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EVALUATION OF THE DIFFERENCES OF HOUSEHOLD INCOME AND PHYSICAL FITNESS VARIABLES IN ELDERLY KOREANS

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ABSTRACT

Background and Objective

Physical activity and fitness are complementary to each other, but they are independent concepts with regard to health. Although there are some studies about the relationship between one's physical activity and economic level, there are very few studies about the relationship between one's fitness level and economic level. Therefore, this study aimed to investigate the fitness level of elderly Koreans according to their economic level.

Material and Methods

In 2015, 1,068 elderly Koreans (men=452, women=616) over 65 years of age participated in the Korean national fitness assessment. Their household income was collected using a self-report survey, and physical fitness variables (grip strength, sit-up, sit to stand, sit and reach, back scratch, one leg standing with eyes open, and 6-minute walk) were measured directly. Then the differences between household income and physical fitness variables were evaluated by conducting one-way analysis of variance (ANOVA) and the Tukey test (post-hoc testing).

Results

Elderly men showed significant differences in grip strength ($p=0.009$), sit-up ($p<0.001$), and sit to stand ($p<0.001$) according to the four household income groups (under 70,000 won group, 700,000 to under 2,030,000 won group, 2,030,000 to under 3,500,000 won group, and over 3,500,000 won group) by one-way ANOVA. Elderly women showed significant differences in grip strength ($p=0.001$), sit-up ($p<0.001$), one leg standing with eyes open ($p=0.048$), and 6-minute walk ($p<0.001$) according to the four groups by one-way ANOVA.

Conclusion

Physical fitness variables related to muscular strength and muscular endurance can be affected by household income in elderly Koreans.

According to the World Health Organization report in October 2017, the worldwide obesity population has increased by almost three times; 1.9 billion adults over 18 years are overweight, and 650 million adults are obese.[1]

Obesity is directly and physiologically linked to hypertension, diabetes, and cancer incidence, and it has a direct relationship with depression, low self-esteem, and bullying.[2–4] Furthermore, obesity is recognized as a very serious social problem, as it induces mental, physiological, and social public health problems worldwide.[5] The annual obesity-related medical cost in the United States (US) was $137 billion in 2008.[6] This cost will be $861 to $957 billion by 2030 based on this tendency in the US.[7]

The increase of fat mass and decrease of skeletal muscle mass occurs because of changes in endocrine and metabolic systems by aging.[8] Obesity including central obesity with visceral fat along the subcutaneous abdominal fat is linked to a high risk of cardiometabolic disease, morbidity, and mortality.[8-9] The cause of obesity is affected by smoking, drinking, lack of sleep, sedentary life, and abnormal dietary intake.[10] Interestingly, according to a recent study, it was reported that obesity is also strongly and closely related to socioeconomic variables such as low household income.[11]

For decades the promotion of physical activity has been strongly recommended as one of the methods to prevent obesity.[12] In addition, many advanced studies have reported that socioeconomic variables, especially low household income, are closely related to physical activity, as the promotion of physical activity is related to the decrease of obesity.[13,14] The relationship between socioeconomic status and body mass index, which is one of the representative indexes of obesity, is affected by a low level of education, moderate physical activity level, cost per calorie, and weight of food items.[15,16] The socioeconomic status affects one's eating habits and physical activity level, thereby increasing the risk of being overweight.[17]

Aging causes a decline in skeletal muscle mass as well as strength.[18] Body fat mass is also increased by aging due to body composition changes that can induce obesity.[19] The increase of adiposity and decrease of muscle mass is called sarcopenic obesity.[20] Sarcopenic obesity causes metabolic syndrome, physical disability, and mortality in elderly individuals.[21]

In the field of exercise science, physical activity and fitness are complementary to each other, but they are independent concepts with regard to health.[22] Although there are many studies about the relationship between physical activity and economic level,[13,14] there are very few studies about the relationship between one's fitness and economic level. Recently, Choi et al. suggested the relationship between socioeconomic factors and physical fitness,[23] but a study about elderly individuals is a priority, as this population is very vulnerable to a lower economic status after retirement. Therefore, this study aimed to investigate the relationship between one's fitness and economic level in elderly Korean patients over age 65 in order to add further information to existing studies on adults.

METHODS

Participants

One thousand sixty-eight elderly Koreans (men=452, women=616) over age 65 who participated in the Korean national fitness assessment, a nationally representative physical fitness test conducted by the Korea Institute of Sport Science, were analyzed in this study. Their names, social security numbers, addresses, and telephone numbers were not collected; therefore, ethical approval was not required. All research procedures were controlled and approved by the Korea Institute of Sport Science. Informed consent was obtained from the study participants.

Household Income

Household income was classified according to the following question: "What is your family income per month?" The possible responses were (1) under

700,000 won (US estimate, $1=1,100 won), (2) 700,000 to under 2,030,000 won, (3) 2,030,000 to under 3,500,000 won, and (4) over 3,500,000 won.

Physical Fitness Variables

Each physical fitness variable was evaluated by having the participants perform the following tests. Grip strength: (1) Grab the dynamometer and place it on the joint of your second finger. Adjust the screw so it fits your finger. (2) Pull the dynamometer as hard as possible by extending your arm straight and maintaining a 5° angle between your trunk and arm. (3) Record the maximum value as a unit of 0.1 kg after conducting steps 1–2 twice using your right hand.

Sit-up: (1) Lie down on the mat and place your feet in a wide stance of about 30 cm, keep your knees perpendicular to the floor, and lock your fingers behind your head. (2) Allow the assistant to hold your ankles with two hands. Once you hear "start," raise your upper body and touch your knees with both elbows, and return to lying position. (3) Count the number of repetitions for 1 minute. It is considered 1 complete repetition only when both elbows touch the knees.

Sit to stand: (1) Place your arms on your chest in an X-shape, straighten your spine, and sit on the middle part of the chair with the soles of your feet flat on the ground. (2) Repeat the motion of moving from stand-up position to sitting position when you hear "start." Count the number of repetitions completed within 30 seconds.

Sit and reach: (1) Sit on the mat with your shoes off, extend your knee, and place the entire sole of your foot on the perpendicular plane of the measuring apparatus. (2) Do not widen your stance over 5 cm and keep your legs straight. (3) From the ready position, stretch out both hands to touch the measuring scale, and record the value as a 0.1-cm unit.

Back scratch: (1) Place one hand on the back of your shoulder and lower it to the middle of your back. The elbow should be behind your head. (2) Use your other hand to touch or grab the hand on the middle of your back in the palm-up position. (3) Do not move either hand or correct your hands so your middle finger is in the right position. Practice the back scratch twice, and record the best value in 0.1-cm units.

One leg standing with eyes open: (1) After hearing "start," raise one leg and arm parallel to the ground. (2) Stop the test if the foot touches the ground. (3) Practice one leg standing with eyes open once, and record the best score in seconds after conducting it twice.

Six-minute walk: (1) Get ready on the starting line and begin when you hear the "start" signal. (2) Walk as long and fast as possible within 6 minutes. (3) Listen to the time remaining to control your pace. (4) Stop if 6 minutes has passed, move to the mark point located 5 m away, and walk slowly for the remaining minutes as a cooldown. Record the duration walked within 6 minutes in 0.1-m units.

The safety of the elderly participants was considered in all fitness tests in accordance with the *Advanced Fitness Assessment and Exercise Prescription* and guidelines of the *Senior Fitness Test Manual*.[24,25]

Statistical Analysis

All results from this study are shown as mean ± standard deviation or number (%). One-way analysis of variance (ANOVA) was used to verify the inter-group differences in physical fitness variables according to the four household income level groups. The Tukey test (post-hoc testing) was conducted to confirm which groups showed differences when a difference between groups was observed. The statistical analyses were performed using SPSS, version 18.0 (Chicago, IL, USA), and statistical significance was set at $p<0.05$.

RESULTS

The physical characteristics of the subjects are shown in Table 1. Table 2 displays the differences in physical fitness among the household income level groups. Elderly men showed significant differences in grip strength ($p=0.009$), sit-up ($p<0.001$), and sit to stand ($p<0.001$) according to the four household income level groups (under 70,000 won group, 700,000 to under 2,030,000 won group, 2,030,000 to under 3,500,000 won group, and over 3,500,000 won group) by one-way ANOVA. Accordingly, the Tukey test (post-hoc testing) showed that the 700,000 to under 2,030,000 won group had a higher sit-up value ($p<0.05$) than the under 70,000 won group.

The 2,030,000 to under 3,500,000 won group had a higher grip strength value ($p<0.05$) than the under 70,000 won group. The over 3,500,000 won group had higher sit-up ($p<0.001$) and sit to stand values ($p<0.001$) than the under 70,000 won group.

Elderly women showed significant differences in grip strength ($p=0.001$), sit-up ($p<0.001$), one leg standing with eyes open ($p=0.048$), and 6-minute walk ($p<0.001$) according to the four household income level groups by one-way ANOVA. Accordingly, the Tukey test (post-hoc testing) showed that the 700,000 to under 2,030,000 won group had higher grip strength ($p<0.05$) and 6-minute walk values ($p<0.01$) than the under 70,000 won group. The 2,030,000 to under 3,500,000 won group had higher sit-up ($p<0.01$) and 6-minute walk values ($p<0.001$) than the under 70,000 won group. The over 3,500,000 won group had higher grip strength ($p<0.01$), sit-up value ($p<0.001$), and 6-minute walk value ($p<0.001$) than the under 70,000 won group.

DISCUSSION

Our results indicated that both male and female elderly individuals showed more strength and muscular endurance in physical fitness variables as their income level increased, but there was no group difference according to the household income level with regard to flexibility and balance.

Sarcopenia represents muscular strength and endurance and is a syndrome that includes the characteristic of decreased skeletal muscle mass and strength along with various pathologic conditions due to natural aging.[26] Aging people with sarcopenic obesity experience disability in living function and lower physical capacity.[27,28] Sarcopenia usually develops in aged people and can largely be involved in physical decrepitude,

TABLE 1 Characteristics of the Participants

Variables		Men (n=452)	Women (n=616)
Age (years)		71.81 ± 5.36	71.84 ± 5.85
Height (cm)		164.54 ± 5.63	152.92 ± 5.66
Weight (kg)		63.72 ± 7.81	57.14 ± 7.78
Body mass index (kg/m^2)		23.53 ± 2.61	24.43 ± 3.05
Physical fitness	Grip strength (kg)	30.42 ± 6.64	20.07 ± 5.28
	Sit-up (reps/60 sec)	12.22 ± 9.60	5.23 ± 7.39
	Sit to stand (reps/30 sec)	16.94 ± 7.62	15.54 ± 6.55
	Sit and reach (cm)	5.36 ± 9.02	11.64 ± 8.76
	Back scratch (cm)	−12.83 ± 13.71	−5.51 ± 12.69
	One leg standing with eyes open (sec)	21.14 ± 26.63	20.96 ± 29.64
	6-minute walk (m)	479.66 ± 137.41	448.30 ± 138.50
Household income	Under 70,000 won (US $636.36)	191 (42.2)	285 (46.2)
	700,000 to under 2,030,000 won	168 (37.2)	200 (32.5)
	2,030,000 to under 3,500,000 won	55 (12.2)	72 (11.7)
	Over 3,500,000 won (US $3,181.82)	38 (8.4)	59 (9.6)

Results are expressed as mean ± standard deviation or n (%).
Estimate, US $1=1,100 won.
US = United States.

TABLE 2 Differences in Physical Fitness among the Household Income Level Groups

	Group 1	Group 2	Group 3	Group 4	Overall F	Overall *p*
Men	(n = 191)	(n = 168)	(n = 55)	(n = 38)		
Grip strength (kg)	29.39 ± 7.04	30.60 ± 6.17 N/S	32.13 ± 5.95 #	32.32 ± 6.82 N/S	3.866	0.009**
Sit-up (reps/60 sec)	10.34 ± 8.76	12.92 ± 9.75 #	13.54 ± 9.26 N/S	16.71 ± 11.39 ###	6.049	<0.001***
Sit to stand (reps/30 sec)	15.56 ± 6.68	17.18 ± 7.80 N/S	17.70 ± 7.50 N/S	21.63 ± 9.42 ###	7.375	<0.001***
Sit and reach (cm)	4.41 ± 9.04	6.45 ± 8.28 N/S	3.98 ± 9.87 N/S	7.23 ± 10.17 N/S	2.496	0.059 N/S
Back scratch (cm)	−13.13 ± 15.96	−13.19 ± 11.41 N/S	−11.47 ± 12.28 N/S	−11.62 ± 13.23 N/S	0.343	0.794 N/S
One leg standing with eyes open (sec)	20.60 ± 30.57	19.63 ± 21.64 N/S	20.88 ± 21.29 N/S	30.94 ± 31.18 N/S	1.936	0.123 N/S
6-minute walk (m)	468.33 ± 129.99	478.33 ± 141.04 N/S	490.88 ± 137.81 N/S	526.87 ± 150.80 N/S	2.021	0.110 N/S
Women	(n=285)	(n=200)	(n=72)	(n=59)		
Grip strength (kg)	19.29 ± 5.42	20.57 ± 5.28 #	20.25 ± 4.23 N/S	21.86 ± 5.16 ##	5.099	0.001**
Sit-up (reps/60 sec)	4.24 ± 6.80	4.74 ± 6.87 N/S	7.57 ± 8.18 ##	8.81 ± 9.14 ###	9.389	<0.001***
Sit to stand (reps/30 sec)	15.37 ± 6.40	15.06 ± 6.49 N/S	16.13 ± 7.20 N/S	17.31 ± 6.39 N/S	2.054	0.105 N/S
Sit and reach (cm)	11.94 ± 8.41	11.86 ± 8.50 N/S	10.04 ± 9.55 N/S	11.34 ± 10.15 N/S	0.974	0.405 N/S
Back scratch (cm)	-6.51 ± 14.00	-5.69 ± 12.88 N/S	-3.57 ± 8.42 N/S	-2.48 ± 8.58 N/S	2.295	0.076 N/S
One leg standing with eyes open (sec)	18.43 ± 30.79	20.50 ± 29.94 N/S	27.64 ± 25.60 N/S	26.53 ± 26.02 N/S	2.641	0.048*
6-minute walk (m)	415.89 ± 148.65	454.73 ± 129.43 ##	499.22 ± 114.64 ###	521.11 ± 87.91 ###	14.837	<0.001***

*Note. *p < 0.05; **p < 0.01; ***p < 0.001; one-way analysis of variance.*
Group 1 = under 70,000 won; Group 2 = 700,000 won to under 2,030,000 won; Group 3 = 2,030,000 won to under 3,500,000 won; Group 4 = over 3,500,000 won
N/S = not significant, #p < 0.05; ##p < 0.01; ###p < 0.001 compared with Group 1; Tukey's post-hoc testing

functional disability, decrease of health-related quality of life, and premature death,[29] and it was reported that even low strength is highly related to the inflammatory response and chronic inflammation.[30] In addition, the lack of muscle mass can be linked to lower capacity of protein synthesis for recovery and to functional decrease related to immunity, as the strength of elderly individuals is the driving force to maintain daily life and physical activity.[31]

Based on this study's results, it can be inferred that the higher socioeconomic level, the more physical fitness variables are related to sarcopenia, and the

reduction of muscle mass can be prevented. Namely, it is suggested that a physically healthier life can be induced by a higher socioeconomic level. Future studies about the physical fitness variables related to sarcopenia should be conducted in detail.

Socioeconomic status is a classification of the societal position of an individual, which is usually based on education, income, and occupation.[32] The risk of cardiovascular disease and all-cause mortality as well as a poor residential area are associated with a low socioeconomic status.[33–35] In flexibility and balance, although there was no significant difference, the fitness level of flexibility and balance showed a tendency to increase with the increase of household income. Poor living conditions with a lack of clean water, inadequate sanitation, and insufficient hygiene can be linked to abdominal pain, diarrhea, anemia, growth retardation, reduced physical fitness, cognitive impairment, and poor academic achievement.[36,37] Additionally, it was reported that a low socioeconomic status was associated with a significantly reduced level of fitness.[38] Future studies should examine the relationship between socioeconomic status and various fitness variables.

Interestingly, we observed that in elderly women, the higher the socioeconomic status, the significantly higher the cardiorespiratory endurance was. There is a sex difference of the fitness level.[39] According to Milanović et al., reduction in the physical activity level and functional fitness during aging was equal for men and women.[40] It has been reported that a decrease in maximal oxygen uptake adversely affects aerobic activities in elderly individuals.[41] It has been also reported that the pattern of physical activity deteriorated more with aging in men than in women.[42] Physical activity is directly related to fitness; therefore, a change of physical activity might affect the cardiorespiratory endurance differently by sex. According to the National Survey on the Current Status of Participation of Lifetime Sport in Korea from 2017, the rates of regular exercise participation more than twice per week were 30.6%, 34.2%, and 29.9% for men in their 50s, 60s, and over 70s, respectively, whereas those rates were 41.5%, 40.2%, and 37.9% for women in their 50s, 60s, and over 70s, respectively.[43] Elderly females showed a much higher rate of regular exercise participation (twice per week) than their male counterparts. Moreover, according to Church et al., physical activity can alter fitness as well as mortality, and there is a dose-response training effect on fitness.[44] This finding is consistent with our study result of a higher cardiorespiratory fitness level in female elderly individuals who showed a much higher exercise participation rate than their male counterparts. Namely, the difference of cardiorespiratory fitness between male and female elderly individuals would be affected by the level of physical activity including exercise.[44]

The main limitations of this study are as follows. This study just examined the group difference of socioeconomic status according to fitness level; we did not determine a cause and effect relationship since we only assessed the difference among four household income level groups. Moreover, we did not consider confounding variables, such as the participants' medical condition. Nevertheless, this study included a large sample of elderly individuals in Korea, and it is possible to generalize our study's findings to other research settings.

CONCLUSION

Physical fitness variables related to muscular strength and muscular endurance can be affected by household income in elderly Koreans.

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