Severity of injuries associated with falls in the community dwelling elderly are not affected by fall characteristics and physical function level

Severity of injuries associated with falls in the community dwelling elderly are not affected by fall characteristics and physical function level

Shinichi Demura[a], **Takayoshi Yamada**[b,*], **Kosho Kasuga**[c]

[a] Graduate School of Natural Science & Technology, Kanazawa University

Kakuma, Kanazawa, Ishikawa 920-1192 Japan

[b] Department of Health & Physical Education, Fukui National College of Technology

Geshi, Sabae, Fukui 916-8507 Japan

[c] Faculty of Education, Gifu University

1-1 Yanagido, Gifu, Gifu 501-1193 Japan

*Corresponding author

Phone: +(81-778)-628-229

Fax: +(81-778)-623-417

E-mail: takay@fukui-nct.ac.jp

Abstract

Many elderly people experience difficulty with independent living after injuries associated with falls. This study aimed to examine the influence of fall characteristics and physical function level on the severity of fall related injuries. The surveys were conducted in 1,955 community dwelling elderly. The questions regarded the following: fall experience within the past year, fall direction, fall cause, injured parts and degree of injury, and an activity of daily living (ADL) questionnaire from the Ministry of Education, Culture, Sports, Science and Technology Japan. Data of 1,850 subjects with available and complete responses were used for analysis. Three hundred eighty-six (20.9%) elderly people experienced a fall within the past year and 257 (66.7%) were injured. ADL score was significantly higher in the elderly without fall experience than the elderly with fall experience. No significant difference was found in frequency of fall cause and fall direction between the elderly with and without injuries caused by falling. Significant correlations were found between fall direction and fall cause and injured parts (φ = 0.49 and 0.32). ADL score of the elderly who fell by leg backlash was significantly lower than that of the elderly who fell by tripping, slipping and staggering. A decrease of ADL affects the rate of falls in the elderly, but not the degree of injury. Fall characteristics may not be related to the extent of fall injury.

Keywords: fall risk screening, healthy elderly, fallers, ADL, age-level changes

1. Introduction

About 20% of the Japanese elderly experience a fall within a year (Haga et al., 1986; Yasumura et al., 1991; Niino and Nakamra, 1996). Their fall rate decreases markedly with an increased degree of independence. Fall associated bone fractures that often result in bed confinement and nursing care markedly decrease with independence. Kanis et al. (2002) reported that about 10% of the elderly who fell experienced fractures. In 1987, the number of transcervical fractures for the year was 53,200, but today, it has more than doubled (117,900) (Orimo and Sakata, 2004). Because the elderly population is predicted to increase, fall incidence and the number of serious injuries related to falls may increase. As a result, it is feared that the number of elderly who will need nursing care or become bedridden will increase.

However, falls do not necessarily result in nursing care or bed confinement. Luukinen et al. (2000) reported that the incidence of indoor falls was higher than that of outdoor falls, and falls caused by slipping or stairs have an increased bone fracture risk. Moreover, Smeesters et al. (2001) reported that falls caused by tripping or from an upper level induce forward falling and impact the anterior body, and falls caused by slipping or staggering induce sideways or backwards falls and impact the hip or buttocks, therefore, increasing the risk of lumbar bone fracture. Namely, the body parts injured and the degree of injury may be affected by fall cause, such as tripping, slipping and staggering, and fall direction.

Furthermore, Gillespie et al. (2009) reported that the incidence and risk of falls were reduced by exercise intervention, particularly in the elderly with inferior physical function. Because physical function affects incidence and risk of fall, it may influence degree of injury. Little is known about the degree of injury affected by the above stated fall characteristics and physical function. It will be beneficial to prevent post fall syndromes of the elderly by clarifying the relationships between extent of injury and fall cause, fall direction, and physical function.

This study aimed to examine the influence of fall characteristics, such as fall cause and fall direction, and physical function level on the extent of injuries associated with falls.

2. Subjects and methods

2.1. Subjects

The survey was conducted in the community dwelling elderly living independently. Surveys were sent to 2,345 elderly after the study was explained and consent was obtained. Data were collected from 1,995 subjects (collect rate: 85.1%), of which 1,850 were completed. Six hundred thirty two subjects were male (age: 71.0 ± 6.7) and 1,218 subjects were female (age: 70.6 ± 7.0). The experimental protocol in this study was approved by an inquiry committee of studies intended for humans, the ”Kanazawa University Health & Sports Science Ethics Committee”.

2.2. Questionnaire items and procedure

Subjects responded to basic attributes such as register day, birth day, name, sex and age, questions regarding the fall incidence and extent of injury caused by the fall, and an ADL questionnaire from the Ministry of Education, Culture, Sports, Science and Technology Japan. Subjects were instructed to respond to the question, “Did you fall within the past year?” Types of fall were listed as “trip fall with knee down”, “fall on buttocks”, “fall from stair” and “fall by deliquium animi and black out”. Fall causes were as follows: “leg backlash”, “tripping”, “slipping”, “dizziness and staggering” and “other (open question)”. Fall direction was also studied (“forward fall”, ”backward fall”, ”sideways fall” and “other (open question)”. The injured region was classified as “upper limb injury (shoulder, arm or hand)”, “lower limb injury (lumber, leg or foot)”, “trunk injury (back, abdominal or chest)”, “head injury (head, neck or face)” and “other (open question)”. The extent of injury was defined as “fracture”, “sprain”, “contusion or cut and graze”, “no injury” and “other (open question)”. In addition, the above stated question items were selected in reference to Haga et al. (1986) and Yasumura et al. (1991).

2.3. Statistical analysis

One-way analysis of variance was used to examine the mean differences of age and ADL score among subjects who did not experience a fall and subjects who experienced a fall but were and were not injured, and the mean differences of ADL scores were compared among various fall causes, directions, injured parts and extent of injury. Tukey's HSD was used for the post hoc test. The chi square test was used to examine the difference in frequency of cause and direction of fall between fall experience with and without injury. Frequency among each category was compared using adjusted standardized residual. φ coefficient was used to examine relationships among cause and direction of fall, and parts and degree of injury by fall. In addition, data corresponding to "other" was excluded from any analysis. A probability level $p < 0.05$ was indicative of statistical significance and adjusted in reference to Bonferroni's method.

3. Results

Table 1 shows the frequency of falls and fall injuries. The rate of falls was 20.9% and that of injuries was 66.6%. Table 2 shows the results of one-way analysis of variance and post hoc analysis for age and ADL score among the three groups. Significant differences were found in age and ADL. Younger subjects had a lower fall rate and subjects with a lower ADL score had a higher fall rate. However, mean ADL score was over 25 even in the group with fall experience. Table 3 shows the results of one-way analysis of variance and post hoc analysis for ADL score among cause and direction of fall and injured parts and extent of injury. A significant difference was found among fall causes, and the ADL score was lower in the subjects with falls caused by leg backlash than in those with falls caused by tripping, slipping and staggering. Table 4 shows the frequency of fall cause and fall direction between injured and noninjured groups. No significant difference was found between the groups. Table 5 shows the correlations among cause and direction of fall, and injured parts and extent of injury. Significant correlations were found between fall direction and fall cause, and parts injured during the fall ($\varphi = 0.49$ and 0.32).

4. Discussion

The fall incidence was 20.9%. Yasumura et al. (1991) surveyed fall incidence for 685 elderly and reported that 19.2% of males and 20.3% of females experienced falls. Niino et al. (1996) and Haga et al. (1986) also surveyed fall incidence for 395, 527 and 1,406 elderly people respectively and reported that 14.5-22.9% experienced falls. Although physical function level and basic attributes of the elderly somewhat differed from those in this study, there was a similar fall incidence. From the above, about 20% of the Japanese elderly living in a community dwelling are judged to experience a fall within a year. The American Geriatric Society (2001) presented the major fall risk factors as follows: muscle strength decrease, fall history, gait function decrease, balance function decrease, assistive devise use, visual function decrease, arthritis, daily living activity dysfunction, blues, cognitive dysfunction and age over 80 years, and reported that the relative risks of each factor ranged from 1.7 to 4.4. Above all, a decrease of muscle strength, gait and balance ability correspond to a relative risk for fall incidence over 3.0. It is inferred that physical function decrease has a large influence on fall incidence. Moreover, Gillespie et al. (2009) examined the effect of various interventions on fall incidence and reported that physical function improvement by exercise intervention is most effective to reduce fall incidence and fall risk. From the above, physical function level is inferred to affect fall incidence greatly. In the present study, subjects who fell had a lower ADL score, supporting the findings of the American Geriatric Society (2001) and Gillespie et al. (2009). However, the ADL score of the fall group was high, over 25 points. This means that from the ADL question content, the elderly in this study have high motor and physical function and can live independently without any support. Hence, even in the elderly with high motor and physical function experience falls, a large portion (about 67%) experience injuries caused by falls. Thus, the healthy elderly are at risk of obtaining serious injuries after falls and thus requiring nursing care or bed confinement.

A relationship with ADL was not found in degree of injuries such as fracture, sprain and contusion or cut and graze. Hence, ADL may not impact fall injuries; in other words, in the healthy elderly, even if ADL is somewhat low, serious injuries such as fractures may not always occur. Shapiro et al. (2001) surveyed the types of injuries and physical conditions immediately and three months after injury, and reported that a short-term physical function decrease was induced even in the elderly who experienced slight injuries such as contusions. In the present study based on cross-sectional data, time period from injury occurrence to the survey differed among subjects. Therefore, a physical function decrease after fall and injury could not be estimated properly. From the Shapiro et al. (2001) report, it is inferred that even slight injury such as contusion or cut and graze in addition to fracture induces a physical function decrease. Moreover, it is suggested that the elderly with decreased physical function fall repeatedly, and thus physical function decrease becomes more marked. Further studies will be required to examine the above in detail.

Meanwhile, Smeesters et al. (2001) examined the relationships between fall causes such as fainting, slipping, stepping down and tripping and parts injured, and the degree of impact, and reported that fall direction and parts injured differed by fall cause. Falls caused by tripping induce forward falling with impact on the anterior body, and falls caused by slipping and staggering induce sideways or backward falls with impact on the hip or buttocks. In this study, significant relationships were found between fall direction and fall cause, and parts injured as well, but not between the presence and degree of injury and fall cause and fall direction. Fall and injury are related intricately to internal factors such as physical function decrease and disease, and external factors such as life environment (Cummings, 1996; Nevitt et al., 1991). From now on, relationships among fall cause, injured parts and degree of injury caused by falling will need to consider the above stated factors.

5. Conclusion

A decrease of ADL affects the rate of falls in the elderly, but not the degree of injury. Fall characteristics may not be related to the extent of fall injury.

Conflict of interest statement: None.

Acknowledgement

The authors have no financial disclosures to make on this paper. Both authors contributed to all aspects of this paper and there is no sponsor to this study.

References

American Geriatrics Society, British Geriatrics Society, American Academy of Orthopaedic Surgeons Panel on Falls Prevention, 2001. Guideline for the prevention of falls in older persons. J. Am. Geriatr. Soc. 49, 664-672.

Cummings, S.R., 1996. Treatable and untreatable risk factors for hip fracture. Bone 18, 165S-167S.

Gillespie, L.D., Robertson, M.C., Gillespie, W.J., Lamb, S.E., Gates, S., Cumming, R.G, Rowe, B.H., 2009. Interventions for preventing falls in older people living in the community. Cochrane. Database. Syst. Rev. 15, CD007146.

Haga, H., Shibata, H., Shichita, K., Matsuzaki, T., Hatano, S., 1986. Falls in the institutionalized elderly in Japan. Arch. Gerontol. Geriatr. 5, 1-9.

Kanis, J.A., Johnell, O., De Laet, C., 2002. International variations in hip fracture probabilities: Implication for risk assessment. J. Bone. Miner. Res. 17, 1237-1244.

Luukinen, H., Herala, M., Koski, K., Honkanen, R., Laippala, P., Kivelä, S.L., 2000. Fracture risk associated with a fall according to type of fall among the elderly. Osteoporos. Int. 11, 631-634.

Nevitt, M.C., Cummings, S.R., Hudes, E.S., 1991. Risk factors for injurious falls: a prospective study. J. Gerontol. 46, M164-M170.

Niino, N., Nakamura, K., 1996. Circumstances and factors related to falls in the institutionalized elderly. Jpn. J. Geriatr. 33, 12-16.

Orimo, H., Sakata, K., 2004. Results of fourth nationwide survey on femoral neck fracture. Japan Medical Jounral: Tokyo. 4180, 25-30.

Shapiro, M.J., Partridge, R.A., Jenouri, I., Micalone, M., Gifford, D., 2001. Functional decline in independent elders after minor traumatic injury. Acad. Emerg. Med. 8, 78-81.

Smeesters, C., Hayes, W.C., McMahon, T.A., 2001. Disturbance type and gait speed affect fall direction and impact location. J. Biomech. 34, 309-317.

Yasumura, S., Haga, H., Nagai, H., Shibata, H., Iwasaki, K., Ogawa, T., Ahiko, T., Ihara, K., 1991. Incidence of and circumstances related to falls among the elderly in a Japanese community. Jpn. J. Pub. Health. 38, 735-742.

Table 1. Frequency of falls and injuries, n(%)

Cases	n (%)
Falls without injury	129 (7.0)
Falls with injury	257 (13.9)
Total falls	386 (20.9)
No falls	1464 (79.1)

Table 2. The results of one-way analysis of variance and post hoc analysis of age and ADL score among fall and injury experience, mean ± S.D.

	Fall experience					
	A	B	C	F=	p<	post-hoc
Number	1464	129	257			
Age	70.3 ± 6.8	72.3 ± 7.6	72.1 ± 8.0	10.24	0.001	B,C > A
ADL	28.6 ± 5.3	25.8 ± 6.5	25.3 ± 7.0	47.96	0.001	A > B,C

Notes: A = no falls; B = falls without injury; C = falls with injury

Table 3. The results of one-way analysis of variance and post hoc of ADL score among cause and direction of fall and parts and degree of injury in the fall-experi-enced grou

		n	Mean±S.D.	F=[d]	p=	post-hoc
Fall direction[a]	Forward	204	25.4±7.1	0.74	0.478	
	Backward	42	26.3±7.2			
	Sideways	77	24.7±6.8			
Fall cause[b]	Leg backlash	49	20.6±7.4	9.54	<0.001	slip, trip, dizziness, stagger > leg back-slash
	Trip	154	25.7±6.6			
	Slip	72	27.0±6.8			
	Dizziness+stagger	30	25.1±6.9			
Injured parts[c]	Head	22	25.3±7.0	1.01	0.389	
	Upper limb	39	26.4±6.9			
	Trunk	14	23.8±6.0			
	Lower limb	100	26.8±6.7			
Extent of injury						
	Fracture	37	23.3±7.1	1.37	0.251	
	Sprain	32	25.8±7.6			
	Contusion or cut and graze	188	25.5±6.9			
	No injury	129	25.8±6.5			

Notes: [a]as 63 subjects gave a reply to "other", they were excluded from analysis.[b]as 81 subjects gave a reply to "other", they were excluded for analysis. [c]as 211 subjects gave a reply to "other", they were excluded for analysis. [d]degree of freedoms were $df_1 = 2$ and $df_2 = 320$ in "Fall direction", $df_1 = 3$ and $df_2 = 301$ in "Fall cause", $df_1 = 3$ and $df_2 = 171$ in "Injured parts" and $df_1 = 3$ and $df_2 = 382$ in "Extent of injury".

Table 4. The difference in frequency of cause and direction of fall between fall experience groups with and without injury, n

Falls	without injury[a]	ASR	with injury[b]	ASR	χ^{2c} =	p =
Fall direction						
Forward 50	-0.5	154	0.5	0.79	0.674	
Backward 13	0.9	29	-0.9			
Sideways 19	-0.2	58	0.2			
Fall cause						
Leg backlash	12	-0.3	37	0.3	8.24	0.041
Trip	43	0.7	111	-0.7		
Slip	12	-2.1	60	2.1		
Dizziness and stagger	13	2.2	17	-2.2		

Notes: [a]as 47 subjects in "Fall direction" and 49 subjects in "Fall occasion" gave a reply to “other”, they were excluded for analysis. [b]as 16 subjects in "Fall direction" and 32 subjects in "Fall cause" gave a reply to “other”, they were excluded for analysis. [c]degree of freedoms were df = 2 in "Fall direction" and df = 3 in "Fall cause".

ASR = adjusted standadized residual (it was not significant in either of cases).

Table 5. The correlation among cause and direction of fall, and parts and extent of injury by fall

	A	B	C
Fall direction, A			
Fall cause, B	0.49 (< 0.001)		
Injured parts, C	0.32 (0.010)	0.29 (0.144)	
Extent of injury, D	0.14 (0.415)	0.20 (0.194)	0.26 (0.066)

Notes: Numbers in parentheses indicate p = or p <