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The Effects of Obesity on Fall Efficacy in Elderly People

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Abstract. [Purpose] The aim of this study was to identify the effects of obesity on falls as a practical verification of the importance of obesity-targeting interventions as part of future fall prevention programs. [Subjects and Methods] The study involved 351 elderly people (172 men, 179 women) living in rural areas. The dependent variable, fall efficacy, was measured using the Falls Efficacy Scale, while the independent variables, body mass index (BMI) and visceral fat, were measured using the InBody 720. The Faces Pain Scale was used to measure pain. Mobility was measured using the Timed Up and Go Test, and balance ability was measured according to the duration subjects could stand on one foot with their eyes closed. Hierarchical multiple regression analysis was performed for the final data analysis. [Results] Investigation of the correlations between the variables revealed a negative correlation between fall efficacy and the other variables. Ultimatley, investigation of the causality of fall efficacy revealed that the BMI, pain, and mobility were influential factors. In other words, fall efficacy tends to be lower when there are higher degrees of obesity, increased pain, and decreased mobility. [Conclusion] To improve the fall efficacy of elderly people living in rural areas, pain management and the maintenance of physical functionality are required. The present study confirms that the elderly need continuous obesity management to lead healthy lives.
Key words: Fall efficacy, Obesity, Elderly

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INTRODUCTION

Falling not only results in physical injury but also limits the physical activity of elderly people who have experienced falls, as the majority of elderly people with a history of falling fear that they will fall again[1)]. Numerous studies have argued that elderly people living in communities have a fear of falling, which acts as an obstacle to maintaining an independent daily life[2–4)]. Not all falls lead to physical injury, but approximately 20% of falling accidents require medical treatment; for those who are 75 years or older, this need for medical treatment is doubled[5)].

An analysis of previous studies revealed that factors related to falls can be divided into intrinsic and extrinsic factors[6)]. Specifically, internal factors include the person's age, physical abilities including strength and balance, pain, history of falls, orientation, cognitive abilities, and the fear of falling; external factors include medication intake and environmental factors[7, 8)]. Among the internal factors, however, research on whether obesity directly affects the occurrence of falls is limited. Statistically significant positive correlation was previously observed between body mass index (BMI) and functional mobility in the elderly population, and obesity was related to falls[9)]. Among the existing research[10)], a relationship between obesity in the elderly and falls has been shown, and it has been proposed that a lower BMI leads to an increase in osteoporosis due to insufficient nutritional supply, which eventually leads to severe injury from a fall[11)]. The present examined the effects of BMI after a fall rather than investigating the degree of obesity as a direct cause of falls.

The rate of obesity is increasing as a result of economic development and the Westernization of lifestyles, and this leads to various adult disease states[12)]. However, it is difficult to define obesity, and accurate measurement is very limited. Although the amount of fat tissue in the body can be measured, its general use is unfeasible because the measurement method is very difficult, time-consuming, and costly. Nevertheless, the development of measurement methods using bioelectric impedance analysis (BIA) has allowed obesity to be measured more specifically[13)]. Among the various BIA instruments, the InBody 720 (Biospace, Seoul, Korea) presents a very simple method of analyzing body composition and is a very useful tool for predicting falls in the elderly. Notably, existing BMI values provide measurements based on the weight–height ratio, and their accuracy for the very young or elderly is limited[12)]. Computed tomography (CT) scans can be used to obtain an accurate visceral fat measurement, but this method is also limited by its costliness. However, the measurement of visceral fat can be very useful because it is closely related to the risk of coronary arterial diseases and lifestyle diseases[14)]. The

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aforementioned limitations of other measurement methods can be overcome with BIA, which is useful in terms of cost and time reduction[15].

In addition to rehabilitative approaches after an acquired disability, occupational therapy emphasizes health improvement and disease prevention so that people can lead healthy lives by avoiding the onset of disabilities in the first place[16]. To age successfully, it is very important for individuals to participate continuously in their own lives[17]. Therefore, reduced balance ability, muscle weakening, experience of falling, walking ability limitations, and the fear of falling have been evaluated as part of an effort to prevent falls in the elderly population[18], and various preventative intervention programs have been implemented[19, 20]. However, there have been very few studies on the effects of obesity on falls in the elderly; various evaluations and interventions have assigned very little importance to obesity. Therefore, the present study attempted to investigate the effects of obesity on falls as a practical means of identifying the necessity of obesity-related interventions in future fall prevention programs.

SUBJECTS AND METHODS

The local government of a single rural community provided a list of elderly people living in the community. Cluster sampling was conducted to select a sample according to regional characteristics. The clusters ensured an even distribution of towns and rural areas. The final number of study participants was 172 men and 179 women, who were surveyed for their health and experience of falling between March and June 2011. We obtained written informed consent in the form of a research participation agreement from each patient. This study was approved by the Research Ethics Committees at Kangwon Hospital. We trained raters for 1 week on how to use the assessment tools to increase the reliability. The raters were blinded to the characteristics of the subjects.

We used the Falls Efficacy Scale (FES). The fear of falling is defined as low perceived self-efficacy or low sense of assurance at avoiding a fall, and fall efficacy is determined by measuring this fear[21]. The FES surveys the subject's confidence regarding 10 activities of daily living. It consists of 10 questions on the degree of confidence related to fall prevention in daily life, with a minimum score of 10 and a maximum score of 100[22]. The test–retest reliability was assessed with Cronbach's α, which was 0.96[21].

The World Health Organization defines obesity as "the state of excessive accumulation of body fat so as to be harmful for health"; however, as it is difficult to measure the amount of body fat, the BMI was proposed as the index for obesity[23]. The present study measured the BMI and visceral fat area (VFA) using a multi-frequency impedance meter (InBody 720; Biospace) that measures the impedance for each part of the body. The BMI is a measurement based on the ratio between weight and height. Although it is inaccurate for the very young or very old and for individuals with excessive muscle mass such as athletes, it is generally the most reliable measurement and is recommended by the WHO[24]. The WHO[23] defines overweight as a BMI > 25 kg/m^2 and first-degree obesity as a BMI > 30 kg/m^2[2]. CT is usually used as the basis for determining visceral fat accumulation, but the present study used the VFA as determined with an InBody 720, a measurement whose usefulness was confirmed by Gibson et al[15]. The VFA refers to the fat that has accumulated inside organs or in the empty spaces between organs. VFAs exceeding 110 cm^2 are indicative of visceral obesity; it is notable that approximately 40% of all coronary arterial disease patients exhibit an excessive accumulation of visceral fat (>120 cm^2)[25, 26]. The validity of the InBody 720 used in the present study was proposed by Gibson et al.[15], who showed that the correlation coefficient was 0.93 for both the dual energy X-ray absorptiometry scan and the underwater weighing method, which were used as references for the accuracy of body composition analysis.

The Faces Pain Scale was previously used to measure pain in young children who had difficulties expressing themselves[27]. Scherder and Bouma also used the Faces Pain Scale to measure pain in Alzheimer's patients[28]. The results of a validity analysis using the visual analogue scale and colored analogue scale in pediatric subjects were 0.92 and 0.92, respectively[29].

The abilities assessed by the Timed Up and Go (TUG) test are movements such as mobility after sitting down and then getting up, balance ability, the ability to walk a short distance, and the ability to turn. The test is carried out by measuring the time taken by the subject to get up from an armchair upon the researcher's signal, walk 3 m, and return to the chair[30]. The TUG test was previously performed on 60 elderly patients who utilized a day clinic, and it was found that the inter-tester and intra-tester reliabilities were 0.98 and 0.99, respectively[31].

To test static balance, the subjects performed the one-leg standing test. The person taking the measurements demonstrated the standing pose before the test was administered. Subjects were instructed to cross their arms, close their eyes, and stand on both legs before lifting one leg so that the knee was bent at a 90° angle. The time was measured from the moment the subject lifted one leg to when the lifted leg touched the floor or when the subject opened his or her eyes. Measurements were performed 3 times while alternating between each foot, and the highest value was selected[32].

Descriptive statistics were used to determine the general characteristics of the study participants as well as basic information for the variables. An independent sample t-test was conducted to test the mean differences according to sex. The correlations between the variables were identified before confirming the causality for fall efficacy, i.e., the dependent variable, after which the final multiple regression analysis was carried out for the dependent variable. A significance level of 95% was used for the statistical analysis.

RESULTS

The descriptive statistics analysis results of the 351 study participants are summarized in Table 1. The mean fall efficacy was 9.08 (0.83), while the mean BMI was 24.51 (3.42) kg/m^2, which was slightly lower than the overweight

Table 1. Descriptive analysis (N=351)

	Minimum	Maximum	Mean	SD
Falls efficacy	4.00	10.00	9.08	0.81
BMI[a]	17.10	34.00	24.51	3.42
VFA[b]	5.00	231.90	127.54	34.08
Pain	1.00	10.00	5.81	2.59
Mobility	1.00	23.75	10.52	3.02
Balance	0.00	68.50	9.79	9.83
Age	60.00	93.00	73.53	6.18
Gender[c]	0.00	1.00	0.49	0.50

[a]BMI: body mass index, [b]VFA: visceral fat area, [c]Gender: dummy variable (1=male, 0=female)

Table 2. Correlations among the variables (N=351)

	Falls efficacy	BMI	VFA	Pain	Mobility	Balance	Age
BMI	–0.16*						
VFA	–0.12	0.75***					
Pain	–0.40***	0.03	0.06				
Mobility	–0.41***	–0.01	0.02	0.30***			
Balance	0.25**	–0.08	–0.20**	–0.23***	–0.26***		
Age	–0.23**	–0.09	0.14*	0.24***	0.38***	–0.31***	
Gender	0.18*	–0.30***	–0.12*	–0.23***	–0.20***	0.16**	0.06

*p<0.05; **p<0.01; ***p<0.001

Table 3. Regression estimates for fall efficacy (N=351)

Variables		Model 1	Model 2	Model 3
		B	B	B
Body factor	BMI	–0.08*	–0.08*	–0.10**
	VFA	0.00	0.00	0.00
	Pain	–0.14***	–0.10***	–0.10***
Body function	Mobility		–0.11***	–0.11***
	Balance		0.01	0.01
Demographic	Gender			–0.18
	Age			–0.01
Constant		11.51***	12.33***	13.40***
F		10.72***	12.11***	8.84***
R^2		0.19	0.31	0.31

*p<0.05; **p<0.01; ***p<0.001

criterion of 25 kg/m^2. The mean VFA was 127.54 (34.08) cm^2, which was higher than the reference value of 110 cm^2; therefore, visceral obesity was confirmed. The mean values for pain, locomotion speed, and balance ability were 5.81 (2.59), 10.52 (3.02) seconds, and 9.79 (9.83), respectively. For the demographic characteristics, the mean age was 73.53 (6.18) years, and the sex ratio was 49.0% men and 51% women.

The results of the correlation analysis between the dependent variable fall efficacy and the independent variables are summarized in Table 2. Upon examining the statistically significant variables, it was clear that balance ability had a positive correlation with fall efficacy, while there was a negative correlation with the remaining variables (pain, locomotion, BMI, visceral obesity, age, sex). In addition, the correlation between the independent variables showed that pain had a positive correlation with locomotion, age, and sex and a negative correlation with balancing ability. There was a negative correlation between locomotion and balance ability, and a negative correlation between age and sex. The BMI, the index for obesity, had a positive correlation with visceral fat and sex. There was also a positive correlation between the VFA and sex.

Table 3 lists the results of the multiple regression analysis of the factors determining the final dependent variable, fall efficacy. Model 1 was an analysis of the physical factors BMI, VFA, and pain, while Model 2 also included physical functions. Model 3 included the aforementioned variables and the sociodemographic variables sex and age. The results of Model 1 had an F-value of 10.72 and a p-value of 0.00, suggesting that the model was appropriate. The R^2 value, the explanatory power of the physical functions included as variables to explain the dependent variable, was 18.80%. Model 2 had an F-value of 12.11 and a p-value of 0.00, suggesting that the model was appropriate. When mobility and balance ability were also included as explanatory variables, the R^2 value was 30.70%. Model 3 had an F-value of 8.84 and a p-value of 0.00, suggesting that the model was appropriate, while R^2, the explanatory power when physical function, degree of obesity, and demographic variables were included as explanatory variables, was 31.40%. As each model was appropriate, lower degrees of pain and obesity were associated with higher fall efficacy in Model 1. In Model 2, fall efficacy was higher when the BMI, degree of pain, and locomotion speed were low and moving ability was fast. The results of Model 3 were the same as those of Model 2, and the demographic variables included as control variables were not significant.

DISCUSSION

The present study showed that a high BMI has a negative effect on fall efficacy. This finding is consistent with the results, which showed that the degree of obesity affects fall efficacy[33)]. In other words, it is believed that obesity reduces activity in the elderly, thereby increasing the fear of falling. However, a relationship between obesity in the elderly and falls has been shown, and it has been proposed that a lower BMI leads to a higher risk of severe injury[11)]. In women in particular, a low BMI and rapid decrease in weight may lead to severe injury from a fall, as insufficient nutritional supply leads to a higher risk of osteoporosis. This finding emphasizes the influence of BMI on the risk of injury after a fall rather than proposing the BMI itself as a direct influence for a fall[11)]. However, the results of the present study indicate that the BMI does have a direct causal effect on fall efficacy.

According to a 2008 survey, 46.20% of the Korean population aged 60–69 years was obese, while 31.70% of the population aged 70 years and over was obese[34)]. Elderly people living in modern society tend to have a high BMI due to excessive nutritional intake and low activity levels, and the relationship between falls and obesity needs to be studied continuously. To this end, a variety of methods in addition to the more superficial measurement of the BMI should be used to measure the actual degree of obesity. Along with the BMI, the present study used the VFA, which affects lifestyle diseases; however, the analysis found that the VFA was not a significant factor for fall efficacy.

In addition, mobility is an important factor that affects falls in the elderly[35, 36)]. The elderly experience significant muscle loss, which amounts to more than 25% in people aged over 65 years and approximately 50% in people over 80 years old[37)]. Such a reduction in muscle mass affects functional movement and increases the fear of falling[38)]. The present study was also consistent with prior studies in that fall efficacy was lower when locomotion time was longer. The loss of muscle mass in the elderly leads to reductions in physical strength, activity level, and the abilities required for daily living, eventually rendering independent life impossible[38)]. Occupational therapy must understand the process of physical change in the elderly accurately and actively participate in the promotion of health.

Physical factors include weakening of lower body strength, reduction in walking ability, reduced balance ability, reduced grip, sensory deficits such as vision impairment, and decreased sensory motor control[39)]. Among these, balance ability has been proposed as an important factor for predicting falls in the elderly[35)], but it was not significant in the present study. We believe this is because we only examined static balance. It is believed that dynamic balance, rather than static balance, is more meaningful when considering balance ability for falls[6)]. In future research, tools that can measure more detailed balance abilities should be used. Nevertheless, the results of examining the correlation between obesity and balance ability showed that there was a statistically significant positive correlation with visceral obesity. These results are consistent with the findings of the study of Han, in which the weight of the obese group exerted an additional mean pressure of 5.12% on the heels, which had a negative effect on balance ability[10)]. Therefore, it is believed that the risk of a fall is increased for obese individuals because postural stability is compromised, thereby limiting movement.

A literature review that analyzed the results of 51 studies on fall risk factors in the elderly individuals living in communities found that pain affected physical function in the elderly in addition to being a risk factor for falls[40)]. In the study by Jeon et al., the mean age of the participants was 72 years, and most of them complained of physical discomfort such as joint pain; this discomfort was an important factor that determined fall efficacy[33)]. In the present study, the analysis deemed pain an important factor affecting fall efficacy as well. Accordingly, fall assessment and intervention programs for the elderly must account for the influence of pain.

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