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# Is there a Difference between the Timed Up and Go Test and Physical Function due to the Difference in Perception of Slip?

Kazuki Kubo<sup>1</sup>, Yuta Suto<sup>2</sup>, Shin Okazaki<sup>3</sup>, Yuko Takahashi<sup>4,5</sup>, Tomoyuki Shinohara<sup>4,5</sup>, Kazumasa Nakagawa<sup>4,5</sup>

<sup>1</sup> Department of Rehabilitation, Horie Hospital

<sup>2</sup> Japanese Red Cross Maebashi Hospital

<sup>3</sup> Fujioka General Hospital

<sup>4</sup> Takasaki University of Health and Welfare, Faculty of Health Care, Department of Physiotherapy, Gunma, Japan

<sup>5</sup> Takasaki University of Health and Welfare, Graduate School of Health Care, Department of Physiotherapy

Correspondence: Kazuki Kubo, Department of Rehabilitation, Horie Hospital, Ota, Takahayashihigashi-cho, 1800, Japan. Tel: +81 276-38-1215. E-mail: kubo.k.pt.59@gmail.com

## Abstract

The purpose of this study was to examine whether there are differences in the timed up and go (TUG) test results and physical functions due to the differences in slip recognition when performing TUG on wood flooring. The study consisted of 30 community-dwelling elderly subjects, aging over 65 years old. The differences in the perception of floor slippage before and after TUG were as follows: (1) slippery-slipped group (S-S group), (2) slippery-not slipped group (S-N group), and (3) not slippery-not slipped group (N-N group). The modified falls efficacy scale, grip strength, knee extension strength, one-leg standing time, functional reach test, Trail Making Test (TMT), two-step test were used in this study. The results showed no statistically significant difference in TUG test. However, statistically significant difference was observed in TMT between the S-S and N-N groups ( $p = 0.019$ ,  $r = 0.51$ , respectively) and between the S-S and S-N groups ( $p = 0.003$ ,  $r = 0.65$ , respectively). It was found that there was no statistically significant difference in TUG results due to the recognition differences of slippage. However, it was suggested that the subject who reported a history of slippage had a high attention function and could pay attention to the floor environment.

**Keywords:** Fall prevention, Environmental Adaptation, Attention function, Slip, Elderly

## 1. Introduction

### 1. Background

Falls and fall-related fractures are serious problems in the elderly aged 65 years and above. They are at the highest risk of falling, where 1 in 3 elderly people living in the community experience falling at least once a year (Tinetti ME, 1988).

In a systematic review (Cameron ID et al., 2018), the factors involved in falls in older adults can be classified as either internal or external. Internal risk factors include physical and mental function, history, and complications, whereas external risk factors include home environment and tools. It is necessary to recognize both external and internal factors accurately when an elderly person falls. It has been reported that stumbling or slipping are the most common causes of falls among the elderly, accounting for 20%–30% of all falls (Tang PF, 1998). It is estimated that slipping is relatively common in home environments, such as in the bathrooms, during rainy days, and while walking on tatami mats and wooden floors.

According to previous study (Ono H et al., 1985), the coefficient of slip resistance (CSR) is used to measure floor slipperiness. The lower the CSR is, the more slippery the floor is, and hence, the more likely it is to slip and fall. Floors in Japan are usually made of wood, tatami mats, or carpet. The CSR range of wooden floors, which is between 0.2 and 0.6, is said to be the most slippery followed by tatami mats and carpets, in that order. A study that investigated the difference in gait between flooring, tatami mats, and carpeted floors reported that the stride and ankle flexion angle of wooden floors were smaller than that of other floors (Tanaka S et al., 2011). This suggests that the subject unconsciously changes movements on slippery floor surfaces, such as wooden flooring.

In our previous study (Kubo K et al., 2021), the timed up and go test (TUG) was performed in three conditions: wooden flooring, tatami mats, and carpeted floors. The results showed a delayed wooden flooring condition time and increased number of steps.

They were also investigated in terms of perceptions of slippage. Most of the respondents reported slippage on the wooden flooring, while some respondents did not slip on the wooden flooring. In other words, there are individual differences in the slipperiness perception, which raises the question of which factors affect the differences in the slipperiness perception and whether these differences in perception affect the TUG results.

### *1.2 Purpose*

The purpose of this study was to examine whether there are differences in TUG results and physical functions due to differences in slip recognition when performing TUG on wooden flooring.

## **2. Method**

### *2.1 Subjects*

Thirty elderly subjects (27 females and 3 males, age  $79.2 \pm 4.7$  years, height  $149.9 \pm 6.6$  cm, and weight  $50.3 \pm 8.1$  kg) living in the community were recruited in our study. These subjects were independent in their Activities of Daily Living (ADLs) and had the opportunity to go out for shopping or exercise classes.

This study was approved by the Ethics Committee of the Takasaki University of Health and Welfare (approval number: 3080) and was performed in accordance with the ethical principles of the Declaration of Helsinki.

### *2.2 Study Design*

The differences in floor slippage perceptions before and after TUG were as follows: (1) slippery-slipped group (S-S group), (2) slippery-not slipped group (S-N group), (3) not slippery-not slipped group (N-N group), and (4) not slippery-slipped group (N-S group). There were 13 patients in the S-S group, 7 in the S-N group, 8 in the N-N group, and 0 in the N-S group. Thus, the results were compared among the three groups except the N-S group.

### *2.3 Measurements*

### 2.3.1 Physical Functions

The grip strength, knee extension strength (Yamasaki H et al., 2001), one-leg standing time, functional reach test (Duncan PW et al., 1990), two-step test (Muranaga S et al., 2003), Trail Making Test (TMT) (Corrigan JD et al., 1987), and modified fall efficacy scale (Hill KD, 1996) were used to measure mental and physical functions.

### 2.3.2 Timed up and go test (TUG) Parameters

TUG was measured using a modified version of the Podsiadlo's method (Podsiadlo D, 1991). We measured the time or number of steps it took to walk out of a seated position, fold over a cone 3 m away, and sit down. A wooden flooring (3.5 m wide and 1.8 m deep) used in ordinary houses and a chair without armrests were used (Figure 1). The subject walked barefoot as fast as possible (Shumway-Cook A, 2000). To prepare for falls, a physical therapist was placed near the subject, providing direct assistance if they became wobbly and were expected to fall.

The TUG time was measured from standing up to sitting down using an up and go instrument (Takei Scientific Instruments Co., Ltd. T.K.K.5804). The values were recorded up to two decimal places after rounding off the third decimal place.

The number of steps was measured from a video camera on the frontal or sagittal plane. If any of the feet came in contact with the ground, it was considered as a one step. The respondents were asked to indicate their slippage perceptions of the floor before and after the TUG using a two-response scale: "slippery-slipped" and "not slippery-not slipped."

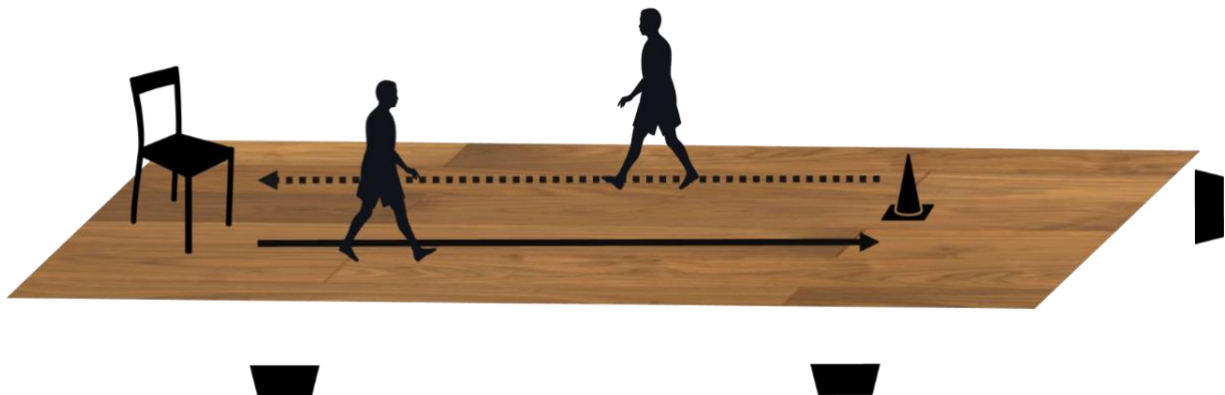


Figure 1: Measurement environment

### 2.4 Analysis

Using the one-way ANOVA or Kruskal-Wallis test, the baseline information, physical function, and TUG parameters of the three groups were compared, while subsequent comparisons between the groups were performed using the Tukey method or Mann-Whitney U test for items found to be significantly different. The SPSS (IBM, version 25) was used for statistical processing, with a significance level of 5%.

## 3. Results

### 3.1 Basic Information

The results of the basic information are shown in Table 1.

Table 1: Comparison of basic information on different perceptions of slippage

	S – S Group (n=13)	S – N Group (n=8)	N – N Group (n=9)	p value
Gender (male : female)	2:11	0:8	1:8	
Age (years)	78.0 (76.0-80.0)	82.0 (77.0-83.0)	80.5 (78.5-83.5)	0.279
Height (cm)	150.1 (147.8-155)	148.9 (146.2-153)	149.0 (146.2-153.9)	0.539
Weight (kg)	47.4 (46-57.1)	52.0 (43.1-56.3)	49.0 (46.1-51.1)	0.856

Values are presented as median (1st quartile–3rd quartile).

S – S=slippery – slipped, S – N=slippery – not slipped, N – N=not slippery – not slipped

### 3.2 TUG Parameters

The results of TUG parameters are shown in Table 2. No significant difference was observed in TUG time and step count among the groups

Table 2: Comparison of TUG parameters on different perceptions of slippage

	S – S Group (n=13)	S – N Group (n=8)	N – N Group (n=9)	p value
Time (sec)	7.3 (6.6-8.1)	7.9 (6.5-9.8)	7.0. (6.1-7.8)	0.751
Number of steps (steps)	14 (13-15)	13.5 (12.8-16.8)	15 (14-18)	0.272

Values are presented as median (1st quartile–3rd quartile).

S – S=slippery – slipped, S – N=slippery – not slipped, N – N=not slippery – not slipped

### 3.3 Physical Functions

The results of the physical functions are shown in Table 3, with a significant difference in TMT ( $p = 0.013$ ). A significant difference was observed in TMT be-tween the S-S and N-N groups ( $p = 0.019$ ,  $r = 0.51$ , respectively) and between the S-S and S-N groups ( $p = 0.003$ ,  $r = 0.65$ , respectively).

Table 3: Comparison of physical functions on different perceptions of slippage

	S – S Group (n=13)	S – N Group (n=9)	N – N Group (n=8)	p value
MFES (point)	134±9	133±12	136±11	0.816
Grip strength (kg)	21.5 (19.1-29.7)	22.4 (16.2-23.9)	22.8 (19.9-24.8)	0.652
Knee extension strength (%)	39.5 (32.4-50.8)	39.9 (37.9-50.1)	44.3 (39-51.4)	0.700
One-legged standing time (Sec)	14.8 (12.8-51.1)	6.0 (3.8-15.1)	14.5 (5.4-21.4)	0.204
FRT (cm)	32 (30-37)	21 (20-30)	34.5 (29-36)	0.072
TMT (Sec)	34.0 (29.50-42.61)	52.6 (50.1-76.4)	47.1 (44.0-98.4)	$p<0.001$
Two-step value	1.28 (1.17-1.34)	1.12 (1.04-1.29)	1.05 (0.93-1.31)	0.191

Values are presented as mean ± SD (range), or median (1st quartile–3rd quartile).

MFES=Modified fall efficacy scale, FRT=Functional reach test, TMT=Trail making test

S – S=slippery – slipped, S – N=slippery – not slipped, N – N=not slippery – not slipped

#### 4. Discussion

The slippage perception among the three groups showed no significant differences in the time or step count. There is a reduced gait on slippery floor surfaces, which avoids slipping. In the present study, there were no differences in TUG results due to differences in the slippage perception. In our study, there was a difference in the time and step count when the floor surface, where TUG was performed, was changed, suggesting the importance of setting the floor surface for TUGs. However, our results show that the time and step count were not affected by the differences in the subject's perception of slippage when TUG was implemented on the same floor.

A significant difference was observed in TMT in physical and mental functioning, with shorter periods of time in the S-S group. The mean TMT in healthy elderly Japanese people between 60 and 85 years of age was reported to be  $52.6 \pm 17.4$  (25–110) seconds (Harada H et al., 2006). Compared to the previous study, the time period observed in the S-S group was faster, while that observed in the S-N group was average. TMT is a measure of attentional function centered in the frontal lobe, which is needed to pay attention to several objects and necessary objects in the daily life. Attention is a fundamental component of various cognitive functions (Kashima H et al., 1986), which is necessary to mobilize appropriate attention for proper cognitive functioning. The S-S group may have paid more attention to the floor environment than the other groups and may have felt that they slipped. By accurately identifying slippery floor surfaces, the who is able to cope with the loss of balance if it slips. It is important to have an attentional function to accurately understand the environment. In addition, other physical functions of the subjects may have been high and not easily differed from each other.

The flooring with a glossy, painted material was used in this study. It is said that the perception of slippage is affected by the visual influence and tactile differences between the elderly and young and that the elderly are less sensitive to slippage (Ohkoshi M et al., 2011), (Hotta S et al., 2017). We suspect that the subjects with impaired vision were not able to accurately perceive the gloss and surface materials of the floor surface before TUG.

In addition, sensitivity to touch is significantly decreased, especially in the lower limbs. The two-point discrimination of the big toe is lower in the elderly who repeatedly fall than in those who never fall (Melzer I, 2004). The slippage or condition of the floor is the input from the plantar sensation. However, the floor slippage information may not be the correct input during the TUG due to the loss of sensation. From these observations, it is suggested that the difference in slip-page perception may have been influenced by the senses, such as sight and touch.

The results of the present study support that the people who perceive that they have slipped on a slippery floor surface have higher attentional functions and are able to pay attention to their environment. Therefore, it is likely that people with higher attentional functions are more predictive of slippage. Improving attentional function to prevent slips and falls is suggested to be necessary.

One of the limitations of this study is the lack of evaluation content on slippage. We did not take into account the reasoning behind their perception of slippage as our study was performed subjectively. Furthermore, because we did not measure the sensation, we could not clarify the extent of the effect of the sensation on the perception of slippage. In addition, many of the subjects had relatively high physical functions, making it difficult to find a difference in the results.

#### Acknowledgments

The slippage perception was found to have no effect on the results of the TUG. However, the TMT values of the subjects who perceived slipping were higher, suggesting a difference in perception of slipping, which may be influenced by attentional functions.

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