보건행정학회지 2022;32(1):21-28 | ISSN 1225-4266
Health Policy and Management Vol.32 No.1, 21-28
https://doi.org/10.4332/KJHPA.2022.32.1.21

ORIGINAL ARTICLE

Regular Physical Exercise and Falling in Middle-Aged and Elderly Population: Results from Korean Longitudinal Study of Ageing

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Background: To investigate the association between regular physical exercise and falling experience for 2 years and fear of falling (FOF) in Korean middle-aged and elderly population.

Methods: Data from the Korean Longitudinal Study on Aging was used and 3,871 participants who exercised regularly were included at 2006 and follow-up until 2018. An analysis was performed to investigate the association between exercise (exercise time per week and duration) and falls (experience over past 2 years and FOF) using the generalized estimating equation model.

Results: Compared to those who exercised more than 5 hours a week (reference group), those who exercised less than 3 hours were more likely to experience falls and FOF (odds ratio [OR], 1.334; 95% confidence interval [CI], 1.059-1.682; OR, 1.218; 95% CI, 1.119-1.326, respectively). Compared to the group who exercised for more than 5 years, those who exercised for less than 1 year were more likely to experience FOF (OR, 1.310; 95% CI, 1.162-1.478).

Conclusion: This study showed that there was a negative relationship between physical exercise time and falling experience and FOF in Korean 45 years or more community-dwelling adults. Based on these results, physical activity can be expected to have a positive effect on fall prevention, which implies the need for policy and research on long-term physical activity programs.

Keywords: Elderly; Exercise; Falling; Fear of falling

INTRODUCTION

Falls are the most common cause of trauma that can occur at all ages. However, for elderly people, falls cause more problems, owing to the serious trauma or complications that can result. In China, falls are the highest cause of death among all types of trauma [1,2] and, in the United States, more than one third of elderly people aged 65 years or older experience falls more than once a year. In Korea, more than half of the physical damage to senior citizens aged 65 years or older is considered to be fall-related [3]. For the elderly, falls can cause serious trauma, such as fractures or head injury, and complications, such as deterioration of function due to these trauma [4]. In addition to these pathological phenomena, falls have high economic costs in medical service utilization worldwide [5]. Falling occurs in daily life (walking, stair climbing, and moving) or when exposed to careless situations during hospitalization. Falls are caused by a loss of balance or damage to the body function of balance in any motion, and, to prevent them, it is important to identify their main causes. Falls are categorized according to intrinsic factors, such as physical factors, disease, and medication, and physiological changes according to vision, cardiovascular system, musculoskeletal system age, and external factors such as environmental factors [6].

In addition to these pathological causes, fear of falling (FOF) is a major independent risk factor for falls, along with depression [7]. FOF

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Received: August 8, 2021, **Revised**: December 6, 2021, **Accepted after revision**: March 8, 2022

is defined as a "persistent feeling related to the risk of falling during one or more activities of daily living" [8]. Not only does it decrease the quality of life, but it is a leading cause of injury, morbidity, and mortality [9]. Moreover, it has a negative effect on physical health and physical activity [10,11]. According to a prior study, physical activity leads to positive effects, such as the prevention of various diseases and premature mortality [12]. For the elderly population, physical activity nurtures physical self-satisfaction and self-esteem and can prevent many diseases, such as depression, cardiovascular disease, and osteoporosis [13-16]. Moreover, appropriate physical activity can improve quality of life [17] and reduce FOF [18] for the elderly population.

Based on a systematic review, physical activity, which refers to a series of exercises that can help balance the body of an elderly person to avoid strain, has been found to prevent falls [19]. In addition, based on prior study, light physical activity in the elderly population can prevent falls in the long term [20]. FOF itself can have a substantial impact on the elderly population [21]. Therefore, if physical activity can reduce FOF or falling, it can prevent various diseases in the elderly population. Consequently, in this study, we aimed to verify the effects of physical activity on FOF and falling.

METHODS

1. Data source

The data used for the following analyses were derived from the Korean Longitudinal Study of Aging (KLoSA) from 2006 to 2018. The KLoSA was constructed by repeatedly surveying the identical content for the same respondents biennially. Thus, all variables surveyed by the KLoSA were repeatedly measured from the 1st wave to the 7th wave to collect observation cases at multiple points in time. This biennial survey involves multistage stratified sampling based on geographical areas and housing types across Korea. Participants were selected randomly using a multistage, stratified probability sampling design to create a nationally representative sample of community-dwelling Koreans 45 years of age and older. Participant selection was performed by the Korea Labor Institute for these rapidly growing populations, including individuals from both urban and rural areas. In case of refusal to participate, another subject was selected from an additional, similar sample from the same district. The KLoSA was approved by Statistics Korea (approval no., 33602) and the survey was conducted after acquiring the verbal consent of participants. The KLoSA data has been released to the public for scientific use, ethical approval was not required for this study. The first baseline survey in 2006 included 10,254 participants. In 2014 and 2016, including new participants 920 and 878, respectively, the number of participants followed up in 2016 was 9,913, of which about 79.6% were the original panel. To investigate the association between regular physical exercise and fall experience/FOF, we only included those who responded that they exercise at least once a week and excluded those who lacked information on variables in the study model. Finally, this study included 3,871 participants at baseline.

2. Independent variables

1) Exercise time per week (hour)

The exercise time per week was calculated through the following two questions: How many times a week do you exercise? and How many minutes do you usually exercise once? The exercise time was divided into "less than 3 hours," "3 hours," "4 hours," and "more than 5 hours."

2) Exercise duration (year)

Exercise duration was extracted from response to the question: How long have you been exercising regularly? The response was divided into "less than 1 year," "1–2 years," "3–4 years," and "more than 5 years."

3. Dependent variables

1) Fall experience for 2 years

Fall experience for 2 years was extracted from response to the question: Have you ever had fall experience in the past 2 years? The response was divided into "yes" and "no."

2) Fear of falling

FOF was extracted from response to the question: Do you have worry about falling? The response was divided into "yes" and "no."

4. Control variables

Covariates were set in consideration of socioeconomic factors,

demographic factors, health status, and behavioral factors that may be related to the occurrence of a fall experience or FOF [22,23].

1) Socioeconomic and demographic factors

Age groups were divided into four categories: ≤54, 55–64, 65–74, ≥ 75 years of age. Education level was categorized into four groups: elementary school or lower, middle school, high school, and college or higher. Gender was categorized male and female and marital status was divided into three groups: married, separated or divorced, and single. Health insurance was categorized into national health insurance and medical aid.

2) Health status and behavioral factors

Activity restrictions were based on responses from the following question: Is there any problem with your work or activity due to your health condition? Respondents of "always" and "sometimes" were divided into "yes" groups, and "rarely" and "never" were divided into "no" groups [23,24]. Depending on current drinking, alcohol consumption was divided into two groups: yes or no. Finally, the number of chronic diseases (consisting of hypertension, diabetes, osteoarthritis, rheumatoid arthritis, cancer, chronic pulmonary disease, liver disease, cardiovascular disease, and cerebrovascular disease) and year dummies were included as covariates in our analyses.

5. Analytical approach and statistics

Chi-square test and a generalized estimating equation (GEE) model were used to investigate the association between regular physical activity and depression. The data used in the study are repeatedly measured data surveyed every 2 years, therefore the use of a GEE model was required in order to handle the unbalanced data [25]. This analysis yielded odds ratio (OR) and 95% confidence interval (95% CI). For all analyses, statistical significance was set to $p<0.05$, two-tailed, and was conducted using the SAS statistical software package ver. 9.4 (SAS Institute Inc., Cary, NC, USA).

RESULTS

1. General characteristics

Table 1 displays the general characteristics of the subjects included in the analysis at baseline. Of the 3,871 research subjects included in the present study, 3.6% (n=141) had experienced falls within the last 2 years, and 36.8% (n=1,423) were afraid of falling. Among those who had experienced falls within the past 2 years, 5.0% (n=61) reported that their average weekly exercise time was less than 3 hours, 3.2% (n=22) reported less than 4 hours, 2.4% (n=10) more than 4 hours, and 3.1% (n=48) more than 5 hours. In addition, 6.4% (n=29) were under 1 year of exercise, 3.9% (n=28) were between 1 year and 2 years, 3.3% (n=25) were between 3 years and less than 4 years, and 3.1% (n=59) were over 5 years. There was a statistically significant difference in the distribution of the dependent variables (fall experience for 2 years and FOF) according to the independent variables, "exercise time per week" (p=0.025, p=0.015, respectively) and "exercise duration" (p=0.007, p=0.042, respectively).

2. Association between fall experience, fear of falling, and physical activity

Table 2 shows the relationship between fall experience, FOF, and physical activity adjusted for socioeconomic status, health risk, and behavioral factors. After adjusting all of these confounders, compared to those who exercised more than 5 hours a week (reference group), those who exercised less than 3 hours were statistically significantly more likely to experience falls and FOF (OR, 1.334; 95% CI, 1.059–1.682; OR, 1.218; 95% CI, 1.119–1.326, respectively). Compared to the group who exercised for more than 5 years, those who exercised for less than 1 year were more likely to experience falls and FOF, but the falls experience were not statistically significant (OR, 1.243; 95% CI, 0.929–1.663; OR, 1.310; 95% CI, 1.162–1.478, respectively). In addition, the exercise duration was "1–2 years" groups and "3–4 years" groups were statistically significantly more likely to experience FOF (OR, 1.186; 95% CI, 1.080–1.303; OR, 1.202; 95% CI, 1.100–1.313, respectively). Those who had a FOF were statistically significantly more likely to have experienced falls over the past 2 years than those who had no FOF (OR, 6.509; 95% CI, 4.649–9.114), and those who have experienced falls over the past 2 years were statistically significantly more likely to have a FOF than those who have not (OR, 6.501; 95% CI, 4.623–9.144).

Table 1. General characteristics of subjects included for analysis at baseline

Characteristic	Fall experience for 2 years			Fear of falling		
	Total	Yes	*p*-value	Total	Yes	*p*-value
Exercise time per week (hr)			0.025*			0.015*
<3	1,232 (31.8)	61 (5.0)		1,232 (31.8)	457 (37.1)	
3	682 (17.6)	22 (3.2)		682 (17.6)	274 (40.2)	
4	413 (10.7)	10 (2.4)		413 (10.7)	126 (30.5)	
≥5	1,544 (39.9)	48 (3.1)		1,544 (39.9)	566 (36.7)	
Exercise duration (yr)			0.007**			0.042*
<1	455 (11.8)	29 (6.4)		455 (11.8)	190 (41.8)	
1–2	721 (18.6)	28 (3.9)		721 (18.6)	275 (38.1)	
3–4	764 (19.7)	25 (3.3)		764 (19.7)	283 (37.0)	
≥5	1,931 (49.9)	59 (3.1)		1,931 (49.9)	675 (35.0)	
Age (yr)			<0.0001***			<0.0001***
≤54	1,434 (37.0)	28 (2.0)		1,434 (37.0)	226 (15.8)	
55–64	1,148 (29.7)	36 (3.1)		1,148 (29.7)	400 (34.8)	
65–74	961 (24.8)	54 (5.6)		961 (24.8)	547 (56.9)	
≥75	328 (8.5)	23 (7.0)		328 (8.5)	250 (76.2)	
Education level			<0.0001***			<0.0001***
≤Elementary school	1,225 (31.7)	88 (7.2)		1,225 (31.7)	754 (61.6)	
Middle school	691 (17.9)	22 (3.2)		691 (17.9)	243 (35.2)	
High school	1,300 (33.6)	24 (1.9)		1,300 (33.6)	297 (22.9)	
≥College	655 (16.9)	7 (1.1)		655 (16.9)	129 (19.7)	
Gender			<0.0001***			<0.0001***
Male	1,880 (48.6)	35 (1.9)		1,880 (48.6)	525 (27.9)	
Female	1,991 (51.4)	106 (5.3)		1,991 (51.4)	898 (45.1)	
Marital status			<0.0001***			<0.0001***
Married	3,263 (84.3)	87 (2.7)		3,263 (84.3)	1,052 (32.2)	
Separated, divorced	592 (15.3)	54 (9.1)		592 (15.3)	365 (61.7)	
Single	16 (0.4)	0		16 (0.4)	6 (37.5)	
Health insurance			0.002***			<0.0001***
National health insurance	3,692 (95.4)	127 (3.4)		3,692 (95.4)	1,318 (35.7)	
Medical aid	179 (4.6)	14 (7.8)		179 (4.6)	105 (58.7)	
Activity restriction			<0.0001***			<0.0001***
Yes	1,040 (26.9)	76 (7.3)		1,040 (26.9)	666 (64.0)	
No	2,831 (73.1)	65 (2.3)		2,831 (73.1)	757 (26.7)	
Alcohol consumption			0.051			<0.0001***
Yes	1,626 (42.0)	48 (3.0)		1,626 (42.0)	437 (26.9)	
No	2,245 (58.0)	93 (4.1)		2,245 (58.0)	986 (43.9)	
No. of chronic disease†			0.001***			<0.0001***
0	2,032 (52.5)	55 (2.7)		2,032 (52.5)	504 (24.8)	
1	1,100 (28.4)	43 (3.9)		1,100 (28.4)	463 (42.1)	
≥2	739 (19.1)	43 (5.8)		739 (19.1)	456 (61.7)	
Total	3,871 (100.0)	141 (3.6)		3,871(100.0)	1,423 (36.8)	

Values are presented as number (%).
*p<0.05. **p<0.01. ***p<0.001. †Hypertension, diabetes, osteoarthritis, rheumatoid arthritis, cancer, chronic pulmonary disease, liver disease, cardiovascular disease, and cerebrovascular disease.

DISCUSSION

In modern society, the importance of quality of life due to the increase in life expectancy is growing, and this is no exception for the elderly. By preventing diseases, quality of life can be preserved, and the most frequent cause of trauma in older people is fall [1-4]. In this

Table 2. Association between physical exercise and falling

Variable	Fall experience for 2 years		Fear of falling	
	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Exercise time per week (hr)				
<3	1.334 (1.059–1.682)	0.015**	1.218 (1.119–1.326)	<0.0001***
3	0.761 (0.565–1.025)	0.073	1.062 (0.968–1.165)	0.201
4	0.927 (0.636–1.351)	0.694	0.891 (0.793–1.001)	0.051
≥5	1.000		1.000	
Exercise duration (yr)				
<1	1.243 (0.929–1.663)	0.143	1.310 (1.162–1.478)	<0.0001***
1–2	0.869 (0.663–1.139)	0.309	1.186 (1.080–1.303)	0.000***
3–4	0.672 (0.505–0.895)	0.007***	1.202 (1.100–1.313)	<0.0001***
≥5	1.000		1.000	
Fear of falling				
Yes	6.509 (4.649–9.114)	<0.0001***		
No	1.000			
Fall experience for 2 years				
Yes			6.501 (4.623–9.144)	<0.0001***
No			1.000	
Age (yr)				
≤54	1.000		1.000	
55–64	0.956 (0.669–1.366)	0.805	2.121 (1.915–2.350)	<0.0001***
65–74	1.000 (0.692–1.444)	0.999	5.120 (4.577–5.727)	<0.0001***
≥75	1.016 (0.672–1.536)	0.939	11.108 (9.604–12.849)	<0.0001***
Education level				
≤Elementary school	1.321 (0.884–1.974)	0.175	1.552 (1.385–1.739)	<0.0001***
Middle school	1.000 (0.646–1.548)	1.000	1.313 (1.170–1.474)	<0.0001***
High school	1.115 (0.746–1.666)	0.596	1.091 (0.988–1.204)	0.084
≥College	1.000		1.000	
Gender				
Male	1.000		1.000	
Female	1.638 (1.264–2.122)	0.000***	1.865 (1.720–2.023)	<0.0001***
Marital status				
Married	1.000		1.000	
Separated, divorced	1.404 (1.105–1.785)	0.006***	1.143 (1.030–1.268)	0.012**
Single	0.511 (0.069–3.795)	0.512	1.245 (0.754–2.057)	0.391
Health insurance				
National health insurance	1.000		1.000	
Medical aid	1.160 (0.793–1.695)	0.444	1.768 (1.425–2.193)	<0.0001***
Activity restriction				
Yes	1.830 (1.479–2.263)	<0.0001***	3.275 (3.005–3.569)	<0.0001***
No	1.000		1.000	
Alcohol consumption				
Yes	1.000		1.000	
No	0.887 (0.699–1.125)	0.324	1.307 (1.213–1.409)	<0.0001***
No. of chronic disease†				
0	1.000		1.000	
1	1.247 (0.959–1.620)	0.100	1.096 (0.990–1.214)	0.077
≥2	1.187 (0.823–1.710)	0.359	1.620 (1.361–1.928)	<0.0001***
Year				
2006	4.802 (2.973–7.755)	<0.0001***	0.258 (0.224–0.297)	<0.0001***
2008	3.198 (1.982–5.160)	<0.0001***	0.391 (0.341–0.449)	<0.0001***
2010	2.682 (1.641–4.386)	<0.0001***	0.548 (0.477–0.630)	<0.0001***
2012	2.161 (1.307–3.572)	0.003***	0.519 (0.452–0.596)	<0.0001***
2014	2.221 (1.353–3.645)	0.002***	0.616 (0.536–0.707)	<0.0001***
2016	1.291 (0.753–2.216)	0.353	0.713 (0.622–0.818)	<0.0001***
2018	1.000		1.000	

OR, odds ratio; CI, confidence interval.
**p<0.01. ***p<0.001. †Hypertension, diabetes, osteoarthritis, rheumatoid arthritis, cancer, chronic pulmonary disease, liver disease, cardiovascular disease, and cerebrovascular disease.

study, we wanted to verify how physical activity affects the FOF or fall experience in Korean elderly people, and the analysis confirmed three facts.

1. First, high physical activity time per week is associated with lower falls.

However, statistically, only those who had physically activity for less than 3 hours compared to those who performed more than 5 hours a week showed meaningful results and other response groups showed no significant results. This phenomenon seems to be due to the inclusion of those who do not engage in physical activities in the case of the group who said it was less than 3 hours. Thus, the fall experience can be confirmed to be affected by the presence of physical activity (whether physical activity is done or not at all).

2. Second, high physical activity time per week is associated with lower FOF.

As shown in the first analysis, only those who performed physical activities for less than 3 hours showed a statistically significant view compared to those who performed physical activities for more than 5 hours a week. That confirms FOF is also affected by the presence of physical activity.

3. Third, the longer periods of physical activity were associated with lower FOF.

Unlike the first fact, this result was statistically meaningful for all groups. Compared to those who had more than 5 years of physical activity, the 1–2 years group and the less than 1-year group had a higher fear of falls. These results indicate that the longer the period of physical activity, gets the less FOF. Overall, the length of time spent performing physical activity did not have a significant impact on falls and FOF, but the through the analysis result determined that whether physical activity affected falling and FOF, and also it is confirmed that the duration of physical activity had a significant relationship with the fear of falls. FOF is classified as a major risk factor for falls [7], and the duration of physical activity has a significant relationship with the FOF, it is confirmed that steady physical activity can prevent falls. Not only do steady physical activities prevent falls, but they also reduce the risk factors of cardiovascular disease, metabolic syndrome, and various cancer risks [26-28]. In addition, the World Health Organization recommends regular physical activities for people with lack of physical activity [29]. Therefore, programs are needed to support physical activities for the elderly population.

In Ontario, Canada, health promotion programs are being operated by recognizing the importance of physical activity for the elderly and preparing measures to utilize the resources around them [30]. Also, 28 European Union countries have published a policy called "health-enhancing physical activity" to encourage physical activity to all ages [31]. There is no clear policy on physical activity in the United States, but there are guidelines such as how to do proper exercise by compiling a physical activity guidelines for American, and encouraging exercise by dividing the appropriate types of exercise by age group and disease group [32]. However in Korea, there are only proper programs for those who are at risk of chronic diseases, while there are shortages such proper programs for the elderly [33]. It is believed that institutional study is needed to support long-term physical activities for the elderly in Korea.

There are several limitations to this study that should be taken into consideration. First, since this study is based on 3,871 participants' analysis through KLoSA, there is a limit to generalizing it as a result of the entire elderly. Therefore, further research should be discussed to expand the analysis target. Second, data was gathered from self-reports of socioeconomic factors as well as health status and risk factors. Self-reporting data may be an imperfect indicator of actual behavior. Third, information regarding health status and risk behavior factors was not sufficient. In particular, physical exercise is an independent variable and its intensity is also important. However, due to the limitation of the data used in the study, the factor could not be reflected. Therefore, we tried to control the intensity of physical activity by adding exercise duration and exercise time together. Finally, this study analyzed the panel data surveyed biennially by applying the GEE model. Therefore, all changes between 2 years could not be observed, and the analysis results mean correlation, not causality. There may be an inverse-causality between physical exercise and falling experiences and FOF. In this study, the results of the falls experience according to the survey year show it is possible that the fall experience preceded, and the results of GEE analysis that the duration of exercise increases, the more likely to falls experience, suggesting that there may be an inverse causal relationship. Therefore, the causal

relationship between physical activity and falls or FOF further needs to be clarified in future research.

Despite these limitations, in previous studies, muscle training and improvement of physical control ability through exercise did not increase the experience of falling, and it was confirmed that exercise reduced the FOF [16,17]. The results of our study were consistent with those of previous studies that performed controlled trials and meta-analyses. Therefore, our findings that exercise has a positive association with the reduction of falls and FOF are meaningful. In addition, this study uses a population-based representative sample database, and unlike the preceding study [13-16], which directly confirmed the association between falls and physical activity, this study is valuable in that it confirmed the association between falls and physical activity through a variable called fear of fall.

In conclusion, this study aimed to verify the effects of physical activity on FOF and falling experiences in elderly people. The results showed that physical activity have a significant impact on falling and FOF. Based on these results, physical activity can be expected to have a positive effect on fall prevention, which implies the need for policy and research on long-term physical activity programs.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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REFERENCES

1. GBD 2017 DALYs and HALE Collaborators. Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet 2018;392(10159):1859-1922. DOI: https://doi.org/10.1016/S0140-6736(18)32335-3.
2. Leilei D, Pengpeng Y, Haagsma JA, Ye J, Yuan W, Yuliang E, et al. The burden of injury in China, 1990-2017: findings from the Global Burden of Disease Study 2017. Lancet Public Health 2019;4(9): e449-e461. DOI: https://doi.org/10.1016/S2468-2667(19)30125-2.
3. Korea Disease Control and Prevention Agency. Falling [Internet]. Cheongju: Korea Disease Control and Prevention Agency; 2019 [cited 2022 Mar 5]. Available from: https://www.kdca.go.kr/contents.es?mid=a20203070000.
4. Sterling DA, O'Connor JA, Bonadies J. Geriatric falls: injury severity is high and disproportionate to mechanism. J Trauma 2001;50(1): 116-119. DOI: https://doi.org/10.1097/00005373-200101000-00021.
5. Stevens JA, Corso PS, Finkelstein EA, Miller TR. The costs of fatal and non-fatal falls among older adults. Inj Prev 2006;12(5):290-295. DOI: https://doi.org/10.1136/ip.2005.011015.
6. Chung NS, Choi KH. Cause and prevention of falling in the elderly. Phys Ther Korea 2001;8(3):107-117.
7. Gazibara T, Kurtagic I, Kisic-Tepavcevic D, Nurkovic S, Kovacevic N, Gazibara T, et al. Falls, risk factors and fear of falling among persons older than 65 years of age. Psychogeriatrics 2017;17(4):215-223. DOI: https://doi.org/10.1111/psyg.12217.
8. Kumar A, Delbaere K, Zijlstra GA, Carpenter H, Iliffe S, Masud T, et al. Exercise for reducing fear of falling in older people living in the community: Cochrane systematic review and meta-analysis. Age Ageing 2016;45(3):345-352. DOI: https://doi.org/10.1093/ageing/afw036.
9. Hadjistavropoulos T, Delbaere K, Fitzgerald TD. Reconceptualizing the role of fear of falling and balance confidence in fall risk. J Aging Health 2011;23(1):3-23. DOI: https://doi.org/10.1177/0898264310378039.
10. Rantakokko M, Manty M, Iwarsson S, Tormakangas T, Leinonen R, Heikkinen E, et al. Fear of moving outdoors and development of outdoor walking difficulty in older people. J Am Geriatr Soc 2009; 57(4):634-640. DOI: https://doi.org/10.1111/j.1532-5415.2009.02180.x.
11. Mishra N, Mishra AK, Bidija M. A study on correlation between depression, fear of fall and quality of life in elderly individuals. Int J Res Med Sci 2017;5(4):1456-1460. DOI: https://doi.org/10.18203/2320-6012.ijrms20171245.
12. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, et al. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet 2012;380(9838):219-229. DOI: https://doi.org/10.1016/S0140-6736(12)61031-9.
13. McAuley E, Blissmer B. Self-efficacy determinants and consequences of physical activity. Exerc Sport Sci Rev 2000;28(2):85-88.

14. Nguyen TV, Center JR, Eisman JA. Osteoporosis in elderly men and women: effects of dietary calcium, physical activity, and body mass index. J Bone Miner Res 2000;15(2):322-331. DOI: https://doi.org/10.1359/jbmr.2000.15.2.322.
15. Lerche S, Gutfreund A, Brockmann K, Hobert MA, Wurster I, Sunkel U, et al. Effect of physical activity on cognitive flexibility, depression and RBD in healthy elderly. Clin Neurol Neurosurg 2018;165:88-93. DOI: https://doi.org/10.1016/j.clineuro.2018.01.008.
16. Cheng SJ, Yu HK, Chen YC, Chen CY, Lien WC, Yang PY, et al. Physical activity and risk of cardiovascular disease among older adults. Int J Gerontol 2013;7(3):133-136. DOI: https://doi.org/10.1016/j.ijge.2013.03.001.
17. Won D, Bae JS, Byun H, Seo KB. Enhancing subjective well-being through physical activity for the elderly in Korea: a meta-analysis approach. Int J Environ Res Public Health 2019;17(1):262. DOI: https://doi.org/10.3390/ijerph17010262.
18. Jeon MY, Jeong H, Petrofsky J, Lee H, Yim J. Effects of a randomized controlled recurrent fall prevention program on risk factors for falls in frail elderly living at home in rural communities. Med Sci Monit 2014;20:2283-2291. DOI: https://doi.org/10.12659/MSM.890611.
19. Sherrington C, Michaleff ZA, Fairhall N, Paul SS, Tiedemann A, Whitney J, et al. Exercise to prevent falls in older adults: an updated systematic review and meta-analysis. Br J Sports Med 2017;51(24):1750-1758. DOI: https://doi.org/10.1136/bjsports-2016-096547.
20. Oliveira JS, Sherrington C, Paul SS, Ramsay E, Chamberlain K, Kirkham C, et al. A combined physical activity and fall prevention intervention improved mobility-related goal attainment but not physical activity in older adults: a randomised trial. J Physiother 2019;65(1):16-22. DOI: https://doi.org/10.1016/j.jphys.2018.11.005.
21. Whipple MO, Hamel AV, Talley KM. Fear of falling among community-dwelling older adults: a scoping review to identify effective evidence-based interventions. Geriatr Nurs 2018;39(2):170-177. DOI: https://doi.org/10.1016/j.gerinurse.2017.08.005.
22. Scheffer AC, Schuurmans MJ, van Dijk N, van der Hooft T, de Rooij SE. Fear of falling: measurement strategy, prevalence, risk factors and consequences among older persons. Age Ageing 2008;37(1):19-24. DOI: https://doi.org/10.1093/ageing/afm169.
23. Yang JM, Kim JH. Association between activity restriction due to fear of falling and mortality: results from the Korean longitudinal study of aging. Geriatr Gerontol Int 2022;22(2):168-174. DOI: https://doi.org/10.1111/ggi.14336.
24. Choi K, Ko Y. Characteristics associated with fear of falling and activity restriction in South Korean older adults. J Aging Health 2015;27(6):1066-1083. DOI: https://doi.org/10.1177/0898264315573519.
25. Diggle PJ, Heagerty P, Liang KY, Zeger SL. Analysis of longitudinal data. 2nd ed. Oxford: Oxford University Press; 2002.
26. Friedenreich CM, Neilson HK, Lynch BM. State of the epidemiological evidence on physical activity and cancer prevention. Eur J Cancer 2010;46(14):2593-2604. DOI: https://doi.org/10.1016/j.ejca.2010.07.028.
27. Lakka TA, Laaksonen DE. Physical activity in prevention and treatment of the metabolic syndrome. Appl Physiol Nutr Metab 2007;32(1):76-88. DOI: https://doi.org/10.1139/h06-113.
28. Wannamethee SG, Shaper AG. Physical activity in the prevention of cardiovascular disease: an epidemiological perspective. Sports Med 2001;31(2):101-114. DOI: https://doi.org/10.2165/00007256-200131020-00003.
29. World Health Organization. Global strategy on diet, physical activity and health. Geneva: World Health Organization; 2004.
30. Stathokostas L, Belfry S, Fitzgerald C, Lytle B, Trinnear M. Physical activity promotion for older adults: a step-by-step guide. Toronto (ON): Ophea; 2013.
31. Cavill N, Foster C, Oja P, Martin BW. An evidence-based approach to physical activity promotion and policy development in Europe: contrasting case studies. Promot Educ 2006;13(2):104-111. DOI: https://doi.org/10.1177/10253823060130020104.
32. Piercy KL, Troiano RP, Ballard RM, Carlson SA, Fulton JE, Galuska DA, et al. The physical activity guidelines for Americans. JAMA 2018;320(19):2020-2028. DOI: https://doi.org/10.1001/jama.2018.14854.
33. Ministry of Health and Welfare; Korea Health Promotion Foundation. 2021 Guidelines for promoting integrated health care in communities [Internet]. Sejong: Ministry of Health and Welfare, Korea Health Promotion Foundation; 2020 [cited 2022 Mar 5]. Available from: http://www.mohw.go.kr/upload/viewer/skin/doc.html?fn=1615424710210_20210311100513.pdf&rs=/upload/viewer/result/202203/.