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GENDER DIFFERENCES IN BODY COMPOSITION, PHYSICAL ACTIVITY LEVEL, PHYSICAL FITNESS, AND BONE MINERAL DENSITY AMONG ELDERLY INDIVIDUALS LIVING ALONE COMPARED TO THOSE LIVING WITH THEIR SPOUSES

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ABSTRACT

Background and Objective

This study aimed to examine the differences in body composition, physical activity level, physical fitness, and bone mineral density (BMD) among elderly individuals who lived alone and those who lived with their spouses.

Material and Methods

A total of 136 elderly individuals, older than 65 years (63 males and 73 females) were surveyed according to whether they lived alone or with their spouses, age, and sex. BMI and percentage body fat were also measured, as well as 7 days of physical activities of daily life by accelerometer. The physical fitness test consisted of 6 minutes walking for cardiorespiratory fitness and grip strength and leg strength for muscular strength. BMD and T-score were measured by sonography at the calcaneus. Independent *t*-test was used to examine the group difference according to the living status with spouse by gender.

Results

First, in body composition, elderly females who lived alone showed higher percentage body fat compared with elderly females who lived with their spouses (p=0.010). Second, regarding total physical activity, elderly males and females who lived alone showed significantly lower calorie consumption during daily physical activity compared with elderly males and females who lived with their spouses (p<0.05). Particularly, elderly males and females who lived alone showed significantly lower high intensity (p=0.045) and moderate

intensity (p=0.015) physical activity time, respectively. Third, regarding fitness, elderly males and females who lived alone showed significantly lower upper and lower limb strength compared with elderly males and females who lived with their spouse (p<0.05), but there was no difference in cardiovascular endurance (p>0.05). Fourth, regarding BMD, only elderly males who lived alone showed significantly lower BMD and T-score (p<0.05). There was no significant difference in BMD and T-score among elderly females who lived alone and those who lived with their spouses (p>0.05).

Conclusion

Elderly individuals who lived alone showed lower physical activity levels, strength, and BMD level as well as higher percentage body fat. An exercise and physical activity program for elderly individual who live alone should be developed to improve percent body fat, strength and BMD.

The rapidly increasing aging population has resulted in an increase in the number of elderly individuals living with the nuclear family, increasing need of support for the elderly, and a difference in life expectancy between elderly male and female individuals.[1] About 50% of elderly individuals in America and Europe live alone,[2] and the proportion of single elderly individuals who live alone was surveyed as 33.5% in Korea, indicating that the type of residency among Korean elderly individuals keeps changing.[3]

The type of senior housing is very important as elderly individuals spend most of their time at home, compared with other age groups.[1] Elderly individuals who live alone are prone to malnutrition or obesity from eating alone, as it can be difficult to go shopping alone.[4,5] The incidence of chronic diseases and pain increases and self-efficacy for activities of daily living reduces due to loss of physical function and economic power.[6,7] Also, the mortality caused by insufficient management of chronic diseases is high.[8]

Even though previous studies have focused on the health care risks of elderly individuals who live alone, the approach with physical activity for health care among elderly individuals who live alone is very limited. Physical activity is a very important health factor with diet in all age groups. However, there are no studies examining the differences in physical characteristics and physical activity according to the environmental condition of the elderly, even though physical activity is a health behaviour that could improve the physical and mental health of many elderly individuals.[9,10] In a recent cross-sectional study and review, it was reported that most elderly individuals older than 70 could not follow physical activity guidelines, as well as decreased physical activity caused by aging and gender problems,[9,11] however, there is a lack of studies on physical activity among the elderly.[9]

Due to the report from previous studies that assessing the elderly as a homogeneous group can distort the findings,[4,12] we thought that it would be necessary to identify the characteristics of physical activity and fitness according to the type of residence, which largely affects the daily life of the elderly, and to gather basic data for a physical activity program development to manage and promote the health of the elderly. Thus, this study aimed to evaluate the body composition, physical activity level and fitness, and bone mineral density (BMD) among elderly individuals who lived with their spouse or alone by considering their environmental characteristics in order to provide basic data for the development of a health care program for the elderly.

METHODS

Participants

The participants of this study were elderly individuals older than 65 and who visited 2 senior welfare centres in downtown of Seoul, Korea. The data of 63 male and 73 female elderly individuals who consented to partake in the study and the measured values of all variables were analyzed. There was no difference in age among the groups, as shown in Table 1 (p>0.05). The present study protocol was approved by the Samsung Advanced Institute of Health Sciences and Technology. Informed consent was obtained from all participants prior to their participation in this study.

TABLE 1 Participant Characteristics

Variable	Elderly Male (*n*=63)			Elderly Female (*n*=73)		
	Don't live alone (*n*=25)	Live alone (*n*=38)	*p*	Don't live alone (*n*=43)	Live alone (*n*=30)	*p*
Age (years)	73.6 ± 6.1	74.4 ± 6.2	0.590	73.0 ± 6.0	73.7 ± 4.3	0.560

Data are presented as mean ± standard deviation.
Tested by independent t-test

Measurements

The residence status of living with family or not, age, and gender were surveyed, and an automatic height and weight scale (BSM370, BioSpace Inc., Korea) was used to measure the heights and weights after taking off the shoes and maintaining an upright posture. Bioelectrical impedance analysis (Inbody 720; BioSpace Inc., Korea) was used to measure the percentage of body fat after removing all accessories and metals. Body Mass Index (BMI) was calculated from the measured body weight and height.

The accelerometer, Actical™ (Mini Mitter, Bend, OR, USA) was used to quantify the physical activity intensity and calories. The accelerometer was applied for 7 consecutive days to measure the physical activity level during weekdays and weekends. The accelerometer was attached to the iliac crest area using a belt to measure physical activity level. The Actical™ which was used in this study is a multiaxial motion accelerometer and records up-down and left-right movements by detecting motion acceleration signal. The quantified volume (count) of acceleration is totalled by a user-defined epoch interval. The result of physical activity level is automatically measured and saved by internal sensors and the total energy expenditure (kcal/hour), activity energy, and activity time and frequency by intensity are calculated according to the age, gender, height, and weight recorded at registration. The data were classified into sleeping or sedentary activity (0 metabolic equivalents [METs]), light physical activity (1~1.5 METs), moderate physical activity (3~6 METs), and vigorous physical activity (more than 6 METs) according to the calculated activity time and intensity. The calculated value was averaged to obtain the daily activity level.

Strength was determined using grip and let tests. Grip strength was measured 4 times, twice each for the left and right hands, and the mean value was recorded as 0.1 kg (TKK-5401, Takei, Japan). Leg strength was measured by sitting on leg strength measuring equipment, fixing the ankles on pads, and extending both legs on command (TKK-5402, Takei, Japan). The higher value that was measured twice at maximal extension was recorded as 0.1 kg. The percentage of leg strength was calculated by applying weights to the measured leg strength. The value derived by dividing the measured value by body weight was used for relative evaluation, as leg strength was not adjusted for leg weight and body weight.

The 6-minute walk test (6MWT) was used to measure cardiorespiratory function. A tetragonal path with 20 m width and 10 m length was installed on the ground and the movement meter was read after 6 minutes of sounding the whistle. The participants were asked to walk as fast as possible.[13] The Sahara Bone Sonometer (Hologic, USA) was used to measure the BMD and T-score for the elderly individuals.

Statistical Analyses

All analyses were performed using SPSS version 18.0 for Windows (SPSS Inc., Chicago, IL, USA). The means and standard deviations of all variables were calculated, and group difference by existence of spouse was compared and analyzed by using the independent t-test after dividing the participants into males and females. Statistical significance was set at $p<0.05$.

RESULTS

The Difference in Body Composition according to the Existence of a Spouse

The difference in body composition according to the existence of spouse among the male and female elderly individuals was compared and the results are shown in Table 2. There was no significant difference in height, weight, and BMI between the 2 groups (p>0.05). However, percent body fat was significantly higher in elderly female individuals who lived alone compared with elderly female individuals who lived with their spouses (p=0.010).

The Difference in Physical Activity according to the Existence of a Spouse

The difference in group physical activity level according to the existence of spouse among male and female elderly individuals was compared by analyzing the daily average of 7 days data from the accelerometer and the results are shown in Table 3. In total physical activity, both male and female elderly individuals who lived alone showed significantly lower daily physical activity calorie expenditure compared with older individuals who lived with their spouses (p<0.05). Particularly, older male and female individuals living alone showed significantly lower vigorous physical activity (p=0.045) and moderate physical activity levels (p=0.015), respectively.

The Difference in Fitness according to the Existence of A Spouse

Cardiorespiratory function and strength were evaluated to compare group difference in fitness according to the existence of spouse. The results are shown in Table 4. Both male and female elderly individuals who lived alone showed significantly lower upper and lower limb strength compared with those who lived with their spouses (p<0.05), but there was no significance in cardiorespiratory endurance (p>0.05).

The Difference in Bone Density according to the Existence of a Spouse

The difference in group bone density according to the existence of spouse in male and female elderly individuals was compared and the results are shown in Table 5. Only elderly male individuals who lived alone showed significantly lower bone density and T-score (p<0.05). There was no significant difference in BMD and T-score between elderly female individuals who lived alone and those who lived with their spouses (p>0.05).

DISCUSSION

This study compared and evaluated the difference in body composition, physical activity, physical fitness, and BMD according to the type of residence by dividing the elderly individuals into those who lived alone and those who lived with their spouses.

TABLE 2 The Difference of Body Composition between the Elderly Living Alone and those Who Do Not Live Alone

	Elderly Male (*n*=63)			Elderly Female (*n*=73)		
	Do not live alone (*n*=25)	Live alone (*n*=38)	*p*	Do not live alone (*n*=43)	Live alone (*n*=30)	*p*
Height (cm)	165.8±4.9	165.2±5.8	0.660	150.5±5.4	150.2±5.7	0.810
Weight (kg)	65.2±8.2	65.5±7.2	0.890	54.9±8.2	58.1±7.4	0.090
Body mass index (kg/m^2)	23.7±2.7	24.3±3.7	0.520	25.0±3.1	25.0±3.1	0.980
Body fat (%)	27.6±5.8	30.1±7.4	0.150	28.4±7.8	32.7±4.7	0.010*

Data are presented as mean ± standard deviation.
**p<0.05; tested by independent t-test*

TABLE 3 Differences in Physical Fitness between Elderly Individuals Who Live Alone and Those Who Do Not Live Alone

	Elderly Males			Elderly Females		
Group Variable	**Do not live alone (*n*=25)**	**Live alone (*n*=38)**	***p***	**Do not live alone (*n*=43)**	**Live alone (*n*=30)**	***p***
Energy expenditure (kcal/day)	2853.9±254.3	2215.8±163.7	0.031*	2818.5±190.6	1996.9±176.5	0.003**
Total count (count/day)	1150440 ±143556.4	824574.8 ±76195.8	0.033*	988291.0 ±85441.7	717989.2 ±86518.5	0.034*
Sedentary (min/day)	1134.3±22.1	1172.5±17.3	0.176	1158.4±16.7	1205±17.7	0.064
Light (min/day)	202.0±15.6	180.4±12.1	0.274	181.1±12.8	157.5±11.1	0.194
Moderate (min/day)	112.7±11.8	94.4±7.4	0.173	108.2±7.07	81.4±8.0	0.015*
Vigorous (min/day)	0.52±0.28	0.06±0.3	0.045*	0.40±0.2	0.12±0.4	0.349
MVPA (min/day)	113.2±11.9	94.5±7.4	0.165	108.6±7.1	81.5±8.0	0.015*

Data are presented as mean ± standard deviation.
MVPA, moderate-vigorous physical activity.
**p<0.05, **p<0.01; tested by independent t-test.*

TABLE 4 Differences in Physical Fitness between Elderly Individuals Who Live Alone and Those Who Do Not Live Alone

	Elderly Males			Elderly Females		
Group Variable	**Do not live alone (*n*=25)**	**Live alone (*n*=38)**	***p***	**Do not live alone (*n*=43)**	**Live alone (*n*=30)**	***p***
Grip strength (kg)	26.1±1.2	22.2±1.1	0.018*	27.4±1.0	21.1±1.2	0.002**
Leg strength (kg)	48.9±2.9	38.6±2.9	0.019*	50.8±2.5	41.3±3.3	0.024*
Relative leg strength (%)	0.76±0.5	0.60±0.5	0.030*	0.95±0.3	0.71±0.3	0.005**
6MWT (m)	508.8±73.8	499.3±55.6	0.569	470.6±114.0	480.8±100.7	0.673

Data are presented as mean ± standard deviation.
Relative leg strength=leg strength divided by weight; 6MWT, six-minute walk test.
**p<0.05, **p<0.01; tested by independent t-test.*

Regarding the percentage body fat, even though there was no significant difference among elderly male individuals, elderly females who lived alone showed a higher percentage body fat compared with those who lived with their spouses. This is consistent with the findings of previous studies that older individuals who live alone have a higher frequency of sedentary leisure time compared with those who live with their spouses,[6,14,15] and with another study that reported that the low physical activity level among elderly people who live alone increases the obesity rate.[4,16] Older people who live alone tend to skip meals or

TABLE 5 Differences in Bone Mineral Density between Elderly Individuals Who Live Alone and Those Who Do Not Live Alone

	Elderly Males			Elderly Females		
Group Variable	**Do not live alone (*n*=25)**	**Live alone (*n*=38)**	***p***	**Do not live alone (*n*=43)**	**Live alone (*n*=30)**	***p***
T-score	−1.40±1.74	−2.24±1.38	0.036*	−1.89±1.19	−2.31±1.47	0.190
Bone mineral density (g/cm^2)	0.38±0.14	0.30±0.13	0.038*	0.35±0.11	0.32±0.12	0.228

Data are presented as mean ± standard deviation.
**p<0.05, tested by independent t-test.*

eat unbalanced diet that lack vegetables as there is no family to care for them,[4,17,18] indicating that these bad dietary habits and low physical activity pattern are reasons for the high percentage body fat.

On the other hand, a prior study reported that elderly male individuals who live alone have a higher probability of being obese or overweight, compared with elderly female individuals who live alone, but this study showed a significant difference in percentage body fat in female elderly individuals.[4] It is thought that the significantly lower moderate and vigorous physical activity in elderly females who lived alone compared with elderly males would affect these results.

In physical activity, both older male and female individuals who lived alone showed lower total physical activity, and older males and females who lived alone showed lower vigorous and moderate-vigorous physical activity time, respectively. These results are different from a physical activity survey and prior study that did not assess elderly individuals according to gender.[4,16] This study was able to identify the fact that living alone largely affects the physical activity level of elderly females compared with elderly males by analyzing the data according to gender from accelerometer. Previous studies have indicated that lower physical activity in elderly individuals who live alone can increase their risk of chronic disease or ischemic stroke.[14,19]

In terms of fitness, the significantly lower strength of elderly individuals who lived alone compared with those who lived with their spouses can be related to a decline of physical activity in those who lived alone, indicating that care should be taken, as low strength can increase the risk for falling from lower physical function.[16] Similar to a previous study that reported that elderly females showed higher frequency of falls,[6] care should be taken to prevent decline of fitness as elderly females who live alone showed low physical activity levels. The low strength level among elderly individuals who live alone could be the reason for sarcopenia or frailty which are recent issues.[20] However, there was no significant difference in cardiorespiratory function in this study. A well-designed future study should be necessary.

Elderly males who lived alone showed lower bone densities compared with elderly individuals who lived with their spouses. This result is consistent with those of prior studies that reported higher correlation among physical activity, strength, and bone density.[21,22] Generally, bone density decreases with aging and shows a close relationship with muscle mass.[23] In this study, elderly individuals who lived alone showed significantly lower upper and lower limb strength compared with elderly individuals who lived with their spouses. Also, low bone density increases the risk of fractures, as shown in many studies; thus, care should be taken as the risk of fracture by falling could be increased. However, future management programs are necessary as regular exercise programs can slow the reduction of bone density,[22,23] as well as decrease the risk of falling. Nevertheless, additional future studies are necessary as there was no significant group difference in elderly females.

Similar to the results of various field studies among elderly individuals who lived alone, this study also found higher percentage body fat, lower physical activity, lower strength level, and lower bone density among elderly individuals who lived alone. It is thought that this result could be the main reason for sarcopenia or frailty as well as the incidence of chronic diseases, heart disease and falling, which are high risks for mortality in elderly individuals who live alone. Thus, a customized exercise program that considers the type of residence of the elderly, rather than regarding them as one group, should be applied in future studies and program.

CONCLUSION

This study found lower physical activity levels, higher percentage body fat, and decreased upper and lower limb strength, as well as decreased bone density in elderly individuals who lived alone without their spouse. Overall, the exercise program to promote physical activity level and to improve percent body fat and muscular function of the elderly who lives alone should be developed.

DISCLOSURE

The authors have no conflicts of interest to declare.

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