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NORMATIVE VALUES FOR TIME UP AND GO TEST FOR HEALTHY ADULTS

Original Research

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ABSTRACT

Background: The Timed Up and Go (TUG) test is a widely utilized clinical tool to assess functional mobility, balance, and fall risk, particularly in older adults. Establishing normative reference values for TUG is essential for identifying deviations from normal physical function. Various factors, including age, gender, and body composition, influence TUG performance. Currently, no standardized normative data are available for healthy adults in Pakistan, emphasizing the need for population-specific reference values.

Objective: To establish normative reference values for the TUG test in healthy Pakistani adults and examine its relationship with demographic and anthropometric factors.

Methods: A cross-sectional study was conducted among 326 healthy adults aged 40–70 years, recruited using non-probability convenience sampling. Participants self-reported being free from medications and musculoskeletal, cardiovascular, neurological, or psychiatric disorders. Individuals with a history of lower limb surgery or cognitive impairments were excluded. Data collection included age, gender, height, weight, and BMI. The TUG test was conducted using standardized guidelines, with the average of three trials recorded for analysis. Descriptive statistics, independent t-tests, one-way ANOVA, and Pearson's correlation were performed using SPSS version 26, with significance set at $p < 0.05$.

Results: The mean age of participants was 55.62 ± 6.6 years, with 56.4% male (n = 184) and 43.6% female (n = 142). Participants were distributed across age groups as follows: 40–50 years (27.3%), 51–60 years (52.1%), and 61–70 years (20.6%). Mean TUG time was 9.86 ± 2.14 seconds, with males performing faster (9.29 ± 2.04) than females (10.59 ± 2.05, $p = 0.000$). TUG time increased significantly with age ($r = 0.587$, $p = 0.000$) and BMI ($r = 0.261$, $p = 0.000$), while height ($r = -0.210$, $p = 0.000$) and weight ($r = -0.119$, $p = 0.031$) were negatively correlated with TUG scores.

Conclusion: The study provides normative reference values for the TUG test in healthy Pakistani adults, with significant variability observed across gender, age groups, and BMI categories. The findings suggest that TUG performance declines with increasing age and BMI, while taller and lighter individuals perform better. These results serve as a valuable resource for clinicians in assessing fsunctional mobility and fall risk in older adults.

Keywords: Anthropometry, balance, body mass index, functional mobility, normative values, Timed Up and Go.

INTRODUCTION

Balance, the ability to maintain the body's center of gravity within its base of support, is a fundamental aspect of physical function and stability. Impairments in balance are a significant concern not only in individuals with neurological conditions but also among healthy individuals, where they can lead to an increased risk of falls and fall-related injuries (1). It has been reported that 22% of individuals over the age of 65 experience balance issues, often during routine activities such as walking, climbing stairs, or transitioning between positions. With advancing age, sensory and motor functions naturally decline, contributing to postural instability (2, 3). Changes in the vestibular and somatosensory systems have been specifically linked to deficits in balance control among older adults. Additional factors, such as reduced muscle strength, slower reaction times, visual impairments, the use of certain medications, vertigo, and chronic medical conditions, further exacerbate balance problems and increase the likelihood of falls (4).

A fall is defined as an unintentional and unexpected change in body position that results in the individual coming to rest on the ground. Aging has been associated with deterioration in the musculoskeletal system as well as cognitive domains, including memory, executive function, learning, attention, and the processing of sensory information from peripheral receptors (5). Assessments of physical function are therefore invaluable in identifying declines in function, evaluating the effects of interventions, and providing detailed insights into domains such as balance, strength, and mobility. Performance-based tools play an essential role in clinical and research settings by identifying impairments, assessing physical fitness, and predicting the risk of falls, enabling early intervention for individuals at risk (6, 7).

The Timed Up and Go (TUG) test is a widely used, quick, and simple tool for assessing functional mobility, particularly in elderly populations. Initially proposed by Podsiadlo and Richardson in 1991 as a modified version of the Get Up and Go test, it involves timing an individual as they stand up from a chair with armrests, walk a distance of three meters at a comfortable pace (with or without their usual walking aid), turn around, walk back, and sit down again. The test provides critical information about an individual's ability to perform functional daily tasks and identifies those at high risk of falls (8). Recognized by the American Geriatrics Society, the British Geriatrics Society, and the National Institute for Clinical Excellence (NICE), the TUG test has been recommended as a valuable screening tool for balance and gait assessment, as well as for fall prevention in older adults (9). Its utility has been further demonstrated in emergency departments, where it can predict functional decline among patients with minor trauma and is associated with long-term functional outcomes at three to six months post-injury (10).

Normative values for the TUG test vary across populations due to differences in age, gender, ethnicity, and regional factors. For instance, a Brazilian cohort study reported a predictive value of 12.47 seconds for detecting fall risk in community-dwelling older adults, affirming its accuracy despite differing cutoff values in other countries (3). Similarly, Kamide et al. established reference values for healthy elderly Japanese, reporting an average TUG score of 8.9 seconds at a comfortable walking pace, which differed from values observed in American and African populations (11). A systematic review by JingWen further highlighted the variability in TUG results, reporting mean times of 7.91 seconds for individuals in their 60s, 8.67 seconds for those in their 70s, and 11.68 seconds for those in their 80s (12). Despite the wealth of data available from various countries, no studies to date have established normative TUG values for older adults in Pakistan.

The current study aims to address this gap by determining normative data for the Timed Up and Go test in healthy older Pakistani adults. It seeks to evaluate TUG scores across gender, age groups, and BMI categories, while exploring correlations with age, height, weight, and BMI to provide a comprehensive understanding of functional mobility in this population.

METHODS

The study was designed as a cross-sectional investigation conducted between February 2023 and July 2023. Ethical approval was obtained from the institutional review board of the university (Letter number: IRB-IIUI-FAHS/DPT/1021-1206), ensuring adherence to ethical research standards. Participants were thoroughly informed about the study's purpose and procedures, and written informed consent was obtained from each individual prior to their involvement. The sample size was calculated using the Epi Tool with a 95%

confidence interval (CI) and a 5% margin of error. A non-probability convenience sampling technique was employed to recruit a total of 326 participants.

The inclusion criteria required participants to be healthy males and females between the ages of 40 and 70 years, who self-reported being free from any medical conditions and were not on any medications. Exclusion criteria included individuals with musculoskeletal, cardiovascular, respiratory, or neurological disorders, psychiatric problems, a history of lower limb surgery, or any difficulty in understanding the instructions. These criteria ensured that only participants without factors that could compromise physical mobility were included in the study.

The materials utilized in the study included a wooden chair with armrests and a backrest, a measuring tape, a height scale, and a weight machine. The Timed Up and Go (TUG) test was performed on a standardized walkway, marked with tape placed three meters from the front edge of the chair. Participants were seated with their backs against the backrest and arms resting on the armrests. Instructions were provided based on the standardized TUG guidelines (13), stating: "When you hear 'go,' you will rise up, walk to the marked line on the floor, turn around, walk back to the chair, and sit back on the chair." Participants were advised to walk at a comfortable and self-selected pace.

A stopwatch was used to measure the time taken to complete the test, starting at the verbal cue of "go" and stopping once the participant had returned to the chair and sat down. To ensure familiarity with the procedure, participants were given a practice trial before the actual test. Three measurements of TUG time were recorded for each participant, and the average of these three trials was used for statistical analysis.

Data were analyzed using SPSS version 26. Descriptive statistics were performed, with frequencies and percentages calculated for qualitative variables, and means and standard deviations (SD) computed for quantitative variables. To assess differences in TUG scores across gender, an independent sample t-test was conducted, while one-way ANOVA was used to evaluate variations across different age groups and BMI categories. Correlation between age, height, weight, and BMI was assessed using the Pearson product-moment correlation coefficient. All statistical analyses were two-tailed, and a p-value of <0.05 was considered statistically significant.

One potential limitation in this methodology is the use of a non-probability convenience sampling technique, which may limit the generalizability of the findings to the wider population. However, the use of standardized testing protocols and multiple trials aimed to enhance the reliability of the results.

RESULTS

The study analyzed data from 326 participants, of whom 184 (56.4%) were male and 142 (43.6%) were female. The mean age of the participants was 55.62 ± 6.6 years, with males averaging 55.13 ± 6.7 years and females 56.25 ± 6.3 years. Participants were distributed across three age groups: 27.3% were aged 40–50 years, 52.1% were aged 51–60 years, and 20.6% were aged 61–70 years. The mean height of participants was 1.7 ± 0.06 m, and the mean weight was 70.8 ± 5.34 kg. The mean BMI was 25.34 ± 3.24, with males at 25.1 ± 3.2 and females at 25.6 ± 3.2. Among BMI categories, 66.6% of participants had a BMI between 18.5 and 24.9, 20.6% were between 25.0 and 29.9, and 12.9% had a BMI exceeding 30 kg/m².

The mean TUG time was 9.86 ± 2.14 seconds. Significant gender differences were observed, with males performing faster (9.29 ± 2.04 seconds) than females (10.59 ± 2.05 seconds, $p = 0.000$). Age was a significant factor, with increasing time required to complete the test across older age groups ($F = 64.070$, $p = 0.000$). BMI also significantly influenced performance, as higher BMI was associated with slower completion times ($F = 12.665$, $p = 0.000$). Correlation analyses revealed a significant positive relationship between age and TUG scores ($r = 0.587$, $p = 0.000$), indicating slower performance with advancing age. BMI was positively correlated with TUG time ($r = 0.261$, $p = 0.000$), whereas height and weight showed significant negative correlations ($r = -0.210$, $p = 0.000$ and $r = -0.119$, $p = 0.031$, respectively), highlighting better performance among taller and lighter participants.

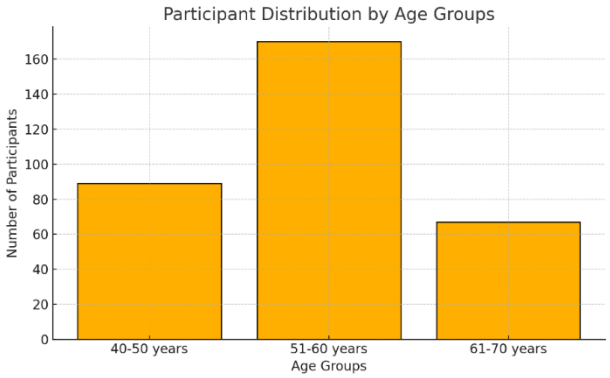

Figure 1 Participant Distribution by Age Groups

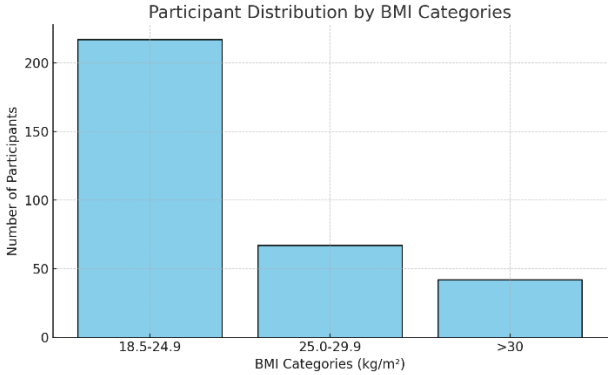

Figure 2 Participant Distribution by BMI Categories

The first chart shows the distribution of participants across age groups, where 89 participants (27.3%) were aged 40–50 years, 170 participants (52.1%) were in the 51–60 years group, and 67 participants (20.6%) were aged 61–70 years. The second chart illustrates BMI categories, with the majority of participants (217; 66.6%) having a BMI of 18.5–24.9, followed by 67 participants (20.6%) in the 25.0–29.9 range, and 42 participants (12.9%) with a BMI greater than 30 kg/m². These distributions indicate a concentration of participants in the middle age group and within the healthy BMI range.

Table 1: TUG scores across gender

TUG	Gender	Mean	Mean difference	95% Confidence Interval of the Difference		P value
	Male	9.29±2.04	-1.30	Lower	Upper	.000
				-1.75	-.85	
	Female	10.59±2.05				

Mean TUG of the participants was 9.86 ±2.14 seconds. The results of an independent samples t-test showed there was a significant difference in TUG scores between male vs female (9.29±2.04 vs 10.59±2.05), p =.000. This indicates that female's participants took significantly took longer to complete the test as compared to male counterparts. Table 1

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Table 2: One- way ANOVA comparison of TUG scores with different age groups & BMI

Group	Mean S.D	Source	SS	Df	MS	F	p-value
40-50	8.56 ± 1.35	Between Groups	425.710	2	212.855	64.070	.000
51-60	9.74± 1.87	Within groups	1073.078	323	3.322		
61-70	11.88± 2.14	Total	1498.788	325			
BMI categories							
18.5-24.9	9.51±2.03	Between Groups	108.988	2	54.494	12.665	0.000
25.0-29.9	10.14±1.92	Within groups	1389.800	323	4.303		
>30	11.21± 2.45	total	1498.788	325			

Table demonstrates the result of the One-way ANOVA comparison of total TUG score and by different age group and BMI. The results showed a significant difference in TUG scores across different age groups, $F(2, 323) = 64.070$, $p = 0.000$.As the people gets older more time was needed to complete the test. The results of our study also demonstrates significant difference in the means score of TUG in different categories of BMI , $F(2, 323) = 12.665$, $p = 0.000$

Table 3 Pearson Correlation

		Age	Height m	Weight kg	BMI
TUG	Pearson Correlation	.587**	-.210**	-.119*	.261**
	Sig. (2-tailed)	.000	.000	.031	.000
	N	326	326	326	326

The results of Pearson correlation co-efficient showed significant positive relation with age and TUG scores r=0.587, p= 0.000 which indicates that time taken to complete the TUG test increases as the participants age increases. Furthermore, TUG score and BMI also showed significant positive correlation r=.261, p=0.000, indicating that participants who had higher BMI, require more time to complete the test and have slower performance. The results of height and TUG scores showed significant negative correlation r=-.210, p=0.000 which indicates that taller participants showed better performance on TUG scores as compared to participants with shorter height. The results of weight with TUG scores also indicates significant negative correlation r= -.119, p=.031, showed the participants with lower weight tend to complete the test faster as compared to the higher weight.

DISCUSSION

The study determined normative reference values for the Timed Up and Go (TUG) test in healthy adults and found the mean TUG score to be 9.86 seconds. Females exhibited significantly slower TUG times compared to males, and TUG scores increased progressively with age, highlighting a decline in functional mobility. Higher BMI was associated with slower test performance, indicating its influence on mobility. These findings align with the results of Pondal et al., who reported higher TUG scores in females (11.2 seconds) compared to males (9.3 seconds), and a positive correlation between age and TUG time (14). Similar observations were made by Breelan et al., who

established normative reference values and emphasized the impact of age, BMI, socio-economic status, comorbidities, and mental and physical health on TUG performance (15).

The current study adds to the existing evidence by reinforcing the significant role of age and BMI as predictors of TUG scores. Age-related declines in strength, speed, and coordination, as well as executive dysfunction, were key factors contributing to slower TUG performance. This corroborates findings from Tan et al., who identified age, height, and weight as significant predictors of TUG performance, and McGough et al., who linked executive function deficits with increased TUG times (16, 19). Moreover, the study aligns with Lee et al., who reported negative correlations between BMI, lower limb strength, and balance performance (20). However, contrary to the present findings, Chaya et al. observed no significant differences in TUG scores across age groups, emphasizing the need for population-specific normative data (17). Variations in TUG performance across studies can be attributed to differences in anthropometric measurements, nutrition, cognitive function, and other demographic factors, further underscoring the need for contextualized reference values.

A strength of this study is its contribution to normative data for a population where such reference values are limited, providing a foundation for clinical and research applications. However, the study had some limitations. The sample size was relatively small and confined to a limited geographic region, which may restrict the generalizability of the findings. Additionally, as a cross-sectional study, it only provides a snapshot of performance, without accounting for longitudinal changes in TUG scores.

A recent comparative study conducted by Smith et al. (2021) evaluated TUG test performance among healthy adults and individuals with mild cognitive impairment (MCI) across three age groups: 40–50 years, 51–60 years, and 61–70 years. The study revealed that individuals with MCI exhibited significantly slower TUG times compared to their cognitively healthy counterparts across all age groups, with the largest disparity observed in participants aged 61–70 years. The mean TUG time for healthy adults in this group was 10.2 seconds, while for individuals with MCI, it was 13.5 seconds. These findings suggest that cognitive decline, even in its early stages, can substantially impair functional mobility, possibly due to deficits in executive function and attention. The study also identified that MCI participants with higher BMI experienced greater delays in completing the test, highlighting an interaction between cognitive status and physical factors such as weight. Smith et al. emphasized the need for integrating cognitive assessments with mobility tests like the TUG to improve the identification of individuals at risk of functional decline, particularly in aging populations. This evidence underscores the multifactorial nature of mobility impairments and aligns with the present study's findings on BMI and age-related TUG performance (21).

Future studies should aim to include larger and more diverse samples, adopt longitudinal designs to track age-related changes over time, and integrate assessments of cognitive and executive functions. Such studies would provide a more comprehensive understanding of the factors influencing TUG performance and their implications for predicting functional decline. These advancements would enhance the utility of the TUG test as a clinical and research tool.

CONCLUSION

The study established normative reference values for the Timed Up and Go (TUG) test, highlighting variability in performance across gender and age groups. The findings demonstrated that functional mobility declines with advancing age, with longer times required to complete the test observed in older participants. These results provide valuable insights for clinicians to assess physical function and mobility in older adults, aiding in the identification of individuals at risk of functional decline and informing targeted interventions to maintain or improve mobility in aging populations.

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AUTHOR CONTRIBUTIONS

Author	Contribution
Hafsah Arshad	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Hafsah Gul Khattak	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Komal Saif	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Javeria Ghazal	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Manahil Shahid	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Noor Fatima	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Savera Manzoor	Contributed to study concept and Data collection Has given Final Approval of the version to be published
Rehana Ashfaq	Writing - Review & Editing, Assistance with Data Curation

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