

### CHANGE IN OBESITY AND PHYSICAL ACTIVITY ACCORDING TO GENDER IN SOUTH KOREAN ADULTS, 2002–2013

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#### ABSTRACT

##### Background and objective

Physical activity (PA) is essential for preventing obesity and cardiovascular risks, but the percentage of obese individuals in different populations is gradually increasing, while PA is decreasing with economic development. This study analyzed the changing trends in obesity and PA participant rates during a 10-year period in Korea. Men and women were examined separately.

##### Material and methods

The census population data from the database of Korean National Health Insurance Service (KNHIS) used in this study comprised information on more than 86.4 million individuals between 2002 and 2013. PA participation was classified as follows: low PA (0–2 days/week), middle PA (3–4 days/week), and high PA (5–7 days/week). Obesity was measured by calculating body mass index (BMI) using the parameters of height and weight of an individual, and was classified as normal (BMI less than 24.9), overweight (BMI 25.0–29.9), and obese (BMI 30.0 or higher). Men and women were separately analyzed.

##### Results

The percentage of obese men increased from 2.6 to 4.2%, and the percentage of obese women increased from 2.9 to 3.7% during the study period. For men, their Low PA decreased from 80.7 to 78.4%, and High PA increased from 7.9 to 8.2% ( $p < 0.001$ ). The women's middle PA increased from 6.6 to 11.3%, and their high PA decreased from 8.1 to 7.5% ( $p < 0.001$ ). Among obese individuals, men's High PA decreased from 7.7 to 7.1%, and women's High PA decreased from 8.5 to 6.8% ( $p < 0.001$ ).

## Conclusion

Obesity increased by 1.6% in men and by 0.8% in women over a decade. Low PA participation decreased, whereas middle PA increased in both men and women; thus, the overall PA participation rate increased. High PA increased in the normal weight BMI group, but it decreased in the obese group.

**Key Words:** *exercise; physical activity; obesity*

## INTRODUCTION

Economic growth and social change are associated with a pattern of decreasing physical activity (PA) and increasing obesity.<sup>1</sup> Economic growth might be associated with individuals' health, but lifestyle changes, such as changes to occupational structure, increased sedentary activities, and dietary changes, are causing obesity.<sup>2-5</sup> Reduced PA has several health-related negative effects, including an predisposition for obesity.<sup>6</sup> In contrast, positive results for PA help in preventing the risk of developing colorectal cancer, stroke, hypertension, diabetes, depression, cardiovascular diseases, and obesity.<sup>7,8</sup>

The global obese population is increasing. One global study found that body mass index (BMI) increased by 0.4 kg/m<sup>2</sup> every 10 years between 1980 and 2008.<sup>9</sup> In the United States, the obese population (BMI of 30 or higher) increased from 22.9% in 1988–1994 to 30.5% in 1999–2000.<sup>10</sup> A more recent US study reported that 35.5% of men and 35.8% of women were obese in 2009–2010.<sup>11</sup> However, in Korea, about 1.8% of men and 3.1% of women had a BMI higher than 30 in 1998. Over the following 3 years, the percentage of obese men increased to 2.8, while the percentage of obese women remained the same.<sup>12</sup> In a US study using similar years, periods, and ages, obesity in men increased from 27.5 to 31.1%, while in women it increased from 33.4 to 33.2%.<sup>13</sup> Along with this increase in obesity, many people did not engage in sufficient PA. In the United States, just about 27.1% of men and 25.5% of women reported that they engaged in the recommended levels of PA,<sup>14</sup> and a Korean study reported that about 71.8% of the

surveyed individuals were inactive, 14.9% had low PA, 6.9% had middle PA, and 6.4% had high PA levels.<sup>15</sup>

However, these studies were sample selection studies, and they have limited applicability with regard to representing a nationwide population. Therefore, this study used data from health screening census, conducted every 2 years in the country. All Korean adults are required to undergo health screenings conducted by the Korean National Health Insurance Service (KNHIS), and the data are archived in a public institution system. This study used census data from 2002 to 2013 to analyze the trend of changes in obesity and PA, and to investigate the change in the frequency of PA by separate BMI classification for men and women.

## METHODS

The KNHIS conducts health screening for all Korean adults every 2 years. The information collected includes obesity and PA information, which is pertinent to this study. Health screenings are conducted according to the year of birth of the screened individuals. For example, people born in 1940 were screened in 2002, 2004, and 2006, while those born in 1941 were screened in 2003, 2005, and 2007. The years and numbers of people in the database are shown in Table 1. The total number of cases was 86,400,425 (average 14,400,071). The baseline year comprised 5,094,120 men and 3,501,834 women (2002–2003), and data on 9,851,289 men and 9,460,344 women were collected in 2012–2013.

The Yonsei University Gangnam Severance Hospital Institutional Review Board approved

**TABLE 1.** Age and Subject Number per 2 Years from 2002–2003 to 2012–2013

	2002–2003	2004–2005	2006–2007	2008–2009	2010–2011	2012–2013
Men, <i>n</i>						
20–39 years	2,251,601	2,496,753	2,708,064	3,074,055	3,019,269	2,925,833
40–59 years	2,165,001	2,556,200	3,087,896	3,864,035	4,495,777	4,787,726
60–79 years	677,518	897,642	1,237,972	1,648,655	1,949,747	2,137,730
Total	5,094,120	5,950,595	7,033,932	8,586,745	9,464,793	9,851,289
Women, <i>n</i>						
20–39 years	1,099,576	1,361,710	1,611,247	1,994,923	3,117,870	2,828,643
40–59 years	1,680,880	2,185,070	2,987,144	3,981,930	3,944,510	4,654,489
60–79 years	721,378	981,698	1,436,243	1,931,592	1,922,836	1,977,212
Total	3,501,834	4,528,478	6,034,634	7,908,445	8,985,216	9,460,344

*These data are quoted from the Service Report.<sup>16</sup>*

this research (3-2015-0059). The research was funded by the KNHIS research fund and service support in 2015, and its results were partially extracted and quoted from the report.<sup>16</sup>

#### **Physical activity**

PA was measured with responses to the question, “How many days a week do you do sweating exercise?” The American College of Sports Medicine (ACSM) guidelines recommend at least 3 days of high-intensity or at least 5 days of moderate-intensity PA.<sup>17</sup> For the analysis, we applied ACSM’s guidelines and classified PA levels as follows: low PA (0–2 days/week), middle PA, (3–4 days/week), and high PA (5–7 days/week).

#### **Obesity**

Obesity was measured using the standard BMI formula based on the subject’s height and weight. Body weight was divided by height squared (Body weight [kg]/Height<sup>2</sup> [m]). A BMI less than 24.9 was considered normal, BMI from 25.0 to 29.9 was considered overweight, and BMI above 30 was considered obese.<sup>4</sup>

#### **Data analysis**

The SAS (version 9.4; SAS Institute Inc., Cary, NC, USA) statistical computing program was

used to analyze the data. A chi-square test was performed to examine the changes. P-trends were outputted through linear by linear association. Because the health screenings were biennial, the data were grouped into 2-year categories. Statistical significance was determined at  $p < 0.05$ .

## **RESULTS**

Change was indicated by comparing the baseline data (2002–2003) to the latest data (2012–2013). Table 2 shows the changes in obesity over this time period. Among men, normal weight decreased from 65.8 to 61.5%, overweight increased from 31.6 to 34.3%, and obesity significantly increased from 2.6 to 4.2%. The women’s normal weight hardly changed, dropping slightly from 73.7 to 73.1%, but obesity significantly increased from 2.9 to 3.7%. Based on these results, overweight and obesity in men, and obesity in women were increased.

Table 3 presents the results of the analysis of the PA participation rates. PA increased in men and women. Men’s Low PA significantly decreased from 80.7 to 78.4%, but middle PA and high PA increased from 11.4 to 13.4% and 7.9 to 8.2%, respectively. Women’s Low PA decreased from

**TABLE 2.** BMI Classification Trend from 2002–2003 to 2012–2013

	2002–2003	2004–2005	2006–2007	2008–2009	2010–2011	2012–2013	p-trend
Men, %							
Normal	65.8	65.4	64.3	63.2	62.2	61.5	<0.001*
Overweight	31.6	31.9	32.6	33.3	34.0	34.3	<0.001*
Obesity	2.6	2.8	3.0	3.5	3.8	4.2	<0.001*
Women, %							
Normal	73.7	74.6	73.7	73.4	73.2	73.1	0.011*
Overweight	23.4	22.6	23.2	23.3	23.3	23.2	0.025*
Obesity	2.9	2.8	3.0	3.3	3.5	3.7	<0.001*

\* $p < 0.05$ ; BMI classification: normal,  $\leq 24.9$ ; overweight, 25.0–29.9; obese,  $\geq 30.0$ . These data are quoted from the Service Report.<sup>16</sup>

**TABLE 3.** Physical Activity Trend from 2002–2003 to 2012–2013

	2002–2003	2004–2005	2006–2007	2008–2009	2010–2011	2012–2013	p-trend
Men, %							
Low PA	80.7	79.1	79.4	78.8	79.3	78.4	<0.001*
Middle PA	11.4	12.5	12.6	13.3	12.9	13.4	<0.001*
High PA	7.9	8.4	7.9	7.9	7.8	8.2	<0.001*
Women, %							
Low PA	85.3	81.4	80.8	81.2	81.8	81.2	<0.001*
Middle PA	6.6	8.8	10	10.8	10.8	11.3	<0.001*
High PA	8.1	9.8	9.2	8.1	7.3	7.5	<0.001*

\* $p < 0.05$ ; PA, physical activity; low PA, 0–2 days; middle PA, 3–4 days; high PA, 5–7 days. These data are quoted from the Service Report.<sup>16</sup>

85.3 to 81.2%, and High PA decreased from 8.1 to 7.5%, but Middle PA significantly increased from 6.6 to 11.3%.

The results on the change in PA by BMI are shown in Figure 1. In men, Low PA decreased from 82.0 to 78.0% in normal weight; the same group saw a change in overweight status from 79.4 to 77.4%, and from 80.7 to 79.7% in obesity. Middle PA increased across the BMI groups. High PA decreased from 7.6 to 7.1% in obese participants and increased among those within the normal and overweight groups. In women, Low PA and High PA decreased from 9.2 to 8.0% in the overweight group and from 8.5 to 6.8% in the

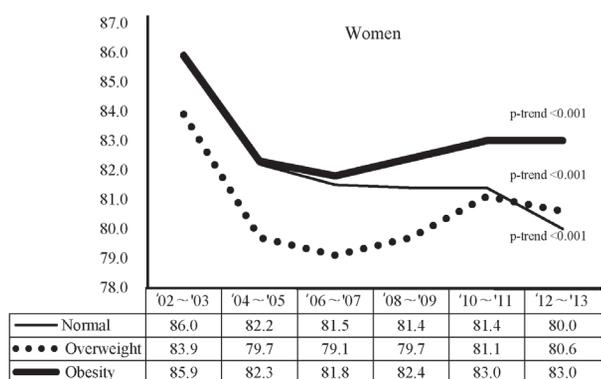
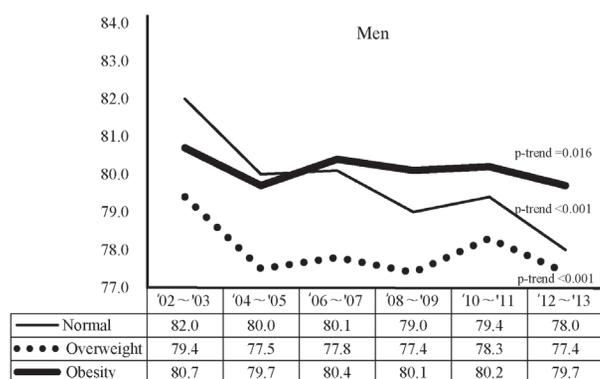
obese group, while it increased from 6.7 to 7.6% in the normal weight group. Women's Low PA decreased across the BMI groups.

## DISCUSSION

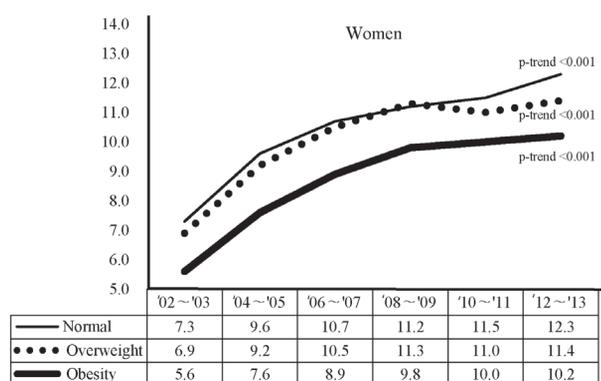
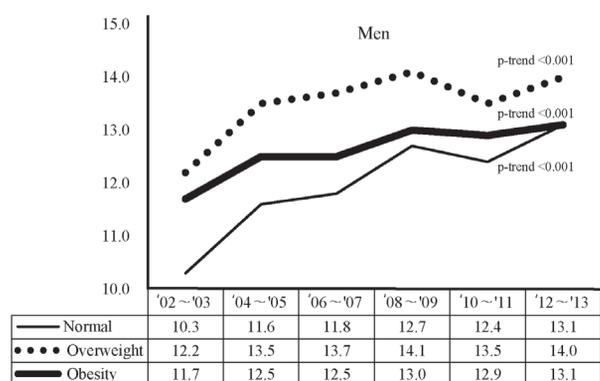
The most important feature of this study is that it analyzed national-level health screening data of the Korean population. Considering that the total population of Korea is about 50 million, a significant number of people were surveyed in this study. This study analyzed the long-term changes in obesity and PA using national adult census data beyond the concern as regional selection and personal condition of subjects.

# Change of physical activity and obesity

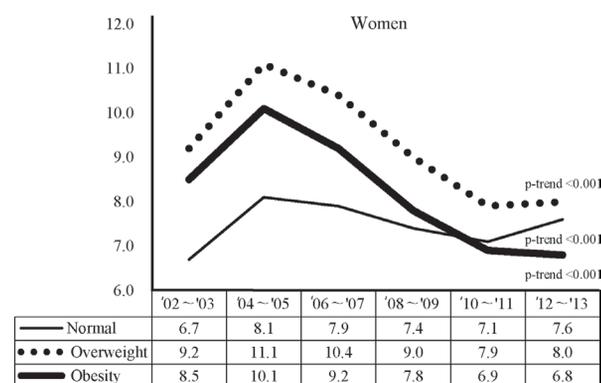
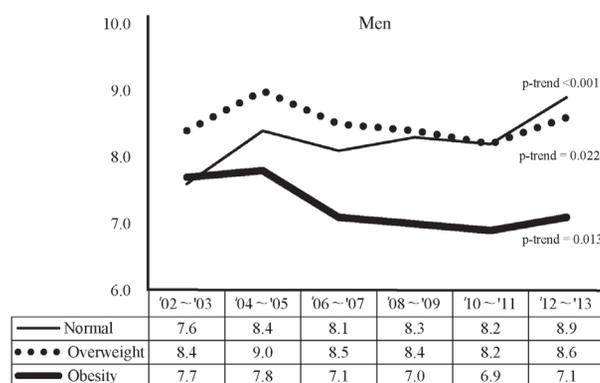
a) Low frequency physical activity rate, %



b) Middle frequency physical activity rate, %



c) High frequency physical activity rate, %



**FIG. 1** \* $p<0.05$ ; (a) changes in low PA according to BMI classification; (b) changes in middle PA according to BMI classification; and (c) changes in high PA according to BMI classification. BMI classification: normal,  $\leq 24.9$ ; overweight, 25.0–29.9; obese,  $\geq 30.0$ ; PA, physical activity: low, 0–2 days; middle, 3–4 days; high, 5–7 days. These data are quoted from the Service Report.<sup>16</sup>

The results found that both obesity and PA increased during the study period. Men with normal BMI decreased by about 4.3%, and overweight and obesity increased by 2.7 and 1.6%, respectively. Similar results were obtained for women as well. The normal weight and overweight women decreased by 0.6 and 0.2%, respectively, and obese women increased from 2.9 to 3.7%. Middle PA or High PA in men and Middle PA in women slightly increased; however, men and women's Low PA decreased.

Obesity is increasing worldwide. One previous study estimated that the number of obese men has increased from 31 to 281 million and the number of obese women has increased from 69 to 390 million between 1975 and 2016.<sup>18</sup> In the United States, just 26.2% of adults engage in PA at the recommended level, which is similar to our results in Korea.<sup>14</sup> We cannot ignore the social phenomena that accompany economic growth as related to this global increase in obesity. Economic growth changes urbanization, mechanization, transportation, lifestyle activity, and diet, which lower PA, increase food intake, and lead to obesity.<sup>5</sup>

Korea has witnessed substantial economic growth since the 1997 economic crisis. Although the gross domestic product (GDP) growth rate in 1998 was -5.7%, it grew to 10.7% in 1999, and continued to grow steadily until 2010. Foreign direct investment also grew very rapidly, from about US \$6000 million in 2002 to about US \$12,000 million.<sup>19</sup> In addition, there have been many changes in lifestyle. For example, the popularization of smartphones and the aging population contributed to less PA.<sup>20,21</sup> Economic growth has both negative and positive impacts on health. Although obesity has increased, economic growth has also promoted PA and an interest in health-related activities and information seeking due to a stronger focus on healthcare promotion and facilities, as well as advancements in exercise science.<sup>22,23</sup> In this study, the

combination of Middle PA and High PA was shown to increase PA in 2013 than 2002 in the normal weight, overweight and obese groups of men and women, which may be reflective of these social changes. Nevertheless, the increase in the obese population may have caused various negative factors, and there is a change in dietary habits. If calorie intake exceeds the PA level, there is a limit to the obesity issue being resolved in spite of the PA.<sup>24,25</sup> Therefore, nutritional/dietary management, including controlling calorie intake, is important in weight management.<sup>26</sup>

One of the main findings of this study is that men are more likely to become obese than women. As was discussed in the introduction, studies in the United States have shown similar results.<sup>13</sup> On the other hand, men's High PA decreased from 7.7 to 7.1%, while women's High PA decreased from 8.5 to 6.8% in this study. This means that men are more obese than women even though their PA is relatively higher. Similar results were found in Hellerstedt et al. (1997). The average BMI for men was 26.5 and for women it was 25.1. Men participated in 9.4 PA sessions per week, while women completed 8.5 sessions.<sup>27</sup> However, certain studies in the United States have also shown reverse results. Women with a BMI > 30 (41.1%) were higher than men (37.9%).<sup>28</sup> A study on gender and obesity suggests that cultural differences should be considered while analyzing the causes of obesity. There is a difference between developed and developing countries. The literature explained that in the developed countries, men's alcohol intake was higher than women, and in the developing countries, men's physical activities and labor was higher than women.<sup>29</sup>

In Korea, men tend to have higher earnings and more participation in economic activities than women; this results in them eating out more frequently, leading to higher fat intake, alcohol, and excessive calories, which may be responsible for the increase in obesity in men.<sup>30,31</sup>

This study has the following limitations. One of the most important study results was only about 20% in Middle and High PA. How many days a week do you do sweating exercise? Therefore, occupational physical activity or low intensity walking are not included.

ACSM PA guidelines recommend that individuals engage in moderate-intensity exercise for at least 30 min on 5 or more days a week, for a total of 150 min per week, or vigorous-intensity exercise for at least 20–25 min on 3 or more days a week, for a total of 75 min per week.<sup>17</sup> Some participants can accomplish enough PA by participating in exercise activities once or twice a week. This classification error should be considered a limitation of this study. Furthermore, the World Health Organization (WHO) has suggested that people of Asia Pacific should have a normal BMI level of up to 22.9, overweight 23.0–24.9, and obesity of 25 or more.<sup>32</sup> However, this study used the most widely used worldwide classifications.

WHO developed an international PA questionnaire (the IPAQ) in 1998, which has been translated into several languages and covers PA time and frequency according to intensity.<sup>33,34</sup> Consequently, further research should use that tool so that results can be compared with those of other countries.

This study's data comprised about 8.5 million Koreans in 2002–2003 and about 19.20 million Koreans in 2012–2013. This large difference is because of the accumulation of data over time, the advancements in computing technologies, and improved data collection methods. Although health screening is a free service and penalties are imposed on those who do not comply, there likely is a limit to involving the entire population. Future studies should be conducted on children and adolescents, and long-term follow-ups of the correlations between obesity and PA should be a priority. Finally, this study examined longitudinal trends and did not confirm the prevalence of obesity according to PA status. This will be the subject of further research.

## CONCLUSION

This analysis of national data revealed that there was an increase in the proportions of overweight and obese men and women. There was also an increase of Middle PA and High PA in men, and Middle PA in women. Low PA decreased and High PA increased in the normal weight group of both sexes. However, High PA in obese men and women decreased.

## CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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