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Research Article

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Comparisons of lower extremity strength, cognition, and ankle mobility according to the 8.5seconds cut-off point for the 8-foot up-and-go test in elderly women

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| Abstract |

PURPOSE: The purpose of this study was to investigate the effects of the 8.5seconds cut-off of the 8-foot up-and-go test as a predictor of falling and a good discriminator of fallers and non-fallers in women in their 60s to 80s.

METHODS: The final subjects of this study were 98 elderly women from six senior centers of B metropolitan city. The 8-foot up-and-go test evaluated agility and dynamic balance. The chair-stand test measured the muscle strength for of the lower body. Ankle dorsiflexion and plantar flexion were measured to assess the ankle mobility of the subjects in this study.

RESULTS: The below 8.5seconds group showed significantly low values in age and high values in chair- stand (times/30 s), plantar flexion (°), and K-MMSE (score) compared to the over 8.5seconds group. This group was significantly faster compared to the over 8.5seconds group. In the below 8.5seconds group, only plantar flexion (°) of all the items showed significantly higher values among those in their 60s compared to those in their 70s and 80s.

CONCLUSION: The 8.5seconds cut-off on the 8-foot up-and-go test as a good discriminator and predictor of falling showed differences among fall risk factors (age, lower extremity strength, cognition, and ankle mobility) in women in their 60s to 80s without having regular exercise and a fall experience over the past ones year.

Key Words: Falls, Elderly women, Lower extremity strength, 8 foot up-and-go, Ankle mobility

Ⅰ. Introduction

The 8-foot up-and-go is a test of speed, agility, and dynamic balance that is used to measure functional mobility in elderly peoples (aged 60-94 years). This test is a modified version of the three-meter timed up-and-go (TUG) test (Rikli and Jones, 2013). More interestingly, previous study (Rose et al, 2002) suggested that the 8.5s cut-off point for the 8-foot up-and-go test had been identified as a predictor of falling risk and a good discriminator of fallers or non-fallers in older adults. This study conducted the 8-foot up-and-go test in 71 older peoples (76.6 years) with no history of falls in the last one year and 63 older peoples (78.1 years) with a history of two or more falls in the last one year. Performance on this test was significantly

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different between the two groups ($p<.01$). Fallers required 8.5seconds or longer to perform the 8-foot up-and-go test and it showed an overall prediction rate of 82%. The specificity of the test was 86% and the sensitivity was 78%. It showed a higher sensitivity compared to the TUG (71%).

Commonly reported aging-related physiological changes may increase fall risk in elderly peoples. Falls occurred more often in elderly women compared with elderly men (Liu-Ambrose et al, 2008). Therefore, advanced age can be the strongest risk factor for falls, and elderly women may be one of the risk factors for falls.

Falls result from multiple factors in elderly peoples (Mecagni et al, 2000; Toraman and Yildirim, 2010). However, the major contributors to fall risk have generally been referred to as intrinsic factors (subject-related) (Toraman and Yildirim, 2010). Therefore, most studies have analyzed the relation between intrinsic factors, such as age-related factors, balance function (Gschwind et al, 2013; Toraman and Yildirim, 2010) and muscle strength of lower extremity (Bird et al, 2013; Gschwind et al, 2013), and fall risk.

Elderly women show lower levels of ankle ROM (Range of motion) compared to elderly men, and a decreased ankle ROM may induce decreases in balance capacity (Mecagni et al, 2000). Therefore, foot- and ankle-related problems have also been shown to be important contributors to fall risk in some studies (Bird et al, 2013; Bok et al, 2013; Macdonald, 2013; Menz et al, 2006; Spink et al, 2011). Falls also are associated with cognitive dysfunction (Liu-Ambrose et al, 2008; Muir et al, 2012). Even the incidence of falls in people with cognitive disorders is almost twice that of people without cognitive impairments (Winter et al, 2013).

These findings suggest that the effects of the 8.5seconds cut-off for the 8-foot up-and-go test are predictors of falling and good discriminators of fallers and non-fallers in terms of fall risk factors, such as lower extremity strength, cognitive function, and ankle mobility among women in their 60s to 80s. Moreover, exercise and physical activity can affect intrinsic factors, such as muscle strength and balance (Gschwind et al, 2013; Kruse et al, 2010; Patil et al, 2015). Therefore, it is especially important to consider an assessment of fall risk factors (intrinsic factors) in elderly women without having regular exercise. To our knowledge, no earlier studies have addressed both fall risk factors and the effects of the 8.5seconds cut-off point for the 8-foot up-and-go test in elderly women without having regular exercise as the main topic of the study. Therefore, the purposes of this study were to compare the lower extremity strength, cognition, and ankle mobility among women in their 60s to 80s, as well as to investigate whether there were differences in these factors between the over 8.5seconds group and the below 8.5seconds group after performing the 8-foot up-and-go test in elderly women. Another purpose was to identify whether there were differences in these factors among women in their 60s to 80s within the below 8.5seconds group.

Ⅱ. Methods

1. Study subjects

In total, 119 elderly peoples (aged 52-92 years) were recruited initially from six senior centers of B metropolitan city. All elderly peoples were initially evaluated for their cognition level using the Korean-Mini mental state examination (K-MMSE) test (Shin et al., 2011). Exclusion criteria included having a score below 20 (N = 7), being below 60 years in age (N = 1), being over 90 years in age (N = 2), being an elderly man (N = 3), having a history of falls during the last one year (N = 6), and participating in regular exercises within the last six months (N = 2). Therefore, 21 elderly peoples were eliminated from the base data. The remaining 98 were interviewed face-to-face and were included as subjects with a mild cognitive

Table 1. General characteristics of the subjects

	Age (years)	Height (cm)	Weight (kg)
Total group (n=98)	72.60±6.09	153.75±5.65	57.51±7.01

Mean ± standard deviation

Table 2. Comparisons of the differences on lower extremity strength, cognition and ankle mobility between 60s to 80s

	60s (N=33, a)	70s (N=51, b)	80s (N=14, c)	Post-hoc
Age (years)	65.87±2.31	74.21±2.74	82.60±1.78	
Chair stand (times/30s)	13.39±3.37*	12.94±4.31*	10.57±3.29	a, b > c
Dorsi flexion (°)	27.60±9.53*	23.31±8.61	22.00±5.20	a > b, c
Plantar flexion (°)	31.06±12.63*	25.19±8.26	24.00±9.63	a > b, c
8-foot up-and-go (second)	6.86±1.73*	7.84±1.98	8.71±2.08	a > b, c
MMSE-K (score)	26.09±2.49*	25.07±2.39	24.07±2.58	a > c

M ± SD
* p< 0 .05

impairment level (20-23 score, N = 27) (Andersen et al, 2004). All subjects understood the purpose of this study and provided written informed consent prior to participation in accordance with the ethical principles of the Declaration of Helsinki. The final subjects of this study were 98 elderly women (Table 1).

2. Measurements Tools and Methods

1) The chair-stand test

The chair-stand test measured muscle strength for lower body. The subjects were invited to cross their arms over the chest and then, as quickly as possible, stand up and sit down on the chair for 30seconds. The score was the total number (times/30s) of stands completed for 30seconds.

2) The 8-foot up-and-go test

The 8-foot up-and-go test evaluated agility and dynamic balance. It involves recording the time required for the participant to stand up from a chair, walk 8 feet as quickly as possible (2.44 meters), turn around a cone, and return to sitting back down in the chair. It was measured twice and average time values were recorded.

The chair-stand and 8-foot up-and-go tests were based on the senior fitness test manual (Rikli and Jones, 2013) and previous study (Toraman and Yildirim, 2010).

3) Ankle mobility

Ankle dorsiflexion and plantar flexion were measured to assess the ankle mobility of the subjects in this study. It was referred to in an earlier study (Lee et al, 2012) and goniometer measurement manual of Norkin and Whithe (Norkin and White, 2009). Ankle dorsiflexion and plantar flexion ranges were measured using the 180° stainless goniometer (Six-Piece Goniometer set, Sammons preston, USA).

Testing was conducted on the self-reported dominant limb with the participant barefoot. The examiner considered measuring the most appropriate ankle ROM, as it reflected the functionally available range for the subject. The ankle dorsiflexion range was evaluated in the supine position and the ankle plantar flexion range was evaluated in the prone position on a table. It was measured twice and the average time values were recorded. The normal range of plantar flexion is 0° to 45° and the normal range of dorsiflexion is 0° to 20°(Hislop and Montgomery, 2002).

Table 3. Comparisons of the differences on lower extremity strength, cognition and ankle mobility between over 8.5seconds and below 8.5seconds

	Over 8.5seconds(N=32)	Below 8.5seconds(N=66)
Age (years)	75.15±5.37*	71.36±6.07
Chair stand (times/30s)	10.06±2.98	14.06±3.71*
Dorsi flexion (°)	24.87±8.62	24.42±8.89
Plantar flexion (°)	23.62±9.65	28.63±10.47*
8-foot up-and-go (second)	10.00±1.12	6.49±1.13*
MMSE-K (score)	23.90±2.26	25.93±2.37*

M ± SD
* p< 0 .05

All the tests were carried out in the senior center and three assistants and two examiners per item helped during the evaluations for the prevention of test-related injuries and for the safety of the subjects.

3. Data analysis

The data were analyzed using SPSS software (Version 18.0). A one-way ANOVA was conducted to compare the items between the group of women in their 60s to 80s and all subjects, as well as between the age groups within the below 8.5seconds group. The least significant difference (LSD) was used for a post-hoc analysis. Comparisons between the over 8.5s group and the below 8.5s group were conducted by independent sample t-tests. Statistical significance was set at $p<.05$, and the PASW Statistics 18.0 version was used for the analysis.

Ⅲ. Results

The differences in lower extremity strength, cognition, and ankle mobility were compared between the women in their 60s to 80s (Table 2). Those in their 60s and 70s showed significantly high values in the chair-stand test (times/30 s) compared to those in their 80s ($p<.05$). For subjects in their 60s, there were significant differences in dorsiflexion (°), plantar flexion (°), and 8-foot up-and-go (s) compared to those in their 70s and 80s ($p<.05$). In addition, the K-MMSE (score) showed significant high values compared to subjects in their 80s ($p<.05$).

The differences in lower extremity strength, cognition, and ankle mobility were compared between the over 8.5seconds and the below 8.5seconds groups (Table 3). The below 8.5seconds group showed significantly low values in age and high values in chair-stand (times/30 s), plantar flexion (°), and K-MMSE (score) compared to the over 8.5seconds group ($p<.05$). This group was significantly faster compared to the over 8.5seconds group ($p<.05$).

The differences in lower extremity strength, cognition, and ankle mobility were compared according to age in the below 8.5seconds group (Table 4). Only plantar flexion (°) of all the items showed significantly higher values among those in their 60s compared to those in their 70s and 80s ($p<.05$).

Ⅳ. Discussion

Falls in older adults are generally induced by a combination of intrinsic and extrinsic factors (van Ooijen et al, 2013). Balance is important not only to control postural sway but also to avoid falls (Gschwind et al, 2013). In particular, dynamic balance (multi-tasking) was related

Table 4. Comparisons of the differences on lower extremity strength, cognition and ankle mobility according to the ages within below 8.5seconds

	60s (N=27, a)	70s (N=32, b)	80s (N=7, c)	Post-hoc
Age (years)	65.59±2.42	73.71±2.66	82.85±2.03	
Chair stand (times/30s)	14.22±3.10	14.40±4.18	11.85±3.28	
Dorsi flexion (°)	27.11±8.62	22.56±9.36	22.57±5.12	
Plantar flexion (°)	32.96±12.39*	25.59±7.66	25.9±3.3	a > b, c
8-foot up-and-go (second)	6.24±1.20	6.58±1.08	7.00±0.96	
MMSE-K (score)	26.44±2.45	25.53±2.32	25.85±2.67	

M ± SD
* p< 0 .05

to walking speed and daily life activities, such as getting on/off of a bus and walking into the kitchen. Therefore, balance measurement for fall risk should be considered to assess dynamic balance under multi-task conditions instead of single tasks (Shumway-Cook et al, 2000).

The 8-foot up-and-go test is not only a good discriminator of fallers and non-fallers, but it is also an indicator of the increased risk for falls in elderly peoples (Rikli and Jones, 2013).

The main objective of this study was to investigate the effects of the 8.5s cut-off of the 8-foot up-and-go test as a predictor of falling and a good discriminator of fallers and non-fallers in women in their 60s to 80s. Therefore, this study was designed to compare lower extremity strength, cognition, and ankle mobility among women in their 60s to 80s, as well as to investigate whether there were differences among these factors between the over 8.5seconds group and the below 8.5seconds group after performing the 8-foot up-and-go test in elderly women. It was also designed to identify whether there were differences in these factors among women in their 60s to 80s within the below 8.5seconds group.

We confirmed that lower extremity strength, ankle mobility, dynamic balance, and cognitive function decreased ($p<.05$) among women aged in their 60s and 80s. In addition, elderly women who performed below 8.5seconds on the 8-foot up-and-go test were found to have a higher capacity ($p<.05$) in lower extremity strength, cognitive function, and ankle dorsiflexion than women who performed over 8.5seconds. Among women in their 60s to 80s performing below 8.5seconds on the 8-foot up-and-go test, interestingly, there were no differences ($p<.05$) in lower extremity strength, cognitive function, and ankle dorsiflexion. However, women in their 60s performing below 8.5seconds on the 8-foot up-and-go test had a good capacity ($p<.05$) on ankle plantar flexion compared to those in their 70s and 80s.

As mentioned previously, until now, the lack of research in this area has limited the possibility for a direct comparison with other studies. Therefore, we have no option but to only partially discuss comparisons of our work with other studies. The results of this study, which showed risk factors for a fall were lower ($p<.05$) in women in their 70s to 80s compared to women in their 60s, were similar to that of a previous study (Toraman and Yildirim, 2010) on the fall risk increase with age.

In this study, elderly women who performed below 8.5seconds on the 8-foot up-and-go test were found to have a higher capacity of lower extremity strength, cognitive function, and ankle dorsiflexion than women who performed over 8.5s. Interestingly, the subjects of this study demonstrated 7.00(second) for women in their 80s who performed below 8.5seconds on the 8-foot up-and-go test and it was faster than the 8.5seconds cut-off, whereas

women in their 80s demonstrated 8.71(second). This suggests that dynamic balance indicates that women in their 80s who performed below 8.5seconds on the 8-foot up-and-go test have a greater capacity than all groups of women in their 80s. We believe this confirmed the effects of the 8.5s cut-off on the 8-foot up-and-go test as a predictor of falling and a good discriminator of fallers and non-fallers based on risk factors for a fall (Rikli and Jones, 2013) in women in their 60s to 80s.

In this study, the most interesting is ankle plantar flexion among women in their 60s to 80s. However, previous studies (Long et al, 2013; Mecagni et al, 2000; Menz et al, 2006; Spink et al, 2011) suggested that decreased ankle dorsiflexion ROM and force may be risk factors associated with decreased balance in elderly peoples. ROM tends to decrease with age due to the mechanics and joint structures (Mecagni et al, 2000) and the ankle is an independent predictor of balance (Menz et al, 2006).

Ⅴ. Conclusion

We confirmed that women in their 60s to 80s performing below 8.5seconds on the 8-foot up-and-go test have no age-related differences in lower extremity strength, cognitive function, and ankle dorsiflexion in this study. However, ankle plantar flexion ROM showed higher values among women in their 60s compared to those in their 70s and 80s. In other words, women in their 60s to 80s with a lower risk for falls have the same degree of lower extremity strength and cognitive function, and women in their 70s and 80s with the same degree of dynamic balance capacity should be provided an exercise program to improve ankle mobility in a clinical setting. Finally, The 8.5seconds cut-off on the 8-foot up-and-go test as a good discriminator and predictor of falling showed differences among fall risk factors (age, lower extremity strength, cognition, and ankle mobility) in women in their 60s to 80s without having regular exercise and a fall experience over the past one year.

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