Time Difference between Dominant and Non-Dominant Leg Turning During Timed Up and Go Test

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ABSTRACT

Falls are global health issue among older adults. Most of our everyday tasks involve turning and it is one of the common causes of falls. The aim of this study was to examine the time difference between dominant and non-dominant leg turning during Timed Up and Go Test (TUG) standard and TUG cognitive among healthy older adults. A cross-sectional study was conducted among 50 community-dwelling older adults (age: 70.0±6.0). The participants were assessed using TUG standard and TUG cognitive by turning towards dominant and non-dominant leg. A two-way ANOVA with repeated measures was used to examine the effects of dominant and non-dominant leg turning during TUG standard and TUG cognitive. The results of the study showed a significant main effect for time difference between TUG standard and TUG cognitive [$F(1,49)= 62.495$, $p<0.001$]. TUG cognitive is a dual task test and it places additional loads on the brain's executive function which interferes with motor control tasks such as walking. However, there was no significant ($p = 0.79$) time difference between dominant and non-dominant leg turning during TUG standard and TUG cognitive. This study suggest that older adults can turn to their preferred side during TUG test.

Keywords: older adults; turning; dominant leg; non-dominant leg; falls; TUG

INTRODUCTION

Approximately 30% older people aged 60 and above experience a fall in a year (Rubenstein 2006). Depending on the settings, prevalence of falls among Malaysian older adults ranged between 4 to 60% (Shaharudin, Singh & Shahar 2018). It was also noted that the risk of falls increases by three-folds for those with history of falls (Allan et al. 2009; Suttanon et al. 2013). Unprecedented falls could restrict activities in daily living and increase fear of falling among older adults (Terroso et al. 2014).

Fall-related injuries were estimated to occur eight times more common during turning than straight-line walking (Cumming & Klineberg 1994). Turning or changing direction while walking involves multiple changes in the body mechanics, complex motor planning and execution (Dite & Temple 2002). Thus, ability to turn while walking is important to regain independence, given that performance measures such as longer time taken to turn, increased number of steps taken to turn, lack of pivoting or staggering when turning were all identified as indicators of turning difficulty (Thigpen et al. 2000; Tinetti 1986).

The Timed Up and Go Test (TUG) is a single-task test, known to be useful in predicting falls among older adults with frailty. Although TUG was found to be the best simple test to screen for fallers and non-fallers among healthy older adults (Samah et al. 2018), this test on its own may be inadequate in predicting falls (Ibrahim et al. 2017). Even among healthy older adults, TUG test is dependent on the age, gender and cognitive status of each individual (Ibrahim, Singh, Shahar 2017).

Unlike TUG standard, TUG cognitive is a method of assessing executive function while walking (Gothe et al. 2014; Toulotte et al. 2006). It has been reported that a decline in executive function was significantly associated with altered gait (Springer et al. 2006; Shumway-Cook et al. 2000) and physical performance (Won et al. 2014) in older adults. Postural stability decreases during concurrent performance of physical and cognitive tasks in older adults (Shumway-Cook et al. 1997). The inability to perform two or more tasks simultaneously (multi or dual tasking) is an indicator for a higher fall risk (Mesbah et al. 2017; Shumway-Cook et al. 2000). These observations could be explained by research results showing that cognitive capacity for processing information is limited (Hall et al. 2011).

TUG standard and TUG cognitive tests involve four important motor execution i.e. body shifting, transferring, walking and turning. Whilst many studies focused on the time taken to complete these TUG tasks, there remain a lack of knowledge on the time difference between each direction of turning during TUG tests (DeMorais-Faria et al. 2016; Chow 1997; Heung & Ng 2009). In only three studies the time difference between each direction of turning was reported, in which two of these studies were among participants with stroke (DeMorais-Faria et al. 2016; Heung & Ng 2009) and one study among participants with hip and lower limb fractures (Chow 1997). However, results of these three studies were inconsistent and showed discrepancy. Turning direction had no significant effect on the time to complete the TUG test in strokes participants in a study by DeMorais-Faria et al. 2016. Whereas, in the study by Chow et al. (1997) and Heung & Ng (2009), shorter time to complete TUG test was reported when turning on unaffected side in participants with hip and lower limb fractures and affected side in participants with stroke, respectively. To the best of our knowledge, the time difference between turning towards dominant or non-dominant leg among older adults without lower limb impairments has not been examined.

There is limited information available on the difference between turning towards dominant or non-dominant leg during Timed Up and Go test (TUG) in healthy older adults. The aim of our present study was to examine the time difference between turning towards dominant or non-dominant leg during TUG standard and TUG cognitive among older adults. We hypothesized that turning towards dominant leg takes shorter time compared to the non-dominant leg during performance of both TUG standard and TUG cognitive among healthy older adults.

METHODOLOGY

In this cross-sectional study, 50 community-dwelling older adults who fulfilled the inclusion criteria (including aged 60 years and above, ability to understand simple verbal instruction for TUG and ability to independently walk for at least 5 meters with or without walking devices) were recruited using convenient sampling. Participants were recruited at senior citizen clubs located at two urban cities in Selangor, Malaysia. The participants were excluded if they presented with musculoskeletal, cardiac and neurological impairments that could prevent their participation in TUG tests or were on medication that causes drowsiness, nausea and sleepiness. Informed consent was obtained from each participant. Ethical approval was obtained from the secretariat of research and ethics, Universiti Kebangsaan Malaysia (UKM PPI/111/8/JEP-2018-061) prior to the study.

INSTRUMENT
TIMED UP & GO TEST (TUG)

TUG standard test is a measure of functional mobility among older adults. It was reported to have high reliability score (ICC = 0.98) in older adults (Singh et al. 2015). TUG standard test was initially developed by Mathias et al. (1986) to measure the stand up and sit ability among older adults and was modified by Podsiadlo and Richardson (1991). It was demonstrated to exhibit high reliability and validity (0.99). TUG cognitive is a test to measure dual task: walking while counting backwards and was demonstrated to have good to excellent reliability [(ICC2,1) = 0.70–0.93] (Yang et al. 2016).

PROCEDURE

TUG-standard and TUG-cognitive were conducted under similar conditions in a comfortable environment. TUG-standard was tested using a standardized procedure, where each participant was asked to rise from the chair (46 cm high), walk forward in normal speed for 3 meters, make a 180° turn, walk back to the chair and sit down (Whitney et al. 2005). Participants were allowed to use their walking aids but no assistance was provided. The time taken for two TUG sessions was recorded and presented in seconds (Bohannon 2006). Participants were allowed to familiarize with the procedure via an experimental session, and two trial sessions were performed with adequate rest in between tests. The mean scores of the two tests were taken as the test score.

TUG cognitive was conducted using same procedure but with an additional task that included counting backwards by subtraction of 2 numbers from a randomly selected number between 20 and 100 while performing the test. During both TUG standard and cognitive tests, in which the turning was performed towards both sides, participants were first instructed to perform TUG with turning towards their preferred side (considered as dominant leg turning). After a rest (about 1 to 5 minutes) participants were instructed to perform a second trial turning towards the opposite side (considered as non-dominant leg turning). All participants performed TUG standard and cognitive turns towards both directions, and the results were included for analyses. During the tests, the examiner stood by the participants for safety in case there was a risk of fall (DeMorais-Faria et al. 2016).

STATISTICAL ANALYSIS

Data obtained from this study was analyzed using Statistical Package of Social Sciences (SPSS, Version 23 from Armonk, NY: IBM Corp). Descriptive statistics was used for demographic data and two-way ANOVA with repeated measures was used for comparison of mean difference between dominant and non-dominant leg turning for normally distributed TUG standard and TUG cognitive data. Analysis was considered statistically significant at $p<0.05$.

RESULTS

Table 1 shows the demographic data for 50 participants involved in this study, whereby 78% were females (n = 39). Mean age of the participants was 70 (SD = 6) years.

TABLE 1. Demographic data among older adults at Kampung Tunku Mosque and Suvarnamitra house (n = 50)

Demographic	**Mean (SD)**	**n (%)**	**Range**
Age years	70 (6)		60 - 83
Gender			
Male		11 (22)	
Female		39 (78)	

Table 2 shows the descriptive statistics for TUG-standard and TUG-cognitive tests with both dominant and non-dominant leg turnings. Examination of the means indicated that time taken to complete TUG-cognitive (dominant leg: Mean = 10.81; SD = 3.02, non-dominant leg: Mean = 10.61; SD = 3.27) was longer than TUG-standard (dominant leg: Mean =8.71; SD = 2.03, non-dominant leg: Mean = 8.58; SD = 1.85), regardless of the turning direction.

Table 3 reports the comparison of time difference between dominant and non-dominant leg turning during TUG standard and TUG cognitive. Although a significant main effect was obtained for time difference between TUG standard and TUG cognitive [$F(1,49) = 62.495$, $p<0.001$], no significant main effect was detected for time difference between dominant and non-dominant leg turning [$F(1,49) = 0.069$, $p>0.79$]. There was also no significant main effect for the time difference between dominant and non-dominant leg turning during TUG standard and TUG cognitive tests [$F(1,49) = 1.529$, $p>0.22$].

DISCUSSION

Results from our study rejected the hypothesis that turning using dominant leg takes shorter time compared to the non-dominant leg during TUG

TABLE 2. Descriptive statistics of time taken during TUG-standard and TUG-cognitive by using dominant leg and non-dominant leg (n = 50)

Variables	**Mean (SD)**	**Range**
TUG-standard (dominant leg), s	8.71 (2.03)	5.00 – 14.50
TUG-standard (non-dominant leg), s	8.58 (1.85)	5.00 – 13.00
TUG-cognitive (dominant leg), s	10.81 (3.02)	5.50 – 20.00
TUG-cognitive (non-dominant leg), s	10.61 (3.27)	5.50 – 19.21

Notes: s, second, TUG, Timed Up and Go

TABLE 3. Time difference between dominant leg and non-dominant leg turning during TUG standard and TUG cognitive among older adults (n = 50)

Factors	df1	df2	F	p value	Partialη^2
Dominant and non-dominant leg turning	1	49	0.069	0.79	0.001
TUG-standard and TUG-cognitive	1	49	62.495	<0.00	0.561
TUG*Dominant leg turning	1	49	1.529	0.22	0.030

Notes: TUG, Timed Up and Go; significant at p < 0.001

tests among healthy older adults. This result is similar to results found in post-stroke adults, suggesting that turning directions does not have any significant effect on the time taken to complete TUG test (DeMorais-Faria et al. 2016). Our results support a previous study by Vaisman et al. (2017), that highlighted that no statistical difference was found in the maximal power between dominant and non-dominant legs among non-athletes ($p = 0.316$) or single-leg-dominant professional soccer players ($p = 0.281$).

In contrast, TUG performance time was reported to be shorter when turning to hemiparesis side among participants with stroke (Heung & Ng 2009). Turning time to affected side is expected to be longer compared to the unaffected side as reported by Chow 1997. Biomechanically, participants have to shift their weight onto the leg of the turning direction. Muscle weakness and impairment in the lower limb due to stroke, might explain the differences in the performance while turning to affected and unaffected side.

It can be deduced that the differences in factors related to bilateral lower limb motor impairment, pain level, muscle tone abnormality, distribution of muscle weakness and skills in using a walking aid among stroke survivors could have affected the results (Heung & Ng 2009). In another study among stroke survivors, it was shown that the average joint torques for the paretic leg were significantly lower than non-paretic leg for all movements tested (Lomaglio & Eng 2005). Moreover, patients with a hip fracture experienced knee-extension strength deficit of more than 50% in the fractured limb compared to the non-fractured limb (Kristensen et al. 2009).

We also found that healthy older adults took a longer time to complete TUG cognitive than TUG standard. This is possible given that the degree of difficulty for secondary task may affect the pattern in the primary task such as speed of gait (Vance et al. (2015). Adding a secondary cognitive task to TUG test provides more information regarding mobility and risk of fall because it also measures the cognitive capacity in the performance of this dual task (Shumway-Cook et al. 2000). TUG dual task is known to place additional loads on the brain's executive function and interfere with motor control tasks such as walking (Coulthard et al. 2015).

To the best of our knowledge, there is no published research data on the difference between dominant and non-dominant leg turning in association to falls among healthy older adults. There is also limited insight about normal turning behaviour and the critical features of safe and efficient turning behaviour among older adults. Instructions for the TUG test were suggested as confusing in respect to which sides were participants supposed to turn when performing this test (Wall et al. 2000). More information about the turning behaviour in older adults is required.

One of the limitations of our study was that only time difference for turning between dominant and non-dominant side turning was investigated. Details of the characteristics of turning could provide more information about how it may affect turning time. For example, staggering (defined as loss of balance), the number of steps taken to turn and the type of turn used (from pivoting through to multiple steps) (Dite & Temple 2002).

The results of the present study provide information that there are no differences in the time taken to perform TUG regardless the turning side among older adults without lower limb impairments. It may also be important to test TUG cognitive in healthy older adults as it can provide valuable information in terms of functional postural stability and cognitive status while performing dual task activities.

CONCLUSION

Our study findings showed that there is no significant time difference between dominant and non-dominant leg turning during TUG standard and TUG cognitive. Therefore, when performing TUG test, health professionals can instruct healthy older adults to turn to their preferred side.

ACKNOWLEDGEMENT

The authors would like to thank the staffs and the participants from Kampung Tunku Mosque and Suvarnamitra house for their assistance and participation in this study.

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