

## Relationship between fear of falling and arm movements in the elderly women: A preliminary study.

Tomonori Nomura<sup>1</sup>, Toshiko Futaki<sup>2</sup>

Key words : elderly, fear of falling, arm movement

### **Abstract**

The purpose of this study was to examine the relationship between fear of falling and the arm movements in the elderly women. The subjects consisted of 48 elderly women (mean age,  $74.8 \pm 7.1$  years) and 10 young women ( $20.9 \pm 0.3$  years). Fear of falling and experiences of falls in the previous year were investigated, and forward, lateral, and downward arm movement times in the standing position were measured. The arm movement time was compared with the degrees of fear of falling, as well as with the presence and absence of experiences of falls. The results indicated that the average arm movement time was longer in the elderly women than in the young women, but the presence or absence of falling experience did not influence that time the average arm movement time was longer in the elderly women who were very fearful of falling than in the young women or the elderly women without such a fear, and the average downward arm movement time was longer in the elderly women who were moderately fearful of falling than in the young women. This study suggest that the arm movement time is prolonged in elderly women with a fear of falling, even in a presence of moderate fear of falling, and downward arm movement is particularly associated with such a fear.

### **Introduction**

Fear of and anxiety over falling restrict activities of daily living in the elderly and reduce their area of activities even if they are capable of performing these activities, causing decreases in physical function and the quality of life (QOL). Therefore, such fear and anxiety have been suggested to be more serious problems than falling itself (Cumming et al., 2000; Friedman et al., 2002). Studies on the fear of falling and physical function in elderly people in the community have shown a significantly intense fear of falling in the group with decreased balance and locomotion functions in the standing position (Maki et al., 1991; Lawrence et al., 1998; Fuzhong et al., 2002). For balance in the standing position, the ability to move the center of gravity in the forward and lateral directions is particularly important (Binda et al., 2003).

Those studies examined the relationship between a fear of falling and the parameters of physical strength. Previous studies on arm reactions in the forward and lateral directions assuming the prevention of falling have shown a longer movement time in elderly than in young subjects (Robinovitch et al., 2005). Thus, studies are necessary to evaluate the ability to move the center of gravity through arm reactions for the prevention of falling. However, few studies examining the association between arm

---

<sup>1</sup> Faculty of Medical Technology, Niigata University of Health and Welfare  
1398 Shimami-cho, Kita-ku, Niigata City, Niigata 950-3198, JAPAN  
TEL: 025-257-4554 FAX: 025-257-4554 E-mail: nomura@nuhw.ac.jp

<sup>2</sup> Human Health Sciences, Graduate School of Medicine, Kyoto University

movement and fear of falling, exist.

The purpose of this study was to examine the relationship between fear of falling and the arm movements in the elderly women. Significance of this study is to contribute for developing a fall prevention program.

## Methods

### 1) Subjects

The subjects consisted of 48 elderly women aged 65-88 years (mean,  $75.5 \pm 7.3$  years) living in the community and 10 healthy young women aged 20-21 years (mean,  $20.9 \pm 0.3$  years) as controls (Table 1). All the elderly women did not have any restriction in their locomotion ability nor dementia. After an explanation of the purpose of this study, all subjects submitted their written informed consent. This study was performed with the approval of the Ethical Committee of Kanazawa University (No.43).

### 2) Assessment of fear of falling, and falling experience in the previous year

The investigated items were fear of falling and

falling experience during the previous year. Fear of falling was evaluated by the question, "Are you fearful of falling?", and the answer was chosen among "Very fearful", "Moderately fearful", and "Not fearful". Falling experience during the previous year was evaluated by the question, "Did you fall during the previous year?", and the answer was chosen between the presence ("Falling") and absence ("No falling") of falling.

### 3) Measurement of forward, lateral, and downward arm movement times

In the measurement of forward, lateral, and downward arm movement times of the upper limbs in the standing position, the time required to turn a lamp from on to off was measured. An A/D converter (PC CARD, CONTEC) was connected to a PC (Panasonic). The lamp was placed 50-cm anterior to the subject at a high of 80-cm level (Fig.1). The examiner manually lit the lamp, and the subject turned it off in the straight standing position. The subject was asked to turn off the switch with both hands in the

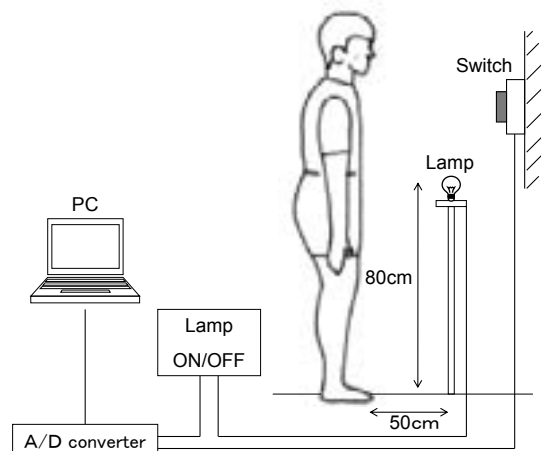


Figure 1. Measuring machine device of arm movement time

An A/D converter was connected to a PC, and the time required to turn a lamp from on to off was measured. The lamp was placed 50-cm anterior to the subject at a 80-cm level.

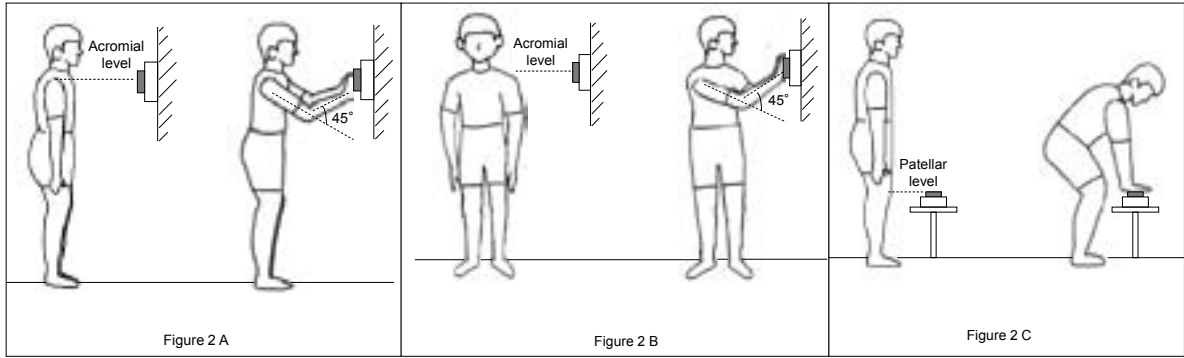


Figure 2. Measurement of forward, lateral, and downward movement times of the upper limbs in the standing position

A) Forward movement time.

The switch was placed at the subject’s acromial level and middle of the trunk width. The distance to the subject was adjusted so as to set the initial limb position to 45° flexion of the bilateral cubital joints.

B) Lateral movement time.

The switch was placed at the subject’s left acromial level. The distance to the subject was adjusted so as to set the initial limb position to 45° flexion of the bilateral cubital joints.

C) Downward movement time.

The switch was placed at the subject’s patellar level and middle of the trunk width.

forward, lateral, and downward movement of the arms. Based on the report by Robinovitch et al. (2005), for the forward and lateral directions, the switch was placed at the subject's left acromial level, and the initial upper limb position was set at a 45 flexion of the elbow joint (Fig.2 A and B). For the downward, the switch was placed at the subject's patellar level (Fig.2 C).

4) Statistical analysis

The arm movement times of the elderly subjects were compared with those of control group among each degree of fear of falling. Those times were also compared between the presence and absence of fall experiences. Statistical analysis was performed by multiple comparison (Bonferroni's method). For statistical processing, statistical analysis software SPSS 15.0J was used, and a p-value lower than 5% was regarded as significant.

**Results**

1) Characteristics of subjects (Table 1)

Table 1 Demographics of elderly women subjects n=48

Age (Mean±SD)	75.5±7.3
Assistive device	
None	32 (66.7%)
Cane	16 (33.3%)
Mental status questionnaire	
Median (Range)	10 (8-10)
Fear of falling	
Very fearful	20 (41.7%)
Moderately fearful	22 (45.8%)
Not fearful	6 (12.5%)
Falls in previous year	15 (31.3%)

On the degree of fear of falling, “Very fearful” was observed in 18 elderly subjects (41%), “Moderately fearful” in 21 (48%), and “Not fearful” in 5 (11%). On the falling experience during the previous 1 year, “Falling” was observed in 13 elderly subjects (29%) and “No falling” in 31 (71%).

2) Relationship between fear of falling and arm movement times (Fig. 3)

The average arm movement time of the “Very fearful” group were longer than the “Not fearful” group or the young control group in all 3 directions. In the downward, the average arm movement time was prolonged in the “Very fearful” and “Moderately fearful” groups ( $p = 0.015$ ). The average arm movement times of the “Very fearful” group significantly longer than the young control group (forward,  $p = 0.018$ ; lateral,  $p = 0.002$ ; downward,  $p = 0.001$ ) and the “Not

fearful” group (forward,  $p = 0.026$ ; lateral,  $p = 0.028$ ; downward,  $p = 0.05$ ) in all 3 directions, the downward arm movement time of the “Moderately fearful” group was significantly longer than the young control group ( $p = 0.015$ ).

3) Relationship between falling experience and arm movement times (Fig. 4)

The average arm movement time did not differ significantly between the “Falling” and “No falling” groups in any of the 3 directions. Lateral and downward arm movement times of the

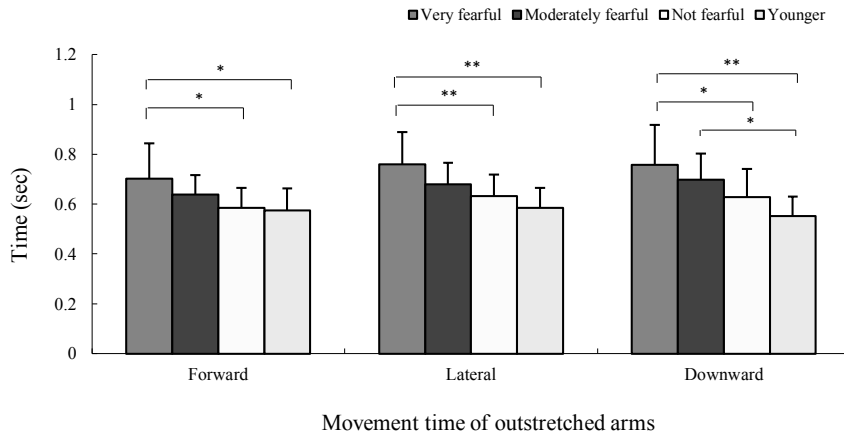


Figure 3. The mean and standard deviation (SD) of fear of falling and movement time of outstretched arms (Forward, Lateral, and Downward). Significant differences were set as  $p < 0.05$  (\*) and  $p < 0.01$  (\*\*).

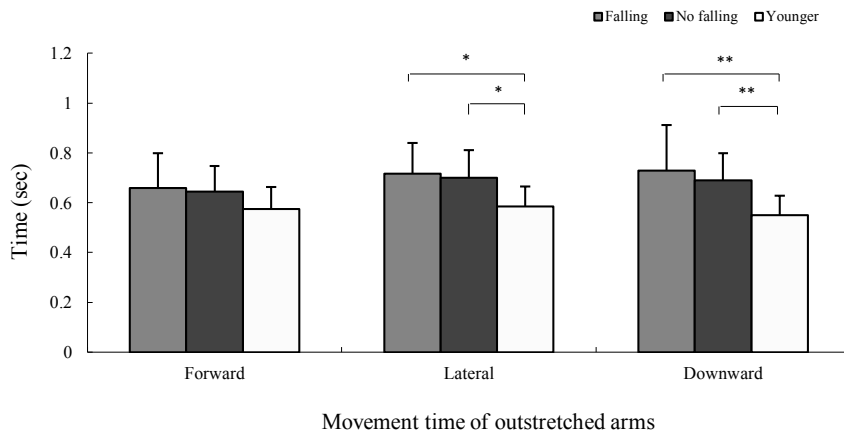


Figure 4. The mean and standard deviation (SD) of falling and movement time of outstretched arms (Forward, Lateral, and Downward). Significant differences were set as  $p < 0.05$  (\*) and  $p < 0.01$  (\*\*).

“Falling” and “No falling” groups were significantly longer than the young control group.

### **Discussion**

The purpose of this study was to evaluate differences in forward, lateral, and downward arm movement times according to fear of falling and falling experience.

The average arm movement time of the elderly groups did not differ between presence and absence of experiences of falls, but was longer in two elderly groups than in the young control group. Studies on arm reaction time in the elderly have shown prolonged times in more aged subjects (Yan et al., 1998) and women compared with men (DeGoede et al., 2001). Delayed arm reactions in women are clear, but the results of this study showed longer arm movement time in elderly women with a fear of falling than in those without.

A fear of falling led to a difference between downward and forward/lateral arm movements. Binda et al (2003) suggested that a fear of falling is associated with balance rather than muscle strength. In balance, forward and lateral movements of the center of gravity are considered to be particularly important. A study that compared forward and lateral reaction time between elderly and young subjects showed a significantly longer movement time until the hands contact the wall on hearing a signal in elderly compared to young subjects (Robinovitch et al., 2005). On the other hand, Hsiao (1998) examined young people's arm movements during falling. The average arm movement time between the tripping over and their wrists and pelvis touching the ground was  $680 \pm 116$  m/s and  $715 \pm 160$  m/s, respectively. The subjects got first attaches to the floor during falling with their hands. The downward arm movement is very similar to the action during the fall. Based on the results of the present study, forward, lateral, and downward arm movement times tend to be

prolonged, in elderly women with a fear of falling. In particular, the downward arm movement time was prolonged even in women who were moderately fearful of falling, suggesting the influence of downward arm movements on the fear of falling.

In this study, the times of quick movements were measured, since these movements are used to prevent falling when balance is lost in the standing position. We had expected the association between the movement time and the presence or absence of falling experience, but no such an association was found. The presence of a fear of falling even in the absence of falling experience has been reported (Arfken, 1994; Howland, 1998). There is a possibility that the arm movement evaluated in this study is an element not associated with falling experience, and is a movement element characteristic of a fear of falling.

Whipple (1997) suggested that vertical movement training effectively improve balance of the elderly. Therefore, dynamic vertical movement training might be an effective intervention. For example, exercises or sports that involve moving into a low squatting position could be a useful method. In the future, for those who have lost confidence in ADL due to fear of falling, research is required on how to support the expansion of daily activities and improvement of self-efficacy by reducing this fear.

The results of this study suggest that the arm movement time is prolonged in elderly women with a fear of falling, even in a presence of moderate fear of falling, and downward arm movement is particularly associated with such a fear. The next stage of the research would be the application of this result in evaluation and intervention programs.

The major limitation of this study is it has little relation with the actual life of the elderly people. Further study is required in a real life situation of those population to check whether the results of

this research can be applied.

### References

- Arfken, CL., Lach, HW., Birge, SJ., et al (1994). The prevalence and correlates of fear of falling in elderly persons living in the community. *Am J Public Health*. 84,565-570
- Binda, SM., Culham, EG., & Brouwer, B.(2003). Balance, muscle strength, and fear of falling in older adults. *Exp Aging Res*.29, 205-219
- Cumming, RG., Salkeld, G., Thomas, M., et al. (2000). Prospective study of the impact of fear of falling on activities of daily living, SF-36 scores, and nursing home admission. *J Gerontol A Biol Sci Med Sci*. 55, M299-305
- DeGoede, KM.(1998). How quickly can healthy adults move their hands to intercept an approaching object? Age and gender effects. *J Gerontol A Biol Sci Med Sci*. 24, 155-168
- Friedman, SM., Munoz, B., West, SK., et al. (2002). Falls and fear of falling: which comes first? A longitudinal prediction model suggests strategies for primary and secondary prevention. *J Am Geriatr Soc*. 50, 1329-1335
- Fuzhong, L., McAuley, E., Fisher, KJ., et al. (2002). Self-efficacy as a mediator between fear of falling and functional ability in the elderly. *J Aging Health* 14, 452-66
- Howland, J., Lachman, ME., Peterson, EW., et al.(1998). Covariates of fear of falling and associated activity curtailment. *Gerontologist*. 38, 549-555
- Hsiao, ET.(1998). Common protective movements govern unexpected falls from standing height. *Journal of biomechanics*. 31, 1-9
- Lawrence, RH., Tennstedt, SL., Kasten, LE., et al.(1998). Intensity and correlates of fear of falling and hurting oneself in the next year: baseline findings from a Roybal Center fear of falling intervention. *J Aging Health*. 10,267-286
- Maki, BE., Holliday, PJ., & Topper, AK.(1991). Fear of falling and postural performance in the elderly. *J Gerontol*. 46, M123-31
- Robinovitch, SN., Normandin, SC., Stotz, P., & Maurer, JD.(2005). Time requirement for young and elderly women to move into a position for breaking a fall with outstretched hands. *J Gerontol A Biol Sci Med Sci*. 60, 1553-1557
- Whipple, RH.(1997). Improving balance in older adults: Identifying the significant training stimuli, in Masdeu JC et al,(Eds), *Gait Disorders of Aging Falls and Therapeutic Strategies* (pp. 355-379), Lippincott-Raven.