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Role of regular physical activity in modifying cardiovascular disease risk factors among elderly Korean women

Seunghui Baek[1], Lorraine S. Evangelista[2], & Youngmee Kim[3]*
[1]*Department of Sports & Leisure, Health & Wellness College, Sungshin Women's University, Seoul, Korea*
[2]*Sue & Bill Gross School of Nursing, University of California, Urvine, USA*
[3]*Red Cross College of Nursing, Chung-Ang University, Seoul, Korea*

Abstract

Introduction: This study examined physical activity (PA) participation rates and the role of PA in the modification of cardiovascular disease (CVD) risk factors according to types of PA in elderly Korean women using data from 2007 to 2012 from a nationally representative South Korean database.

Materials and Method: In total, 3,456 elderly women aged ≥65 years, without CVD, were included in the study. CVD risk was evaluated using both the 10-year Framingham risk score (FRS) and atherogenic index (AI), as well as well-known CVD risk factors such as hypertension, diabetes mellitus, smoking, and hypercholesterolemia.

Results: The PA participation rates were 4.7%, 33.9%, and 61.4% for the regular PA, regular walking, and no PA groups, respectively. Multiple linear regression analyses revealed that regular PA and regular walking were associated with a favorable lipid profile and lower AI, after controlling for socio-demographic factors and types of PA. PA did not significantly affect the FRS.

Conclusion: This study suggests that regular PA and walking are important in the modification of CVD risk factors among elderly Korean women.

Key words: Cardiovascular risk factors, Elderly women, Physical activity

Introduction

Population aging is a global phenomenon. The percentage of the population aged ≥65 years is growing rapidly worldwide and will reach about 22% of the total population by 2050 (WHO, 2016a). South Korea is one of the rapidly aging countries in the world; people aged 65 years are expected to account for 37.4% of the total population in 2050 (Korea National Statistical Office, 2016). Despite the improvement in life expectancy, many elderly people have cardiovascular disease (CVD) (Stamatakis, Davis, Stathi & Hamer, 2012). Despite efforts by public healthcare systems to improve CVD management globally, CVDs such as stroke or coronary artery disease (CAD) are the leading cause of death, accounting for about 17.3 million deaths in 2008 and 23 million expected deaths

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Correspondence : youngkim234@gmail.com,
ykim@cau.ac.kr

in 2030 (ACSM, 2013; WHO, 2016b). Even in South Korea, CVD has been the second or third leading cause of death over the past 10 years (Korea National Statistical Office, 2015). The risk factors of CVD have been well identified, and they include high blood pressure, lack of exercise, obesity, personal habits such as smoking or drinking, and socioeconomic status (WHO, 2016b). Needless to say, physical activity (PA) is an important preventive measure for reducing the risk of CVD (Thompson et al., 2003). In addition, PA reportedly lowers the risk of cancers such as breast and colon cancers, type 2 diabetes, or osteoporosis (Kokkinos & Myers 2010; Laht, Holstila, Lahelma, & Rahkonen, 2014; Thompson et al., 2003). Furthermore, the health benefits of PA have been demonstrated in psychosocial aspects such as cognitive function (Weuve et al., 2004), quality of life, depression (Cordero, Masiá & Galve, 2014; Elavsky, 2009), and sleep duration (Cho, 2014).

The rates of PA participation among the elderly in South Korea are not well understood, even though most elderly people do not seem to engage in PA (Lee, 2005). Both moderate and vigorous intensities with different time requirements are equally recommended for gaining health benefits from PA in individuals older than 65 years (WHO, 2016c).

It is interesting that the overall CVD-related mortality for Korean women exceeded that for men. For example, the incidence of death was 50.4 cases in 100,000 women compared to 47.8 cases in 100,000 men in 2013, respectively (Korea National Statistical Office, 2016). This implies that CVD is no longer a disease common only among men. It has also become a major health problem in elderly Korean women. Considering that the economic and social burdens from CVD-related morbidity and mortality are high and PA is a major preventive measure to reduce CVD risk, understanding the factors associated with PA participation and CVD is important for modifying the overall CVD-related morbidity and mortality in the elderly population. Therefore, this study aimed to: 1) examine the PA participation rates among elderly Korean women (≥65 years) without CVDs such as CAD and stroke, 2) assess the association between PA levels and various CVD risk factors, and 3) determine whether PA levels independently predict CVD risk. Data from a nationally representative database of South Korea (Korea National Health and Nutrition Examination Survey [KNHANES]) was used. This study suggests that participation in regular PA and regular walking are important for the modification of CVD risk factors in elderly Korean women.

Materials & Methods

Study Design and Participants

The present study involved secondary analysis of data from 7 consecutive KNHANES, conducted from 2007 to 2012 by the Korea Centers for Disease Control and Prevention (KCDC). The KNHANES is a nationwide annual cross-sectional survey for collecting data on physical and mental health, lifestyles (e.g., smoking, drinking, and physical activity), and dietary intake of the general population of South Korea.

The KNHANES utilizes a complex, stratified multistage probability-sampling design based on geographic areas, age, and sex. Additional details regarding study design and sampling process can be obtained elsewhere (Kim, Cho, & Evangelista, 2013; Korea Centers for Disease Control and Prevention, 2015). Health interview survey and examination data were also analyzed in the present study.

During the study period, 47,806 individuals participated in the survey. The inclusion criteria for the study were as follows: (1) female participants and (2) age ≥65 years. The exclusion criteria were as follows: 1) participants previously diagnosed with CVD (i.e., myocardial infarction or stroke), 2) those missing data on types of activities, 3) those undertaking both moderate PA and walking, and 4) those missing data related to the 10-year Framingham risk score (FRS). Figure 1 displays the inclusion and exclusion processes and the numbers of study participants.

Ethical Considerations

The Institutional Review Board of the KCDC annually reviews and approves the KNHANES. Only participants who had signed the written informed consent form were included in the survey (Korea Centers for Disease Control and Prevention, 2015). The data were downloaded from the official KNHANES website (http://knhanes.cdc.go.kr/) after completing the registration procedure.

Measurements and Definitions of Variables

Socio-demographic characteristics and types of physical activity of the participants. Socio-demographic characteristics of the participants such as age, marital and employment statuses, educational level, adjusted household income quartiles, living place, smoking habit, and drinking habit were included in the analysis. Current smokers were defined as those with a smoking history of ≥100 cigarettes in their lifetime and who currently smoked. Regular drinkers were defined as those consuming ≥30 g/day of alcohol. Socio-demographic characteristics were compared according to the following types of PA: regular PA, walking, or no PA. Regular PA was defined as moderate-intensity PA (e.g., moderately paced swimming, volleyball, badminton, or table tennis) of ≥30 minutes per session at least 5 times a week(WHO, 2016c). The American College of Sports Medicine (ACSM, 2013) recommends 30 minutes of walking at least 5 times a week for adults. Therefore, walking was defined as walking ≥30 minutes per session at least 5 times a week. No PA was defined as not meeting the PA or walking category.

Cardiovascular risk factors. All blood samples were collected after an overnight fast (Korea Centers for Disease Control and Prevention, 2015). Smoking, hypercholesterolemia, hypertension, and diabetes mellitus are traditionally considered CVD risk factors (Vazquez-Benitez et al., 2015). Therefore, systolic and diastolic blood pressures, cholesterol levels, body mass index, waist circumference, central obesity, self-reports on diagnosis, and information on medication for hypertension and diabetes mellitus were included in the evaluation. Hypertension was defined as systolic blood pressure ≥140 mmHg, diastolic blood pressure ≥90 mmHg, or current treatment with antihypertensive medication. Diabetes was defined as fasting glucose level ≥126 mg/dL, current treatment with oral hypoglycemic agents or insulin injection, or a diagnosis of diabetes. The FRS and atherogenic index (AI) were also used to evaluate CVD risk factors since they are commonly used as clinical assessment tools to predict the risk of CVD or coronary heart disease (D'Agostino et al., 2008; NECP-ATP III, 2002; Goff et al., 2013; Nwagha, Ikekpeazu, Ejezie, Neboh, & Maduka, 2010; Singh, Issac, Benjamin, & Kaushal, 2015).

Statistical Analysis

The data were analyzed using SAS version 9.3 (SAS Institute Inc., Cary, NC, USA). P values < 0.05 were considered statistically significant. The data were presented as mean±standard error (SE) for continuous variables or proportions (±SE) for categorical variables. Analysis of variance and chi-square tests were conducted to evaluate differences between groups for continuous and categorical variables, respectively. Socio-demographic characteristics were analyzed according to the three types of PA participation. Cardiovascular risk factors were also analyzed according to the types of PA. Univariate analyses were conducted to determine the associations between FRS and various factors, including socio-demographic characteristics and types of PA. Multiple linear regression analyses were also conducted to examine the associations between AI and cardiovascular risk factors after controlling for socio-demographic factors and types of PA. Results are presented as regression coefficient and p values.

Results

Of the 3,456 study participants, 61.4% were not engaged in any type of PA at the time of the survey and 38.6% practiced either walking (33.9%) or regular PA (4.7%; Figure 1).

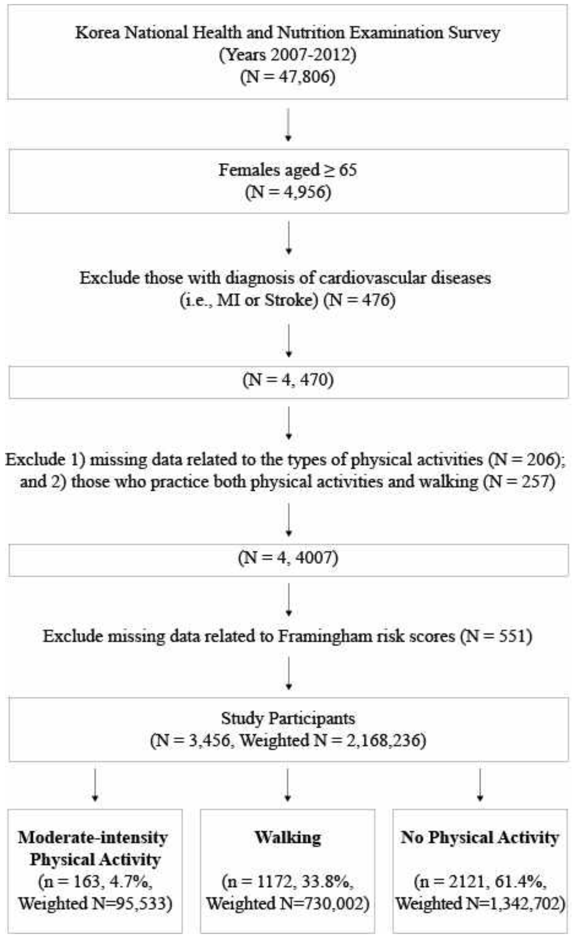

Figure 1. *Flowchart showing inclusion and exclusion of study participants*

Sociodemographic Characteristics of the Study Participants

Table 1 shows the sociodemographic characteristics of the participants according to the type of PA they engaged in. Mean age was lowest (71.5±0.52 years) in the regular PA group and highest in the no PA group (73.2±0.15 years, $p < 0.001$). The number of married participants was higher in the regular PA group than in the other groups ($p = 0.005$). The current employment rate was highest in the regular PA group (53.3%, 26.9%, and 24.3% in the regular PA, walking, and no PA group, respectively; $p < 0.001$), but household incomes did not significantly differ between the groups. More people lived in a rural environment in the regular PA group than in the other groups ($p = 0.007$). The current smoking rate was lowest in the regular PA group (13.0%, 18.8%, and 16.8 in the regular PA, walking, and no PA group, respectively).

Cardiovascular Risk Factors among the Study Participants

Table 2 presents the differences in well-known cardiovascular risk factors according to the types of PA. Most of the factors, including body mass index, blood pressure, and the prevalence of diabetes, did not significantly differ according to the type of PA. However, the mean high-density lipoprotein-cholesterol (HDL-C) level was significantly higher in the regular PA group than in the other groups (51.3±1.22, 50.5±0.45, and 48.8±0.34 mg/dL in the regular PA, walking, and no PA group, respectively, p = 0. 004). Furthermore, the mean percentage of the participants with low-density lipoprotein cholesterol (LDL-C) levels 160 mg/dL, and the mean triglyceride level were lowest in the regular PA group (LDL-C 160 mg/dL = 7.7%, 10.5%, and 13.8%; triglyceride = 134.4±6.81, 141.1±2.96, and 149.6±2.42 mg/dL in the regular PA, walking, and no PA group, respectively). The mean AI was lowest in the PA group among all the groups ($p = 0.002$). The mean 10-year FRS was lowest in the PA group and was highest in the no PA group; however, the differences were not significant.

Factors Associated with FRS and AI in the Multiple Linear Regression Analysis

Table 3 shows the results of the multiple linear regression analyses of various factors associated with FRS. Women who were older, less educated, and current smokers had higher FRSs after controlling for socio-demographic factors and types of PA. Conversely, people who lived in rural areas and consumed alcohol regularly had lower FRSs. Type of PA was not associated with the FRS. Table 3 also presents the factors associated with AI. Women who were less educated, unemployed, and current smokers had an increased AI even after controlling for socio-demographic factors and types of PA.

Table 1. *Characteristics of Participants according to the Types of Physical Activities Female (N = 3,456)*

Variables	Moderate-intensity PA (n = 163)	Walking (n = 1,172)	No PA (n = 2,121)	p
Age (years)	71.5±0.52	72.3±0.19	73.2±0.15	< 0.001
Age group (%)				
65-74	71.9 (4.58)	66.6 (1.75)	59.9 (1.33)	0.001
≥75	28.1 (4.58)	33.4 (1.75)	40.1 (1.33)	
Married (%)	59.4 (4.46)	43.1 (1.80)	43.5 (1.32)	0.005
Education level (%)				0.002
Elm to Middle school	96.8 (1.77)	89.8 (1.10)	93.5 (0.64)	
High school to University	3.2 (1.77)	10.2 (1.10)	6.5 (0.64)	
Currently Employed (%)	53.3 (4.85)	26.9 (1.79)	24.3 (1.28)	< 0.001
Household income (Quartiles)				0.152
Lowest to Lower middle	41.7 (4.28)	50.1 (1.93)	50.7 (1.41)	
Upper middle to Upper	58.3 (4.28)	49.9 (1.93)	49.3 (1.41)	
Living place (% rural)	43.4 (5.03)	29.7 (2.25)	35.6 (2.23)	0.007
Current smoker (%)	0.6 (0.59)	5.5 (0.82)	5.2 (0.61)	< 0.001
Regular drinker (%)	13.0 (2.78)	18.8 (1.49)	16.8 (1.02)	0.161

Values are weighted mean ± SE or weighted percentage (±SE); P-values are by ANOVA or chi-square test as appropriate. Abbreviation: Elm, elementary.

Table 2. *Cardiovascular Risk Factors*

Variables	Moderate-intensity PA (n = 163)	Walking (n = 1,172)	No PA (n = 2,121)	p
BMI (Kg/m^2)	24.6±0.26	24.1±0.12	24.3±0.10	0.131
BMI ≥ 25Kg/m^2 (%)	45.1 (4.57)	37.6 (1.71)	39.2 (1.33)	0.304
WC (Cm)	83.9±0.82	83.0 ± 0.35	83.7±0.29	0.289
WC ≥ 85 cm (%)	40.5 (4.87)	42.7 (1.78)	44.6 (1.43)	0.563
SBP	130.3±1.70	131.5±0.68	130.6±0.48	0.472
DBP	73.8±1.04	75.5±0.36	74.9±0.27	0.214
High BP (≥ 140/90) (%)	30.2 (4.52)	29.7 (1.71)	29.3 (1.22)	0.963
HTN diagnosis (%)	55.8 (4.90)	52.3 (1.79)	54.4 (1.47)	0.605
Use of antihypertensives (%)	52.0 (4.93)	49.2 (1.87)	52.1 (1.47)	0.458
TC (mg/dL)	199.6±3.05	200.9±1.33	201.6±1.01	0.788
TC ≥ 200 (%)	47.3 (4.43)	51.3 (1.80)	48.8 (1.26)	0.457
HDL-C (mg/dL)	51.3±1.22	50.5±0.45	48.8±0.34	0.004
HDL-C < 50 (%)	49.0 (4.80)	50.0 (1.91)	55.9 (1.35)	0.024
LDL-C (mg/dL)	121.5±2.27	122.2± 1.21	122.9±0.91	0.787
LDL-C ≥ 160 (%)	7.7 (2.39)	10.5 (1.07)	13.8 (0.91)	0.010
FBS (mg/dL)	103.4±2.40	102.2±0.86	103.7±0.73	0.434
DM (%)	22.8 (4.14)	19.2 (1.57)	20.6 (1.03)	0.638
Triglycerides (mg/dL)	134.4±6.81	141.1±2.96	149.6±2.42	0.017
Triglycerides ≥ 150 (%)	30.5 (4.26)	34.2 (1.68)	39.4 (1.32)	0.015
Use of anti-hypercholesterolemia drugs (%)	0.3 (0.11)	11.9 (1.31)	10.3 (0.80)	0.366
Framingham risk score	16.8±1.08	17.7±0.46	18.3±0.32	0.258
Atherogenic index	3.1±0.09	3.2±0.04	3.3±0.03	0.002

Values are weighted mean±SE or weighted percentage (±SE); P-values are by ANOVA or Chi-square test as appropriate. See METHOD section for the formulas of Framingham risk score and atherogenic index; Abbreviation: BMI, body mass index; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; FBS, fasting blood sugar; DM, diabetes mellitus.

Table 3. Factors associated with FRS of general CVD and AI by multiple linear regression analyses

	Framingham Risk Score (FRS)				Atherogenic Index (AI)			
	B	β	SE	p	B	β	SE	p
Age	0.654	0.324	0.05	<0.001	0.007	0.032	0.01	0.193
Marital status								
Married and living together	Reference				Reference			
Unmarried	0.536	0.024	0.45	0.229	-0.025	-0.011	0.05	0.620
Education level								
Elementary to Middle school	2.877	0.070	0.65	<0.001	0.454	0.105	0.08	<0.001
High school to University	Reference				Reference			
Currently employed								
Yes	Reference				Reference			
No	0.493	0.020	0.52	0.343	0.105	0.040	0.05	0.045
Household income								
Lower to Lower middle	-0.337	-0.015	0.44	0.449	-0.078	-0.034	0.05	0.105
Middle upper to Upper	Reference				Reference			
Residence								
Urban	Reference				Reference			
Rural	-1.523	-0.065	0.50	0.002	-0.058	-0.024	0.06	0.290
Current smoking	10.661	0.211	1.53	<0.001	0.389	0.074	0.12	0.002
Regular drinking	-1.875	-0.064	0.51	<0.001	-0.204	-0.066	0.07	0.002
Types of PA								
Walking	Reference				Reference			
Moderate-intensity PA	0.472	0.009	1.04	0.650	-0.068	-0.012	0.10	0.493
None	0.128	0.006	0.46	0.781	0.122	0.051	0.05	0.021

P-values are by multiple linear regression analyses adjusted for demographic factors and the types of PA. Adjusted R^2=0.192 for FRS and 0.029 for AI. *Abbreviation:* CVD, cardiovascular disease; PA, physical activity

The women who did not participate in any PA had a higher AI than those who participated in regular walking or PA after controlling for socio-demographic factors and types of PA. In addition, regular drinking was associated with a reduced AI.

Discussion

This study examined the rates and types of PA participation, factors related to PA participation, and cardiovascular risks according to the type of PA among elderly women who did not have any CVD, using 7 years of data from Korea's nationally representative database. The major findings in our study can be summarized as follows: 1) Of the 3,456 women who were eligible for this study, 61.4% were not engaged in any type of PA; 2) women who were younger, married, currently employed, or living in a rural area were more likely to be engaged in regular PA; and 3) although PA had no significant effect on the FRS, regular PA and regular walking were associated with favorable lipid profiles, contributing to a lower AI.

This study found that more than half of the study participants did not engage in any type of PA. Only a few population-based studies have examined PA participation rates. Keadle and colleagues (2016) found that only 27.3% to 44.3% of older adults (≥65 years) participated in moderate to vigorous PA for 150 minutes/week in the US according to leading national surveys. Given the well-known health benefits of PA, these low participation rates are quite surprising and concerning.

Table 1 shows the characteristics of the study participants according to the types of PA. In summary, the participants in the regular PA group tended to be younger, married, currently employed, non-smokers, and in a rural environment. Decreased PA is expected with aging because physical and psychosocial functioning decrease as people age (Moschny, Platen, Klaaßen-Mielke, Trampisch, & Hinrichs, 2011). Other studies have reported that characteristics of the living environment such as opportunities or safety issues for PA (increased frailty and fear of falling) are important for determining participation of elderly people in PA (Eichinger, Titze, Haditsch, Dorner, & Stronegger, 2016). Married women or women living with a partner were more frequently engaged in PA in this study. Studies in this regard have shown conflicting results. Being married was associated with increased PA rates among the elderly population in the US (Pettee et al., 2006), whereas living alone was associated with increased PA rates in elderly women in a German study (Moschny et al., 2011). The reason for these contradictory results is not clear, but encouragement from the spouse or partner could increase motivation for engaging in PA. However, being married might also decrease motivation for PA because of obligations to do housework. Previous studies have reported that higher educational level is positively associated with PA participation (Kim & Park, 2013; Wilcox, Bopp, Oberrecht, Kammermann, & McElmurray, 2003). Higher income and greater social support were also reported to increase PA participation among older women in the US (Lee & Levy, 2011; Wilcox, Castro, King, Housemann, & Brownson, 2000). Conversely, smoking and living in a rural environment were negatively associated with PA participation (Kaczynski, Manske, Mannell, & Grewal, 2008; Wilcox, Castro, King, Housemann, & Brownson, 2000). In our study, household income did not affect PA participation. However, we also found that living in a rural environment and not smoking were positively associated with PA participation. Taken together, the factors that influenced PA participation in the elderly female population could differ in terms of ethnicity, culture, or geography.

Table 2 shows that the participants in the regular PA group have a favorable lipid profile based on a higher HDL-C level. The specific effect of exercise on HDL-C is well known (Kodama et al., 2007). Other than HDL-C, other well-established cardiovascular risk factors such as body mass index, waist circumference, hypertension, or total cholesterol level were not significantly different between groups. Whether these findings are relevant for our study population, i.e., elderly female Koreans, requires further verification using a different study population.

The multivariate regression analysis revealed that both lower education levels and smoking were associated with increased FRS and AI. Although we cannot assume that participants with a lower educational level had less knowledge about the beneficial effects of PA on health, our findings might indirectly suggest the importance of education in this regard. Regular drinking was associated with decreased FRS and AI. This might reflect findings reported by others that low to moderate alcohol consumption, particularly of wine, is associated with decreased CVD-related morbidity and mortality (Klatsky, 2015). In this study, the total 10-year FRSs did not significantly differ according to the type of PA. The reason for no significant effect of PA on the FRS, despite improvement in the lipid profile, is unclear. Our findings could have been impacted by our exclusion of women with a previous diagnosis of CVD from the study to avoid possible confounding factors. It is interesting that the FRS has been reported to likely predict CVD risks more accurately in Americans than in non-Americans, and in European Americans and African Americans than in Hispanic and Native Americans, although this needs to be further verified (Brindle et al., 2003; Nishimura et al., 2014; Riddell et al., 2010; Sacco et al., 2009). The FRS may not be a good tool to assess CVD risk factors in elderly Korean women.

The overall beneficial health effect of PA in our study was most prominent with regard to the lipid profile, leading to improvement of AI. The usefulness of AI for CVD risk assessment in the Korean population has been well verified (Lee et al., 2016). The multivariate regression analysis showed that improvement in the lipid profile occurred not only in the regular PA group, but also in the regular walking group. Previous studies have reported the favorable effects of even minor exercise, such as simple regular walking, on CVD reduction (Manson et al., 2002; Tanasescu et al., 2002).

A major strength of this study is that it has examined the health effects of PA using a homogeneous population in terms of race, ethnicity, and gender using population-based national data. Thus, the study findings are representative. Previously, similar studies have been done in on the Korean population. However, the target study population was “metabolically healthy obese” Korean people in one study (Moon et al., 2017), while the outcome variable was prevalence of CVDs in another study (Park & Park, 2017). Thus, our study is different in terms of the study population and outcome variable.

This study also has a few limitations. Firstly, this study utilized a cross-sectional study design. Therefore, findings from this study merely represent statistical associations between PA levels and CVD risk factors rather than cause and effect. Secondly, PA or exercise is only effective when performed consistently. However, detailed data, such as duration of PA, were not available at the time of the survey. Further studies using longitudinal approaches may be required to verify our study’s findings.

Conclusion

More than half of the elderly Korean female participants of this study were not engaged in any kind of PA. This study suggests that regular PA participation is important to modify CVD risk factors in the elderly Korean female population. Additional studies to examine the factors that lead to low PA participation rates and strategies for promoting PA in the population are warranted.

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