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ORIGINAL ARTICLE

Reference values for sit-to-stand tests in Colombian adults: a multicenter cross-sectional study

Valores de referencia para las pruebas sit-to-stand en adultos colombianos: un estudio transversal multicéntrico

Jenifer Rodríguez-Castro,[1] Vicente Benavides-Cordoba,[2] Rodrigo Torres-Castro [3] Matías Otto-Yáñez,[4] Jhonatan Betancourt-Peña,[5,6] Juan Carlos Ávila-Valencia[6,7]

1 Fundación Universitaria de Ciencias de la Salud, Facultad de Ciencias del Movimiento, Bogotá, Colombia. **2** Universidad del Valle, Facultad de Salud, Escuela de Ciencias Básicas, Cali, Colombia. **3** Universidad de Chile, Departamento de Kinesiología, Santiago de Chile, Chile. **4** Universidad Autónoma de Chile, Facultad de Ciencias de la Salud, Kinesiología, Santiago de Chile, Chile. **5** Universidad del Valle, Facultad de Salud, Escuela de Rehabilitación Humana, Cali, Colombia. **6** Institución Universitaria Escuela Nacional del Deporte, Facultad de Salud y Rehabilitación, Cali, Colombia, **7** Clínica de Occidente S.A., Cali, Colombia.

Abstract

Background:

Submaximal tests such as the Sit-to-Stand Test (STS) in its three modalities are used to evaluate strength and aerobic capacity in people with respiratory, cardiovascular, and metabolic diseases. However, international reference values do not account for the genetic and environmental particularities of the Colombian population, underscoring the need to establish local references.

Aim:

To establish sex and age specific reference values for the 5-repetition, 30-second, and 1-minute sit-to-stand tests in community-dwelling Colombian adults.

Methods:

A cross-sectional study was conducted between 2023 and 2024 in Colombia, with the participation of healthy adults aged 18 to 80 years. Anthropometric characteristics and physical activity were assessed using the IPAQ questionnaire and the Sit-to-Stand Test (STS) at 1 minute, 30 seconds, and 5 repetitions. Normative percentiles were calculated by sex and age with a sample of 393 people.

Results:

The study included 393 participants (208 women and 185 men), with an average age of 44 years and a BMI of 25.9 ± 4.1. Age was negatively correlated with repetitions (R= 0.493; 60 sec and R= -0.497; 30 sec), height showed a positive correlation (R= 0.262; 60 sec). High BMI was associated with worse performance (R= -0.119; 60 sec, R= -0.153; 30 sec).

Conclusions:

This study establishes reference values for STS testing in healthy adults in Colombia, accounting for age, sex, BMI, and physical activity.

Conflict of interest

The authors certify that they have NO affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

Acknowledgments

To the patients who voluntarily participated in the study.

Data Availability

The data that support the findings of this study are available from the corresponding author, VB-C, upon reasonable request.

CRediT authorship contribution statement

JRC: Conceptualization, Methodology, Data curation, Investigation, Writing-original draft, Writing-review & editing. **VBC:** Conceptualization, Methodology, Formal analysis, Supervision, Writing-original draft, Writing-review & editing. **RTC:** Conceptualization, Methodology, Validation, Writing-review & editing. **MOY:** Conceptualization, Methodology, Validation, Formal analysis, Writing-review & editing. **JBP:** Conceptualization, Methodology, Formal analysis, Supervision, Writing-original draft, Writing-review & editing. **JCAV:** Conceptualization, Methodology, Formal analysis, Supervision, Writing-original draft, Writing-review & editing.

Corresponding author

Jenifer Rodríguez-Castro, E-mail: rodriguezcastrojt@gmail.com, **Vicente Benavides-Cordoba, E-mail:** vicente.benavides@correounivalle.edu.co

Resumen

Antecedentes:

Las pruebas submáximas, como la prueba de sentarse y levantarse (Sit-to-Stand, STS), en sus tres modalidades, se utilizan para evaluar la fuerza y la capacidad aeróbica en personas con enfermedades respiratorias, cardiovasculares y metabólicas. Sin embargo, los valores de referencia internacionales no consideran las particularidades genéticas y ambientales de la población colombiana, lo que evidencia la necesidad de establecer referencias locales.

Objetivos:

Establecer valores de referencia específicos por sexo y edad para las pruebas de sentarse y levantarse de 5 repeticiones, a 30 segundos y a 1 minuto en adultos colombianos que viven en la comunidad.

Métodos:

Se realizó un estudio transversal en Colombia entre 2023 y 2024, con la participación de adultos sanos de 18 a 80 años. Se evaluaron las características antropométricas y el nivel de actividad física mediante el cuestionario IPAQ, así como la prueba de sentarse y levantarse (STS) en sus modalidades de 1 minuto, 30 segundos y 5 repeticiones. Se calcularon percentiles normativos por sexo y edad en una muestra de 393 participantes.

Resultados:

El estudio incluyó 393 participantes (208 mujeres y 185 hombres), con una edad media de 44 años y un IMC de 25.9 ± 4.1. La edad se correlacionó negativamente con el número de repeticiones (R= -0.493 a los 60 segundos y R= -0.497 a los 30 segundos). La estatura mostró una correlación positiva con el desempeño (R= 0.262 en 60 segundos). Un IMC mayor se asoció con un peor rendimiento (R= -0.119 en 60 segundos y R= -0.153 en 30 segundos).

Conclusiones:

Este estudio establece valores de referencia para la prueba STS en adultos sanos en Colombia, considerando variables como la edad, el sexo, el IMC y el nivel de actividad física.

Remark

1) Why was this study conducted?

This study was conducted because existing sit-to-stand reference values are derived from non-Colombian populations and do not account for population-specific differences, potentially leading to misclassification of functional capacity.

2) What were the most relevant results of the study?

PSex- and age-specific reference values were established for all STS modalities. Performance decreased with age, men outperformed women, and higher BMI was associated with poorer performance. Regression models identified age, sex, and anthropometry as significant but modest predictors.

3) What do these results contribute?

These findings provide population-specific reference values that improve the accuracy of functional assessment, support clinical decision-making, and enable better monitoring of interventions in Colombian adults, for whom previously only non-local reference standards were available.

Introduction

Functional capacity reflects the ability to perform daily activities, such as walking or household tasks, which typically involve moderate aerobic effort, without experiencing excessive fatigue or shortness of breath [1]. It is a key indicator of physical fitness and cardiovascular health, as it integrates the response of systems such as the cardiovascular, pulmonary, muscular, and metabolic systems during exercise [2,3].

The Sit-to-Stand (STS) test is a measure of functional and motor capacity of the lower limbs, providing relevant information on impairments often caused by aging or other pathological conditions. Various versions of the STS test have been validated, including the five-repetition sit-to-stand test (5-STS), the 30-second sit-to-stand test (30s-STS), and the one-minute sit-to-stand test (1min-STS), which assesses overall physical performance [4]. These are quite similar to other tests that require more specialized training for healthcare personnel and entail higher associated costs, making their implementation in out-of-hospital settings more difficult [5].

Tests such as the STS are relevant and may serve as alternatives to other commonly used assessments [6,7]; furthermore, their variations have enabled use in both clinical and research settings [8-11], and across a range of health conditions including chronic obstructive pulmonary disease (COPD) [12], interstitial lung disease (ILD) [13], asthma [14], cardiac conditions such as heart failure [15], pulmonary hypertension [16], and even in non-cardiorespiratory conditions such as kidney disease [16], cancer [17] and in the elderly population [18].

Given their usefulness and applicability, reference values have been established for the STS tests. These reference values are necessary as they help describe the population and allow for comparisons [19,20]. Normative values have also been set for the 30-second and five-repetition STS tests [21]. However, these values have been obtained in populations other than the Colombian one [20-24], making it imperative to establish population-specific reference values to define normality parameters and assess response to interventions in which the STS test is used as a follow-up measure. Therefore, this study aims to establish sex and age specific reference values for the 5-repetition, 30-second, and 1-minute sit-to-stand tests in community-dwelling Colombian adults.

Materials and Methods

Study design and participants

This cross-sectional study was conducted between March 2023 and June 2024 in four Colombian cities: Bogotá, Cali, Popayán, and Pasto. The Ethics Committee of the Fundación Universitaria de Ciencias de la Salud (FCM-I-032-2024) approved the study, and all participants signed an informed consent form. The study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [25].

Participant selection and recruitment

The sample size was calculated using a standard formula. Considering that Colombia has a population of approximately 50 million people, a 5% margin of error and a 95% confidence level were chosen. A critical Z value of 1.96 was used, which is appropriate for this confidence level. A conservative proportion of 0.5 was applied to maximize the sample size in the absence of a precise estimate of the proportion of the population able to perform the STS correctly. The resulting calculation yielded a sample size of 384 participants.

Individuals were recruited from the general population in Bogotá, Cali, Popayán, and Pasto. While participants reported good health, a proportion had controlled chronic conditions (e.g., hypertension, diabetes), reflecting the community's real-world characteristics. Information about

the study was disseminated via social media, email, and word of mouth. Inclusion criteria were adults aged 18 to 80 years who self-reported being in good health and able to perform sit-to-stand movements. Exclusion criteria included a body mass index (BMI) >35 or any recent respiratory, musculoskeletal, or neuromuscular condition that could interfere with test performance.

To standardize measurements, training sessions were held in which all assessors were instructed to record three demonstration videos of the STS tests using a designated pilot participant [4]. The purpose was to ensure adherence to protocol. Once validation of all three recorded assessments was confirmed, authorization was granted to begin data collection.

Procedures

Participants were evaluated in a single session in which anthropometric data were collected, and physical activity levels were assessed using the short version of the International Physical Activity Questionnaire (IPAQ) [26]. During the same session, participants performed the 1-minute, 30-second, and 5-repetition sit-to-stand (STS) tests. Perceived exertion was measured before and after each test using the modified Borg scale [27]. Before testing, participants received standardized instructions and a demonstration; however, no formal familiarization trial was conducted. To minimize fatigue effects, only a single trial was performed for each test modality.

The tests involved rising from a seated position to a fully upright posture with knees extended. A standard chair (43-46 cm in height) with thoracolumbar support was used. Participants sat upright, with hips and knees flexed and feet flat on the floor, shoulder-width apart. Per instructions given before the tests, participants were asked to perform as many repetitions as possible within 1 minute and 30 seconds; for the 5-repetition test, participants were instructed to complete exactly 5 sit-to-stand movements. The number of repetitions completed during the 1-minute and 30-second tests was recorded as the primary outcome measure. In the 5-repetition test, the primary outcome was the total time taken to complete the task [24]. A single trial was performed for each test, and the test order was randomized. A 30-minute rest interval was maintained between tests [20-22]. Additional variables were measured at baseline and post-test, including peripheral oxygen saturation (SpO_2), respiratory rate (RR), heart rate (HR), and lower limb fatigue/dyspnea perception using the modified Borg scale. Blood pressure was measured at baseline, immediately post-test, and after 1 minute of recovery using a manual aneroid sphygmomanometer and tensiometer (Welch Allyn® DS44-11CBT).

Statistical analysis

Data was analyzed using IBM SPSS version 25.0 (IBM Corporation, Armonk, NY, USA). The Kolmogorov-Smirnov test was used to assess the data distribution. Numerical variables were presented as means and standard deviations, while categorical variables were expressed as frequencies and percentages. Correlation analysis was conducted using Pearson or Spearman tests, as appropriate, to explore the relationship between quantitative variables (age, weight, height, BMI, initial and final Borg scores) and test performance. Reference values were determined based on previously used classification categories. Normative percentiles (2.5%, 25%, 50%, 75%, and 97.5%) were calculated directly from the empirical distribution of the data, without parametric assumptions, and stratified by sex and predefined age groups.

To examine the relationship between individual performance on the 1-minute STS and age, scatter plots were created showing the distribution of performance by age and sex.

Reference values are reported separately by sex and age group. The proposed values by Strassmann (p50) were compared with those obtained in our study population [20]. The comparison was made between measured values and the 50th percentile (p50) reported by Strassmann et al. [20] for each sex and age group. Additionally, a multiple linear regression analysis using the "enter" method was performed between these variables.

Table 1. Demographic and clinical characteristics of the study population

Variables	Total (N= 393)	Women (n= 208)	Men (n= 185)
Age range, n (%)			
18-29	109 (27.7)	57 (27.4)	52 (28.1)
30-39	60 (17.3)	29 (13.9)	31 (16.8)
40-49	62 (15.8)	37 (17.8)	25 (13.5)
50-59	51 (13)	27 (13)	24 (13)
60-69	59 (15)	31 (14.9)	28 (15.1)
70-80	52 (13.2)	27 (13)	25 (13.5)
Height (m), mean (SD)	1.64 ± 0.09	1.58 ± 0.06	1.70 ± 0.07
Weight (kg), mean (SD)	68.3 ± 11.3	64.7 ± 10.5	72.3 ± 10.8
BMI (kg/m^2), mean (SD)	25.5 ± 3.8	25.9 ± 4.1	25.1 ± 3.4
Comorbidities, n (%)			
Hypertension	94 (23.9)	55 (26.4)	39 (21.1)
DM	66 (16.8)	41 (19.7)	25 (13.5)
Coronary Heart Disease	19 (4.8)	10 (4.8)	9 (4.8)
Acute Myocardial Infarction	5 (1.3)	1 (0.5)	4 (2.2)
Alcohol	70 (17.8)	33 (15.9)	37 (20)
Smoking	56 (14.3)	31 (14.9)	25 (13.5)
Other comorbidities	36 (9.2)	24 (11.5)	12 (6.5)
Wood smoke exposure	57 (14.5)	37 (17.8)	20 (10.8)
Physical Activity Level (IPAQ)			
Low	174 (44.3)	108 (51.9)	66 (35.7)
Moderate	152 (38.7)	77 (37)	75 (40.5)
High	67 (17)	23 (11.1)	44 (23.8)

Values are presented as n (%) for categorical variables and mean ± standard deviation (SD) for continuous variables
BMI: body mass index; DM: diabetes mellitus; IPAQ: International Physical Activity Questionnaire

Results

During the study period, 415 subjects participated; of these, 22 were excluded due to having a BMI >35 kg/m^2. Therefore, a total of 393 participants were analyzed, with a mean age of 44 years. The sample included 208 women and 185 men. Most participants were in the 18-29 age group, with 28.1% among men, followed by the 40-49 age group among women (17.8%) and the 30-39 age group among men (16.8%). The average BMI was 25.9 ± 4.1 in women, which was very similar to that in men (25.1 ± 3.4).

Regarding physical activity levels, a predominance of low activity was reported overall, with 174 individuals (44.3%) in this category. However, among men, moderate activity was more common (75 individuals, 40.5%), whereas low activity predominated among women (108 individuals, 51.9%) (Table 1).

Percentiles were calculated for the different age and sex groups in the STS tests of 1 minute, 30 seconds, and 5 repetitions. The percentiles included the 2.5th percentile lower limit of normality (LLN), which identifies the lowest values still considered normal; the 50th percentile (median), which represents the average performance in each group; and the 97.5th percentile upper limit of normality (ULN), which frames the highest values within the normal range. These values allow the establishment of reference ranges to interpret an individual's physical performance relative to a similar population by age and sex (Table 2).

Table 3 presents the differences in physiological variables related to performance, revealing statistically significant differences across the three test modalities, particularly in the number of repetitions and systolic blood pressure (SBP). Men performed better than women. In the 1-minute test, the average number of repetitions was 36 ± 13.8 in men and 32.3 ± 11.5 in women. In the 30-second test, men achieved 18.8 ± 7.0 repetitions compared to 17.4 ± 6.1 in women.

Table 2. Percentile values for the 1-min, 30-second, and 5-repetition sit-to-stand test.

STS	Age range		18-29	30-39	40-49	50-59	60-69	70-80
1 min	**Women (N= 208)**	**n**	57	29	37	27	31	27
		p2.5	22	20	17	19	19	14
		p25	31	31	25	21	22	19
		p 50	38	39	33	26	25	20
		p 75	44	43	38	31	28	22
		p 97.5	58	57	45	44	35	28
	Men (N= 185)	**n**	52	31	25	24	28	25
		p2.5	20	20	25	18	19	14
		p25	30	26	34	26	24	18
		p50	40	42	42	32	27	22
		p75	51	51	48	41	30	23
		p97.5	66	72	67	48	34	25
30 sec	**Women (N= 208)**	**n**	57	29	37	27	31	27
		p2.5	12	11	10	10	10	7
		p25	17	14	13	12	12	9
		p50	20	19	17	14	13	11
		p75	23	22	22	19	16	13
		p97.5	32	28	28	26	19	19
	Men (N= 185)	**n**	52	31	25	24	28	25
		p2.5	10	11	11	10	9	8
		p25	17	15	16	13	14	10
		p50	23	20	20	18	15	11
		p75	26	25	24	24	18	12
		p97.5	35	34	33	27	21	14
5 rep	**Women (N= 208)**	**n**	27	32	32	26	27	15
		p2.5	4.0	5.1	5.0	5.7	5.6	6.2
		p25	5.2	6.6	6.4	8.0	9.6	10.0
		p50	7.0	7.9	8.1	11.0	11.3	11.3
		p75	8.9	11.4	12.0	13.8	12.8	13.4
		p97.5	12.8	14.7	16.0	17.3	16.7	17.3
	Men (N= 185)	**n**	28	34	26	26	26	15
		p2.5	4.0	4.0	4.1	4.6	5.1	8.4
		p25	4.5	5.5	6.3	6.0	7.8	10.3
		p50	6.2	6.9	6.9	7.1	9.4	11.2
		p75	9.2	10.3	11.0	9.2	11.4	13.1
		p97.5	14.3	14.6	16.8	14.4	18.8	15.7

During recovery, SBP values were higher in men. In the 1-minute test, women had an average SBP of 120.4 ± 10.7 mmHg, while men recorded 125.4 ± 14.4 mmHg. In the 30-second test, the values were 118.6 ± 10.7 mmHg for women and 124.7 ± 13.2 mmHg for men. In the 5-repetition test, the averages were 121.2 ± 10.3 mmHg for women and 125.7 ± 13.3 mmHg for men (Table 3).

Additionally, a Pearson correlation analysis was performed to explore the relationship between continuous variables and performance in the STS tests. Significant associations were found between age, height, and BMI with performance in two modalities.

Age showed a statistically significant negative correlation with the number of repetitions in both the 1-minute test (R= -0.493, p <0.001) and the 30-second test (R= -0.497, p <0.001). Regarding the time required to complete the 5 repetitions, a positive correlation was found (R= 0.420, p <0.001).

In contrast, height showed a statistically significant positive correlation with performance in both the 1-minute test (R= 0.262, p <0.001) and the 30-second test (R= 0.201, p <0.001), while a negative correlation was observed in the 5-repetition test (R= -0.158, p= 0.002). These results suggest that taller individuals tend to perform more repetitions and, in less time, possibly due to biomechanical advantages that enhance physical performance.

Table 3. Comparison of the 1-minute, 30-second, and 5-repetition sit-to-stand test at baseline, post-test, and recovery by sex.

Variables	1 min STS baseline			1 min STS post-test			1 min STS recovery		
	Total (N=393)	Women (n=208)	Men (n=185)	Total (N=393)	Women (n=208)	Men (n=185)	Total (N=393)	Women (n=208)	Men (n=185)
Number of repetitions	34 ± 12.7	32.3 ± 11.5	36 ± 13.8						
HR	76.1 ± 9.3	76.9 ± 9.2	75.2 ± 9.3	104.6 ± 18.1	104.7 ± 18.2	104.4 ± 18.0	86.3 ± 14.5	86.3 ± 14.3	86.3 ± 14.8
RR	17.1 ± 3.2	17.1 ± 3.3	17.0 ± 3.0	22.4 ± 4.5	22.0 ± 4.4	22.8 ± 4.6	18.8 ± 3.9	18.7 ± 4.1	19.0 ± 3.7
SBP	117.6 ± 10.0	115.9 ± 9.6	119.5 ± 10.2 *	132.0 ± 14.0	129.5 ± 11.9	134.9 ± 15.5 *	122.7 ± 12.8	120.4 ± 10.7	125.4 ± 14.4 *
DBP	75.9 ± 8.6	75.4 ± 8.5	76.5 ± 8.8	80.1 ± 9.3	79.5 ± 8.8	80.9 ± 9.8	77.0 ± 9.0	76.3 ± 8.8	77.7 ± 9.2
SpO_2	95.1 ± 2.3	95.2 ± 2.3	95.0 ± 2.3	94.8 ± 3.0	94.8 ± 3.4	94.8 ± 2.3	95.3 ± 2.3	95.3 ± 2.4	95.4 ± 2.1
Dyspnea	0.1 ± 0.6	0.2 ± 0.7	0.1 ± 0.6	1.7 ± 1.8	1.7 ± 1.8	1.6 ± 1.9	0.7 ± 1.1	0.7 ± 1.1	0.6 ± 1.1
Lower limb fatigue	1.7 ± 2.5	1.6 ± 2.5	1.7 ± 2.6	3.8 ± 3.3	3.9 ± 3.1	3.8 ± 3.5	2.2 ± 2.4	2.1 ± 2.4	2.3 ± 2.5
	30 sec STS baseline			**30 sec STS post-test**			**30 sec STS recovery**		
Number of repetitions	18.1 ± 6.6	17.4 ± 6.1	18.8 ± 7.0						
HR	76.3 ± 10.4	77.0 ± 9.8	75.4 ± 10.9	99.4 ± 16.5	99.4 ± 16.9	99.4 ± 16.2	83.9 ± 13.0	84.1 ± 13.4	83.6 ± 12.6
RR	17.3 ± 3.1	17.3 ± 3.3	17.3 ± 2.9	20.8 ± 5.2	20.7 ± 5.2	20.8 ± 5.2	18.5 ± 4.0	18.6 ± 4.2	18.5 ± 3.8
SBP	117.7 ± 10.1	115.9 ± 9.7	119.7 ± 10.1 *	130.0 ± 13.5	126.8 ± 10.9	133.5 ± 15.3 *	121.5 ± 12.3	118.6 ± 10.7	124.7 ± 13.2 *
DBP	75.7 ± 8.5	74.8 ± 8.6	76.6 ± 8.3	79.7 ± 9.5	79.0 ± 9.5	80.5 ± 9.4	76.6 ± 9.6	76.2 ± 8.8	77.0 ± 10.4
SpO_2	95.1 ± 2.3	95.2 ± 2.2	95.1 ± 2.3	94.7 ± 2.2	94.8 ± 2.1	94.7 ± 2.2	95.2 ± 2.2	95.2 ± 2.2	95.1 ± 2.2
Dyspnea	0.2 ± 0.7	0.3 ± 0.8	0.2 ± 0.6	1.2 ± 1.5	1.2 ± 1.5	1.1 ± 1.5	0.6 ± 1.1	0.7 ± 1.3	0.5 ± 1.0
Lower limb fatigue	1.7 ± 2.5	1.6 ± 2.5	1.8 ± 2.6	2.9 ± 2.6	2.9 ± 2.6	2.9 ± 2.6	2.1 ± 2.5	2.0 ± 2.5	2.2 ± 2.5
	5 rep- STS baseline			**5 rep- STS post-test**			**5 rep- STS recovery**		
Time (seconds)	9.4 ± 6.5	9.4 ± 3.4	9.4 ± 8.8						
HR	76.1 ± 9.3	76.9 ± 9.2	75.2 ± 9.3	76.6 ± 10.7	77.4 ± 10.7	75.7 ± 10.6	87.0 ± 14.8	88.3 ± 14.8	85.4 ± 14.7
RR	17.1 ± 3.2	17.1 ± 3.3	17.0 ± 3.0	17.3 ± 3.2	17.3 ± 3.2	17.2 ± 3.1	19.8 ± 7.4	19.4 ± 4.4	20.2 ± 9.7
SBP	117.6 ± 10.0	115.9 ± 9.6	119.5 ± 10.2 *	117.9 ± 9.7	116.2 ± 9.6	119.8 ± 9.5 *	123.3 ± 12.0	121.2 ± 10.3	125.7 ± 13.3 *
DBP	75.9 ± 8.6	75.4 ± 8.5	76.5 ± 8.8	76.0 ± 8.8	75.1 ± 9.0	77.0 ± 8.5	77.9 ± 9.1	77.1 ± 9.2	78.8 ± 8.8
SpO_2	95.1 ± 2.3	95.2 ± 2.3	95.0 ± 2.3	95.2 ± 2.2	95.2 ± 2.2	95.1 ± 2.2	94.5 ± 5.3	94.9 ± 2.2	94.0 ± 7.3
Dyspnea	0.1 ± 0.6	0.2 ± 0.7	0.1 ± 0.6	0.3 ± 0.9	0.3 ± 0.9	0.2 ± 0.9	0.7 ± 1.2	0.7 ± 1.2	0.6 ± 1.1
Lower limb fatigue	1.7 ± 2.5	1.6 ± 2.5	1.7 ± 2.6	1.7 ± 2.5	1.6 ± 2.5	1.9 ± 2.6	2.2 ± 2.4	2.1 ± 2.4	2.4 ± 2.5

Values are presented as mean ± standard deviation (SD) for continuous variables. * p-value <0.005.
Rep: repetitions, HR: heart rate, RR: respiratory rate, SBP: systolic blood pressure, DBP: diastolic blood pressure, SpO_2: oxygen saturation, LL: lower limbs. Dyspnea and fatigue were assessed using the modified Borg scale.

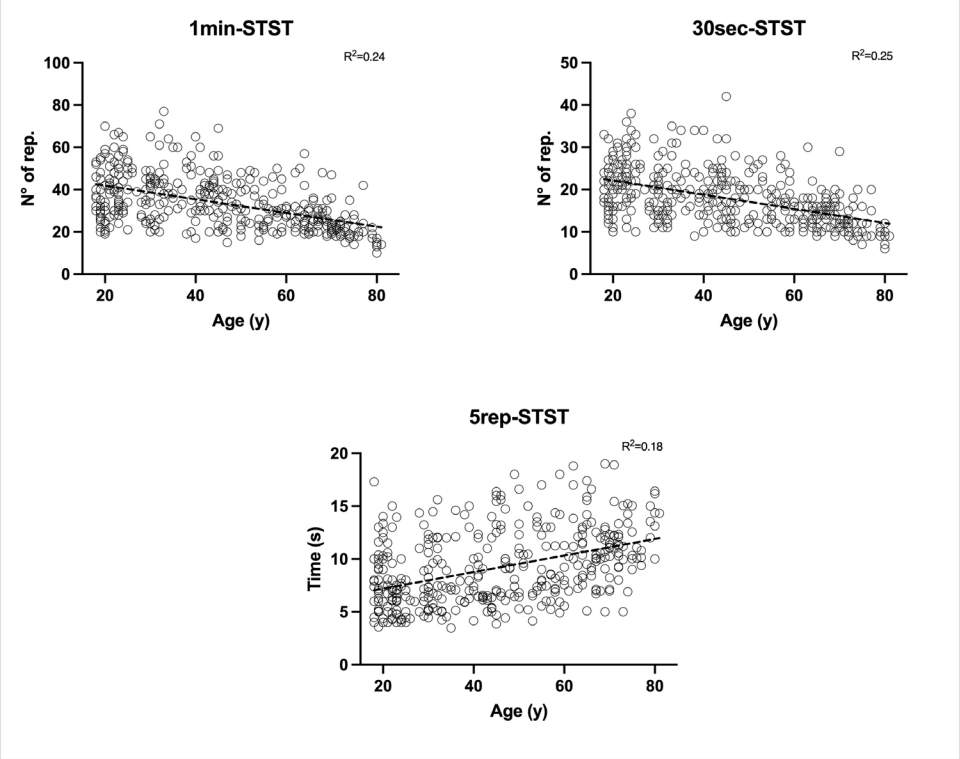

Figure 1. Association between age and performance in sit-to-stand (STS) tests

Table 4. Predictive equations for the 60-second, 30-second, and 5-repetition sit-to-stand tests

	Predictive equations	
60sec-STS (rep)	= 23.885 - 0.307 × (age*) - 1.988 × (sex*) + 15.185 × (height*)	R^2= 0.272
30sec-STS(rep)	= 26.458 - 0.171 × (age*) - 1.394 × (sex*)	R^2= 0.258
5rep-STS(s)	= 3.160 + 0.074 × (age*) + 0.095 × (BMI*) + 0.460 × (sex*)	R^2= 0.192

*Age of the participant (in years), sex: 1 for men and 2 for women, height: participant's height (in meters), BMI: Body Mass Index of the participant (kg/m^2).

Conversely, BMI showed negative correlations with performance on the 1-minute test (R= -0.119, *p*= 0.018) and the 30-second test (R= -0.153, *p*= 0.002). In the 5-repetition test, a stronger negative correlation was observed (R= -0.207, *p* <0.001), indicating that a higher BMI is associated with poorer performance and longer test duration, which may be due to the impact of excess body weight on functional physical capacity (Figure 1).

Multiple linear regression models were developed to predict performance across the three test modalities, accounting for individuals' sociodemographic and anthropometric characteristics (Table 4).

Discussion

The present study aimed to establish sex- and age-specific reference values for the 5-repetition, 30-second, and 1-minute STS tests in community-dwelling Colombian adults. A representative sample was therefore collected from Bogotá, Cali, Pasto, and Popayán. The values obtained provide a solid foundation for assessing the functional performance of the local population. In this way, comparisons with other countries can be made, and longitudinal monitoring of functional capacity is facilitated in both clinical and research settings.

For this study, the sample included 393 participants distributed across cities with diverse demographics. Bogotá, as the capital of Colombia, contributed a higher proportion of participants due to its population density and access to study information. Cali, located in the southwestern region of Colombia, was represented by a sample that allowed for an assessment covering different sociodemographic profiles. This geographic distribution collected normative values that adequately reflect the characteristics of the healthy urban adult population in the Colombian context [28].

The findings showed a progressive decline in performance with increasing age, consistent with previous research associating aging with reduced muscle strength and endurance, as well as a decrease in execution speed [4]. This functional decline may be influenced by physiological changes such as sarcopenia and decreased aerobic capacity [29,30]. Regarding BMI and adult performance, a significant negative correlation was observed, consistent with studies highlighting the impact of excess body weight on deterioration of physical function [31].

Regarding gender differences, men performed better across all STS test modalities. This can be associated with differences in muscle mass and body composition [32]. The regression models developed confirmed that factors such as sex, age, and height are key predictors of test performance [11]. However, the relatively low coefficients of determination observed in the regression models suggest that the included variables explain only a limited proportion of the variability in STS performance. This indicates that other factors, such as neuromuscular capacity, physical fitness, and biomechanical characteristics, may also play a significant role. Therefore, these models should be interpreted as exploratory rather than predictive.

The established percentiles allow for the interpretation of an individual's performance relative to a similar population group, taking age and gender into account, facilitating the identification of those who fall outside the normal range. The lower limit of normality, corresponding to the 2.5th percentile, represents the lowest acceptable value within the normal range. Values below this threshold may indicate decreased muscle strength, increased fall risk, or impaired physical function [33-35].

These reference values are crucial for long-term patient monitoring, as they enable the evaluation of changes or deterioration in functional capacity over time [36]. They also provide an objective basis for tailoring therapeutic measures to design specific rehabilitation programs aimed at improving body composition and functional capacity [37]. In this way, outcomes are optimized, and improvement priorities can be established. The multiple linear regression models developed also allow for performance estimation in the STS test, considering participants' demographic and anthropometric characteristics, showing how these variables influence performance [38].

The study also highlights that the test has a good safety profile, as demonstrated by physiological responses such as heart rate, respiratory rate, oxygen saturation, and perceived exertion in participants [5,9,10,15]; moreover, no adverse events occurred during its administration.

One of the main contributions of this study was the ability to compare results from Colombia with those from other countries. In the Colombian male group, the 1-minute STS test yielded an average of 36 repetitions, while in the female group, the average was 32. These results were similar to those obtained in a study conducted in Brazil, where both men and women averaged 32 repetitions [21]. In Colombia, the 18-29 age group averaged 40 repetitions during the 1-minute STS test. At the same time, a study in Chile found that young men averaged 38 repetitions per minute, suggesting similar performance across both populations. Among women, the average observed in Colombia was 38 repetitions, the same as that recorded in the Chilean group of the same age [24].

In the 30-second STS test, Colombian men achieved an average of 18.8 ± 7.0 repetitions, slightly higher than the Brazilian adult group, which recorded an average of 17.0 ± 0.34 repetitions [21]. For Colombian women, the mean was 17.4 ± 6.1 repetitions, similar to the 16.0 ± 0.35 repetitions observed in Brazil [21]. This similarity in results suggests that both population groups exhibit comparable physical performance in this test, which may be related to similar levels of physical activity and social contexts in both countries.

While similarities and differences were observed when comparing our findings with those from other countries, these results should be interpreted with caution, as no direct statistical comparisons between populations were made. The observed variability may be partially explained by anthropometric, sociodemographic, and environmental factors. For instance, variables such as height, body composition, and body mass index have been shown to influence performance in functional tests due to their impact on movement mechanics and neuromuscular efficiency [31,38]. In addition, differences in physical activity levels across populations may contribute to variations in functional capacity, given that lower activity levels are associated with reduced muscular endurance and physical performance [39].

Furthermore, geographical factors such as altitude above sea level may also play a role in shaping physiological responses to submaximal exercise. Chronic exposure to moderate or high altitude has been associated with cardiovascular and respiratory adaptations that can influence oxygen transport and utilization during physical effort [2,3]. Therefore, although our findings show both similarities and differences compared to other Latin American populations, these comparisons should be considered descriptive rather than inferential. Future studies incorporating direct comparative analyses and controlling for contextual variables will be essential to better understand the contribution of these factors to functional performance.

In the 5-repetition STS test, the results obtained in Colombia, average times of 9.4 ± 8.8 seconds for men and 9.4 ± 3.4 seconds for women, are comparable to those reported in the 2022 study by Furlanetto et al. [21], in Brazil, where times of 9.33 ± 0.22 seconds for men and 9.55 ± 0.21 seconds for women were observed. This similarity supports the need for consistent predictive values for functional tests, which are fundamental in evaluating disease progression and monitoring treatments such as pulmonary rehabilitation. Anthropometric differences and population habits may influence results, highlighting the importance of considering these factors when making clinical decisions.

Additionally, the importance of developing strategies to promote higher levels of physical activity is emphasized, as the Colombian population performed worse than expected in most tests. This finding underscores the need for strategies to increase physical activity to improve functional performance, especially among individuals with insufficient physical activity levels [39].

Among the main limitations of this study were the difficulty in obtaining a representative sample from all regions of the country and the underrepresentation of older age groups. In addition, the sample size was calculated based on overall population parameters rather than ensuring a predefined number of participants within each age and sex specific stratum, which may affect the precision of percentile estimates, particularly at the extremes (e.g., 2.5th and 97.5th percentiles) and in underrepresented subgroups. However, these limitations are partially mitigated by the inclusion of participants from multiple geographically distinct cities, which provides variability in sociodemographic and anthropometric characteristics and enhances the external validity of the findings within urban Colombian populations.

Conclusions

This study presents reference values for the STS test across its variants in adults in Colombia, accounting for demographic and anthropometric variables. The results highlight the influence of factors such as age, sex, BMI, and physical activity level on functional performance, and underscore the importance of promoting strategies that encourage an active lifestyle. Moreover, the study found that the values in Colombia differ significantly from those reported in international studies, emphasizing the need to tailor interventions to local specificities.

References

1. Arena R, Myers J, Williams MA, Gulati M, Kligfield P, Balady GJ. Assessment of functional capacity in clinical and research settings a scientific statement from the american heart association committee on exercise, rehabilitation, and prevention of the council on clinical cardiology and the council on cardiovascular nursing. Circulation. 2007;116(3):329–343. doi: 10.1161/CIRCULATIONAHA.106.184461. [PubMed] [CrossRef] [Google Scholar]

2. Ammar H, Hashish R, Mohamed AS, Salem A, Hagras A. Evaluation of functional aerobic exercise capacity among chronic e-cigarette users compared to combustible cigarette smokers and non-smokers a comparative study. Bull Fac Phys Ther. 2023;28(1):43–43. doi: 10.1186/s43161-023-00154-7. [CrossRef] [Google Scholar]

3. Medrano-Ureña MDR, Ortega-Ruiz R, Benítez-Sillero JD. Physical fitness, exercise self-efficacy, and quality of life in adulthood a systematic review. Int J Environ Res Public Health. 2020;17(17):6343–6343. doi: 10.3390/ijerph17176343. [PubMed] [CrossRef] [Google Scholar]

4. Cruz-Montecinos C, Torres-Castro R, Otto-Yáñez M, Barros-Poblete M, Valencia C, Campos A. Which sit-to-stand test best differentiates functional capacity in older people. Am J Phys Med Rehabil. 2024;103(10):925–928. doi: 10.1097/PHM.0000000000002504. [PubMed] [CrossRef] [Google Scholar]

5. Fuentes-Abolafio IJ, Escriche-Escuder A, Bernal-López MR, Gómez-Huelgas R, Ricci M, Trinidad-Fernández M. Estimation of functional aerobic capacity using the sit-to-stand test in older adults with heart failure with preserved ejection fraction. J Clin Med. 2022;11(10):2692–2692. doi: 10.3390/jcm11102692. [PubMed] [CrossRef] [Google Scholar]

6. Léger LA, Mercier D, Gadoury C, Lambert J. The multistage 20 metre shuttle run test for aerobic fitness. J Sports Sci. 1988;6(2):93–101. doi: 10.1080/02640418808729800. [PubMed] [CrossRef] [Google Scholar]

7. Léger L, Boucher R. An indirect continuous running multistage field test the Université de Montréal track test. Can J Appl Sport Sci. 1980;5(2):77–84. doi: 10.1080/02640418808729800. [PubMed] [CrossRef] [Google Scholar]

8. Csuka M, McCarty DJ. Simple method for measurement of lower extremity muscle strength. Am J Med. 1985;78(1):77–81. doi: 10.1016/0002-9343(85)90465-6. [CrossRef] [Google Scholar]

9. Bohannon RW, Crouch R. 1-minute Sit-to-Stand Test Systematic review of procedures, performance, and clinimetric properties. J Cardiopulm Rehabil Prev. 2019;39(1):2–8. doi: 10.1097/HCR.0000000000000336. [PubMed] [CrossRef] [Google Scholar]

10. Figueiredo PHS, Veloso LRDS, Lima MMO, Vieira CFD, Alves FL, Lacerda ACR. The reliability and validity of the 30-seconds sit-to-stand test and its capacity for assessment of the functional status of hemodialysis patients. J Bodyw Mov Ther. 2021;27:157–164. doi: 10.1016/j.jbmt.2021.02.020. [PubMed] [CrossRef] [Google Scholar]

11. Bohannon RW. Test-retest reliability of the five-repetition sit-to-stand test a systematic review of the literature involving adults. J Strength Cond Res. 2011;25(11):3205–3207. doi: 10.1519/JSC.0b013e318234e59f. [PubMed] [CrossRef] [Google Scholar]

12. Spence JG, Brincks J, Løkke A, Neustrup L, Østergaard EB. One-minute sit-to-stand test as a quick functional test for people with COPD in general practice. NPJ Prim Care Respir Med. 2023;33(1):11–11. doi: 10.1038/s41533-023-00335-w. [PubMed] [CrossRef] [Google Scholar]

13. Zamboti CL, Pimpão HA, Bertin LD, Krinski GG, Garcia T, Dos Santos FSLS. Functional measures in Non-COPD chronic respiratory diseases a systematic review. J Clin Med. 2024;13(22):6887–6887. doi: 10.3390/jcm13226887. [PubMed] [CrossRef] [Google Scholar]

14. Zampogna E, Pignatti P, Ambrosino N, Cherubino F, Fadda AM, Zappa M. The 5-repetition sit-to-stand test as an outcome measure for pulmonary rehabilitation in subjects with asthma. Respir Care. 2021;66(5):769–776. doi: 10.4187/respcare.08452. [PubMed] [CrossRef] [Google Scholar]

15. Adsett JA, Bowe R, Kelly R, Louis M, Morris N, Hwang R. A Study of the reliability, validity, and physiological changes of sit-to-stand tests in people with heart failure. J Cardiopulm Rehabil Prev. 2023;43(3):214–219. doi: 10.1097/HCR.0000000000000739. [PubMed] [CrossRef] [Google Scholar]

16. Keen C, Smith I, Hashmi-Greenwood M, Sage K, Kiely DG. Pulmonary Hypertension and Measurement of Exercise Capacity Remotely Evaluation of the 1-min Sit-to-Stand Test (PERSPIRE) - a cohort study. ERJ Open Res. 2023;9(1):00295–02022. doi: 10.1183/23120541.00295-2022. [PubMed] [CrossRef] [Google Scholar]

17. van-Cappellen-van-Maldegem SJM.Hoedjes M.Seidell JC.van-de-Poll-Franse LV.Buffart LM.Mols F Self-performed Five Times Sit-To-Stand test at home as (pre-)screening tool for frailty in cancer survivors Reliability and agreement assessment. J Clin Nurs. 2023;32(7-8):1370–1380. doi: 10.1111/jocn.16299. [PubMed] [CrossRef] [Google Scholar]

18. Yamako G, Punchihewa NG, Arakawa H, Tajima T, Chosa E. Evaluation of Sit-to-Stand movement in older adults with locomotive syndrome using the Nintendo Wii balance board. Sensors (Basel) 2023;23(7):3368–3368. doi: 10.3390/s23073368. [PubMed] [CrossRef] [Google Scholar]

19. Ozarda Y. Reference intervals current status, recent developments and future considerations. Biochem Med (Zagreb) 2016;26(1):5–16. doi: 10.11613/BM.2016.001. [PubMed] [CrossRef] [Google Scholar]

20. Strassmann A, Steurer-Stey C, Lana KD, Zoller M, Turk AJ, Suter P. Population-based reference values for the 1-min sit-to-stand test. Int J Public Health. 2013;58(6):949–953. doi: 10.1007/s00038-013-0504-z. [PubMed] [CrossRef] [Google Scholar]

21. Furlanetto KC, Correia NS, Mesquita R, Morita AA, Do Amaral DP, Mont'Alverne DGB. Reference values for 7 different protocols of simple functional tests a multicenter study. Arch Phys Med Rehabil. 2022;103(1):20–28. doi: 10.1016/j.apmr.2021.08.009. [PubMed] [CrossRef] [Google Scholar]

22. Lein DH, Alotaibi M, Almutairi M, Singh H. Normative reference values and validity for the 30-second chair-stand test in healthy young adults. Int J Sports Phys Ther. 2022;17(5):907–914. doi: 10.26603/001c.36432. [PubMed] [CrossRef] [Google Scholar]

23. Klukowska AM, Staartjes VE, Vandertop WP, Schröder ML. Five-repetition sit-to-stand test performance in healthy individuals reference values and predictors from 2 prospective cohorts. Neurospine. 2021;18(4):760–769. doi: 10.14245/ns.2142750.375. [PubMed] [CrossRef] [Google Scholar]

24. Otto-Yáñez M, Torres-Castro R, Barros-Poblete M, Barros M, Valencia C, Campos A. One-minute sit-to-stand test Reference values for the Chilean population. PLoS ONE. 2025;20(1):e0317594. doi: 10.1371/journal.pone.0317594. [PubMed] [CrossRef] [Google Scholar]

25. Cuschieri S. The STROBE guidelines. Saudi J Anaesth. 2019;13(Suppl 1):S31–S34. doi: 10.4103/sja.SJA_543_18. [PubMed] [CrossRef] [Google Scholar]

26. Lee PH, Macfarlane DJ, Lam TH, Stewart SM. Validity of the International Physical Activity Questionnaire Short Form (IPAQ-SF) a systematic review. Int J Behav Nutr Phys Act. 2011;8:115–115. doi: 10.1186/1479-5868-8-115. [PubMed] [CrossRef] [Google Scholar]

27. Johnson MJ, Close L, Gillon SC, Molassiotis A, Lee PH, Farquhar MC. Use of the modified Borg scale and numerical rating scale to measure chronic breathlessness a pooled data analysis. Eur Respir J. 2016;47(6):1861–1864. doi: 10.1183/13993003.02089-2015. [PubMed] [CrossRef] [Google Scholar]

28. DANE Censo Nacional de Población y Vivienda 2018. [28 january 2025]. Available: https://www.dane.gov.co/index.php/estadisticas-por-tema/demografia-y-poblacion/censo-nacional-de-poblacion-y-vivienda-2018 .

29. Wiedmer P, Jung T, Castro JP, Pomatto LCD, Sun PY, Davies KJA. Sarcopenia - Molecular mechanisms and open questions. Ageing Res Rev. 2021;65:101200–101200. doi: 10.1016/j.arr.2020.101200. [PubMed] [CrossRef] [Google Scholar]

30. Narici MV, Maffulli N. Sarcopenia characteristics, mechanisms and functional significance. Br Med Bull. 2010;95:139–159. doi: 10.1093/bmb/ldq008. [PubMed] [CrossRef] [Google Scholar]

31. Huang SW, Lee YH, Liao CD, Escorpizo R, Liou TH, Lin HW. Association of physical functional activity impairment with severity of sarcopenic obesity findings from National Health and Nutrition Examination Survey. Sci Rep. 2024;14(1):3787–3787. doi: 10.1038/s41598-024-54102-z. [PubMed] [CrossRef] [Google Scholar]

32. Li H, Konja D, Wang L, Wang Y. Sex differences in adiposity and cardiovascular diseases. Int J Mol Sci. 2022;23(16):9338–9338. doi: 10.3390/ijms23169338. [PubMed] [CrossRef] [Google Scholar]

33. Baltasar-Fernandez I, Alcazar J, Mañas A, Alegre LM, Alfaro-Acha A, Rodriguez-Mañas L. Relative sit-to-stand power cut-off points and their association with negatives outcomes in older adults. Sci Rep. 2021;11(1):19460–19460. doi: 10.1038/s41598-021-98871-3. [PubMed] [CrossRef] [Google Scholar]

34. Ramírez-Vélez R, Izquierdo M, García-Hermoso A, Ordoñez-Mora LT, Cano-Gutierrez C, Campo-Lucumí F. Sit to stand muscle power reference values and their association with adverse events in Colombian older adults. Sci Rep. 2022;12(1):11820–11820. doi: 10.1038/s41598-022-15757-8. [PubMed] [CrossRef] [Google Scholar]

35. Kim M, Won CW. Cut points of chair stand test for poor physical function and its association with adverse health outcomes in community-dwelling older adults a cross-sectional and longitudinal study. J Am Med Dir Assoc. 2022;23(8):1375–1382. doi: 10.1016/j.jamda.2021.11.007. [PubMed] [CrossRef] [Google Scholar]

36. Khalili G, Zargoush M, Huang K, Ghazalbash S. Exploring trajectories of functional decline and recovery among older adults a data-driven approach. Sci Rep. 2024;14(1):6340–6340. doi: 10.1038/s41598-024-56606-0. [PubMed] [CrossRef] [Google Scholar]

37. Mittaz HA-G, Mathieu N, Lenoble-Hoskovec C, Swanenburg J, de Bie R, Hilfiker R. Effects of three home-based exercise programmes regarding falls, quality of life and exercise-adherence in older adults at risk of falling protocol for a randomized controlled trial. BMC Geriatr. 2019;19(1):13–13. doi: 10.1186/s12877-018-1021-y. [PubMed] [CrossRef] [Google Scholar]

38. Sampa MB, Hoque MR, Hossain MN. Impacts of anthropometric, biochemical, socio-demographic, and dietary habits factors on the health status of urban corporate people in a developing country. Healthcare (Basel) 2020;8(3):188–188. doi: 10.3390/healthcare8030188. [PubMed] [CrossRef] [Google Scholar]

39. Reis RS, Salvo D, Ogilvie D, Lambert EV, Goenka S, Brownson RC. Scaling up physical activity interventions worldwide stepping up to larger and smarter approaches to get people moving. Lancet. 2016;388(10051):1337–1348. doi: 10.1016/S0140-6736(16)30728-0. [PubMed] [CrossRef] [Google Scholar]