effect on the association. In the Copenhagan City Heart Study, Prescott et al. [17] found that psychosocial and behavioral factors did little to explain the inverse association between education and metabolic syndrome.

However, it is important to investigate the contribution of the lifestyle factors and psychological factors on the relationship between SES and obesity because it could suggest that intervention on these factors would have influence on socioeconomic disparity in obesity if a large part of the association is adjusted by the factors. Also, there is a lack of evidence of whether or to what extent health-related behavioral and psychological factors contribute to the association in Korea. To our knowledge, only two studies in Korea evaluated the relationship between SES and obesity adjusting for obesity-related health behaviors [18,19]. In the first study, Lee and Sobal [18] examined the association taking into account dietary transition using Korean nutrition surveys from 1969 to 1993. In the second study, Yoon et al. [19] used 1998 KNANES to assess the relationship after controlling for health-related behavioral factors. Thus, we aimed to examine the associations of SES with obesity and BMI in men and women using data from three survey periods of the KNHANES (2001, 2005, and 2007 to 2009). In addition, we assessed whether the associations could be explained by health-related behavioral and psychological factors.

METHODS

Study Population

Data were obtained from the 2001, 2005, and 2007 to 2009 survey periods of the KNHANES, which were conducted by the Korea Ministry of Health and Welfare. A stratified, multistage clustered probability design was used to collect representative data on non-institutionalized Korean population for each survey period. After the 2005 KNHANES data, data has been collected annually since 2007. The response rates were 77.3%, 70.2%, and 74.5% in the 2001, 2005, and 2007 to 2009 datasets, respectively. The details of these surveys have been described elsewhere [20-22]. In 2001, 2005, and 2007 to 2009, there were 9670, 7551, and 23 489 participants, respectively, who completed Health Examination Survey. Of those who completed all three parts of the survey (health interview, health-related behavior interview, and health examination), we excluded those younger than 20 or older than 79 (2001, 18%; 2005, 28.2%; 2007 to 2009, 29.2%), or women who reported being pregnant during the survey periods (2001, 11.3%; 2005, 0.5%; 2007 to 2009, 0.5%), or participants having missing data for main variables or covariates (2001, 10.2%; 2005, 2.6%, 2007 to 2009, 14.9%). As a result, 5848, 5182, and 13 011 participants comprised the final study populations for the 2001, 2005, and 2007 to 2009 datasets, respectively.

Indicators of Socioeconomic Status

Monthly household income and individual education level were used as indicators of SES. For income, participants were asked "What was your average monthly household income over the past year?" and answers were categorized into quartiles (Q1, Q2, Q3, and Q4) (2001: <1 000 000 Korean won [KRW], 1 000 000 to <1 800 000 KRW, 1 800 000 to <2 500 000 KRW, and ≥2 500 000 KRW; 2005: <1 000 000 KRW, 1 000 000 to <2 000 000 KRW, 2 000 000 to <3 000 000 KRW, and ≥3 000 000 KRW; 2007 to 2009: <1 150 000 KRW, 1 150 000 to <2 500 000 KRW, 2 500 000 to <3 900 000 KRW, and ≥3 900 000 KRW). Education level was divided into three groups according to the total number of completed years in school as: up to 9 years (primary school), 10 to 12 years (high school), or ≥13 years or more (college or higher).

Anthropometrics

Height was measured to the nearest 0.1 cm using a stadiometer (Holtain, Crymych, United Kingdom) and weight was measured to the nearest 0.1 kg using a scale (Giant 150N; HANA Co., Seoul, Korea). BMI (kg/m^2) was calculated as weight (kg) divided by height squared (m^2). Obesity was defined as a BMI $\geq$25 kg/m^2 according to the Asia-Pacific guidelines of the World Health Organization [23].

Covariates

Demographic factors and health-related behavioral and psychological factors were attained from questionnaires. The demographic factors were age, gender and marital status. Age was divided into three groups for the descriptive analysis and was a continuous variable for the regression analysis. Marital status was divided into three categories: unmarried, married, and others that included anyone divorced, separated, or widowed. The health-related behavioral factors were smoking, alcohol use, and weekly exercise. Smoking status was categorized nonsmoker, ex-smoker, and current smoker. Alcohol use was recorded in the questionnaire as the frequency of alcohol consumption per month. We divided it into three categories: none (never consume), light (1 time/mo), and moderate or heavy (>1 time/mo). Weekly exercise was defined as the frequency of leisure-time physical activity per week and was classified none, ≤2 times/wk, and ≥3 times/wk. Because data on the leisure-time physical activity were not collected in 2007 to 2009, the frequency of vigorous physical activity per week was used for that period (none, ≤2 times/wk, and ≥3 times/wk). In addition, stress level and depression were used to define psychological factors. Stress level was ascertained by asking "How stressed are you in your everyday life?" The answers were categorized as none (not stressed), low (slightly stressed), and high (stressed very much). Depression was recorded as either yes or no.

Statistical Analyses

Survey weights were used in all analyses to account for the stratified, multistage sampling design. Unweighted frequencies and weighted mean BMI were estimated for all descriptive variables in this study. Differences of the mean BMI were examined using analysis of variance for marital status and smoking and independent *t*-test for sex and depression. Tests for linear trends were used for ordinal variables including age and income. Gender-specific analyses were performed for all analyses due to the interaction effect of sex with income ($p<0.0001$) and education ($p<0.0001$) in the regression models. For adjusting, demographic factors and the other indicator of SES were included to model 1. In model 2, health-related behavioral factors were added to the covariates used in the model 1. Lastly, model 3 included the covariates of the second model plus psychological factors. The results of the logistic regression analyses were presented as odds ratios and 95% confidence intervals, and tests for linear trends were performed. Multivariate linear regression models were also used to assess the associations between SES and BMI with the same adjustments mentioned above. In the models, coefficients of mean BMI were estimated for each SES category, and tests for linear trend were also performed. SAS version 9.1 (SAS INc., Cary, NC, USA) was used for all analyses and two-sided *p*-value of <0.05 was considered significant.

RESULTS

Descriptive characteristics and mean BMIs of the study participants are presented in Table 1. The majority of the participants was aged between 20 to 59 years and was married. The proportions in the SES categories were similar across 2001 to 2009. For each survey period, the majority of participants reported as never smoking and approximately half of participants were moderate or heavy alcohol users, did not regularly exercise, and had low levels of stress. In addition, the majority of participants from 2005 to 2007 to 2009 reported no depression. In 2007 to 2009, a decreasing trend for mean BMI was significantly observed in those with a high income ($p=0.0021$). A high level of education among women was inversely associated with mean BMI in all the three surveys ($p<0.0001$). The two psychological factors, stress level and depression, were not significantly related to mean BMI in all the surveys.

Table 2 presents the odds ratios of the association between obesity and SES separately for men and women. In men, no linear trend was found for obesity with increasing income; different shapes were observed for each survey period. Moreover, the associations between SES variables and obesity did not change after adjusting for behavioral and psychological factors (models 2 and 3). A high income of women was also not linearly related to obesity and the association did not change by adjusting for behavioral and psychological factors (models 2 and 3). However, in women, income and obesity tended to follow a linear trend with time (Figure 1). Inverse associations were observed between the second and fourth quartiles of income in three datasets and the linear relationship was significant in 2007 to 2009 (model 3, $p=0.0074$).

Table 1. Descriptive characteristics and mean BMI stratified by survey periods for the 2001, 2005, and 2007 to 2009 Korea National Health and Nutrition Examination Survey

Variables	2001 (n=5848)		2005 (n=5182)		2007-2009 (n=13 011)	
	Unweighted no. (%[1])	Mean BMI±SE	Unweighted no. (%[1])	Mean BMI±SE	Unweighted no. (%[1])	Mean BMI±SE
Age (y)						
20-39	2354 (39.9)	22.7±0.1	1736 (38.3)	22.9±0.1	4670 (37.5)	23.0±0.1
40-59	2285 (39.3)	24.1±0.1	2197 (41.7)	24.3±0.1	5159 (39.6)	24.1±0.1
60-79	1209 (20.8)	24.0±0.1	1249 (20.0)	24.1±0.1	3182 (22.9)	24.0±0.1
p for trend[2]		<0.001		<0.001		<0.001
Sex						
Men	2595 (44.3)	23.7±0.1	2207 (45.0)	24.0±0.1	6090 (46.5)	24.1±0.1
Women	3253 (55.7)	23.4±0.1	2975 (55.0)	23.3±0.1	6921 (53.5)	23.0±0.1
p-value[3]		0.010		<0.001		<0.001
Marital status						
Unmarried	869 (15.1)	22.0±0.1	719 (16.7)	23.3±0.2	2030 (15.9)	22.8±0.1
Married	4359 (74.2)	23.7±0.1	3804 (71.5)	24.2±0.1	9546 (73.3)	23.8±0.0
Others[4]	620 (10.7)	24.2±0.2	659 (11.8)	23.5±0.2	1435 (10.8)	24.1±0.1
p-value[3]		<0.001		<0.001		<0.001
Income[5]						
Q1	1092 (19.2)	23.6±0.1	984 (17.0)	23.9±0.1	3246 (24.2)	23.7±0.1
Q2	1829 (31.1)	23.6±0.1	1329 (26.2)	23.6±0.1	3257 (25.4)	23.7±0.1
Q3	1161 (19.7)	23.6±0.1	1201 (23.8)	23.5±0.1	3253 (25.5)	23.5±0.1
Q4	1766 (30.0)	23.4± 0.1	1668 (33.0)	23.6±0.1	3255 (24.9)	23.4±0.1
p for trend[2]		0.032		0.31		0.002
Education (y)						
Up to 9	2040 (35.1)	24.4±0.1	1839 (31.4)	24.4±0.1	4374 (32.1)	24.2±0.1
10 to 12	2104 (36.0)	23.3±0.1	1767 (35.3)	23.7±0.1	4905 (38.5)	23.4±0.1
≥13	1704 (28.9)	22.8±0.1	1576 (33.3)	23.0±0.1	3732 (29.4)	23.3±0.1
p for trend[2]		<0.001		<0.001		<0.001
Smoking						
Never smoker	3613 (62.2)	23.5±0.1	3101 (57.3)	23.4±0.1	7027 (49.1)	23.2±0.1
Former smoker	521 (8.8)	23.9±0.1	905 (18.2)	24.3±0.1	2703 (38.5)	24.0±0.1
Current smoker	1714 (29.0)	23.6±0.1	1176 (24.5)	23.7±0.1	3281 (29.4)	23.9±0.1
p-value[3]		0.025		<0.001		<0.001
Alcohol use						
None	2993 (52.2)	23.5±0.1	1285 (22.7)	23.6±0.1	2163 (13.7)	23.5±0.1
Light	391 (6.5)	23.3±0.2	1325 (25.2)	23.6±0.1	4307 (32.0)	23.4±0.1
Moderate or heavy	2464 (41.3)	23.7±0.1	2572 (52.1)	23.7±0.1	6541 (54.3)	23.7±0.1
p for trend[2]		0.14		0.82		0.002
Weekly exercise						
None	4187 (71.4)	23.4±0.1	2697 (51.7)	23.4±0.1	8915 (66.0)	23.5±0.0
≤2 times/wk	404 (6.8)	23.8±0.2	666 (13.7)	23.7±0.1	2419 (30.5)	23.7±0.1
≥3 times/wk	1257 (21.8)	24.0±0.1	1819 (34.6)	24.0±0.1	1677 (13.5)	24.0±0.1
p for trend[2]		<0.001		<0.001		<0.001
Stress level						
None	1010 (17.9)	23.8±0.1	770 (14.0)	23.9±0.1	1952 (13.6)	24.0±0.1
Low	2846 (48.0)	23.5±0.1	2627 (51.4)	23.6±0.1	7238 (56.6)	23.4±0.0
High	1992 (34.1)	23.5±0.1	1785 (34.6)	23.6±0.1	3821 (29.8)	23.7±0.1
p for trend[2]		0.17		0.14		0.21
Depression						
No	NA	NA	4381 (84.8)	23.6±0.1	11 099 (86.9)	23.5±0.1
Yes	NA	NA	801 (15.2)	23.7±0.2	1912 (13.1)	23.6±0.0
p-value[3]		NA		0.75		0.36

BMI, body mass index; SE, standard error; NA, not applicable.
[1]The percentages (%) were calculated from weighted frequencies.
[2]Survey regression test for linear trend in mean BMI across the covariate levels.
[3]Analysis of variance test for marital status and smoking; *t*-test for sex and depression.
[4]Others group included divorced, separated and widowed individuals.
[5]Q1, Q2, Q3, and Q4 refer to quartiles of income (2001: <1 000 000 Korean won [KRW], 1 000 000 to <1 800 000 KRW, 1 800 000 to <2 500 000 KRW, and ≥2 500 000 KRW; 2005: <1 000 000 KRW, 1 000 000 to <2 000 000 KRW, 2 000 000 to <3 000 000 KRW, and ≥3 000 000 KRW; 2007-2009: <1 150 000 KRW, 1 150 000 to <2 500 000 KRW, 2 500 000 to <3 900 000 KRW, and ≥3 900 000 KRW).

Table 2. Multivariate odds ratios (95% confidence interval) for obesity according to income and education levels, stratified by sex and each dataset for the 2001, 2005, and 2007 to 2009 Korea National Health and Nutrition Examination Survey

	Men			Women		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Income[1]						
2001						
Q1	1.00	1.00	1.00	1.00	1.00	1.00
Q2	1.18 (0.90, 1.53)	1.58 (0.89, 1.51)	1.56 (0.89, 1.51)	1.40 (1.11, 1.77)	1.36 (1.07, 1.71)	1.36 (1.08, 1.72)
Q3	1.24 (0.93, 1.65)	1.22 (0.91, 1.64)	1.22 (0.91, 1.64)	1.28 (0.98, 1.67)	1.23 (0.94, 1.61)	1.24 (0.95, 1.62)
Q4	1.20 (0.91, 1.58)	1.13 (0.86, 1.49)	1.13 (0.86, 1.49)	1.24 (0.97, 1.59)	1.19 (0.92, 1.52)	1.19 (0.93, 1.53)
p for trend	0.29	0.53	0.53	0.29	0.50	0.47
2005						
Q1	1.00	1.00	1.00	1.00	1.00	1.00
Q2	0.87 (0.61, 1.24)	0.89 (0.62, 1.28)	0.89 (0.62, 1.28)	1.16 (0.89, 1.51)	1.21 (0.93, 1.57)	1.21 (0.93, 1.58)
Q3	0.85 (0.58, 1.24)	0.86 (0.58, 1.26)	0.85 (0.58, 1.25)	0.96 (0.70, 1.33)	0.99 (0.72, 1.36)	1.00 (0.72, 1.38)
Q4	1.25 (0.89, 1.76)	1.20 (0.85, 1.70)	1.19 (0.85, 1.69)	1.04 (0.78, 1.39)	1.06 (0.79, 1.42)	1.07 (0.79, 1.43)
p for trend	0.045	0.11	0.11	0.80	0.83	0.83
2007-2009						
Q1	1.00	1.00	1.00	1.00	1.00	1.00
Q2	1.26 (0.99, 1.59)	1.26 (0.99, 1.60)	1.26 (0.99, 1.60)	1.11 (0.92, 1.35)	1.10 (0.90, 1.33)	1.09 (0.90, 1.33)
Q3	1.22 (0.94, 1.58)	1.21 (0.94, 1.57)	1.21 (0.94, 1.57)	0.90 (0.72, 1.12)	0.88 (0.70, 1.10)	0.87 (0.70, 1.10)
Q4	1.22 (0.95, 1.57)	1.21 (0.94, 1.56)	1.21 (0.94, 1.56)	0.81 (0.65, 1.01)	0.79 (0.63, 0.98)	0.78 (0.63, 0.98)
p for trend	0.26	0.29	0.29	0.015	0.008	0.007
Education (y)						
2001						
Up to 9	1.00	1.00	1.00	1.00	1.00	1.00
10 to 12	1.13 (0.89, 1.43)	1.07 (0.84, 1.36)	1.06 (0.84, 1.35)	0.51 (0.41, 0.63)	0.49 (0.39, 0.61)	0.49 (0.40, 0.62)
≥13	1.16 (0.90, 1.49)	1.05 (0.81, 1.36)	1.04 (0.80, 1.35)	0.20 (0.15, 0.28)	0.20 (0.14, 0.27)	0.20 (0.15, 0.28)
p for trend	0.30	0.80	0.83	<0.001	<0.001	<0.001
2005						
Up to 9	1.00	1.00	1.00	1.00	1.00	1.00
10 to 12	1.37 (1.00, 1.88)	1.35 (1.00, 1.84)	1.35 (1.00, 1.84)	0.59 (0.44, 0.80)	0.59 (0.44, 0.80)	0.59 (0.44, 0.80)
≥13	1.18 (0.81, 1.71)	1.12 (0.76, 1.64)	1.12 (0.77, 1.65)	0.28 (0.19, 0.41)	0.27 (0.19, 0.40)	0.27 (0.19, 0.40)
p for trend	0.72	0.95	0.94	<0.001	<0.001	<0.001
2007-2009						
Up to 9	1.00	1.00	1.00	1.00	1.00	1.00
10 to 12	1.08 (0.88, 1.34)	1.07 (0.87, 1.33)	1.07 (0.87, 1.32)	0.62 (0.51, 0.76)	0.62 (0.50, 0.76)	0.61 (0.50, 0.75)
≥13	1.17 (0.94, 1.46)	1.17 (0.94, 1.45)	1.17 (0.94, 1.45)	0.37 (0.29, 0.48)	0.37 (0.29, 0.47)	0.36 (0.28, 0.46)
p for trend	0.13	0.12	0.12	<0.001	<0.001	<0.001

Model 1, adjusted for age, marital status, and the other socioeconomic status factor; Model 2, adjusted for covariates in model 1, smoking, alcohol use, and weekly exercise; Model 3, adjusted for covariates in model 2, stress level, and depression.
[1]Q1, Q2, Q3, and Q4 refer to quartiles of income (2001: <1 000 000 Korean won [KRW], 1 000 000 to <1 800 000 KRW, 1 800 000 to <2 500 000 KRW, and ≥2 500 000 KRW; 2005: <1 000 000 KRW, 1 000 000 to <2 000 000 KRW, 2 000 000 to <3 000 000 KRW, and ≥3 000 000 KRW; 2007-2009: <1 150 000 KRW, 1 150 000 to <2 500 000 KRW, 2 500 000 to <3 900 000 KRW, and ≥3 900 000 KRW).

Health-related behavioral and psychological factors had influence on the relationship between education and obesity in men as demonstrated in the regression models. The impacts of these factors were stronger in 2001 than that in 2005 and 2007 to 2009. Compared to the effects of psychological factors, the behavioral factors had more effects on the associations in men. The relationship of education with obesity was not linear in the 2001 and 2005 periods but changed to be a positive re-

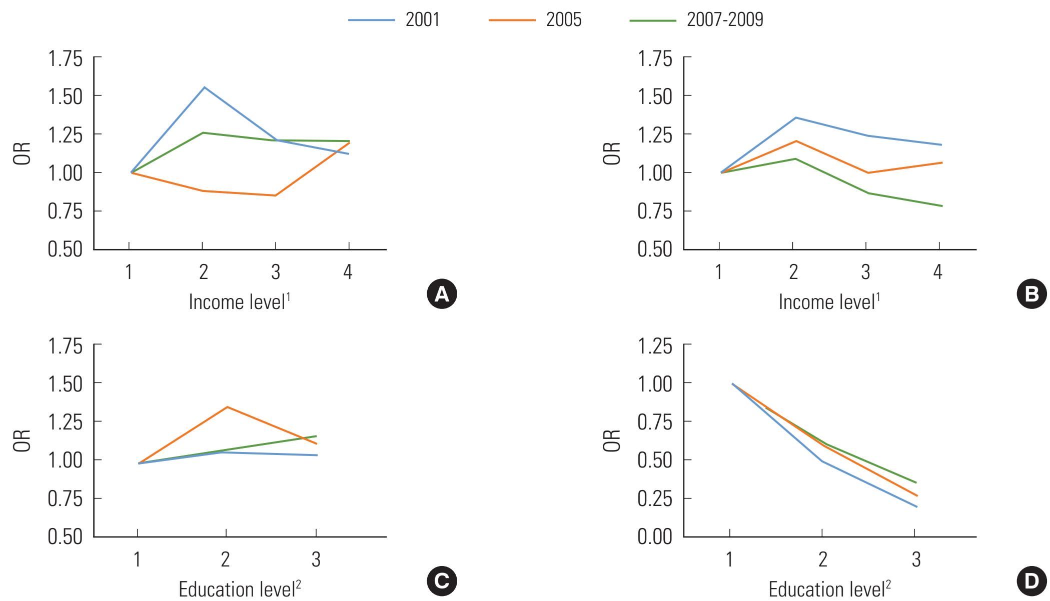

Figure 1. Fully adjusted odds ratios (OR) of obesity for 2001, 2005, and 2007 to 2009 Korea National Health and Nutrition Examination Survey stratified by sex and socioeconomic status (income and education level). (A) Men, (B) women, (C) men, and (D) women. [1]Quartile levels of income. [2]Three levels of education (1, up to 9 years; 2, 10 to 12 years; 3, ≥13 years).

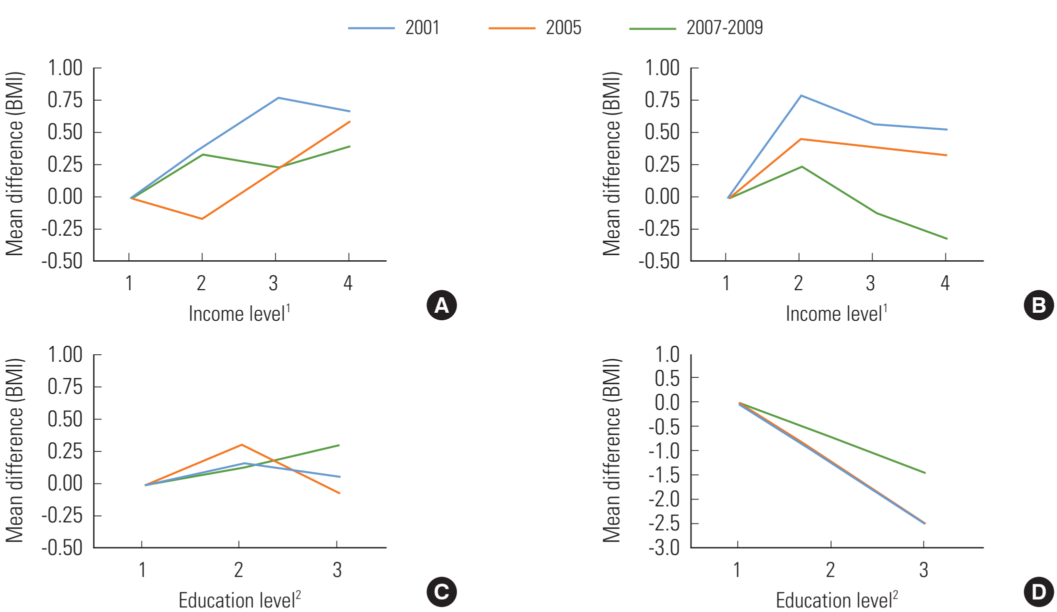

Figure 2. Fully adjusted mean differences in body mass index (BMI) for 2001, 2005, and 2007 to 2009 Korea National Health and Nutrition Examination Survey stratified by sex and socioeconomic status (income and education level). (A) Men, (B) women, (C) men, and (D) women. [1]Quartile levels of income. [2]Three levels of education (1, up to 9 years; 2, 10 to 12 years; 3, ≥13 years).

lationship in the 2007 to 2009 (Figure 1). For women, an inverse and linear association was observed between education and obesity, and this relationship remained after full adjustment (all models, $p<0.0001$).

Table 3 shows the associations between SES and mean BMI. Among men, the association between income and BMI were attenuated after adjusting for health-related behavioral factors. Additionally, all the adjusted associations were significantly positive (2001, $p=0.0004$; 2005, $p=0.0024$) but were not linear in all the survey periods (Figure 2). Among women, adjusting for heath behavioral factors had influence on the relationship between income and BMI and the adjusting effect was

Table 3. Multivariate regression coefficients for the mean differences in body mass index according to income and education levels, stratified by sex and each dataset for the 2001, 2005, and 2007 to 2009 Korea National Health and Nutrition Examination Survey

	Men			Women		
	Model1	Model 2	Model 3	Model1	Model 2	Model 3
Income[1]						
2001						
Q1	0.00	0.00	0.00	0.00	0.00	0.00
Q2	0.42[2]	0.39[2]	0.40[2]	0.89[2]	0.79[2]	0.79[2]
Q3	0.79[2]	0.77[2]	0.77[2]	0.68[2]	0.57[2]	0.57[2]
Q4	0.76[2]	0.67[2]	0.67[2]	0.65[2]	0.51[2]	0.52[2]
p for trend	<0.001	<0.001	<0.001	0.026	0.14	0.14
2005						
Q1	0.00	0.00	0.00	0.00	0.00	0.00
Q2	-0.18	-0.16	-0.17	0.42	0.43	0.45[2]
Q3	0.21	0.23	0.21	0.40	0.37	0.38
Q4	0.66[2]	0.61[2]	0.60	0.40	0.30	0.32
p for trend	<0.001	0.002	0.002	0.24	0.51	0.49
2007-2009						
Q1	0.00	0.00	0.00	0.00	0.00	0.00
Q2	0.34	0.34	0.34	0.26	0.23	0.24
Q3	0.28	0.25	0.25	-0.07	-0.13	-0.12
Q4	0.43[2]	0.39[2]	0.39[2]	-0.26	-0.33[2]	-0.32[2]
p for trend	0.06	0.11	0.11	0.012	0.004	0.004
Education (y)						
2001						
Up to 9	0.00	0.00	0.00	0.00	0.00	0.00
10 to 12	0.24	0.15	0.16	-1.16[2]	-1.24[2]	-1.24[2]
≥13	0.21	0.05	0.06	-2.43[2]	-2.49[2]	-2.49[2]
p for trend	0.33	0.93	0.87	<0.001	<0.001	<0.001
2005						
Up to 9	0.00	0.00	0.00	0.00	0.00	0.00
10 to 12	0.35	0.31	0.32	-1.11	-1.17	-1.17
≥13	0.08	-0.08	-0.07	-2.43	-2.47	-2.48
p for trend	0.85	0.44	0.45	<0.001	<0.001	<0.001
2007-2009						
Up to 9	0.00	0.00	0.00	0.00	0.00	0.00
10 to 12	0.14	0.12	0.12	-0.66[2]	-0.70[2]	-0.70[2]
≥13	0.33[2]	0.31[2]	0.31[2]	-1.35[2]	-1.40[2]	-1.41[2]
p for trend	0.022	0.030	0.029	<0.001	<0001	<0.001

Model 1, adjusted for age, marital status, and the other socioeconomic status factor; Model 2, adjusted for covariates in model 1, smoking, alcohol use, and weekly exercise; Model 3, adjusted for covariates in model 2, stress level, and depression.
[1]Q1, Q2, Q3, and Q4 refer to quartiles of income (2001: <1 000 000 Korean won [KRW], 1 000 000 to <1 800 000 KRW, 1 800 000 to <2 500 000 KRW, and ≥2 500 000 KRW; 2005: <1 000 000 KRW, 1 000 000 to <2 000 000 KRW, 2 000 000 to <3 000 000 KRW, ≥3 000 000 KRW; 2007-2009: <1 150 000 KRW, 1 150 000 to <2 500 000 KRW, 2 500 000 to <3 900 000 KRW, and ≥3 900 000 KRW).
[2]The 95% confidence interval of the value did not include 0.

larger than that in men. An inverse relationship of income with BMI was observed from the second quartile of income in women and was greater in the 2007 to 2009 than that in the 2001 or 2005 (Figure 2) (2007 to 2009, $p=0.0042$).

In men, health-related behavioral factors attenuated the relationship between education and BMI, but psychological factors did not. In 2007 to 2009, the relationship between education and BMI was linear and positive in men ($p=0.0286$ in model 3) but not significant in the 2001 and 2005 datasets (Figure 2). In women, education and BMI were inversely associated and the association was statistically significant for each survey period. The inverse relationships of education and BMI were larger after adjusting for health-related behavioral factors. The linear relationship was lessened in 2007 to 2009 compared to those in 2001 and 2005 (Figure 2).

DISCUSSION

We observed gender-specific patterns in the relationships of SES with obesity and BMI, and the associations changed after adjusting for health-related behavioral factors among Korean adults aged 20 to 79 years. Men with a high income were more likely to have a higher BMI than men with a low income, and women with a high SES were less likely to be obese or have a lower BMI than women with a low SES. In addition, health-related behavioral factors attenuated the associations between SES and obesity or BMI in both men and women; the fully adjusted associations changed between 2001 and 2009. The positive relationships of income observed in men tended to be more robust than those in women were. In women, income was negatively associated with obesity and BMI from the second quartile of income, and a sharp decline was observed in 2007 to 2009. However, in women, negative relationships of education with obesity and BMI were weaker in 2007 to 2009 than those in 2001 and 2005.

These gender-specific relationships have been reported in previous studies [13,19,24] and may reflect gender-based differences in attitudes toward body image in the Korea. Men are more likely to be comfortable with weight gain than women are, but women are more likely to be sensitive to it than men are [25]. Wardle et al. [25] observed that the prevalence of feeling overweight and trying to lose weight in Asian Pacific adults was the highest compared with those of adults from four other regions of the world. In that study, Korean men had the lowest prevalence of feeling overweight (14%) and Korean women had the highest prevalence of trying to lose weight (77%) across the 22 countries [25]. Women with a high education level tended to be more concerned about weight control and body shape than men with a high education level in other countries [26-28]. Thus, in Korea, environment and social pressures that slim women are more valued than obese women may contribute to women being less likely to gain weight as education increases than men [29,30].

The gender-specific associations changed after controlling for health-related behavioral factors. The influence of these factors was more obvious with BMI than obesity and the proportion of change in BMI was larger in women than that in men. This may suggest that the associations between SES and BMI are partially explained by the health-related behavioral factors. In previous studies, stress-related behaviors such as smoking cigarettes and drinking alcohol partially contributed to the positive association between SES and BMI in men [31-34]. In women, the social pressure on body weight may explain the observed effect of health-related behaviors. Women with a high level of education may tend to exercise more regularly and avoid more stress-related behaviors than do women with a low level of education. However, Ball et al. [35] observed that current smoking and vigorous physical activity were associated with a low BMI in women with the highest level of employment. Molarius [16] found that physical activity and heavy alcohol use were main contributors to the inverse association between education and obesity, and the contribution of the two factors was greater in men than that in women. Because this study examined the combined effect of the three behavioral factors on the main associations, it was limited to assess individual effect of the factors. Future research is required to elucidate an effect of each behavioral factor on the association between SES and obesity/BMI.

Results between 2001 and 2009 revealed trends of the gender-specific findings for the three survey periods. Non-linear positive associations in men were observed for all the periods, but tended to be linear in 2007 to 2009. For women, income was negatively associated with obesity and BMI from the second quartile of income in all survey periods. This is in agreement with the results from other studies where a high income was inversely related to obesity among women [5,26,36]. However, it contrasts with a previous Korean study to show a positive association between income and waist circumference using 2007 KNHANES [13]. In our study, among women, the social disparity in obesity and BMI seemed to be increasing with income, whereas the social differences seemed to be decreasing with education. This might imply that income is an important risk factor that increases obesity among women.

This study has some important limitations. First, the cross-sectional study design implies that no causal inference can be made about the relationship between SES and obesity/BMI. Second, the data based on self-reporting could lead measurement error and recall bias, which may have prevented us from accurately estimating the association between SES and obesity. Third, other potential confounders, such as residential area, dietary intake, and sedentary behaviors, were not included to these analyses; thus, we did not control for the other potential confounding factors. However, our study has two important strengths. First, this is the first study to investigate the association of SES with obesity and BMI while estimating the effects of health-related behavioral and psychological factors upon the association by adjustments. Additionally, the results of this study are generalizable to the Korean adult population because nationally representative data was used.

In conclusion, our study showed gender-specific associations of SES with obesity and BMI among Korean adults. Men with a high income and women with a low education level had a higher odd of being obese or a higher BMI than their counterparts had. Health-related behavioral factors partially contributed to changes in the relationship between SES and BMI in men and women. This suggests that public health effort to diminish social equalities in obesity could be effective if it focuses on changing health-related behaviors. Next studies are needed to clarify what underlying mechanisms are in the relationship between SES and obesity.

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CONFLICT OF INTEREST

The authors have no conflicts of interest with the material presented in this paper.

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