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Timed Up and Go test in typically developing children: Protocol choice influences the outcome

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ABSTRACT

Background: The Timed Up and Go (TUG) test is one of the most popular functional dynamic balance tests in children with typical and atypical development. However, the TUG protocol varies in terms of turning-point markers and verbal commands.

Research question: Would the outcomes of TUG be different if a different TUG protocol, especially turning-point markers and verbal commands, was used in different age and gender?

Methods: Two hundred and ten typically developing children aged 6–12 years participated in the study. They were separated into 7 groups according to age. All participants were randomly selected to perform the TUG test in 6 conditions of a cone, a line, and a picture as turning-point markers under nonqualitative and qualitative verbal instructions in terms of the walking speed. The best TUG score (in seconds) of 3 trials in each condition was obtained for analysis.

Results: The time to complete the TUG test was decreased by age. The fastest time was found in the picture condition under qualitative and nonqualitative verbal instructions in all age groups. Additionally, using qualitative verbal instruction resulted in faster times than nonqualitative verbal instruction for all turning-point markers and in all age groups.

Significance: This study provided evidence that the outcome of the TUG test was influenced by turning-point markers and verbal instructions in all age groups. Therefore, a reliable TUG test protocol should be considered in order to measure the change in functional dynamic balance of children.

1. Introduction

The Timed Up and Go (TUG) test is one of the most popular functional dynamic balance tests in a clinical setting. This test has been validated and used in many populations [1,2]. In the TUG test, an individual is required to complete complex motor tasks characterized by the transfer from a static posture to a dynamic or bipedal posture [3].

Presently, the TUG test has been extensively used for children with and without atypical development [4–7]. One problem is the standardization of the procedures, which has not been fully established, especially the type of verbal instructions [4,5,7] and turning-point markers [4–7]. Differences in the instruction and the turning-point marker might have an effect on the TUG speed in typically developing (TD) children who were different in age and gender.

Unfortunately, no study has reported the effects of different turning-point markers and verbal instructions on the TUG test, especially in children. Therefore, the objective of this study was to investigate the effect of age, gender, and condition (turning-point markers and verbal instructions) on the TUG time in TD children aged 6–12 years.

2. Material and methods

2.1. Participants

In a cross-sectional study, 210 TD children (105 girls and 105 boys) aged 6 to 12 years were recruited. They were separated into 7 groups according to age. Each group was composed of 15 girls and 15 boys (Table 1). Participants were excluded if they had a known musculoskeletal or neuromuscular disease that might impede balance control according to their legal guardians' reports. The study protocol was

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Table 1
The characteristics of the participants and the mean and standard deviation of the TUG score in each age, gender, and condition.

Age (year)	Gender	Weight (kg.)	Height (cm.)	Conditions					
				Picture-Qualitative	Line-Qualitative	Cone-Qualitative	Picture-Nonqualitative	Line-Nonqualitative	Cone-Nonqualitative
6	Boy	21.77 (1.19)	117.60 (2.79)	6.01 (2.99)	6.83 (0.29)	7.42 (0.29)	7.06 (0.37)	9.35 (0.35)	9.44 (0.39)
	Girl	21.73 (1.55)	118.13 (2.59)	5.95 (0.26)	6.84 (0.31)	7.13 (0.39)	7.05 (0.40)	9.23 (0.55)	9.19 (0.39)
	Total	**21.75 (1.35)**	**117.86 (2.66)**	**5.98 (0.28)**	**6.84 (0.29)** [a]	**7.28 (0.37)** [a,b]	**7.05 (0.38)** [a]	**9.29 (0.46)** [a,b,c,d]	**9.32 (0.41)** [a,b,c,d]
7	Boy	24.96 (2.96)	125.73 (5.87)	6.03 (0.21)	6.63 (0.32)	6.62 (0.25)	7.15 (0.49)	8.46 (0.37)	8.46 (0.54)
	Girl	23.84 (3.44)	122.34 (5.99)	5.91 (0.24)	6.98 (0.41)	6.93 (0.22)	7.00 (0.31)	8.60 (0.34)	9.04 (0.58)
	Total	**24.40 (3.20)**	**124.03 (6.07)**	**5.97 (0.23)**	**6.81 (0.40)** [a]	**6.77 (0.28)** [a]	**7.08 (0.41)** [a]	**8.53 (0.36)** [a,b,c,d]	**8.75 (0.63)** [a,b,c,d]
8	Boy	29.02 (2.53)	133.13 (4.48)	5.85 (0.26)	6.59 (0.28)	6.67 (0.39)	7.04 (0.70)	8.29 (0.21)	8.49 (0.43)
	Girl	28.67 (2.06)	132.11 (4.29)	5.96 (0.19)	6.44 (0.25)	6.73 (0.30)	7.19 (0.45)	8.39 (0.25)	8.58 (0.35)
	Total	**28.84 (2.27)**	**132.62 (4.33)**	**5.91 (0.23)**	**6.52 (0.27)** [a]	**6.69 (0.34)** [a]	**7.11 (0.58)** [a,b,c]	**8.34 (0.24)** [a,b,c,d]	**8.54 (0.39)** [a,b,c,d]
9	Boy	31.92 (2.42)	137.77 (4.63)	5.91 (0.21)	6.46 (0.37)	6.74 (0.59)	7.26 (0.37)	8.00 (0.26)	8.30 (0.52)
	Girl	32.81 (3.76)	138.67 (6.37)	5.98 (0.32)	6.65 (0.29)	6.68 (0.52)	6.99 (0.38)	7.75 (0.28)	8.22 (0.46)
	Total	**32.36 (3.14)**	**138.21 (5.48)**	**5.95 (0.27)**	**6.55 (0.34)** [a]	**6.71 (0.55)** [a]	**7.13 (0.39)** [a,b,c]	**7.88 (0.29)** [a,b,c,d]	**8.26 (0.49)** [a,b,c,d,e]
10	Boy	35.67 (8.28)	139.85 (4.33)	5.58 (0.39)	6.32 (0.44)	6.49 (0.38)	7.18 (0.37)	8.11 (0.59)	8.20 (0.43)
	Girl	37.44 (4.05)	144.30 (5.96)	5.34 (0.49)	6.54 (0.41)	6.43 (0.38)	6.73 (0.71)	7.73 (0.80)	8.24 (0.33)
	Total	**36.55 (6.46)**	**142.07 (5.59)**	**5.46 (0.45)**	**6.43 (0.43)** [a]	**6.46 (0.37)** [a]	**6.95 (0.60)** [a,b,c]	**7.92 (0.72)** [a,b,c,d]	**8.22 (0.37)** [a,b,c,d]
11	Boy	36.22 (3.26)	139.57 (5.54)	5.06 (0.33)	6.24 (0.29)	6.14 (0.57)	6.52 (0.34)	7.49 (0.52)	7.56 (0.49)
	Girl	38.06 (5.24)	142.27 (8.79)	5.16 (0.29)	5.91 (0.38)	6.24 (0.46)	6.36 (0.55)	7.31 (0.45)	7.59 (0.44)
	Total	**37.14 (4.38)**	**140.91 (7.35)**	**5.11 (0.31)**	**6.07 (0.38)** [a]	**6.19 (0.51)** [a]	**6.44 (0.46)** [a,b]	**7.40 (0.49)** [a,b,c,d]	**7.58 (0.46)** [a,b,c,d]
12	Boy	41.02 (4.30)	145.57 (7.11)	4.81 (0.20)	5.69 (0.24)	5.78 (0.27)	6.15 (0.39)	6.92 (0.31)	7.28 (0.34)
	Girl	41.65 (4.31)	146.53 (5.03)	4.89 (0.21)	5.79 (0.24)	6.00 (0.39)	6.18 (0.36)	6.94 (0.32)	7.56 (0.21)
	Total	**40.15 (8.04)**	**146.05 (6.06)**	**4.85 (0.21)**	**5.75 (0.24)** [a]	**5.89 (0.35)** [a]	**6.17 (0.37)** [a,b,c]	**6.93 (0.32)** [a,b,c,d]	**7.42 (0.31)** [a,b,c,d,e]

Note: [a] Significant difference from picture-qualitative condition, [b] Significant difference from line-qualitative condition, [c] Significant difference from cone-qualitative condition, [d] Significant difference from picture-nonqualitative condition, and [e] Significant difference from line-nonqualitative condition.

Fig. 1. Turning-point markers: a) line, b) cone, and c) picture.

approved by the ethical review committee for research involving human subjects at the University of Sriwijaya, Palembang, South Sumatera, Indonesia. Prior to testing, the objectives and procedures were explained to the participants and their legal guardians. Informed consent was obtained from all individuals included in this study and their legal guardians.

2.2. Data collection

All participants randomly performed the TUG test while wearing sneakers in 6 conditions according to the verbal instructions and the turning-point markers. The instructions were nonqualitative (NQ) and qualitative (Q) verbal instructions in terms of the walking speed. The words "walk, ready, go" were used for the nonqualitative verbal instruction, and the words "walk as fast as you can, ready, go" were used for the qualitative verbal instruction. The turning-point markers were a line (L) marked on the floor, a cone (C) placed on the floor, and a star picture (P) attached to the wall 3 m away from the starting point (Fig. 1).

To perform the TUG test, participants were first asked to sit on an adjustable chair with 90° knee and hip flexion. The instructions were clearly communicated by the physical therapist to the participants depending on the condition. After hearing the word "go," participants promptly stood up and walked forward 3 m to the turning-point marker. Then, they turned around, walked back to the chair, and sat down again. If the turning point was a star picture, participants were asked to touch the picture before turning. The time started on the word "go" and stopped as soon as the participant's bottom touched the seat. A demonstration was provided, and a few trials were allowed for participants to familiarize themselves with the procedure. In each condition, the participants performed the TUG test for 3 trials. A 1-minute break was allowed between trials. The best TUG score from these 3 trials was used for the statistical analysis [7,8].

2.3. Statistical analysis

The statistical analysis was performed using SPSS® statistical software (IBM® SPSS® 23.0 version for Windows). In the present study, the Shapiro-Wilk test showed the normal distribution of all data variables. The main effects and interaction effects of the independent factors on TUG scores were determined by a three-way mixed repeated ANOVA with Bonferroni post hoc test: age (6, 7, 8, 9, 10, 11, and 12 years) × gender (boy and girl) × condition (P–Q, L–Q, C–Q, P-NQ, L-NQ, and C-NQ).

3. Results

Significant age ($F_{6,196} = 241.45$, $p < 0.001$), condition ($F_{5,980} = 1455.1$, $p < 0.001$), and age × condition ($F_{30,980} = 9.46$, $p < 0.001$) interaction effects were found for TUG scores. Pairwise comparison indicated that TUG time deceased when age increased which varied in each condition (Fig. 2). TUG time deceased the most in P–Q condition in all age groups (Table 1).

4. Discussion

The present study aimed to investigate the influence of varying turning-point markers and verbal instructions on the outcome of the TUG test in TD children aged 6–12 years. The results indicate that differences in both turning-point markers and verbal instructions have a significant impact on the outcome of the TUG test in all age groups. The ability to do the TUG test was approximately decreased by age in all protocols.

Under qualitative and nonqualitative verbal instruction in almost all age groups, using a cone or a line as the turning point resulted in a longer time to complete the TUG test compared with using a picture. The difference in completion times for each turning-point marker might be due to the different turning strategies used during the TUG test. To make a turn, participants walked around the turning point when a cone and a line were used. On the other hand, they made a sharp turn after touching the picture. These different turning strategies might lead to walking a shorter distance when a picture is used instead of a cone or a line. Aside from turning strategies, the walking distance when the picture was used as a turning-point marker was also shorter than the walking distance for the other turning-point markers because the picture was attached to the wall 3 m away from the starting point. When turning with the picture turning-point marker, participants mostly reached out to touch the picture before finishing the 3-m walk. Moreover, a concrete task, such as touching a picture, would enhance performance more than an abstract task, such as turning around a cone or a line [9]. Therefore, using a picture as a turning point could result in the lowest TUG test completion time under qualitative and nonqualitative verbal instructions.

Another potential issue was that for every turning-point marker and in all age groups, the qualitative verbal instruction resulted in a faster completion time than the nonqualitative verbal instruction. Previous study reported that minimal change in the instructions' wording had an effect on the performance [10]. In the present study, the words that were changed in the verbal instructions affected the quality of performance. The qualitative verbal instruction could enhance the desired performance [11]. Therefore, the instruction in this study to "walk as fast as you can" could induce a shorter TUG test completion time than the nonqualitative verbal instruction. Although, the qualitative verbal instruction could encourage optimum performance, it might increase risk of falls during the test, especially in a clinical situation.

Because the results of this study showed that there were age- and protocol-effects to the TUG score in TD children, it is significantly important to get data from a reliable protocol that is more applicable for specific age groups of children in order to measure the change, such as pre and post intervention with TD children.

Declaration of Competing Interest

None.

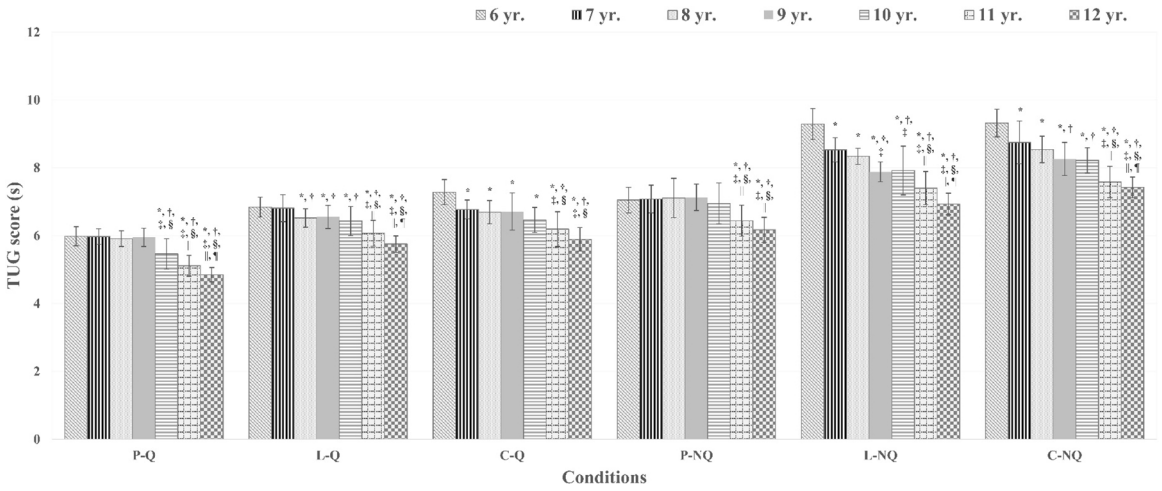

Fig. 2. TUG score in 7 age groups under picture-qualitative condition (P–Q), line-qualitative condition (L–Q), cone-qualitative condition (C–Q), picture-non-qualitative condition (P—NQ), line-nonqualitative condition (L—NQ), and cone-nonqualitative condition (C—NQ). * Significant difference from age 6-year-old, † Significant difference from age 7-year-old, ‡ Significant difference from age 8-year-old, § Significant difference from age 9-year-old, ‖ Significant difference from age 10-year-old, and ¶ Significant difference from age 11-year-old.

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