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Risk Factors for Falls among the Community-Dwelling Elderly in Korea

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Community-based centres were surveyed to determine the frequency of and risk factors for falls among elderly Koreans. We examined fall-related risk factors, including physiological and physical health, psychosocial functions, self-reported physical capacity and activity, vision, and the use of medication, among 351 elderly people aged 65 years or older, with ambulatory. Forty-two per cent of elderly Korean subjects reported at least one episode of falling in the previous 12 months, 38% of whom had consequences that required either the attention of a physician or hospitalization.

Factors significantly associated with an increased risk of falling were a restricted activity during the previous five years (adjusted OR 1.3), use of alternative therapy (adjusted OR 2.7), low knee flexor and extensor-muscle strength (adjusted OR 1.21 and 1.20), and poor balance with closed eyes (adjusted OR 8.32).

We conclude that falls among older persons living in the community are common in Korea and that indicator of bad health and frailty or variables directly related to neuromuscular impairment are significant predictors of the risk of falling.

Key Words : Fall, Risk Factors, Korean, Aged

INTRODUCTION

The elderly population of Korea is rapidly growing both in size and as a proportion of the total population due to rapid economic growth and advances in medical technology. Over the three decades since 1970, the proportion of people aged 65 years and over has more than doubled from 3.1% to 7.6% and is expected to increase to 23.1% of the total population by the year 2030 (National Statistical Office of Korea, 2001). Longevity is associated with greater susceptibility to a number of health problems that can lead to actual impairment. Falls constitute one of the most prevalent and costly health problems facing the elderly and health-care communities (American Geriatric Society, British Geriatrics Society, American Academy of Orthopedic Surgeons [AGS, BGS, AAOS] Panel on Falls Prevention, 2001). Falls represent a major cause of death and disability among older people, and pose a serious threat to their physical health and psychological well-being. The consequences of falls are not confined to the older persons themselves. They not only place a burden on family members, but also strain the economic resources of health-care institutions (Tideiksaar, 2001).

Over the past several decades, the extent to which older people fall in different settings has been studied, predominantly in Western countries. In the population aged

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65 and above taken as a whole, approximately 35% to 40% of community-dwelling, generally healthy older persons fall annually (Rubenstein & Josephson, 2002). Falls and their consequences are a leading cause of death in people aged 65 years and over (Davis, 1995). Unintentional injuries are the fifth leading cause of death in older adults, and falls are responsible for two-thirds of the deaths resulting from unintentional injuries (AGS, BGS, AAOS Panel on Falls Prevention, 2001). More pointedly, 75% of deaths due to falls in the United States occur in the 13% of the population aged 65 and over (Josephson et al., 1991). Fall-related injuries recently accounted for 6% of all medical expenditure for persons aged 65 and over in the United States (Rubenstein & Powers, 1999). The risk of falls increases dramatically with age (Tinetti et al., 1994). Falling is a common problem among the elderly, although the frequency of falling reported in the literature varies: one-third to one-half of elderly people over the age of 65 experience at least one fall per year (Nickens, 1985); among community-resident populations, up to one-quarter of persons aged 65-74 years and one-third or more of those aged 75 or older fall annually (Hale et al., 1992); up to 50% of these individuals experience multiple falling events every year (Tinetti et al., 1988); about 20% of the elderly persons who fall will experience another fall within the next six months (Vellas et al., 1992).

Although the aging trend of Korean society is quite rapid, only a limited number of studies has been conducted on falls among the elderly that include the prevalence of falls and the identification of associated risk factors among the community-dwelling elderly in Korea. Moreover, the rates of falls reported in these studies show excessive variation, ranging from 21.4% (Cho et al., 2001) to 48.2% (Hwang, 1998). Falls are usually caused by the interaction of many factors, including environment, past experiences, judgment, vision, hearing, proprioception, strength, neurological and cardiovascular status, polypharmacy, and others (Hindmarsh & Estes, 1989). The increasing prevalence of chronic illness and longer lifespans are leading to an increase in older adults at risk of or with actual impairments. Impaired function is a prime contributor to high health-care costs. Prevention of disability and the preservation of independence are major clinical priorities in the health-care of older adults. To increase the overall well-being of the elderly, it is important to identify and modify the risk factors that contribute to falling with adverse outcomes.

Research aim

The aim of this study was to identify the risk factors associated with falls and to provide basic information on the prevention of falls among the community-dwelling elderly in Korea. The research questions were: (1) What are the rate of falls, in terms of age group and outdoor activity level in the elderly? (2) What are the differences between the faller and non-faller elderly groups in terms of subjects' characteristics such as socio-demographic and psychological function, and health and physical functioning? (3) What are the risk factors for falls among the elderly?

METHODS

Study design

A retrospective study design was used to evaluate the risk factors associated with falls among community-dwelling elderly people in Korea. The subjects were recruited on a volunteer basis from three health centres and four centres for seniors located in Seoul and the Kyonggi Province of Korea. The centres were chosen to equally represent different geographical locations. The subjects underwent two sessions consisting of an interview and participation in physical performance tests. The first session included structured interviews to elicit demographic and clinical data and an interview about falls. Demographic and clinical data were obtained on the subject's age, gender, educational level, comorbid conditions, height and weight, blood pressure, present illness, use of medications, cognitive status, depression, alcohol use, perceived health status, outdoor activity level, current activity and restrictions, and instrumental activities of daily living (IADL). Data on the frequency of falls, their location, use of ambulatory devices, injuries, and the consequences of falls were obtained in the falls interview. In the second session, two trained nurses carried out physical performance tests. Muscle strength, and simple quantitative and qualitative measures of vision (use of visual aids, visual acuity, depth perception), balance, and gait were assessed through observation and simple quantification of routine movements. These factors have been demonstrated to be predictors of falls, and these measures are in widespread use and have acceptable reliability (Tinetti et al., 1986).

Data collection

The eligibility criteria for elderly subjects included: a)

aged at least 65 years or older; b) ambulatory; c) able to communicate without severe cognitive impairment; d) a score of 20 or higher on the Mini-Mental State Examination - Korea (MMSE-K; Park & Kwon, 1989); and e) able to complete a written consent form. The study sample consisted of 351 elderly subjects who met the above criteria. The subjects invited to participate in the study were provided with both written and oral information about the purpose and procedures of the study, and were assured that they would remain anonymous. Written consent was obtained from all subjects participating in the study, and the approval of the Medical Research Ethics Committee of the Catholic University of Korea was given. All subjects completed a set of questionnaires that compiled the demographic data, together with measurements of muscle strength, balance, activities of daily living, and depression. Three trained nurse-researchers facilitated the study: one recruited potential participants, explained the purpose and procedures of the study, and obtained the subjects' consent; the other two conducted the assessments for the study. Data were collected from January to March 2002.

Measurements

For the purpose of the present study, the following physiological and physical health indicators and psychosocial functions were measured: muscle strength, balance, ankle flexibility, IADLs, and depression.

(a) Muscle strength - The Nicolas Manual Muscle Tester (Model 01160, Lafayette Instrument Co., Lafayette, IN), a hand-held dynamometer, was used to measure the extensor and flexor muscle strength of each knee and ankle. The same techniques for positioning the limbs was used with this device as is used in manual muscle testing. The tester moved the body part activated by the muscle through the maximum range of motion. The subject was asked to hold the maximum against gravity, while the tester applied an opposing pressure to the muscle (Kendall & McCreary, 1983). The hand-held dynamometer was placed between the muscle of the subject and the tester's hand as the tester applied this pressure. The dynamometers readings, measured in kilograms, were made at the time when maximum pressure was exerted by the tester or when the subject was unable to resist the tester's force. Four measurements of the knee extensor, knee flexor, ankle plantarflexor, and ankle dorsiflexor muscles were obtained on the right and left sides. Average strengths on the right and left were analysed. Whereas Mills (1994) reported an inter-rater coefficient over 0.93, this study established an inter-rater kappa coefficient of over 0.90 before the study began.

(b) Balance - The ability to maintain static balance was measured with a stopwatch as the period during which a subject could maintain the following three stances, with eyes open and with eyes closed:

- parallel stance (feet together, side by side).
- semi-tandem stance (toe of one foot beside heel of other foot).
- tandem stance (heel of one foot touching and in a straight line with toe of the other foot).

These stances were all measured in bare feet and no assisting devices were allowed. To minimize the risk of the subject falling during the manoeuvre, two researchers stood nearby, ready to steady the subject if necessary.

(c) Gait - Using a stopwatch, the time and the number of steps taken to cover a distance of 5 m along a pathway at a subject's normal pace were recorded over two trials. During a third trial, a rapid but safe pace was used. Stride length was calculated by dividing the distance by the total number of steps. Walking speed was calculated by dividing the distance walked (5 m) by the time taken.

(d) Instrumental activities of daily living (IADL) - Assessed with the IADL scale developed by Cho (1998) based on the scale of Lawton and Brody (1969). This scale consists of nine items and scores range from 0 to 18. A higher score indicates greater functional capacity to undertake independent living. The internal reliability of the scale was 0.88 in this study.

(e) Depression - A geriatric depression scale developed by Yesavage et al. (1983) and translated into Korean by Kee (1996) was used. The scale consists of 15 items, and scores range from 0 to 30. A higher score indicates greater depression. Cronbach's alpha of the scale was 0.88 in this study.

(f) Perceived health status - Three questions were used to measure the perceived health status based on the questionnaire developed by Speake et al. (1989), and translated and modified by the investigators through translation and back-translation processes. This scale included three items, in a five-point Likert format, in which higher scores reflect better health. The tested alpha reliability coefficient of the scale was 0.80 in this study.

(g) Falls - In this study, the rate of falls refers to

whether the subject had experienced a fall at all during the previous year. We did not analyse multiple falling events because of the possibility of recall bias. A standard definition of "fall", proposed in a recent consensus report (Gibson, 1987), was used. This report defines a fall as an event that results in a person coming to rest inadvertently on the ground or at some other lower level, but not as a consequence of one of the following events: sustaining a violent blow, loss of consciousness, or the sudden onset of paralysis (as in a stroke or epileptic seizure).

(h) Vision - Visual acuity was measured using a standardized vision chart developed by Jin (1997) for Korean people. Stereoscopic depth perception, which is assessed with a graded series of nine panels that tests fine depth discrimination, was measured using stereo test-circles and a standard 3D viewer (Stereo Optical Co. Inc., Chicago, IL). There are four circles within each square and only one of the circles has a degree of crossed disparity, and should appear in front of the plane of reference for those subjects with normal vision. To judge relative depth, the design of a circle within a circular window establishes a constant distance from the test object. The level of stereopsis at the last one chosen correctly is scored. The scale ranges from 0 to 9, and a higher score indicates better discrimination of depth.

Statistical analysis

Distribution and mean differences between subjects who fell and those who did not were determined using x^2 -test for each categorical variable and Student's t-test on the continuous variables. We fitted multivariate logistic regression models using the Statistical Analysis System (SAS, 1996) and presented the adjusted odds ratios with their confidence intervals. A probability level of < 0.05 was deemed to be statistically significant.

RESULTS

The average age (±SD) of the 351 subjects was 73.2 ±6.1 years; 74% were women. One hundred and forty-eight subjects (42.2%) had had at least one fall during the previous year, and 38.1% of those who had fallen had sustained serious injury that required a visit to an emergency room or hospitalization (Table 1). As displayed in Table 1, no gender difference in the frequency of falls was apparent when age groups of 10 years were analyzed because of the relatively small number of men in the study. The fall rates in the age groups 65-74 years, 75-84 years, and 85 years or more were 40.7%, 30.8%, and 28.6% for men and 46.8%, 41.3%, and 27.3% for women, respectively.

Interestingly, the younger people in this study, aged 65 - 74 years, had a higher rate of falls (45.1%) than the older subjects (27.8 - 39.0%). This pattern of decreasing frequency of falls with advancing age still held when the fall rate was examined separately for each sex. Among the elderly, the level of activity decreases as age increases, and less activity presumably leads to a lower risk of falling. Therefore, we examined the pattern of frequency of falls with age on the basis of outdoor activity levels, which were determined by asking the subjects to check one of four categories to describe their activity during the week before the interview: "mostly stayed home", "went out once in a while", "mostly went out", or "went out everyday." Age groups at intervals of five years were studied. As shown in Table 2, the frequency of falls increased with advancing age within the group that went out everyday, although the increment was small (29.8 - 48.1%). In the group that mostly went out, the frequency of falls also decreased with age. Because the numbers of subjects were small in the first two groups with minimal outdoor activity, these groups were combined. In this combined group, the 70 - 74-year-old

Table 1. Distribution of subjects who fell by age, sex and serious injury among fallers

Age (years)	No. of subjects			No. of fallers			Serious injury among fallers+
	Men	Women	Total	Men N (%)	Women N (%)	Total N (%)	Total N (%)
65 - 74	59	156	215	24 (40.7)	73 (46.8)	97 (45.1)	37 (38.1)
75 - 84	26	92	118	8 (30.8)	38 (41.3)	46 (39.0)	17 (16.5)
85+	7	11	18	2 (28.6)	3 (27.3)	5 (27.8)	2 (40.0)
Total	92	259	351	34 (37.0)	114 (44.0)	148 (42.2)	56 (37.8)

+ Subjects saw a physician, visited an emergency room, or were hospitalized for injury due to fall.

subjects had a higher rate of falls than did the 65 - 69-year-old subjects, but the rate decreased for the much older subjects, with a less pronounced gap between subjects of 65 - 69 years and those of 80 years and over.

When the outdoor activity level was examined for each age group (Table 2), the majority of subjects aged 65 - 69 years (47 of 105) or 70-74 years (50 of 111) reported going out every day; the majority of people in the group aged 75 - 79 years (32 of 81) stayed home or went out once in a while. Surprisingly, among the much older subjects, aged 80 years or over, the majority (28 of 54) reported going out everyday.

Socio-demographic characteristics of the subjects who did and did not fall are shown in Table 3. Younger age, use of medications, and depression were associated with a higher risk of falling. Use of alternative therapy and rapid walking was associated with an increased risk of falling, with marginal significance. The other variables were not associated with falling. As displayed in Table 4, a low perceived health status score, a restricted activity during the past five years, difficulty in standing or walking due to recent morbidity and low muscle strength (all four measures) were associated with a higher risk of falling. The other health status and physical functioning variables were not associated with falling.

Table 5 shows the associations of selected variables with falling, when the effects of other variables were controlled for. Some variables such as younger age, perceived health status, low ankle-muscle strength, depression, and rapid walking associated with falling in the univariate analysis. However those variables were strongly correlated with other variables and therefore did not remain in the multivariate model.

Variables significantly associated with an increased risk of falling were restricted activity during the previous five years, use of alternative therapy (taking nutritional supplements or medicines), extensor and flexor knee-muscle strength below 1 SD from mean, and poor tandem stance balance with closed eyes below 1 SD from mean. Poor balance with closed eyes was the highest odds ratio with 8.32, use of alternative therapy came next with 2.72, restricted activity during five years and low knee flexor and extensor-muscle strength followed them with 1.30, 1.21 and 1.20, respectively.

DISCUSSION

In our study, the frequency of falling was 45 - 46% among subjects aged 65-74 years, which is somewhat higher than that reported by another study of the Korean population (Cho et al., 2001) or the study by Tinetti et al. (1994), but is similar to that in yet another Korean study (Hwang, 1998). There may be several reasons for the higher rates of falling in the Korean population. One of these is the unfavourable state of the streets relative to those of advanced countries, in that they are

Table 2. Distribution of of Korean elderly fallers by age and outdoor activity level

Age group (years)	Total subjects	Mostly stayed home or went out once in a while		Mostly went out		Went out everyday	
		No. of subjects	No. of faller (%)	No. of subjects	No. of faller (%)	No. of subjects	No. of faller (%)
65 - 69	105	28	13 (46.4)	30	20 (66.7)	47	14 (29.8)
70 - 74	111	33	17 (51.5)	28	12 (42.9)	50	22 (44.0)
75 - 79	81	32	9 (28.0)	22	10 (45.5)	27	13 (48.1)
80+	54	14	3 (21.4)	12	3 (25.0)	28	12 (42.3)
Total	351	107	42 (39.3)	92	45 (48.9)	152	61 (40.1)

Table 3. Socio-demographic characteristics and psychological functioning of elderly subjects who did and did not fall

Characteristics	Fell (N=148)	Did not fall (N=203)	x^2 or t	*p* value
Mean age ±SD	72.36±5.74	73.00±6.25	2.30	0.0220
Women	115	144	2.03	0.1769
Living alone	25	34	0.00	1.0000
MMSE-K	25.66±3.79	26.10±3.87	0.98	0.3300
Depression	6.63±4.19	5.42±3.72	- 2.84	0.0048
Use of medications	88	97	4.68	0.0039
Alcohol use	61	92	0.59	0.4482
Use of complementary therapy	60	62	3.78	0.0547

bumpy, with continuous on-going construction. Therefore, elderly people in Korea have a greater chance of encountering dangerous "fall-prone" conditions in the streets and their surroundings. Although gender differences have generally been reported for the frequency of falling, with females falling more often than men in community-based studies (Downton & Andrews, 1991; Tinetti et al., 1988), this tendency was not confirmed in our community-based study because the number of older male subjects was relatively small.

Although the risk of falls is known to increase with age in general (Tinetti et al., 1994), the frequency of falls consistently decreased with age in our study. The decline in fall frequency with age may be attributable to many causes. Firstly, it is possible that those who were recruited constitute a select group of relatively healthy and active elderly people because interviews were done in centres for seniors. This kind of selection bias is a potential problem in cross-sectional studies and may differentially represent age groups. In our study, the group of subjects aged 80 years and over was more active than the other groups of younger subjects. Secondly, this trend may be the result of self-imposed restrictions, or the result of frail older subjects living in protected institutional settings, or due to an increase in restraints imposed by families to protect their elderly relatives from falls. Thirdly, the pattern of increasing activity with age may be a reflection of the reality in the Korean population. In a survey comparing elderly Korean and Korean-American people recruited from centres for seniors, it was shown

Tabel 4. Health status and physical functioning of elderly subjects who did and did not fall

Characteristics	Fell (N=147)	Did not fall (N=204)	x^2 or t	*p* value
IADL	16.85±2.55	16.99±2.55	0.50	0.6184
Perceived health status score	10.97±2.72	11.55±2.65	1.98	0.0482
Current activity level	9.33±2.00	9.52±2.14	0.86	0.3915
Activity restriction	9.28±2.88	8.24±3.84	- 2.87+	0.0044+
Difficulty in standing or walking	71	75	4.28	0.0483
Visual acuity	0.46±0.22	0.47±0.25	0.60	0.5478
Depth perception	2.30±2.75	2.45±2.78	0.50	0.6159
Muscle strength (kg)				
Knee extensor	7.71±3.69	12.49±4.88	10.41	<0.0001
Knee flexor	7.96±3.62	12.19±4.89	9.21	<0.0001
Ankle plantarflexor	13.78±4.36	17.47±5.41	7.00	<0.0001
Ankle dorsiflexor	8.68±3.74	13.46±4.69	10.49	<0.0001
Balance (seconds)				
Parallel stance with eyes open	32.62±12.77	33.84±14.20	0.78	0.4333
Parallel stance with eyes closed	30.12±9.94	31.26±10.83	0.98	0.3273
Semi-tandem stance with eyes open	31.66±12.76	34.21±16.05	1.63	0.1036
Semi-tandem stance with eyes closed	39.71±141.83	29.38±11.37	- 0.86	0.3895
Tandem stance with eyes open	30.29±17.43	33.84±20.57	1.73	0.0846
Tandem stance with eyes closed	21.91±11.05	22.62±12.65	0.51	0.6090
Gait(m/seconds)				
Usual walking speed	0.80±0.21	0.79±0.20	- 0.52	0.6035
Rapid walking speed	1.24±0.33	1.18±0.33	- 1.72	0.0857

SD: standard deviation; MMSE-K: Mini-Mental State Examination - Korea
IADL: instrumental activities of daily living

Table 5. Risk factors for falls

Risk factor	Adjusted Odds Ratio	95% CI	*p* Value
Change to restricted activity during past 5 years	1.30	1.12 - 1.50	0.0004
Use of alternative therapy	2.71	1.23 - 5.94	0.013
Low knee-muscle strength			
Flexor (< 6.03 kg)	1.21	1.01 - 1.45	0.036
Extensor (< 6.13kg)	1.20	1.01 - 1.44	0.044
Poor balance with closed eyes (< 10.34 seconds)	8.32	1.09 - 63.43	0.041

CI: confidence interval
+ Adjusted odds ratios were derived from multiple logistic regression analysis.

that scores for health-promoting life patterns increased linearly with increasing age among the Koreans, whereas there was a slight decreasing trend among the Korean-American elderly (Sohng & Lee, 2000).

In our study, variables that were statistically significantly associated with an increased risk of falling, using multivariate logistic regression, were: a restricted activity during the previous five years; use of alternative therapy; low knee- muscle strength; and poor balance with closed eyes. The most significant variable for fall was poor balance with closed eyes with odds ratio 8.32 representing about 830% increased falling in faller group. The second important and significant variable associated with the risk of falls was taking nutritional supplements or herbal medicines. This is a result that is distinctive to Koreans or perhaps to many Asian countries. A survey of Korean adults showed that complementary and alternative medicines are a popular health-care resource, and that Koreans spend a substantial amount on them (Lee et al., 1999). More precisely, the utilization rate of complementary and alternative medicines among Korean adults is 29% and the annual out-of-pocket expenditure associated with complementary and alternative medicines accounts for 41% of all expenditure on medical and pharmaceutical items. Herbal medicine is known to supplement qi and to normalize the physical conditions that in turn contribute to protection from disease or to therapy (Nagasawa et al., 1997). In a transcultural study of treatment-seeking behaviours in patients with rheumatoid arthritis, 95% of Koreans took nutritional supplements compared with 61% of Americans within a year after the onset of the disease. Therefore, the use of nutritional supplements or herbal medicines is an indicator of frailty among elderly Koreans.

To eliminate or ameliorate the risk of falls among older adults it is necessary to identify the risk factors involved. However, deterioration of health may be inevitable in older subjects, and many variables, including the presence of health problems, were not significant factors in our analysis. Despite these difficulties, the most significant variable associated with the risk of falls was a change to restricted activity during the previous five years, even after adjustment was made for low muscle strength and poor balance with eyes closed. This perceived change in health status over five years reflects the personal experience of declining health, the restrictions entailed by morbidity, and the deterioration of physical functioning. In a study of the subjective evaluation of health status, Kaplan and Baron-Epel (2003) recently stated that a high proportion of the elderly compare their health to that of others of the same age. In particular, when subjects are old and unhealthy, they tend to compare themselves to friends or people of their own age. This variable of comparison of health status with that of people their own age was considered in our analysis, but was found to be insignificant. Kaplan and Baron-Epel (2003) concluded that the subjective evaluation of health is a legitimate indicator of overall health status. In our study, subjective health status was a significant predictor of the risk of falls. Other significant variables were intrinsic factors such as lower-extremity function and balance.

This study has several limitations that should be acknowledged. Firstly, because it is a retrospective study, we had to rely on elderly persons to recall their falls during the previous year. Therefore, there are obviously problems of reliability. In terms of the level of outdoor activity, a question about how frequently the subject went out was asked. This question could be refined further to determine the extent and level of indoor and outdoor activities. Secondly, extrinsic risk factors such as environmental hazards were not studied. Thirdly, the use of sedatives could not be analysed due to missing data. Subjects were asked to present all the prescriptions that they had had filled during the previous year, but because only half the subjects could comply, this variable was not included in the analysis. However, analysis of these partial data indicated that the association between the use of sedatives and the risk of falls was not statistically significant.

Any study evaluating the risk of falls poses a challenge for health workers and researchers, because the mechanism of falling is not easy to explain. The fact that low knee-muscle strength and a change to restricted activity during the previous five years were associated with a higher risk of falls may imply an increasing tendency to fall with age. However, in our study, quicker walking was also associated with a higher risk of falls, although with marginal statistical significance, which implies that greater activity may be related to higher rates of falling. These contradictory phenomena require further and more detailed study in the future.

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