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Timed Up and Go test: Reference data for Saudi preschool children.

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Abstract

Objective: To find reference values for the Timed Up and Go (TUG) test on typically developed Saudi preschool children aged from 3 to 5 years, and to determine whether differences in test scores are based on age or gender.

Materials and Methods: This pilot exploratory study involved determining TUG values of Saudi preschool-aged children with typical development. Differences in the mean and standard deviation of TUG values for each age group, gender, height, and Body Mass Index (BMI) were tested.

Results: During the study period, 61 typically developed Saudi preschool children aged 4.37 ± 1.10 were tested, with 55.7% of the sample being male. TUG values ranged from 4.74 to 5.20 seconds across all age groups, with time taken tending to decrease for older children in the study group. No significant differences between males and females in TUG timing (P=0.81) were observed.

Conclusion: This study provides reference data for the TUG test in typically developed Saudi preschoolers, which may benefit clinicians in assessing children with developmental delays and comparing them to age-matched norms.

Keywords: TUG: Timed Up and Go test, Dynamic balance, Preschool, Children, Saudi Arabia, Balance, Balance assessment, Reference value, Typical development, Height, BMI: Body Mass Index.

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Introduction

Balance control is considered an important aspect of early childhood development and is one of the preliminary motor skills children require. Balance is defined as "The ability to maintain the center of mass within the base of support" [1]. Balance has two types: dynamic and static. Dynamic balance is maintaining the center of mass within the base of support during movement. Static balance is maintaining stability and orientation in a fixed (or static) posture [2].

The development of balance is related to the maturation of and integration between multiple systems: visual, vestibular, somatosensory, and musculoskeletal [3-5]. Each system matures at a certain age. The development of balance starts with the somatosensory system at 3 to 4 years of age and ends with the vestibular system at 7 to 8 years of age [6]. Preschool-age children are susceptible to falls because their dynamic balance is still developing. Improvements in dynamic balance start from 3 to 7 years of age. Static balance, however, matures before 3 years of age [7]. If children refrain from movement or fail to develop fundamental motor skills in early childhood, they will struggle to attain higher performance skills later in life [8].

The Timed Up and Go test (TUG), Pediatric Balance Scale, and Functional Reach Test are tools for assessing dynamic balance in children and are essential for identifying balance disorders and the risk of falls [9]. Earlier studies have applied the TUG test for dynamic balance on children with affected balance or with conditions such as Cerebral Palsy(CP), Down Syndrome (DS), and Traumatic Brain Injury (TBI) [10-12]. The TUG test is commonly used in clinical practice because it is simple, cost-effective, and requires little expertise to apply [13].

TUG test performance among preschool children with typical development has been studied in many countries with varying results. Test scores differ significantly with nationality in typically developed preschool children from 3 to 5 years of age [13].

In a south Brazilian study, 74 children performed TUG, resulting in a mean value of 6.59 second [11]. In Australia, the mean value was 6.7 sec with 86 children tested [10]. Whereas in Hong Kong, 60 children gave a mean value of 4.70 second [8]. The differences in mean values may be due to variations in ethnicity, height, and BMI.

Given variations in TUG values around the world, it is important to assess normative values for TUG in Saudi children.

However, to the best of the authors' knowledge, no previous studies have reported normative TUG test reference values for typically developed Saudi Arabian preschoolers.

Obtaining normative TUG test values will allow clinicians to assess children with developmental delays and compare them to age-matched norms of both sexes.

This study will therefore fill a knowledge-gap, examine whether age or gender differences affect TUG scores, and aid in assessing Saudi children's dynamic balance in pediatric physical therapy practice.

Materials and Methods

Sample

A cross-sectional study with a convenient sample of preschool children aged from 3 to 5 years. The sample was of children from Al-Ahsa and Riyadh-KSA who were the neighbors or relatives of each investigator. Children were included in this study if they were aged from 3 to 5 years, were able to walk independently, and were able to follow the test instructions. Children with physical disabilities, mental disorders, auditory impairment, or uncorrected visual impairment were excluded.

Timed Up and Go (TUG) test

The TUG test, developed by Podsiadlo and Richardson in 1996, is a reliable and valid test commonly used to assess balance in all ages in order to prevent falls [14,15]. The TUG test measures the amount of time an individual takes to stand from sitting on a chair or bench, walk in a straight line for 3 meters, return to the same chair, and sit down again. The instruments required are a stopwatch, meter ruler, an object to use as a marker at the end of the 3 meters that subjects are required to walk, a chair suitable for children, and a bodyweight scale. It is considered a good assessment tool for functional mobility in the pediatric population [11].

Procedure

The investigators scheduled an appropriate time to visit the houses of neighbors and relatives and, with the informed and written consent of parents, collected the children's demographic data by questionnaire. Eligibility of the participants was assessed based on the study's inclusion and exclusion criteria. Each child's height and weight was then measured.

The investigator found a suitable test area a quiet place free of obstacles or slippery surfaces so the child could walk freely without distractions or interferences that might jeopardize the test. The test area was prepared with a chair suitable for a child; that is, with a backrest, no armrest, and at a height that allowed the child's hips and knees to flex at 90˚ when the feet were flat on the floor. Subsequently, a distance of 3 m was measured out in a straight line and an object placed at the end of the line to illustrate the direction for the child. The investigator then explained the TUG test procedure to the child by first demonstrating the test and then asking the child to repeat the test as a practical trial run before the actual measurements were taken, ensuring the child understood the procedure.

The test started by measuring the amount of time the child took to stand up from the chair and walk for 3 meters in a straight line to an object at the end of the line. The investigator walked beside the child to minimize the risk of injury from falling, and the child's parent provided supervision. At the end of the line, the child was instructed to return to the same chair and sit down. The instruction given to the child was, "Start, walk as fast as possible, turn back, and sit down." After the practical trial, the child repeated the test three times, and an average of those measurements was taken.

Ethical consideration

All ethical considerations were fulfilled before conducting the study. This research received approval from the IRB committee in Princess Nourahbint Abdulrahman University (IRB number 20-0101). Before the TUG test was undertaken, the participants' parents were informed, and written consent was obtained; however, if a child refused to complete the test, he or she was excluded. All collected data was stored with anonymized codes to ensure participant confidentiality.

Data analysis

Statistical analyses were performed using IBM SPSS Statistics version 22 (IBM Corp., Armonk, NY, USA) for Windows. Demographics data, reference value, and Standard Deviations (SD) of the TUG test results were determined by age. The data were checked for normal distribution using the NORMDIST function. A One-way Analysis of Variance (ANOVA) was used to compare the mean TUG values with age groups. Repeated ANOVA assessed the differences between the three trials. An independent t-test was used to test differences between genders. The intra-rater reliability within each child's trials was analyzed using the Intra Class Correlation Coefficient (ICC) (3,1), and the data were calculated at 95% Confidence Intervals (CIs) and a statistically significant level of $P \leq 0.05$.

Results

A total of 61 (N=61) preschool children were recruited: 38 from Al-Ahsa and 23 from Riyadh. Table 1 shows the demographic data of participants. The sample was composed of 34 males and 27 females, including 16 children aged 3 years, 16 children aged 4 years, and 29 children aged 5 years. Of the total, 15 children were reported to have fallen once a week, and one child was reported to have fallen two or three times a week.

Variables	3 years (n=16)	4 years (n=16)	5 years (n=29)	Total (N=61)
Mean age, y (SD)	3.3 (0.28)	4.3 (0.24)	5.5 (0.27)	4.37 (1.10)
Gender (male/female)	10/6	7/9	17/12	34/27
Mean height, cm (SD)	96.33 (11.00)	103.67(8.52)	110.04 (7.43)	103.35 (6.86)
Mean weight, kg (SD)	14.15 (1.54)	14.74 (2.42)	19.30 (4.32)	16.06 (2.82)
Mean BMI, m/kg2 (SD)	15.86 (4.70)	13.72 (2.04)	15.89 (2.67)	15.16 (1.24)
Number of falling (1/W)	6	4	5	15
Number of falling (2-3/W)	0	0	1	1
Mean TUG 1, sec (SD)	5.08 (0.84)	5.34 (0.87)	4.76 (0.98)	5.06 (0.29)

Mean TUG 2, sec (SD)	5.19 (0.87)	4.72 (1.07)	4.78 (0.88)	4.90 (0.26)
Mean TUG 3, sec (SD)	5.12 (0.87)	4.66 (0.92)	4.80 (0.94)	4.86 (0.24)

Table 1. Demographic data of participants. TUG: Timed Up and Go; y: Year; cm: Centimeter; kg: Kilogram; BMI: Body Mass Index; m/kg2: Meter per kilogram square; (1/W): Once a week; (2–3/W): Two to three times per week; SD: Standard Deviation; sec: Second; n:Number of sample; TUG 1: First trial; TUG 2: Second trial; TUG 3: Third trial.

TUG values by age

Table 2 shows the mean and SD of TUG for each age. The mean and SD of TUG value for preschool children was 4.96 ± 0.90 sec. TUG times tended to decrease as age. The longest mean TUG value was 5.20 sec in children aged 3 years, decreasing to 4.91 sec in children aged 4 years, and declining again in children aged 5 years to 4.79 sec (Table 2 and Figure 1).

Mean (± SD)					
Gender	**Age 3 (n=16)**	**Age 4 (n=16)**	**Age 5 (n=29)**	**Total mean (– SD)**	**P-value between gender**
Male (n=34)	5.00 ± 0.72	5.00 ± 0.72	5.00 ± 0.72	4.95 ± 0.91	0.81
Female (n=27)	5.25 ± 1.02	5.25 ± 1.02	5.25 ± 1.02	4.90 ± 0.81	
P-value among ages	0.3				

Table 2. TUG values for each age and gender.

The one-way ANOVA test revealed that the mean TUG values decreased by 1.2 sec with increasing age in preschool children. However, these differences between the age groups were not considered statistically significant (P=0.30). It can be seen from Figure 1 that children aged 5 years showed a range of mean TUG from 3.42 sec to 6.81 sec, whereas children aged 4 years ranged from 4.02 sec to 6.84 sec, and those aged 3 years ranged from 3.95 sec to 6.31 sec.

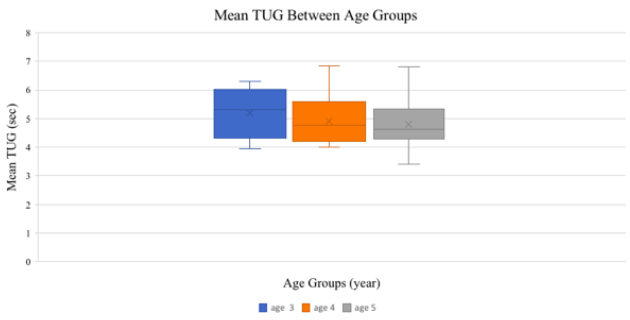

Figure 1. Represents the comparison of mean Timed Up and Go Test (TUG) value among age groups. 3-years (n=16), 4-years (n=16), and 5-years (n=29). This box plot represents that the upper line of the box corresponds with the first quartile (percentile (25, P25), middle line with the median (percentile 75, P75).

TUG values by gender

The mean TUG value for males was 4.95 sec, and for females, 4.90 sec. The independent t-test between the genders revealed no statistically significant differences between males and females (P=0.81). Figure 2 showed a range of mean TUG values from 3.57 sec to 6.31 sec in females, whereas the mean TUG values in males ranged from 3.42 sec to 6.84 sec.

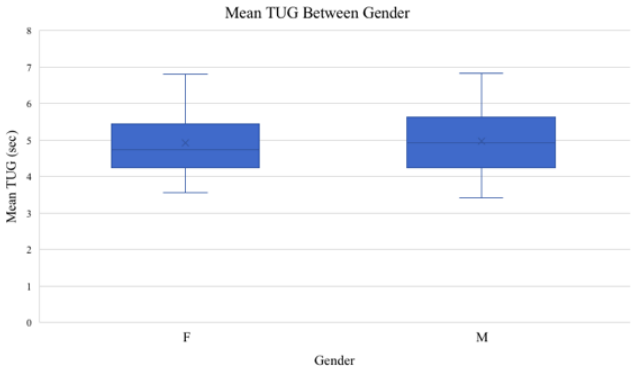

Figure 2. Represents the comparison of mean Timed Up and Go Test (TUG) value between genders. Males (n=34) and females (n=27). This box plot represents that the upper line of the box corresponds with the first quartile (percentile 25, P25), middle line with the median (percentile 50, P50), and the lower line with the third quartile (percentile 75, P75).

Intra-rater reliability

Intra-rater reliability was measured for the TUG using the three trials of each child per investigator. The results showed ICC (3,1)=0.811 (95% CI=4.73 to 5.19),which indicates a good level of intra-rater reliability for each child's trials. Each participant performed the TUG test three times. Repeated ANOVA used to differentiate between the three trialsrevealed no statistically significant difference among the three trials (P=0.77).

Discussion

This study presented the reference value of the TUG test for 61 typically developed Saudi preschool children and highlighted the differences that existed based on age and biological gender. The mean TUG values decrease by 1.2 sec with increasing age in preschool children. No statistically significant gender differences in mean TUG values were discovered. A good level of intra-rater reliability for each child between the three trials was found. The differences between the three trials revealed that trial 3 showed a reduced mean TUG value when compared to trial 1 and trial 2, but only by 0.26 sec, which is not considered statistically significant. Moreover, no correlations were found between TUG values and age, height, or BMI.

The mean TUG value for preschool age in this study was 4.96 ± 0.90 sec, whichis lower than and more variable than in previously reported studies, which reported 6.7 ± 1.2 sec,

6.59 ± 1.36 sec, and 7.86 ± 1.03 sec [10,11,13]. However, this study seems closer to the mean TUG value of Lei et al., which was 4.70 ± 0.90 sec; perhaps the sample size was relatively similar.

The results of the present study revealed slight differences in mean TUG values between males and females, although these were not statistically significant. Mean TUG values were found to decrease with the increasing age of preschoolers, agreeing with the findings of previous studies conducted by Williams et al. and Verbecque et al. [10,13]. These findings can be explained by improved dynamic balance, starting from 3 years of age, and developing with age in children aged from 3 to 5 years, while static balance matures before 3 years of age [6].

In this study, no significant difference in TUG values was found between age groups, unlike in Williams et al. which indicated significant difference in TUG values among age groups [10]. Furthermore, Williams et al. noted differences in the mean TUG values between preschool and primary school-aged children. For preschoolers, the mean TUG value was 6.7 sec, while for primary schoolers, the mean TUG value was 5.2 sec. These findings revealed a statistically significant age difference (P=0.001) that could potentially be explained by maturation. However, in the current study, no significant difference in TUG values was discerned among age groups. This may be because this study included only preschool-aged children while Williams et al. tested children ranging from 3 to 9 years of age [10].

Several factors may explain the differences between the mean TUG value in this study and prior literature, including procedural or instructional differences, and ethnic, cultural, and behavioral differences in participants. For example, Williams et al. and Nicolini-Panisson et al. modified the TUG test by asking the children to touch a target on the wall, while Verbecque et al. altered the chair distance by 3.38 cm and asked the child to sit down on the first chair and, on the cue, "start" and walk to a Duplo Brick placed on a second chair, return the brick to the first chair, and sit down again [10,11,13]. Moreover, this study used an object at the end of the line to indicate the direction of travel for the child. How well the child understands the instruction may contribute to variations in walking speed. The instruction in Nicolini-Panisson et al. was "Go as fast as possible," similar to this study, which stated, "Start, walk as fast as possible." Lei et al. used the TUG test without modification, although their instruction was "RUN!" [8]. The instruction given in Williams et al. was nonspecific except for "Go!" and "Stop!" to start and finish the test [10]. Repeated instruction during the Nicolini-Panisson et al. studies may have helped direct and remind the child, thus affecting the child's performance and, consequently, the result [11,10]. Lei et al. and Verbecque et al. did not mention repeating the instruction during the test [8,13].

Observation during the TUG test suggests that children aged 5 years were able to complete the task with less practice. Conversely, children aged 3 to 4 years need more practice and turned a "big circle" at high running speed upon reaching the turning point. Children aged 4 to 5 years decreased their running speed as they neared the turning point. While children aged 5 years ran quickly, stopped at the turning point, and turned their bodies 180˚. According to the early childhood fitness ability progressionprogram in the preschool guideline children aged from 3 to 5 years have different levels of running ability [16]. Three-year-old children could run around the obstacles. Four year-old children could control their running direction and perform a sudden turn. Five-year-old children could perform a sudden stop, start, and turn [8].

In comparing the differences between three trials, the results of this study were most consistent with Williams et al. taking the mean of three trials [10]. Other studies chose the best of two trials, or the best of three trials [8,11,13]. The TUG test was reliable according to this study, which showed ICC (3,1)=0.811. The reliability of Lei et al. was ICC=0.74; Nicolini-Panisson et al. study was ICC=0.95 and Williams et al. was ICC (1,1)=0.82 [8,11,10]. Several limitations are recognized, including the small sample size and variabilities in age and gender. Other factors that may influence the TUG values, such as physical activity or behavior, were not assessed.

Conclusion

This study provides reference data on the TUG test in Saudi preschool-aged children with typical development. The values of the TUG were comparable with those of other countries. Age and gender had no apparent influence on TUG values. The findings of the current study may benefit clinicians who are assessing children for developmental delays when compared to age-matched norms. Further research with a larger sample size is recommended, as are more geographic diversity in the sample of Saudi Arabian children, and greater age diversity for the Saudi population. Further studies into the effect a child's greater physical activity and behavior or attitude have on the TUG test results would also be useful.

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References

1. Horak FB. Clinical measurement of postural control in adults. Phys Ther 1987;67(12):1881–1885.
2. Westcott SL, Lowes LP, Richardson PK. Evaluation of postural stability in children: Current theories and assessment tools. Phys Ther 1997; 77(6):629–645.
3. Nolan L, Grigorenko A, Thorstensson A. Balance control: Sex and age differences in 9 to 16 year-olds. Dev Med Child Neurol 2005; 47(7):449–454.
4. Westcott SL, Burtner PA. Postural control in children: implications for pediatric practice. Phys Occup Ther Pediatr 2004; 24(1–2):5–55.

5. Woollacott M, Shumway-Cook A. Changes in posture control across the life span-A systems approach. Phys Ther 1990;70(12):799–807.
6. Hirabayashi S, Iwasaki Y. Developmental perspective of sensory organization on postural control. Brain Dev 1995;17(2):111–113.
7. Spodek B, Saracho ON. Handbook of research on the education of young children. Hoboken: Taylor and Francis 2014.
8. Lei Y, Lam CKY, Lams MHS, et al. Validity and reliability of Timed Up and Go test on dynamic balance in 3–5 years old preschool children. J Yoga Phys Ther 2017; 07(02).
9. Butz S, Sweeney J, Roberts P. Relationships among age, gender, anthropometric characteristics, and dynamic balance in children 5 to 12 years old. Pediatr Phys Ther 2015; 27(2):126–133.
10. Williams EN, Carroll SG, Reddihough DS. Investigation of the timed 'up & go' test in children. Dev Med Child Neurol 2005; 47(8):518–524.
11. Nicolini-Panisson RD, Donadio MV. Normative values for the Timed 'Up and Go' test in children and adolescents and validation for individuals with Down syndrome. Dev Med Child Neurol 2014; 56(5): 490–497.
12. Katz-Leurer M, Rotem H, Lewitus H. Relationship between balance abilities and gait characteristics in children with post-traumatic brain injury. Brain Injury 2008; 22(2):153–159.
13. Verbecque E, Vereeck L, Boudewyns A. A modified version of the Timed Up and Go test for children who are preschoolers. Pediatr Phys Ther 2016; 28(4): 409–415.
14. Podsiadlo D, Richardson S. The Timed "Up & Go": A test of basic functional mobility for frail elderly persons. J Am Geriatr Soc 1991; 39(2): 142-148.
15. Christopher A, Kraft E, Olenick H. The reliability and validity of the Timed Up and Go as a clinical tool in individuals with and without disabilities across a lifespan: a systematic review. Disabil Rehabil. 2019; 26:1–15.
16. Cleland-Donnelly F, Muelle S, Gallahue D. Developmental physical education for all children. Champaign: Human Kinetics. 2007.

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