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Original Article

Analysis of trends in physique and physical fitness in Korean adults

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Abstract

Background and objective: This study aimed to investigate the changes and trends in various measures of physique and physical fitness in Korean adults from 2009 to 2017. **Material and methods**: The physique and physical fitness levels of 19,415 Korean adults aged 20-69 years were investigated using data from the Survey of National Physical Fitness conducted by the Korea Institute of Sport Science. Physical fitness variables included muscular strength (grip strength), muscular endurance (sit-up exercise), power (standing long jump), cardiovascular endurance (20-m shuttle run), and flexibility (sit and reach exercise). Differences between physique and physical fitness variables were evaluated using Pearson's correlation coefficient. Results were expressed as an intensification factor. **Results**: A significant relationship was identified between physique and physical fitness variables ($P < 0.05$), excluding power and flexibility (r = -0.003, P = 0.683). Height and weight increased in men and women in all age groups except those in the age group of 60-69 years; in this age group, a decrease in height was observed in men, and a decrease in weight was observed in both sexes. Men aged 40-49 years and women aged 20-29 years demonstrated a rapid increase in body mass index (BMI). Muscular strength decreased dramatically in both sexes from the age of 40 years. Muscular endurance increased within each age group, most significantly in men aged 60-69 years (32.01%) and women aged 50-59 years (21.0%). However, absolute muscular endurance decreased with age. Power increased significantly in men aged 60-69 years (5.61%) and women aged 20-29 years (2.60%), but decreased in men aged 40-49 years (-2.84%) and women aged 60-69 years (-1.89%). Cardiovascular endurance decreased after the age of 30 years in both sexes, with maximum decrease in men aged 40-49 years (-0.77%) and women aged 60-69 years (-9.33%). Flexibility decreased from the age of 30 years in both sexes: men aged 20-29 years (-24.25%) and women aged 30-39 years (-6.60%) showed the maximum decrease. **Conclusion**: Overall, the following trends were found: BMI increase is likely to occur in men in their 30s and 40s and women in their 60s; muscular strength rapidly decreases in men and women in their 40s; muscular endurance increases over time in men compared to that in women; power reinforcement exercise is necessary for both men and women in their 40s to overcome decreased power; cardiorespiratory endurance largely decreases during the 20s; and flexibility tends to decrease largely in men from the 20s to 40s. There is a correlation between physique and physical fitness in Korean adults. Moreover, the physical fitness level decreases with age. Regular exercise is recommended to improve physical fitness and prevent aging.

Keywords
Body mass index; Korean adults; Physical fitness; Physique; Trends

1. Introduction

According to the Organization for Economic Cooperation and Development (OECD) report released in 2017, 19.5% of the adult population was obese. This rate ranged from less than 6% in Korea and Japan to more than 30% in the United States, Hungary, Mexico, and New Zealand [1], and more than 25% in Canada, South Africa, Australia, Chile, and the United Kingdom. In addition, overweight and obesity rates have grown rapidly in the world since the 1990s, especially in England, Mexico, and the United States [1].

As health and power are intrinsically linked in the Korean society, the health of Korean adults is of national importance. According to a recent study, height and weight have increased in Korean men and women aged 18-20 years; however, a decrease in several measures of physical fitness was found [2]. Decreasing levels of physical fitness might have resulted from the increased use of technology in modern society. Cars, cleaning robots, and dishwashers, all of which are designed to make life more convenient, are reducing the amount of physical activity exerted daily and may be partially responsible for the increasing prevalence of metabolic diseases [3–5].

Obesity, which often results from decreased levels of fitness and a subsequent increase in body mass index (BMI), is a health problem affecting individuals worldwide. It has been found that obesity is closely linked with secondary morbidities, including hypertension, diabetes, cerebrovascular diseases, and cardiorespiratory diseases [6]. Decreased physical fitness also has been related to various diseases, whereas a high physical fitness level is related to a higher disease-free rate. High levels of physical fitness are known to increase productivity at workplace and reduce the risks associated with leisure activities [5]. Furthermore, physical fitness is directly correlated with physical, mental, and social health.

Several national health-related statistics, including the national fitness statistics, are used to identify the health status of the Korean population and estimate levels of physical fitness. However, periodic surveys should be conducted as the physical fitness levels of the public can change over time [7]. The necessity for a study on physical fitness trends has been suggested by various advanced studies [8–11].

The Survey of National Physical Fitness by the Korea Institute of Sport Science (2012) [7]. included adults of all ages. This survey was conducted for the first time in 1989 and was used to plan national sports policies. It was conducted by South Korea's Ministry of Culture, Sports and Tourism every 3 years since 1993 as part of a 5-year plan to promote physical education. Since 2009, this survey has been conducted every 2 years. Similar to a Japanese survey, the Survey of National Physical Fitness has been measuring exercise functional physical fitness since 2017 to contribute to the global database. These measurements have replaced health-related physical fitness variables measured previously [2, 12].

A previous study conducted by the Korea Institute of Sport Science used longitudinal data to compare physique and physical fitness; however, there is a lack of research that identifies trends in a range of variables. Additionally, probability sampling of the Korean physique and physical fitness is necessary. Thus, the purpose of this study was to investigate changes and trends in various measures of physique and physical fitness in Korean adults from 2009 to 2017.

2. Methods

2.1 Participants

A total of 19,415 Korean adults, aged 20-69 years, who participated in the Survey of National Physical Fitness conducted by the Korea Institute of Sport Science and the South Korea's Ministry of Culture, Sports and Tourism from 2009 to 2017, were included in the study (Table 1). The research variables included the year of measurement, age, sex, physique (height and weight), BMI, and various physical fitness variables (Table 2). Height, weight, and BMI data were used as sub-variables of physique. BMI, agility (measured by the 50-m dash), power (measured by the standing long jump), flexibility (measured by the sit and reach exercise), muscular endurance (measured by the sit-up exercise), muscular strength (measured by grip strength), and cardiovascular endurance (measured by the 20-m shuttle run) data were used as sub-variables of physical fitness. Descriptive statistics of physique and physical fitness variables are shown in Table 3. The fitness variables chosen for assessment in this study were included in the Survey of National Physical Fitness.

2.2 Data collection

Data were collected from the statistical yearbook maintained by the South Korea's Ministry of Culture, Sports and Tourism. Data concerning the mean physique and physical fitness variables were collected every other year using proportional sampling by region, sex, and age. The data outcomes were calculated using a population proportion weighted calculation of

TABLE 1. The Number and Age of Men and Women Who Took Part in the Survey of National Physical Fitness Conducted by the Korean Institute of Sport Science and Korean Ministry of Culture, Sports, and Tourism.

Year of measurement	Total number of participants	Number of male participants	Average age of male participants (years)	Number of female participants	Average age of female participants (years)
2009	3,783	1,959	39.6	1,824	40.1
2011	3,632	1,914	40.7	1,718	41.3
2013	3,674	1,690	42.7	1,984	43.0
2015	4,034	2,442	38.2	1,592	39.4
2017	4,292	2,146	41.1	2,146	41.1

TABLE 2. Research Variables of Physique and Physical Fitness.

Variables		Contents
Year		2009, 2011, 2013, 2015, 2017
Sex		Males, females
Age		18-69 years
Physique		Height (cm)
		Weight(kg)
		Body mass index (kg/m^2)
Physical fitness	Muscular strength	Grip strength (kg)
	Muscular endurance	Sit-up exercise (reps/min)
	Power	Standing long jump (cm)
	Cardiovascular endurance	20-m shuttle-run (reps)
	Flexibility	Sit and reach exercise (cm)

TABLE 3. Descriptive Statistics of Physique and Fitness Variables.

	N	Minimum value	Maximum value	Mean	Standard deviation	Skewness	Kurtosis
Age	19,415	19.00	68.00	40.65	12.63	0.03	−1.11
Height	19,415	131.60	198.00	166.07	8.89	0.09	−0.62
Weight	19,415	36.30	136.70	65.30	11.64	0.54	0.36
Body mass index	19,415	15.54	44.23	23.58	3.08	0.64	1.01
Grip strength	19,414	6.00	79.40	33.96	10.79	0.32	−0.63
Sit-up exercise	19,413	0.00	86.00	29.55	15.21	0.18	−0.32
Standing long jump	19,415	16.00	300.00	170.56	42.44	0.05	−0.53
20-m shuttle-run	19,415	0.00	124.00	28.90	17.70	1.34	2.04
Sit and reach exercise	19,413	−25.00	40.00	12.48	8.97	−0.39	0.07

region (17 cities) × sex (men and women) × age (20-29, 30-39, 40-49, 50-59, and 60-69 years).

2.3 Measurements

Height and weight were measured using the height and weight scale (BSM330, Inbody, Seoul, South Korea). BMI (kg/m^2), a body composition variable, was calculated using the height and weight data. Measurements of physical fitness were based on the Advanced Fitness Assessment and Exercise Prescription [13].

2.4 Statistical analysis

Data were compiled according to year, sex, age, and various other variables. The percentage change was calculated in Excel of Microsoft® Office 2016 (Microsoft Corporation, Redmond, WA, USA) using the below-mentioned formula:

Current year-Previous year/Previous year (Standard year).

Pearson's correlation coefficient analysis was conducted using SPSS 23.0 (IBM Corp., Armonk, NY, USA) to examine the relationship between physique and physical fitness. Descriptive statistics (mean, standard deviation, skewness, kurtosis, and minimum and maximum values) were performed on the measured variables. All statistical significance was set at $P < 0.05$.

3. RESULTS

3.1 Correlation between physique and physical fitness

There was a significant correlation between physique and all physical fitness variables, except for power and flexibility (r = -0.003, P = 0.683). Correlation between BMI and weight (r = 0.793, $P < 0.001$) was the most significant one, along with the correlation between power and muscular strength (r = 0.717, $P < 0.001$) (Table 4).

3.2 Measurements of physique between 2009 and 2017

Overall, the height of the sampled population increased between 2009 and 2017 (Table 5). Men aged 60-69 years demonstrated a decrease in height (percentage change of -0.07%). Both men and women aged 20-29 years demonstrated an increase in height (0.42% and 0.35%, respectively). Increase and decrease in weight were closely related to age. Men aged 40-49 years and women aged 20-29 years demonstrated the greatest percentage of weight increase (Table 6). Both men and women aged 60-69 years demonstrated negative percentage change in weight. In 2015, the weight of women aged 20-29 years and men aged 40-49 years increased rapidly (5.87% and 3.79% respectively). Overall, both sexes showed an increase in weight in all age groups, except those aged 60-69 years, who demonstrated a decrease in weight. BMI is a reference for obesity; a BMI of more than 25 kg/m^2 is considered to be a risk factor for obesity. During the study period, men aged 40-49 years and women aged 20-29 years demonstrated a rapid increase in BMI (Table 7).

TABLE 4. Correlation between Physique and Physical Fitness.

	Height	Weight	Body mass index	Grip strength	Sit-up exercise	Standing long jump	20-m shuttle-run	Sit and reach exercise
Height	1.000							
Weight	0.686**	1.000						
Body mass index	0.109**	0.793**	1.000					
Grip strength	0.709**	0.670**	0.329**	1.000				
Sit-up exercise	0.470**	0.275**	−0.015*	0.522**	1.000			
Standing long jump	0.664**	0.455**	0.074**	0.717**	0.677**	1.000		
20-m shuttle-run	0.442**	0.244**	−0.027**	0.491**	0.614**	0.626**	1.000	
Sit and reach exercise	−0.202**	−0.222**	−0.137**	−0.115**	0.134**	−0.003	0.083**	1.000

* $P < 0.05$, ** $P < 0.01$; tested by Pearson's correlation coefficient analysis.

TABLE 5. Rate of Change in Height.

Sex	Age	Year	2009	2011	2013	2015	2017	Rank of percentage change
Men	20–29	Mean	173.9	174.1	175.6	175.0	174.7	3
		Percentage change		0.07%	0.87%	−0.31%	−0.21%	0.42%
	30–39	Mean	172.6	174.1	175.6	174.3	174.1	2
		Percentage change		0.87%	0.86%	−0.71%	−0.13%	0.90%
	40–49	Mean	171.9	171.1	172.5	172.4	172.2	4
		Percentage change		−0.47%	0.78%	−0.06%	−0.09%	0.16%
	50–59	Mean	168.2	169.1	169.7	169.2	169.7	1
		Percentage change		0.54%	0.35%	−0.29%	0.33%	0.94%
	60–69	Mean	167.8	167.6	167.9	166.9	167.7	5
		Percentage change		−0.14%	0.22%	−0.62%	0.47%	−0.07%
Women	20–29	Mean	161.3	161.9	162.1	161.6	161.8	4
		Percentage change		0.38%	0.11%	−0.28%	0.13%	0.35%
	30–39	Mean	160.3	160.2	161.5	161.4	161.4	2
		Percentage change		−0.10%	0.82%	−0.06%	−0.01%	0.66%
	40–49	Mean	157.8	158.0	159.3	159.5	159.2	1
		Percentage change		0.12%	0.82%	0.13%	−0.20%	0.86%
	50–59	Mean	156.4	156.6	157.0	157.2	157.2	3
		Percentage change		0.13%	0.29%	0.09%	0.01%	0.52%
	60–69	Mean	155.4	155.3	155.4	155.2	155.7	5
		Percentage change		−0.05%	0.05%	−0.15%	0.32%	0.18%

3.3 Physical fitness variables between 2009 and 2017

None of the participants reported difficulty performing these tests. Both men and women demonstrated a dramatic decrease in grip strength from the age of 40 years. Within the age groups, men aged 40-49 years (4.32%) and women aged 20-29 years (5.98%) demonstrated the most significant increase in muscular strength (Table 8). Overall changes in muscular endurance, measured by the sit-up exercise, were the highest in men aged 50-59 years (23.07%) and 60-69 years (32.01%). Women aged 40-49 and 50-59 years demonstrated the most significant increase in muscular endurance (15.11% and 21.0%, respectively). Muscular endurance increased within the age groups during the study period; however, absolute muscular endurance decreased with increase in age (Table 9). From 2009 to 2017, power (standing long jump) showed the highest increase in men aged 60-69 years (5.61%) and in women aged 20-29 years (2.60%) and the maximum decreases in men aged 40-49 years (-2.84%) and women aged 60-69 years (-1.89%) (Table 10). Cardiovascular endurance, measured using the 20-m shuttle run, decreased from 30 years of age in both sexes. Maximum decrease in the cardiovascular endurance rate was noted in men aged 40-49 years (-0.77%) and women aged 60-69 years (-9.33%) (Table 11.). Flexibility, measured by the sit-and-reach exercise, also decreased from the age of 30 years in both sexes. Men aged 20-29 years (-24.25%) and women aged 30-39 years (-6.60%) showed maximum decreases in flexibility (Table 12).

4. Discussion

The purpose of this study was to examine the relationship between physique, physical fitness, and associated characteristics in Korean adults. The first discussion point of this study was the relationship between physique and fitness variables. This study demonstrated a statistically significant correlation between physique and physical fitness. The only inverse correlation with weight was shown for flexibility, which was measured using a sit-and-reach exercise. Several physical fitness variables demonstrated an inverse correlation with BMI, including muscular endurance (sit-up exercise), cardiovascular endurance (20-m shuttle run), and flexibility (sit-and-reach exercise). This

TABLE 6. Rate of Change in Weight.

Sex	Age	Year	2009	2011	2013	2015	2017	Rank of percentage change
Men	20–29	Mean	72.9	72.8	73.3	71.9	73.4	4
		Percentage change		−0.04%	0.64%	−1.85%	2.03%	0.77%
	30–39	Mean	74.3	75.1	75.5	76.0	76.3	2
		Percentage change		1.03%	0.50%	0.73%	0.36%	2.63%
	40–49	Mean	71.8	71.6	72.2	72.2	74.9	1
		Percentage change		−0.29%	0.81%	−0.09%	3.79%	4.22%
	50–59	Mean	70.4	70.4	70.4	70.8	71.2	3
		Percentage change		0.00%	0.01%	0.43%	0.57%	1.11%
	60–69	Mean	68.7	68.4	68.0	68.5	68.4	5
		Percentage change		−0.44%	−0.63%	0.83%	−0.20%	−0.46%
Women	20–29	Mean	55.1	55.5	55.1	54.3	57.5	1
		Percentage change		0.71%	−0.77%	−1.36%	5.87%	4.46%
	30–39	Mean	57.2	55.7	56.6	56.7	58.4	2
		Percentage change		−2.52%	1.58%	0.20%	2.84%	2.10%
	40–49	Mean	57.7	57.9	58.1	58.5	58.4	3
		Percentage change		0.38%	0.38%	0.59%	−0.04%	1.32%
	50–59	Mean	58.0	58.4	58.1	58.5	58.2	4
		Percentage change		0.78%	−0.62%	0.70%	−0.45%	0.41%
	60–69	Mean	58.7	57.8	57.4	58.8	57.7	5
		Percentage change		−1.44%	−0.82%	2.43%	−1.75%	−1.58%

TABLE 7. Rate of Change in Body Mass Index.

Sex	Age	Year	2009	2011	2013	2015	2017	Rank of percentage change
Men	20–29	Mean	24.1	23.9	23.7	23.5	24.0	2
		Percentage change		−0.79%	−0.90%	−1.10%	2.35%	1.45%
	30–39	Mean	25.0	24.8	24.5	25.0	25.1	3
		Percentage change		−0.78%	−1.37%	2.43%	0.34%	−1.04%
	40–49	Mean	24.3	24.5	24.3	24.3	25.2	1
		Percentage change		0.50%	−0.71%	−0.05%	3.98%	3.28%
	50–59	Mean	24.9	24.6	24.4	24.7	24.7	4
		Percentage change		−1.13%	−0.76%	1.01%	−0.12%	−1.00%
	60–69	Mean	24.4	24.4	24.1	24.6	24.3	5
		Percentage change		−0.14%	−1.12%	1.94%	−1.09%	−0.42%
Women	20–29	Mean	21.2	21.2	21.0	20.8	22.0	1
		Percentage change		0.01%	−1.01%	−0.88%	5.73%	3.85%
	30–39	Mean	22.3	21.7	21.7	21.8	22.4	2
		Percentage change		−2.39%	−0.10%	0.37%	2.83%	0.72%
	40–49	Mean	23.1	23.2	22.9	23.0	23.0	4
		Percentage change		0.20%	−1.27%	0.41%	0.23%	−0.44%
	50–59	Mean	23.7	23.8	23.6	23.7	23.6	3
		Percentage change		0.59%	−1.18%	0.46%	−0.46%	−0.15%
	60–69	Mean	24.3	24.0	23.7	24.4	23.9	5
		Percentage change		−1.28%	−1.03%	2.74%	−2.24%	−1.81%

implies that physical fitness variables are correlated with BMI.

Women aged 20-29 years and men aged 40-49 years demonstrated high increases in weight and BMI.This is considered to be due to the correlation of cohabitation and marriage with changed lifestyles in women during this decade of their lives [14]. Men who are in their 40s may be more stable or incur more stress at home and work, and also may experience changes in their lifestyle, such as increased alcohol consumption, attendance of office dinners, and reduced physical activity at home and work, which are factors in gaining weight. This trend is of concern since a BMI > 25 kg/m^2 indicates a risk of obesity. Men and women aged 60-69 years demonstrated a decrease in weight. Of note, the current study has found that the BMI of women in their 60s was close to 25 kg/m^2, indicating a risk of obesity. According to a study done by Jiang *et al.*, [15] the decreases in height and weight in this age group is due to decrease in total hip and femoral neck bone mineral density as well as decrease in lean mass and fat-free mass. There was a significant correlation between physique and all variables, except power and flexibility.

Another trend of interest is that among fitness variables grip strength was the highest variable in men and women in their 30s. Grip strength tended to decrease in men in their 40s compared to that at earlier ages. Grip strength in women was

TABLE 8. Rate of Change in Muscle Strength.

Sex	Age	Year	2009	2011	2013	2015	2017	Rank of percentage change
Men	20–29	Mean	42.3	43.6	43.3	44.0	43.5	4
		Percentage change		2.89%	−0.72%	1.68%	−1.20%	2.66%
	30–39	Mean	44.3	44.0	44.3	43.5	45.2	5
		Percentage change		−0.63%	0.63%	−1.61%	3.90%	2.28%
	40–49	Mean	41.8	41.2	42.5	42.7	43.6	1
		Percentage change		−1.52%	3.15%	0.60%	2.09%	4.32%
	50–59	Mean	39.1	39.6	40.0	40.0	40.8	2
		Percentage change		1.18%	1.03%	0.16%	1.86%	4.23%
	60–69	Mean	36.9	35.8	36.3	36.6	37.8	3
		Percentage change		−2.74%	1.36%	0.85%	3.22%	2.70%
Women	20–29	Mean	24.4	25.3	25.2	25.1	25.9	1
		Percentage change		3.48%	−0.21%	−0.66%	3.37%	5.98%
	30–39	Mean	25.8	25.1	25.5	26.0	25.9	5
		Percentage change		−2.82%	1.58%	1.91%	−0.27%	0.40%
	40–49	Mean	25.2	24.8	25.2	26.5	25.8	3
		Percentage change		−1.41%	1.38%	5.19%	−2.44%	2.72%
	50–59	Mean	23.8	24.7	24.1	24.0	24.1	4
		Percentage change		3.47%	−2.26%	−0.44%	0.54%	1.31%
	60–69	Mean	22.3	22.7	22.4	22.6	23.4	2
		Percentage change		2.05%	−1.73%	1.27%	3.51%	5.09%

TABLE 9. Rate of Change in Muscle Endurance.

Sex	Age	Year	2009	2011	2013	2015	2017	Rank of percentage change
Men	20–29	Mean	43.4	44.7	46.6	43.1	46.4	3
		Percentage change		3.05%	4.37%	−7.65%	7.73%	7.50%
	30–39	Mean	38.7	37.7	40.5	39.2	41.0	4
		Percentage change		−2.54%	7.53%	−3.19%	4.63%	6.43%
	40–49	Mean	37.1	30.6	35.1	33.0	36.8	5
		Percentage change		−17.63%	14.90%	−5.94%	11.51%	2.84%
	50–59	Mean	26.0	24.9	27.0	29.5	32.3	2
		Percentage change		−4.07%	8.30%	9.26%	9.57%	23.07%
	60–69	Mean	21.4	19.2	21.9	21.8	28.0	1
		Percentage change		−10.34%	14.22%	−0.32%	28.46%	32.01%
Women	20–29	Mean	30.4	30.6	33.3	30.5	30.4	5
		Percentage change		0.66%	8.57%	−8.19%	−0.55%	0.49%
	30–39	Mean	25.0	24.1	26.0	24.6	26.0	3
		Percentage change		−3.73%	7.95%	−5.39%	5.65%	4.49%
	40–49	Mean	21.1	19.9	21.8	21.5	24.2	2
		Percentage change		−6.09%	9.90%	−1.67%	12.98%	15.11%
	50–59	Mean	16.1	12.2	14.7	14.7	18.3	1
		Percentage change		−23.79%	20.01%	0.36%	24.42%	21.00%
	60–69	Mean	14.9	9.2	9.6	10.3	13.5	4
		Percentage change		−38.15%	4.46%	7.06%	30.58%	3.96%

the highest in their 40s, but it largely decreased after their 40s. Thus, exercise to maintain strength after 40 years of age is necessary. Even though there was a high relationship between BMI and body weight, it is assumed that swinging arms to jump far is related to grip strength, as there was a significant correlation between standing long jump and grip strength.

Sit-ups were used to assess muscular endurance, which had a decreasing tendency among generational groups in men. Women showed a different result, since women in their 40s showed the highest sit-up record among those in other generational groups. The degree of decrease was larger and clearer in men than in women with increase in age. In the last 10 years, men had the highest muscle endurance in their 50s (23.07%) and 60s (32.01%), and women showed increasing muscle endurance in their 40s (15.11%) and 50s (21.0%). This is consistent with the results of a previous study done by Kordi *et al.* (2010) [17]., in which women in their 40s showed the start of a decrease in cardiovascular health, strength, and endurance.

Both men and women aged 30-39 years showed the highest muscular strength, with a decrease after the age of 40 years. It is, therefore, necessary for men and women to incorporate exercises that maintain muscular strength into their routine after the age of 40 years. It is thought that muscular strength is closely related to performance in the tests for power

TABLE 10. Rate of Change in Power.

Sex	Age	Year	2009	2011	2013	2015	2017	Rank of percentage change
Men	20–29	Mean	214.8	220.3	226.0	220.2	216.2	4
		Percentage change		2.56%	2.58%	−2.56%	−1.81%	0.78%
	30–39	Mean	205.1	205.3	214.4	206.6	206.8	3
		Percentage change		0.08%	4.43%	−3.62%	0.10%	0.99%
	40–49	Mean	201.1	193.6	202.3	194.8	195.0	5
		Percentage change		−3.74%	4.51%	−3.70%	0.09%	−2.84%
	50–59	Mean	178.9	179.1	179.5	180.2	180.7	2
		Percentage change		0.11%	0.26%	0.39%	0.27%	1.04%
	60–69	Mean	160.7	160.3	159.6	154.9	169.2	1
		Percentage change		−0.25%	−0.41%	−2.94%	9.21%	5.61%
Women	20–29	Mean	149.2	151.9	157.0	158.7	153.0	1
		Percentage change		1.79%	3.32%	1.10%	−3.60%	2.60%
	30–39	Mean	148.0	145.4	146.7	146.0	146.3	4
		Percentage change		−1.77%	0.90%	−0.50%	0.23%	−1.14%
	40–49	Mean	140.7	137.5	142.2	145.5	142.2	2
		Percentage change		−2.26%	3.36%	2.32%	−2.24%	1.18%
	50–59	Mean	128.1	120.7	124.7	124.5	127.5	3
		Percentage change		−5.80%	3.36%	−0.17%	2.41%	−0.21%
	60–69	Mean	115.4	111.5	106.0	109.8	113.0	5
		Percentage change		−3.37%	−4.97%	3.57%	2.88%	−1.89%

TABLE 11. Rate of Change in Cardiovascular Endurance.

Sex	Age	Year	2009	2011	2013	2015	2017	Rank of percentage change
Men	20–29	Mean	43.7	51.6	50.6	48.1	48.6	2
		Percentage change		18.00%	−2.00%	−4.88%	1.04%	12.16%
	30–39	Mean	37.9	38.6	39.5	37.0	41.0	4
		Percentage change		1.99%	2.21%	−6.35%	10.81%	8.65%
	40–49	Mean	35.8	33.6	36.7	31.2	34.7	5
		Percentage change		−6.15%	9.21%	−14.96%	11.13%	−0.77%
	50–59	Mean	26.5	25.9	28.9	26.0	29.3	3
		Percentage change		−2.20%	11.37%	−10.04%	12.94%	12.07%
	60–69	Mean	21.3	19.6	22.4	18.3	24.1	1
		Percentage change		−7.83%	14.38%	−18.40%	31.78%	19.92%
Women	20–29	Mean	25.2	28.7	29.1	27.1	25.2	1
		Percentage change		13.69%	1.58%	−6.77%	−7.15%	1.34%
	30–39	Mean	23.4	21.3	24.2	21.8	21.1	4
		Percentage change		−9.27%	13.71%	−9.69%	−3.32%	−8.56%
	40–49	Mean	19.7	19.4	21.1	18.9	19.0	3
		Percentage change		−1.58%	8.55%	−10.08%	0.13%	−2.97%
	50–59	Mean	16.3	15.6	17.6	15.0	16.0	2
		Percentage change		−4.10%	12.73%	−14.95%	6.94%	0.62%
	60–69	Mean	13.5	11.8	12.6	12.0	12.2	5
		Percentage change		−12.93%	6.54%	−4.83%	1.89%	−9.33%

(standing long jump) and muscular endurance (sit-up exercise) [13]. Thus, it can be hypothesized that regular strength training exercise can help improve these variables. Furthermore, grip strength is thought to be significantly correlated with cardiovascular endurance ($r = 0.491$, $P < 0.001$); thus, well-developed grip strength may positively influence cardiovascular endurance [16]. These results are partially consistent with those of the advanced study carried out by Zhu *et al.*, [16] who showed that handgrip intensity is related to cardiorespiratory function in Chinese patients.

Muscular endurance was measured by sit-up exercises. Men and women demonstrated a constant decrease in muscular endurance with increase in age. This is consistent with a study conducted by Kordi *et al.*, [17] which showed that cardiovascular health, muscular strength, and muscular endurance begin to decrease with age. In this study, muscular endurance had the highest increase for men aged 60-69 years (32.01%) and women aged 50-59 years (21.0%).

Standing long jump was used to measure power. Men showed a decreasing trend in power in their 30s, and women showed a similar trend in their 60s. Another characteristic is that both men and women showed a big decrease in standing long jump in their 40s. Standing long jump for men in their 60s (5.61%) had a larger decreasing tendency, but men in

TABLE 12. Rate of Change in Flexibility.

Sex	Age	Year	2009	2011	2013	2015	2017	Rank of percentage change
Men	20–29	Mean	12.9	14.0	13.5	11.0	9.9	5
		Percentage change		7.90%	−3.20%	−18.39%	−10.57%	−24.25%
	30–39	Mean	10.3	10.3	10.6	9.8	9.6	3
		Percentage change		0.24%	3.21%	−7.99%	−2.18%	−6.72%
	40–49	Mean	11.2	8.8	9.6	8.7	8.5	4
		Percentage change		21.51%	9.46%	−9.85%	−2.30%	−24.20%
	50–59	Mean	9.1	9.0	8.4	9.0	9.3	2
		Percentage change		−1.29%	−6.43%	6.26%	3.89%	2.43%
	60–69	Mean	6.3	6.5	6.7	7.8	9.2	1
		Percentage change		2.46%	3.30%	16.62%	17.54%	39.91%
Women	20–29	Mean	15.1	15.8	17.1	16.2	15.6	3
		Percentage change		5.02%	8.11%	−5.70%	−3.45%	3.97%
	30–39	Mean	15.7	14.8	15.4	14.2	14.6	5
		Percentage change		−5.97%	4.53%	−7.78%	2.63%	−6.60%
	40–49	Mean	15	15.1	14.9	15.2	14.2	4
		Percentage change		0.14%	−1.21%	1.84%	−6.23%	−5.46%
	50–59	Mean	14.6	15.2	15.2	15.5	15.4	2
		Percentage change		3.98%	0.36%	2.11%	−0.71%	5.73%
	60–69	Mean	14.6	15.5	14.9	16.0	16.5	1
		Percentage change		5.79%	−3.57%	7.42%	3.17%	12.82%

their 40s showed a decreasing tendency. Women had an overall increasing tendency in their 20s (2.60%) whereas a decreasing trend was observed in their 60s (1.89%). Thus, power reinforcement exercise to maintain power in the 40s for both sexes should be necessary.

The greatest decrease in power (standing long jump) was observed in men aged 40-49 years (-2.84%) and in women aged 60-69 years (-1.89%). However, men aged 60-69 years (5.61%) demonstrated a significant increase in power compared to other age groups. Women aged 20-29 years also demonstrated an increase in power (2.60%). Further study is needed to explain the increase in power in men aged 60-69 years.

Cardiorespiratory endurance decreased in men in their 40s and in women in their 30s, 40s, and 60s. Women showed an overall decreasing trend in cardiorespiratory endurance with increase in age, with maximum decrease in their 20s. In the 20-m shuttle run, a large decrease was observed in the age groups of 20s (12.16%) and 30s (8.65%) compared with that in other age groups in both sexes. A recent report by the Korean Society for the Study of Obesity (KSSO) (2018) [18] showed an increased incidence of metabolic syndrome-related vascular diseases such as myocardial infarction and stroke. Thus, aerobic exercise should be reinforced in the 30s to prevent metabolic syndrome.

A significant decrease in cardiovascular endurance (20-m shuttle run) was observed in both sexes with increasing age. During the study period, maximum increase in cardiovascular endurance was seen in men aged 60-69 years (19.92%). The KSSO (2018) [18]. recognized that the prevalence of vascular diseases, including myocardial infarction and stroke, has increased due to the increasing incidences of metabolic syndrome. Thus, introducing regular aerobic exercise into the daily routine from the age of 20 years would be useful to prevent the onset of metabolic syndrome.

The sit-and-reach exercise was used to measure flexibility. Interestingly, maximum flexibility decreased in men aged 20-29 (-24.25%) and 40-49 years (-24.20%). The most significant decrease in flexibility in women was observed in those aged 30-39 (-6.60%) and 40-49 years (-5.46%). The Korea Institute of Sport Science (2013)[2] reported that restricted activity, often resulting from sedentary and automated working conditions, lowered physical activity, and subsequently, decreased flexibility. Thus, stretching exercises, yoga, and other similar activities should be introduced to individuals aged above 20 years.

Of note, men and women in their 50s and 60s also showed an increase in flexibility, yet both sexes showed a decrease in flexibility in their 20s. The Korea Institute Sport Science (2013) [2] reported that sedentary working environment and the automated working environment are the main factors for the decrease in physical activity that results in decreased flexibility. Thus, individuals in their 30s should engage in stretching exercises, yoga, and other activities related to flexibility.

This study had several limitations. First, because of budgetary concerns, this study did not include analyses of blood samples, which may have provided more meaningful data. The future studies should include blood samples for analysis of key health parameters such as blood glucose, liver function, and cholesterol. Second, the data from the national survey were only collected every 2 years. We propose that the national fitness survey should be conducted by the national assembly annually. Third, socioeconomic status was not included in the national survey; therefore, the effect of these variables could not be assessed. Socioeconomic variables should be included in the future surveys. Furthermore, a study should be performed to find out whether the participants changed their fitness regime after knowing the results of their assessments. Nevertheless, although this study used the data from the Survey of National Physical Fitness conducted by the Korea Institute of Sport Science and the Ministry of Culture, Sports and Tourism that was a cross-sectional retrospective cohort study in South Korea, it should be possible to generalize the study's findings in other research settings.

5. Conclusions

There is a correlation between physique and physical fitness in Korean adults as demonstrated by the data from 2009 to 2017. Men aged 40-49 years and women aged 20-29 years should be aware that they are at risk of an increased BMI. Muscular strength decreased dramatically in both sexes from the age of 40 years, and both cardiovascular strength and flexibility decreased from the age of 30 years. Although muscular endurance and power increased within the age groups during the study period, the study confirmed that the overall physical fitness level decreased with increase in age. Trend analyses should be conducted periodically so that informed decisions related to important public health policies could be made. The results of this study support the recommendation for regular exercise for improving physical fitness and prevent aging. Moreover, a high physical fitness level might prevent obesity and establish a healthy community. An effective obesity program should monitor and reflect results based on the physical fitness levels assessed in Korean adults.

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Conflicts of interest

The authors declare no conflicts of interest.

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