
RESEARCH REPORT

Relationship between foot problems and foot care, physical function and falls in community-dwelling elderly

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Abstract Objective : We aimed to examine foot problems in community-dwelling elderly and assess the relationship between foot care and physical capacity/falls.

Methods : The subject were 105 elderly (mean age 74.6 ± 6.3 years) who were self-sufficient in their daily lives. Participants completed a questionnaire survey regarding foot problems, foot care, and falls, and we measured primary risk factors for falling, which included walking capacity, muscle strength, and balance capacity.

Results : 1. We found that 61.0% of participants had foot problems including calluses (43.8%), hallux valgus (40.6%), trichophytosis (37.5%), among others. Many subjects reported neglect of their problems or self-treatment. Approximately 80% of subjects, regardless of whether they had foot-related problems or not, reported that they washed their foot, and approximately half did foot exercises. The group with foot problems was more participants in this group reported a habit that was observed the foot ($p < 0.05$). 2. The group with foot problems demonstrated a slower walking speed ($p < 0.05$) compared to the group without foot problems, but no significant difference was observed in balance capacity and muscle strength between groups. The group with foot problems was more likely to have experienced a fall, and more participants in this group reported stumbling tendencies ($p < 0.05$). The majority of participants in both groups reported "stumbling" as the reason for their falls, but the type of surface on which the fall occurred varied. Most participants with foot problems reported falls on level surfaces, while those without foot problems fell on uneven surfaces. Fall-induced injuries were common in the group with foot problems ($p < 0.05$).

Discussion : Approximately 60% of community-dwelling elderly have foot problems. The association between foot problems and falls suggests that interventions for foot problems may prevent falls.

Key words : prevention of falls, community-dwelling elderly, foot problems, foot care

Introduction

Japan is a hyper-aged country, and the elderly population accounts for more than 21% of the total population,

Received for publication November 5, 2010; accepted December 27, 2010.

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nearly 20% of which appears to be care-dependent; therefore, it is important for elderly individuals and their families, as well as society, to reduce care dependency. As falls and fractures account for approximately 10% of the causes of care dependency, fall prevention is regarded as a key preventive measure¹⁾. Considering the fact that falls in the elderly tend to occur during activities of daily living, postural stability during standing and walking, which are basic activities in daily life, may

be essential. The foot is associated with postural stability. It has been reported that 60 to 80% of the elderly have foot problems²⁻⁴⁾, although there have been only a few studies investigating this issue within Japan. Further, following the adoption of Long-term Care Insurance, increasing attention has been focused on the effectiveness of foot care, such as foot bathing and nail clipping, to prevent falls in the infirm elderly requiring care or assistance⁵⁻⁷⁾; however, the association between the foot and falls has not yet been fully investigated.

This study aimed to examine foot problems in the independent community-dwelling elderly, the practice of foot care, and its relationship with the physical capacity and falls.

Methods

1. Subjects

One hundred and five independent community-dwelling elderly people aged over 65, who were voluntarily participating in a health promotion program (twice a month: 1-hour health lecture and 1 hour of exercise) were studied.

2. Data collection

1) Questionnaire survey

A group survey using a self-administered questionnaire regarding foot problems, the practice of foot care, and falls, was conducted in September 2006. Referring to the literature^{3,8)}, hallux valgus, incurvated nails, clavus/callosity, ringworm, and plantar cornification were selected as 5 common foot problems, and their occurrence, symptoms, and treatment during the year prior to the study were investigated. Foot care consisted of 3 items: habit of monitoring the foot status, washing toes and the interdigital skin, and foot exercise. The category of falls included: experiences of falls during the year prior to the study; fears of falling; self-evaluation of the ability to prevent falls; and limitations in activities of daily living. For the self-evaluation of the ability to prevent falls, Soyano's 4-level method based on the Likert scale was employed to evaluate self-confidence in performing 10 items of activities of daily living without falling⁹⁾. The limitations were evaluated in 10 activi-

ties of daily living, similarly to self-evaluation of the ability to prevent falls.

2) Measurement of physical function

As primary factors of falls, the walking ability, muscle strength, and balance were measured, employing simple, generalized methods, which were proven to be reliable and valid.

The walking ability was evaluated by measuring the time needed to walk 10m at their usual speed and the maximum step width, and by performing a 40-cm step test, based on the assessment items of software used to quantitatively evaluate the moving/walking ability¹⁰⁾.

To evaluate the muscle strength, the pressure between the toes of the left and right feet, which is an index of the muscle function of the entire foot¹¹⁾, was measured 2 times each, employing an apparatus named the "Toe Checker" (Shinkikaku Shuppan Co., Ltd.), and the highest values were adopted. The value indicating a risk of falling is 3 kg or less in males, and 2.5 kg or less in females¹¹⁾.

For balance evaluation, static and dynamic balance tests were performed. Static balance was measured by evaluating the ability to maintain the Romberg posture for 20 seconds with the eyes open looking at a fixed point at a 2-m distance and with them closed, employing a gravity measurement unit with an analyzing apparatus named the "Portable Gravi-Corder GS-10" (ANIMA Corporation)¹²⁾. Dynamic balance was measured by performing 2 functional reach tests¹³⁾, in which major values were adopted. The value indicating a risk of falling is 15 cm or less¹³⁾.

3. Data analysis

In data analysis, the ratios of the presence/absence of foot problems, conditions and treatment of each problem, as well as the relationship of the presence/absence of foot problems with the practice of foot care, walking ability, muscle strength, balance, and falls were examined. The data were analyzed by performing a two-sample t-test or χ^2 -test of independence, employing SPSS 13.0. A significant difference was set at 5% or less of the risk rate.

4. Ethical considerations

Subjects were provided with a written explanation of

the study outline and ethical considerations, and those whose written consent was received were studied. Ethical considerations included: completely voluntary participation and withdrawal at any time; the restrictions regarding the use of the study results; privacy protection; and the publication of results. For measurement, noninvasive methods were employed, and a sufficient number of personnel were present to ensure safety.

Results

1. Outline of subjects

The number of subjects with and without foot problems was 64 (61.0%) and 41 (39.0%), respectively. There were no differences between the two groups in terms of the age and sex: the former consisted of 8 males (12.5%) and 56 females (87.5%), and the mean age was 74.0 ± 6.6 ; the latter consisted of 7 males (17.1%) and 34 females (82.9%), and the mean age was 76.1 ± 5.6 .

2. Conditions and treatment of foot problems

1) Types and frequency of foot problems (Table 1)

Clavus/callosity was the most frequent foot problem, observed in 28 (43.8%); hallux valgus was the next frequent: 26 (40.6%); ringworm: 24 (37.5%); plantar cornification: 18 (28.1%); and incurvated nails: 11 (17.2%). Regarding the number of foot problems, 31 subjects had 1 problem (48.4%); and 25 had 2 (39.1%).

2) The presence/absence of pain and its management (Table 2)

Pain was observed in 16 subjects with clavus/callosity (57.1%); 10 with hallux valgus (38.5%); 2 with plantar cornification (11.1%); and 3 with incurvated nails (27.3%). Itching was observed in 12 subjects with ringworm (50.0%). Primary regions where symptoms appeared were as follows: clavus/callosity: forefoot; ringworm: between toes or nails; plantar cornification: heel; and incurvated nails: hallux. The seasonal changes in symptoms were as follows: clavus/callosity: constant throughout year; ringworm: most frequent in summer; and plantar cornification: most frequent in winter. At

Table 1. Types and frequency of foot problems

n=64		
	Foot problems	Number of subjects (%)
Types of foot problem (multiple answers)	Clavus/callosity	28 (43.8)
	Hallux valgus	26 (40.6)
	Trichhophytosis	24 (37.5)
	Plantar cornification	18 (28.1)
	Incurvated nails	11 (17.2)
Number of foot problems	1	31 (48.4)
	2	25 (39.1)
	3	5 (7.8)
	4	2 (3.1)
	5	1 (1.6)

Table 2. The presence of pain and its management

n=64			
Foot problems	Pain ¹⁾	Management	
		Consultation ²⁾	Self-treatment
Clavus/callosity (n=28)	16 (57.1)	3 (10.7)	· Removal of affected regions using scissors/razor
Hallux valgus (n=26)	10 (38.5)	2 (7.7)	· Putting on wider shoes
Ringworm (n=24)	12 (50.0)	5 (20.8)	· Applying over-the-counter medicine
Plantar cornification (n=18)	2 (11.1)	0 (0.0)	· Paying more attention to the cleanliness and drying of the foot · Applying creams and milky lotions available on the market
Incurvated nails (n=11)	3 (27.3)	2 (18.2)	· Avoiding excessive nail clipping

1) Pain: Itching was observed only in subjects with ringworm

2) Consultation: Having consulted a doctor or currently attending a hospital

the time of the study, none of the subjects experienced pain interfering with activities of daily living, such as walking.

The number of subjects who were receiving or had received treatment was as follows: clavus/callosity: 3 (10.7%); hallux valgus: 2 (7.7%); ringworm: 5 (20.8%); and incurvated nails: 2 (18.2%). None of the subjects with plantar cornification received treatment. Four subjects with hallux valgus and incurvated nails who received treatment also underwent surgery. As self-treatment, 3 subjects with clavus/callosity were using scissors or a razor to remove the affected regions (10.7%); 2 with hallux valgus were wearing wider shoes (7.7%); 6 with ringworm were applying over-the-counter medicine (25.0%) and 1 was paying more attention to the cleanliness and drying of the foot (4.2%); 2 with plantar cornification were applying cream (11.1%); and 1 with incurvated nails was avoiding excessive clipping (9.1%).

3) The presence/absence of foot problems and treatment (Table 3)

On comparison of the groups with and without foot problems, the number of subjects with a habit of monitoring the foot status was larger in the former: 52 (81.2%) vs. 21 (51.2%), respectively ($p < 0.01$). Subjects with a habit of washing foot fingers and the interdigital skin

accounted for approximately 80% in both groups. Subjects with a habit of foot exercise accounted for approximately 50% in both groups, and the most common exercise was “standing on tiptoes”: 21 (22.8%) and 15 (36.6%), respectively. Other exercises included “toe stretch (curling, opening, and raising)”, “toe massage (massaging toes and the arch of the foot)”, and “ankle stretching”.

3. The presence/absence of foot problems and walking ability, muscle strength, and balance (Table 4)

On comparison of the groups with and without foot problems, subjects in the former took more time to walk

Table 3. The presence/absence of foot problems and treatment

Foot care	Foot problems	
	Present n=64	Absent n=41
Monitoring the foot status ¹⁾	52 (81.2)	21 (51.2)**
Washing the feet ²⁾	49 (76.6)	32 (78.0)
Foot exercise ³⁾	32 (50.0)	22 (53.7)

** $p < 0.01$

- 1) Habit of monitoring the foot status: practicing at a frequency of at least 3 times a week
- 2) Habit of washing the feet: washing the feet including toes and the interdigital skin whenever taking a bath
- 3) Habit of foot exercise: practicing at a frequency of at least 3 times a week

Table 4. The presence/absence of foot problems and walking ability, muscle strength, and balance

Physical function		Foot problems	
		Present n=52	Absent n=30
Time needed to walk 10 m (s)		4.7±1.5	4.2±0.9*
Maximum step width (cm)		99.8±13.9	91.9±13.0
40-cm step	Easy ¹⁾	41 (78.8)	26 (86.7)
	Possible	10 (19.2)	4 (13.3)
	Impossible	1 (2.0)	0 (0.0)
Right interdigital strength (kg)	Male	3.8±1.5	3.1±1.1
	Female	3.1±1.3	2.8±0.9
Variations in the center of gravity (cm)	Eyes open	32.3±12.7	35.7±15.0
	Eyes closed	47.2±28.9	48.4±17.9
Functional reach test (cm)		28.9±5.7	28.1±1.8

* $p < 0.05$

- 1) Easy: Being able to step up a 40-cm step without handrails, maintain an upright posture for a moment at the top, and step down on the other side of the step.

10 m at their usual speed than those in the latter: 4.7 ± 1.5 vs. 4.2 ± 0.9 seconds, respectively ($p < 0.05$). The maximum step width was 90 cm or more, and subjects who easily performed the 40-cm step test accounted for approximately 80% in both groups. The muscle strength appeared not to be associated with foot problems, demonstrating higher values than the cutoff in both groups. No association of foot problems with variations in the center of gravity in the static balance test, which was performed with eyes open and closed, or the results of the functional reach test to evaluate dynamic balance was observed. The values in both tests were higher than the cutoff.

4. Foot problems and falls

1) The presence/absence of foot problems and factors of falls (Table 5)

On comparison of the groups with and without foot problems, the number of subjects with experiences of

falls within the past year was larger in the former: 21 (32.8%) vs. 7 (17.1%), respectively ($p < 0.1$). The number of fall experiences was 1 in 11 (57.9%), 2 in 7 (36.8%), and 3 in 1 (5.3%) in the former; 1 in 6 (85.7%) and 2 in 1 (14.3%) in the latter. The experience of nearly falling was more frequent in the former: 22 (34.4%) vs. 6 (14.6%), respectively ($p < 0.05$).

Regarding the degree of a fear of falling, "a slight fear" was the most frequent in both groups: 29 (45.3%) and 15 (36.6%), respectively. Among subjects who answered "relatively low confidence" or "not confident at all" in their ability to prevent falls, those in the former showed significantly higher values in 3 items: shopping; walking on uneven ground; and holding things in both hands ($p < 0.05$). The majority of subjects in both groups were performing two or more activities of daily living with limitations to prevent falls in the 3 situations in which a large number of subjects answered "not con-

Table 5. The presence/absence of foot problems and factors of falls

Factors of falls	Foot problems	
	Present n=64	Absent n=41
Experiences of falls within the past year	21 (32.8)	7 (17.1) †
Experiences of nearly falls within the past year	22 (34.4)	6 (14.6)*
Fear of falling	Much	5 (12.2)
	Slight	15 (36.6)
	Not much	9 (22.0)
	No fear	5 (12.2)
Self-confidence in the ability to prevent falls ¹⁾		
Lying down/sitting up in bed	5 (7.8)	4 (9.8)
Sitting/standing	14 (21.9)	5 (12.2)
Dressing/undressing	3 (4.7)	0 (0.0)
House cleaning	8 (12.5)	3 (7.3)
Shopping	7 (10.9)	0 (0.0)*
Stairs	18 (28.1)	9 (22.0)
Walking along a crowded street	18 (28.1)	9 (22.0)
Walking in the semi-dark	23 (35.9)	11 (26.8)
Walking on uneven ground	27 (42.2)	9 (22.0)*
Walking holding things in both hands	25 (39.1)	9 (22.0)*

* $p < 0.05$

† $p < 0.1$

1) Subjects who answered "relatively not confident" or "not confident at all" (%)

fidant” in their ability to prevent falls.

2) The presence/absence of foot problems and situations when falls occurred (Table 6)

On comparison of the groups with and without foot problems, falls occurred indoors in the majority of the former, and outdoors in 75% of the latter ($p < 0.1$). Falls on flat surfaces accounted for more than 50% of falls in the former, while falls on steps accounted for approximately 60% in the latter ($p < 0.1$). Stumbling was the most common cause of falls, and accounted for approximately 40% in both groups. The mental and physical status when falls occurred was as follows: “usual” in 60.7%, “being in a hurry” in 28.6%, and “bad physical condition” in 10.7% in the former; answers were divided between “usual” and “being in a hurry” in the latter.

Fall-related injuries were more frequent in the former: 71.4 vs. 37.5%, respectively ($p < 0.05$); bruises and incised cuts accounted for the majority of injuries, while fracture and dislocation occurred in 1 subject each in the former.

Discussion

This study focused on foot problems in Japanese independent community-dwelling elderly, in terms of fall prevention.

The number of subjects with foot problems was 64 (61%), demonstrating that foot problems are common in the elderly; however, the definition of foot problems has not yet been unified, and the frequency of foot problems which has been reported in studies abroad ranges from more than 60 a similar value to that of the results in this study to 80%²⁻⁴⁾. An association between foot problems and experiences of falls was observed; repeat falls, falls on flat surfaces, and fall-related injuries were more frequent in subjects with foot problems. Experiences of nearly falling were also frequent in these subjects. Further, the lack of confidence in the ability to prevent falls during shopping, walking on uneven ground, and holding things in both hands was significantly more marked in subjects with than in those without foot problems: 42.2, 39.1, and 10.9 vs. 22.0, 22.0, and 0%, respectively. Although foot problems appeared not to be associated with the variations in the center of

Table 6. The presence/absence of foot problems and situations when falls occurred

Situations	Foot problems		
	Present n=28	Absent n= 8	
Place of occurrence	Indoors	13 (46.4)	6 (75.0)
	Outdoors	15 (53.6)	2 (25.0) †
Floor/ground conditions	Uneven	9 (32.1)	5 (62.5)
	Wet	4 (14.3)	2 (25.0)
	Flat	15 (53.6)	1 (12.5) †
Causes of falls	Stumbling	11 (39.3)	4 (50.0)
	Slipping	10 (35.7)	3 (37.5)
	Staggering	4 (14.3)	0 (0.0)
	Mis-stepping	2 (7.1)	1 (12.5)
Mental and physical status	Usual	17 (60.7)	4 (50.0)
	Being in a hurry	8 (28.6)	4 (50.0)
	Bad physical condition	3 (10.7)	0 (0.0)
Fall-related injuries	Injured	20 (71.4)	3 (37.5)
	Not injured	8 (28.6)	5 (62.5)*

* $p < 0.05$

† $p < 0.1$

gravity or balance evaluated in the functional reach test, the presence of foot problems may contribute to a fear of situations where it is difficult to maintain balance, such as walking on uneven surfaces and holding things in the hands. These results suggest the effectiveness of interventions for foot problems to prevent falls. While there have been only a small number of studies focusing on interventions for foot problems, Kumada¹⁴⁾ defines foot care by health care providers as “protecting the foot’s ability to walk and healing the whole body through the feet”, highlighting the importance of patient-centered multi-professional team approaches, and pointing out that the objective of foot care in the elderly, among others, is to prevent falls. As it has been reported that foot problems increase along with aging¹⁵⁾, and are more frequent in the facility-dwelling than in the community-dwelling elderly^{5, 6)}, preventive approaches in the healthy elderly to enhance their ability to manage foot problems may be an important issue. Regarding the types of foot problem, clawus, callosity, hallux valgus, and ringworm were observed in approximately 40% of subjects. The pain occurred in approximately 60% of subjects with clawus/callosity, and approximately 40% of those with hallux valgus.

Common foot problems in the elderly include cornification (clawus and callosity), deformation of toes and nails, wounds and ulcers, congestion, and neuropathy, all of which occasionally involve pain^{3, 8)}. In this study, the majority of subjects had 2 or more types of foot problem, and, according to the findings regarding the association of the presence of foot pain or at least two or more foot problems and falls in preceding studies^{4, 16, 17)}, may require appropriate measures. However, most of them, except for a few who were receiving treatment, dealt with symptoms by themselves. On the other hand, considering the result that some subjects with hallux valgus or incurvated nails underwent surgery, symptoms interfering with activities of daily living may lead to consultation. The habit of monitoring the foot status was more common in subjects with (81.2%) than in those without (51.2%) foot problems. Some studies conducted in Western countries reported that the consultation rate in the elderly with foot problems was 30%^{18, 19)}; this dem-

onstrates the fact that an awareness of foot problems and consultation in the elderly are not necessarily high in these countries where podiatric studies have been developed. Nursing interventions may be required to enhance the elderly’s ability to manage foot care problems by seeking consultation.

The limitation of this study was evaluating the presence/absence of foot problems using a self-administered questionnaire, not an objective evaluation scale. The definition of foot problems has not yet been unified, and deformed toes are frequently included in them. Further study is required to examine the association between foot problems and falls using objective evaluation measures.

Conclusion

By examining foot problems in 105 independent community-dwelling elderly people, and their association with foot care, physical capacity, and falls, the following results were obtained:

1. Subjects with foot problems accounted for 61%. Clawus/callosity was the most common problem (43.8%), followed by hallux valgus (40.6%). The majority of subjects had two or more foot problems. Although symptoms were generally dealt with by subjects themselves, they sought consultation in the case of symptoms markedly interfering with their activities of daily living. A habit of monitoring the foot status was observed in 81.2% of subjects with and 51.2% in those without foot problems ($p < 0.05$). The habits of washing the feet and foot exercise were observed in more than 80% and approximately 50%, respectively.

2. In comparison of the groups with and without foot problems while focusing on their association with physical functions which are regarded as primary factors of falls, the walking speed was lower in the former ($p < 0.05$); however, no association with the muscle strength and balance was observed. Experiences of falls and stumbles were more frequent in the former ($p < 0.05$). The most frequent cause of falls was stumbling; subjects with foot problems were more likely to fall on flat surfaces and get injured by falling ($p < 0.05$). In the self-

evaluation of the ability to prevent falls, most of the subjects with foot problems were less confident in their ability during shopping, walking on uneven ground, and holding things in both hands ($p < 0.05$).

Foot problems and the practice of self-treatment for them were common in the healthy community-dwelling elderly. The association between foot problems and falls suggests that interventions for foot problems may prevent falls.

Acknowledgments

We are grateful to all the study subject and the directors for their cooperation during this study. This paper was supported in part by a Grant-in-Aid for Scientific Research (C) (2007-2009) from the Japan Society For the Promotion of Science (JSPS) (theme No. 19592560). Part of the study was presented at the 7th Society of Fall Prevention Medicine (Kyoto).

References

- 1) Suzuki T : Rounenshoukougun ; Youkaigo eno gen'in. Rigakuryouhougaku 18(4) : 183-186, 2000
- 2) Hsu JD : Foot problems in the elderly patient. J Am Geriatr Soc 19:880-886, 1971
- 3) Karpman RR : Foot problems in the geriatric patient. Clinical Orthopaedics and related research 316:59-62, 1995
- 4) Menz HB, Lord SR : The contribution of foot problems to mobility impairment and falls in community-dwelling older people. J Am Geriatr Soc 49(12) : 1651-1656, 2001
- 5) Foot care no arikata ni kansuru kenkyuuinkai : Research report in 2000 9-15, 2001
- 6) Foot care no arikata ni kansuru kenkyuuinkai : Research report in 2001 24-30, 2002
- 7) Foot care no arikata ni kansuru kenkyuuinkai: Research report in 2002 7-29, 2003
- 8) Helfand AE : Assessing onychial disorders in the older patient. Clinics in Podiatric Medicine and Surgery 20(3) : 431-442, 2003
- 9) Soyano A : Tentoukyoufu ni yoru tojikomori wo fusegu tame ni. Community care special issue:31-34, 2005
- 10) Okada S, Kamioka H : Tentouyobou ni yakudatu soft to Hard Kenkyakudo-soft. Community Care : 110-114, 2005
- 11) Yamashita K, Saito M : Evaluation of the aged against tumbling by toe-gap force. The Society of Instrument and Control Engineers 38(11) : 952-957, 2002
- 12) Equilibrium Research : Heikokinokensa no zissai, Nanzando, 1992, pp. 121-133
- 13) Duncan PW : Functional reach : A new clinical measure of balance. J Gerontol 45:192-197, 1990
- 14) Japanese Society for Foot Care : Hajimeyou Foot-care 2ed. Nihonkangokyoukai syuppankai, 2009, pp. 8-11
- 15) Pobbins JM : Recognizing, treating, and preventing common foot problems. Cleve Clin J Med 67:45-57, 2000
- 16) Tinetti ME, Speechley M, Ginter SF : Risk factor for falls among elderly persons living in the community. N Engl J Med 319:1701-1707, 1988
- 17) Koski K, Luukinen H, Laippala P, et al. : Physiological factors and medications as predictors of injurious falls by elderly people : a prospective population-based study. Age Ageing 25:29-38, 1996
- 18) Greenberg L : Foot care data from two recent nationwide surveys : a comparative analysis. JAPMA 108:245, 1993
- 19) Munro SJ, Steele JR : Foot-care awareness. A survey of persons aged 65 years and older. J Am Podiatr Med Assoc 88(5) : 242-248, 1998