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Five-repetition sit-to-stand test validation in adolescents and adults with intellectual disabilities

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This study aims to validate the five repetition sit to stand test (5R-STS) test as a measure of strength and functionality in adolescents and adults with intellectual disabilities (ID). The sample was made up of 159 subjects with ID (85 adolescents and 74 adults) of both sexes, with average age of 18.36 (5.26) years, belonging to four special educational centers from Santiago, Chile. Absolute (AHGS) and relative (RHGS) handgrip strength and countermovement jump (CMJ) were considered as muscle strength evaluation tests. The timed up and go (TUG) and agility test 4 × 10 m were considered as functional tests. Spearman and intraclass correlations, as well as Bland-Altman plots were used to establish the respective correlations. The average values obtained in the 5R-STS test (s) in adolescents were 6.55 and 7.24, while in adults they were 6.82 and 7.17 for men and women, respectively. Significant correlations (p = < 0.05) are established between the 5R-STS test with AHGS (*r*= -0.48) and RHGS (*r*= -0.54), CMJ (-0.53), 4 × 10 m test (-0.50) and TUG (-0.49), as well as in the analysis of agreement between 5R-STS and the TUG (ICC = 0.74) and agility 4 × 10 m (ICC = 0.61) tests, both in adolescents and adults of both sexes. The 5R-STS test is a valid, simple and safe tool to evaluate general and lower extremity muscle strength. Its use is suggested as a simple measure for monitoring functional capacity by professionals in educational and health contexts for the adolescent and adult population with ID.

Keywords Intellectual disability, Validation, Functional capacity, Adolescents, Adults, Disabilities

In the general population, muscular strength[1] and cardiorespiratory fitness[2] as independent predictors of functionality. Functional capacity tends to decline irreversibly with age[3]; however, its preservation is strongly linked to lifestyle choices made in early life[4]. Functional capacity encompasses physical abilities essential for daily tasks, including endurance, muscle strength, and aerobic capacity[3]. Therefore, selecting appropriate tests and instruments for evaluating physical fitness and functional capacity is critical to identifying risk factors that could compromise autonomy in individuals with varying health conditions and states[5].

Evaluating individuals with intellectual disabilities (ID) characterized by significant limitations in intellectual functioning and adaptive behavior, including conceptual, social, and practical adaptive skills[6], presents a particular challenge for professionals who in clinical and school settings[7]. Studies have documented working memory impairments in children on the autism spectrum[8] and declines in executive function among individuals with Down syndrome[9], both of which impact self-efficacy and learning capacity[10]. The heterogeneity of responses among individuals with ID complicates adherence to assessment, affecting the validity and reliability of standard instruments and protocols[11]. To address this, there is a need for simplified evaluation protocols with limited motor demands and instructions tailored to the response capacities of individuals with ID[12]. Functional tests designed for ease of application, reproducibility across contexts, and minimal equipment requirements are thus ideal[13]. These tests, often used in functional capacity assessments for older adults, have also been adapted for

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use with people with ID[14,15]. Notable among these are the handgrip strength (HGS) test, applied in children and adolescents with Down syndrome[16,17] and in adults with Prader-Willi Syndrome[18]; the 4 × 10 m agility test, validated for adolescents with ID[19]; and the timed up and go (TUG) test, used for individuals on the autism spectrum[20], with cerebral palsy[21], and adults with Down syndrome[22]. Additionally, the countermovement jump (CMJ) test is commonly used to estimate lower body strength and is associated with obesity indicators[23] and sports performance in children with ID[24].

One of the most widely used tests to measure functional capacity is the Five-Repetition Sit-to-Stand Test (5R-STS), which assesses lower extremities and balance[25]. This test has been applied to individuals with Parkinson's[26] disease, cerebral palsy[27] and lower limb osteoarthritis[13], and it is also used as a measure of functionality in people with ID[11]. Farias-Valenzuela et al.[28] employed this test in adolescents with ID, finding sex-based differences. In a meta-analysis[29], Muñoz-Bermejo et al. demonstrated high reliability of the 5R-STS test in individuals with hip osteoarthritis, chronic obstructive pulmonary disease, spinal cord injury, stroke, and hip dysplasia; however, this research did not address population with ID.

Despite existing evidence and the broad applications of the 5R-STS test, it has not been validated for individuals with ID. Therefore, the aim of this study was to validate the 5R-STS test as a measure of strength and function capacity in adolescents and adults with ID.

Methods

Study design and sample

This study is characterized by being a cross-sectional study carried out in four special educational centers in the Metropolitan Region, Santiago of Chile. The educational centers and participants were selected by convenience and in a non-probabilistic manner, with whom we have been developed collaborative actions since 2018. Initially, the four directors of the participating special educational centers were contacted, with whom an information meeting was arranged that explained the characteristics of the project; subsequently, this information was shared among the relatives of the participating students. In this instance, the objectives and evaluation protocols of the project were presented. The data were collected between the months of August and November 2021, within the framework of the diagnostic evaluation of the first phase of the "LUDOINCLUSIÓN®" project belonging to the Vice-Rector's Office for Environmental Linkage of the University of Santiago de Chile.

The study population considered Chilean students with ID male or female, who were regular students at special education centers, with ages ranging from 6 to 26 years. The sample was composed of participants of both sexes, aged ≥ 12 years, who met the following inclusion criteria: (1) absence of lower limb injuries and/or referred pain; (2) independent mobility; (3) participation in mandatory physical education classes taught at school (60–90 min/week; 1 day/week); (4) diagnosis of mild or moderate ID[30] (IQ ≤ 70 − 50 and ≤ 50 − 35) with or without associated syndromes, diagnosed through the Wechsler Intelligence Scale for children or WISC III for < 18 years[31], and the Wechsler Intelligence Scale for Adults-IV or WAIS IV for ≥ 18 years of age[32] by the psychologist of the establishments, in addition to a compatible medical health certificate. Exclusion criteria considered those participants who did not complete the physical and functional tests defined for the study, who had wheelchair dependence, a diagnosis of profound and/or severe ID (IQ < 35), and/or were younger than 12 years.

The call for the study was aimed at 223 families and their students, of which 176 agreed to participate, with 17 participants (13 men and 4 women) being excluded for no meeting the defined inclusion criteria. Then, the final sample considered 159 participants diagnosed with ID, of which 85 were adolescents (12–17 years) and 74 adults (18–26 years). The application of the evaluations was authorized by the educational centers involved and the guardians of the participants, who voluntarily agreed and authorized the student's participation through an informed consent. The research complies with the guidelines set out in the Declaration of Helsinki (2014), which regulates research on human beings and has the approval of the ethics committee of the University of Granada, Spain, code 2052 / CEIH / 2021.

The participants carried out the evaluations through a circuit of three stations (anthropometry, muscle strength and functional capacity), each one composed of 2 professionals for its implementation. The participants attended in the company of a tutor, who fulfilled an assisting role through the process if required.

Anthropometry

Body weight (kg) and height (m) were measured barefoot and with light clothing, using an electronic scale with a built-in stadiometer brand (SECA Mod 769®, Hamburg, Germany). Waist circumference (WC) was measured in (cm) with an inextensible metal measuring tape (CESCORF®, Porto Alegre, Rio Grande do Sul, Brazil). The distance between the lower and upper costal edge of the iliac crest was considered the anatomical point[33]. The measurement was performed at the end of a normal expiration while the subject was standing with feet together and arms hanging freely at the sides. The previously mentioned measurements were used to calculate the body mass index ($BMI = kg/m^2$) and the waist-height ratio (WHtR = waist [cm]/(height [cm]).

Muscular strength

The assessment of upper extremity strength was measured using a hand-held dynamometer (Baseline®, Fabrication Enterprises, Inc., New York, USA). Participants received verbal instructions and a brief demonstration of the test, following the protocol established by the American College of Sports Medicine[34] and used by Farias-Valenzuela et al.[35] in people with ID. Participants were asked to squeeze the dynamometer handle as hard as possible for five seconds. A total of three attempts were made for each hand. The first was familiarization, while between the two remaining attempts, the average of the Absolute Handgrip Strength (AHGS) in kg, of both the right and left limb, was calculated. Relative Handgrip Strength (RHGS) was calculated by dividing absolute force by body mass (AHGS (kg)/body weight (kg)).

Lower extremity strength was measured by CMJ using a branded contact platform (Chronojump-Boscosystem®, Barcelona, Spain). To explain the execution of the test, the evaluator provided verbal instructions accompanied by a demonstration as a visual aid. The performance of the jump began in an upright position, with the participant in a bipedal position, with his feet apart and his hands on his hips. He flexed his knees and hips performing a squat, and then extended his limbs in an upward jump[24]. A familiarization test was performed and then two measured attempts, which were averaged to calculate the final result (cm).

Functional capacity

Agility test 4 × 10 m

To evaluate agility, the 4 × 10 m test was used, which was validated in people with ID by Tejero et al.[19]. To carry out this evaluation, two marks were drawn on the ground, maintaining 10 m between them. The development of the test required the participation of two evaluators. The first of them was positioned at the start line, providing pertinent instructions to carry out the test, in addition to taking charge of taking temporary records of the subject. Meanwhile, the second evaluator stood at the finish line. During the execution of the test, the individual undergoing evaluation had to make four runs from the start line to the finish line, having to make contact with the hand of the evaluator located on each line, before changing his direction. During the development of the test, words of encouragement were provided in order to motivate the test taker to run at the maximum possible speed.

Timed up and go

The TUG test was used to evaluate dynamic balance and independent mobility[36], which has been validated by Martín-Díaz et al.[20] in people with ID. To carry out the TUG test, a chair was placed at three meters demarcated by a cone. The test protocol began with the demonstration of the test, then the starting position was adopted once seated in the chair, keeping the back in contact with the back of the chair and ensuring that the feet were correctly positioned on the floor. Next, the evaluated person was required to get up from the chair and walk as fast as possible, avoiding running, go around the cone at the designated point and return to resume his or her seat in the chair[20]. During the execution of the test, the evaluator provided words of encouragement with the purpose of motivating the evaluated person. The final value was obtained from the average of two attempts.

Five repetitions sit to stand test

The 5R-STS is primarily used to assess lower limb muscle strength and functional capacity. To carry out this test, the subject began by sitting in a chair, keeping his back in contact with the backrest, his arms crossed with his hands resting on his shoulders and his feet placed firmly on the floor[27]. The participant was instructed to perform five cycles of getting up and sitting down from the chair in the shortest time possible. In addition to the verbal instructions, a visual demonstration was provided that exemplified the process. During the test, words of encouragement were provided to motivate the participant. Prior to carrying out the test, a test was carried out to familiarize the participant with the procedure, subsequently, the test was executed and the time of two attempts was recorded, the average of which was considered as the final measure[37].

Statistical analysis

The normality distribution of the variables for the total sample made up of adolescents and adults was contrasted using the Kolmogorov-Smirnov test. Descriptive statistics are presented as mean and standard deviations (SDs), as well as median and interquartile range (p25-p75), depending on the nature of the data Comparisons by sex between adolescents and adults were made using the Friedman test. To establish correlations between the 5R-STS test and the AHGS and RHGS of both extremities, CMJ, 4 × 10 m agility test and TUG, the Spearman coefficient (r) was used. Values of $r < 0.30$ were considered null; 0.30–0.49 low; 0.50–0.69 moderate; 0.70–0.89 high and 0.90-1.00 very high[38].

To establish the analysis of internal agreement between variables of the same unit of measurement, the intraclass correlation coefficient (ICC) was used. Bland Altman plots calculated 95% limits of agreement (-1.96 and 1.96) between means and SDs of the differences between 5R-STS and the agility 4 x 10 m and TUG tests. Statistical analyzes were performed with SPSS software version 26.0 (SPSS Inc., IBM Corp., Armonk, New York, NY, USA). A significance of 5% was adopted.

Results

The final sample considered 159 participants (96 men), 85 adolescents (53.4%) with an average age of 14.62 (1.24) years and 74 adults (46.5%) with an average age of 22.66 (4.80) years. In the adolescent group, the average for the total sample of weight, height, BMI, WC and WHtR were 62.59 kg, 1.58 m, 23.96 kg/m^2, 82.6 cm and 0.52, respectively. While in the adult group the same measurements were 69.70 kg, 1.59 m, 24.7 kg/m^2, 88.75 cm and 0.56, respectively. The anthropometric profile, differentiated by sex and age group, as well the physical and functional characteristics of the participants, are presented in Table 1.

The 5R-STS test presents significant correlations ($p < 0.05$) with the AHGS and RHGS (right and left), CMJ, and TUG in adolescents and adults, in both sexes. The highest correlations are identified in the adult female group, showing moderate inverse correlations between the 5R-STS test and the AHGS (r= -0.64 right and r= -0.61 left), RHGS (r= -0.66 right and r= -0.62 left) and CMJ (r= -0.56). Positive correlations were obtained with the 4 × 10 m agility test ($r = 0.60$) and the TUG test ($r = 0.63$) (Table 2). Regarding the agreement analysis between the 5R-STS test and the 4 × 10 m and TUG agility tests, moderate and high and significant intraclass correlations were obtained ($p < 0.05$).

	Adolescents				Adults			
	Total ($n = 159$)	**Total ($n = 85$)**	**Male ($n = 56$)**	**Female ($n = 29$)**	**Total ($n = 74$)**	**Male ($n = 40$)**	**Female ($n = 34$)**	***p* -value**
Age (years)								
Mean (SD)	18.36 (5.26)	14.62 (1.24)	14.43 (1.30)	15.00 (1.03)	22.66 (4.80)	22.8 (5.05)	22.41 (4.56)	< 0.001*
Median (IQR)	17.00	15.00	14.00	15.00	21.00	21.00	21.50	
	(14.00–21.00)	(14.00–15.00)	(13.00–15.00)	(14.00-15.50)	(19.00-24.50)	(19.00-24.75)	(19.75–24.25)	
Weight (kg)								
Mean (SD)	65.90 (19.39)	62.59 (19.54)	62.52 (18.40)	62.72 (21.93)	69.70 (18.41)	70.56 (18.93)	68.69 (18.02)	0.06
Median (IQR)	63.00	58.00	60.25	58.00	65.35	66.25	64.50	
	(52.00–75.00)	(47.50-73.25)	(50.00–72.00)	(45.00-79.50)	(56.75–76.50)	(58.25–78.75)	(55.75-76.00)	
Height (m)								
Mean (SD)	1.58 (0.11)	1.58 (0.11)	1.61 (0.11)	1.52 (0.10)	1.59 (0.11)	1.65 (0.09)	1.51 (0.09)	< 0.001*
Median (IQR)	1.59	1.58	1.62	1.51	1.59	1.68	1.51	
	(1.50–1.69)	(1.49–1.68)	(1.53–1.70)	(1.45–1.60)	(1.50–1.69)	(1.56–1.72)	(1.44–1.59)	
BMI (kg/m^2)								
Mean (SD)	24.31 (10.0)	23.96 (8.59)	22.94 (8.51)	25.89 (8.53)	24.70 (11.43)	21.31 (10.69)	28.68 (11.12)	0.01*
Median (IQR)	23.55	23.48	23.00	25.71	24.04	21.61	29.12	
	(20.27–29.04)	(04.20-27.58)	(19.13–27.13)	(22.10–29:06)	(20.52–31.18)	(17.44–27.27)	(22.18–32.71)	
Waist circumference (cm)								
Mean (SD)	85.46(16.39)	82.60 (16.13)	80.92 (15.90)	85.86 (16.35)	88.75 (16.17)	87.75 (14.03)	89.92 (18.53)	0.40
Median (IQR)	83.80	80.00	79.80	81.54	86.30	85.51	88.00	
	(75.00-93.50)	(72.00–90.00)	(70.00–87.00)	(74.50–97.70)	(77.87–95.25)	(77.62–93.45)	(78.50-97.25)	
Waist height ratio								
Mean (SD)	0.54 (0.11)	0.52 (0.09)	0.50 (0.09)	0.56 (0.09)	0.56 (0.11)	0.53 (0.09)	0.59 (0.13)	0.09
Median (IQR)	0.52	0.51	0.48	0.53	0.55	0.51	0.59	
	(0.47–0.60)	(0.46–0.56)	(0.43–0.55)	(0.50–0.61)	(0.48–0.63)	(0.46–0.58)	(0.50–0.65)	
Right absolute handgrip strength (Kg)								
Mean (SD)	21.26 (12.05)	21.2 (13.20)	23.58 (14.27)	16.61 (10.26)	21.33 (10.38)	26.83 (9.57)	14.86 (7.08)	< 0.001*
Median (IQR)	20.00	19.50	22.85	15.50	20.50	26.00	15.75	
	(13.00–28.00)	(12.00-28.50)	(14.00-13.70)	(8.50–22.50)	(13.22-28.00)	(19.87–33.50)	(9.25–20.50)	
Left absolute handgrip strength (Kg)								
Mean (SD)	20.20 (11.54)	19.86 (12.26)	22.33 (13.03)	15.10 (9.05)	20.58 (10.73)	26.19 (10.37)	13.98 (6.67)	< 0.001*
Median (IQR)	18.00	18.00	20.75	13.50	19.00	26.75	14.00	
	(12.00–26.00)	(11.50–24.50)	(13.50–26.7)	(8.00-19.5)	(12.87–27.12)	(18.25–33.37)	(9.12-19.00)	
Right relative handgrip strength								
Mean (SD)	0.32 (0.16)	0.33 (0.17)	0.37 (0.17)	0.25 (0.12)	0.31 (0.15)	0.39 (0.14)	0.23 (0.12)	< 0.001*
Median (IQR)	0.31	0.28	0.35	0.24	0.31	0.36	0.22	
	(0.21–0.43)	(0.22–0.44)	(0.22–0.47)	(0.18–0.35)	(0.20–0.42)	(0.27–0.51))	(0.11–0.33)	
Left relative handgrip strength								
Mean (SD)	0.31 (0.15)	0.31 (0.15)	0.35 (0.15)	0.23 (0.10)	0.30 (0.16)	0.38 (0.15)	0.21 (0.12)	< 0.001*
Median (IQR)	0.28	0.27	0.33	0.24	0.28	0.36	0.22	
	(0.20–0.40)	(0.20–0.40)	(0.24–0.45)	(0.15–0.29)	(0.19–0.40)	(0.26–0.50)	(0.09–0.31)	
Countermovement jump (cm)								
Mean (SD)	14.09 (6.72)	15.17 (6.01)	16.90 (5.61)	11.81 (5.37)	12.84 (7.3)	16.46 (6.82)	8.46 (5.21)	< 0.001*
Median (IQR)	13.69	14.69	16.65	11.40	12.59	17.37	8.89	
	(9.00-18.80)	(10.80-19.34)	(11.99–21.26)	(7.55–15.95)	(7.55–17.72)	(10.20-20.83)	(3.72–12.78)	
Agility test 4 x 10 m (s)								
Mean (SD)	18.87 (4.99)	18.39 (3.97)	17.64 (3.80)	19.82 (3.96)	19.44 (5.94)	17.84 (6.08)	21.37 (5.23)	< 0.001*
Median (IQR)	18.00	18.00	17.38	19.65	18.00	16.33	20.40	
	(15.45–21.30)	(15.75–20.47)	(14.49–20.08)	(17.00-21.41)	(14.99–22.70)	(14.34–19.17)	(17.70–24.27)	
Time up and go (s)								
Mean (SD)	6.88 (2.33)	6.79 (2.03)	6.55 (1.92)	7.24 (2.20)	6.98 (2.64)	6.82 (2.88)	7.17 (2.37)	0.57
Median (IQR)	6.66	6.90	6.75	7.21	6.39	6.07	6.69	
	(4.97–8.33)	(4.90–8.27)	(4.82–7.80)	(5.13–9.05)	(4.95–8.35)	(4.59–8.24)	(5.50–8.80)	
Five times sit to stand test (s)								
Mean (SD)	10.16 (4.45)	9.54 (2.86)	9.47 (3.02)	9.68 (2.57)	10.87 (5.70)	9.86 (3.86)	12.06 (7.18)	0.12
Continued								

	Adolescents				Adults			
	Total ($n = 159$)	Total ($n = 85$)	Male ($n = 56$)	Female ($n = 29$)	Total ($n = 74$)	Male ($n = 40$)	Female ($n = 34$)	*p* -value
Median (IQR)	9.35	8.72	8.68	9.59	9.62	9.09	10.98	
	(7.71–11.41)	(7.44–10.89)	(7.22–10.84)	(7.61–10.96)	(8.25–11.55)	(7.62–11.39)	(8.89–12.41)	

Table 1. Anthropometric, physical and functional characteristics by sex of adolescents and adults with ID. SD: Standard deviation; IQR: Interquartile interval (p25-p75); *: significance $p < 0.05$ by Friedman test; differences by sex between adolescents and adults.

Variables			Adolescents ($n = 85$)				Adults ($n = 74$)			
	Total ($n = 159$)		Male ($n = 56$)		Female ($n = 29$)		Male ($n = 40$)		Female ($n = 34$)	
	5R-STS (s)									
	r	ICC	*r*	ICC	*r*	ICC	*r*	ICC	*r*	ICC
AHGS-R (kg)	-0.48*	–	-0.41*	–	-0.38*	–	-0.34*	–	-0.64*	–
AHGS-L (kg)	-0.48*	–	-0.40*	–	-0.47*	–	-0.29	–	-0.61*	–
RHGS-R	-0.53*	–	-0.54*	–	-0.24	–	-0.39*	–	-0.66*	–
RHGS-L	-0.54*	–	-0.57*	–	-0.29	–	-0.36*	–	-0.62*	–
CMJ (cm)	-0.53*	–	-0.45*	–	-0.55*	–	-0.35*	–	-0.56*	–
4×10 m (s)	0.50*	0.74*	0.38*	0.61*	0.51*	0.56*	0.37*	0.81*	0.60*	0.76*
TUG (s)	0.49*	0.61*	0.44*	0.54*	0.31	0.53*	0.56*	0.80*	0.63*	0.56*

Table 2. Correlations of the 5R-STS test with upper/lower extremity and functional strength tests in adolescents and adults with ID of both sexes. AHGS-R: Right absolute handgrip strength; AHGS-L: Left absolute handgrip strength; RHGS-R: Right relative handgrip strength; RHGS-L: Left relative handgrip strength; CMJ: Countermovement jump; 4 × 10 m: TUG: Timed up and go. r: Spearman correlation coefficient; ICC: intraclass correlation; *: $p < 0.05$; –:no registration.

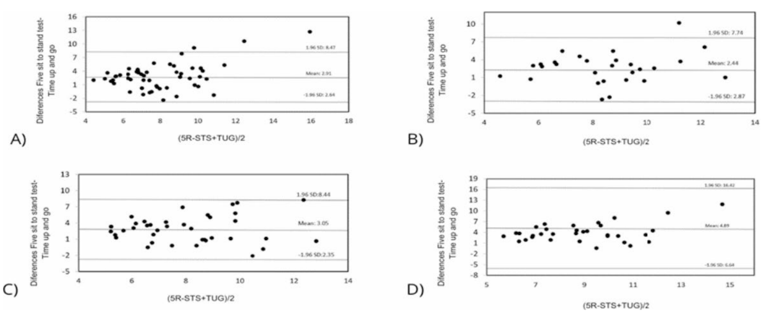

Fig. 1. Bland Altman Plots for the 5R-STS test in adolescents and adults of both sexes with ID. Bland Altman for theanalysis of agreement between the 5R-STS. The sample is represented at each point on the graph by transmitting the average value of the two evaluations (x-axis) and the difference between the two evaluations (y-axis). The mean difference was the estimated bias, and the standard deviation (SD) of the fluctuations around this mean, outliers are considered above 1.96 and under -1.96 SD (outlier). The center line shows the mean difference between the analyzed tests and upper and lower limits of agreement of the 95% CI for the difference between means. (**A**): Male adolescents; (**B**): Female adolescents; (**C**): Male adults; (**D**): Female adults.

The greatest internal consistency between the 5R-STS test and the agility 4 x 10 m and TUG tests was identified in the adult male group, showing values of (ICC = 0.81) and (ICC = 0.80) for the 4 × 10 m and TUG test, respectively, which are presented in Table 2.

Figures 1 and 2, through Bland-Altman Plots, illustrate the agreement between the 5R-STS test and the agility 4 x 10 m (s) and TUG tests, for the group of adolescents and adults depending on sex.

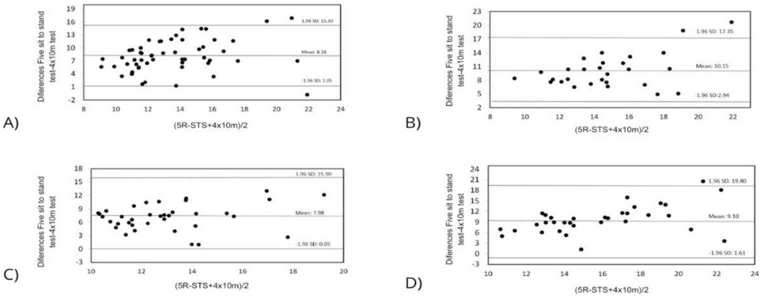

Fig. 2. Bland Altman Plots for the 5R-STS test and the TUG in adolescents and adults of both sexes with ID. Bland Altman Plots for the analysis of agreement between the 5R-STS and TUG tests. The sample is represented at each point on the graph by transmitting the average value of the two evaluations (x-axis) and the difference between the two evaluations (y-axis). The mean difference was the estimated bias, and the standard deviation (SD) of the fluctuations around this mean, outliers are considered above 1.96 and under − 1.96 SD (outlier). The center line shows the mean difference between the analyzed tests and upper and lower limits of agreement of the 95% CI for the difference between means. (**A**): Male adolescents; (**B**): Female adolescents; (**C**): Male adults; (**D**): Female adults.

Discussion

This study aimed to validate the 5R-STS test as a measure of strength and functional capacity in adolescents and adults with ID. Results indicate strong and significant correlations between the 5R-STS and both upper and lower extremity strength tests, as well as functional tests for adolescents and adults with ID across both sexes. Correlation analyses showed the strongest associations in the adult female group, while the highest intraclass correlation was observed in the adult male group.

The 5R-STS test has been used as an indirect measure of lower extremity muscle strength in various populations, including children with cerebral palsy, who have an average performance time of 28.9 s[39], individuals with Parkinson's disease, averaging 20.25 s[26], and patients with multiple sclerosis, where the test has been validated[40]. Literature reports a cut-off of 11.64 s for assessing fall risk and functional independence in older adults[41], while another study demonstrated normative values of 12.6 s for people aged 70 to 79 years[25]. The average values obtained in the present study were 9.54 s in adolescents (women: 9.68; men: 9.47) and 10.87 s in adults (women: 12.06; men: 9.86). According to these data, the female adults in the present study present similar values to older people. Compared to studies of the same test in other populations[42], people with ID have 19.3% of lower performance. The reported values of people with ID are even similar to those of older people with knee and hip osteoarthritis[13], even determining that the average performance of people with osteoarthritis is higher than the performance obtained by the female adult group from this study.

Previous studies have determined that people with ID have lower limb strength compared to people without disabilities[43]. Likewise, other studies in people with ID indicate that this group not only has lower levels of general strength, but also has less muscle mass and less explosive strength in the lower limbs, which translates into a risk factor that affects their functional capacity[44,45]. This may be due to certain barriers that affect social participation, added to the lack of physical stimuli received by this population, a shortage of exercise programs in special schools and the low participation and inclusion of people with ID in sports activities both inside and outside of the school context[46]. This participation may be limited by the lack of infrastructure and suitable spaces for the implementation of physical activity programs, as well as by the limited experience and training of physical activity professionals to work in special education settings[47]. In addition to the above, Yu et al.[48] identified other barriers related to personal factors, including biomedical conditions inherent to the disability, lower self-confidence, lack of parental support, insufficient or inaccessible facilities, and the lack of appropriate programs which can predispose this population to a decline of physical fitness and, consequently affect performance on this particular test.

The 5R-STS is influenced by nutritional status, where people with ID with a higher BMI took longer to perform the test[49], indicating lower functional capacity and lower limb strength. Likewise, male groups present better performance than female groups, which is repeated in previous studies in people with and without ID[18,28,50,51] and translates into a lower functional capacity for the female group. However, it has been shown that after a training plan both performance and body composition are improved[52], which suggests physical exercise as a good alternative to improve these parameters within this population, being even more beneficial when combined with a nutritional intervention that influences the eating habits of the participants[53,54]. Following this line, both the 5R-STS test and the TUG test are used to evaluate the strength and functionality of lower limbs, so, in studies in other populations, similar values are observed in both tests, yielding strong correlations and being presented as alternative tests to measure functional capacity[42,55,56].

A previous study demonstrated that the 5R-STS test had also correlations with the handgrip strength test, where the group of participants with a higher level of strength had better performance in 5R-STS and TUG[57], which may be due to handgrip is considered an indicator of general strength. Regarding the results of this study, both the adolescent and adult groups had higher values in men than in women in all the measurements, which coincides with previous studies carried out in people with and without ID[18,50,51]. Reference values in a previous study even determine that, in women, AHGS has been declining since adolescence and this reaches average values below the cut-off point established as the risk of sarcopenia in older people[35].

The 5R-STS test presents a strong negative correlation with the CMJ test[58], which aligns with the results of the present study. Previous research has noted low CMJ scores in individuals with ID, likely due to higher levels of inactivity in this population[59]. Since the CMJ assesses lower-limb strength and power, and power is recognized as a marker of health, the 5R-STS test may serve as a proxy for survival rates and overall health[60]. This suggests that individuals with lower CMJ scores may be at a higher risk of premature mortality. Additionally, recent study have demonstrated that jump strength can be protective against obesity, with established cut-off points in relation to the waist-to-height index at 17.1 cm for adolescents and 12.9 cm for adults, and in relation to BMI of 14.2 cm and 8.9 cm for adolescents and adults, respectively[23]. Another study used the 5R-STS test among with the agility test 4 x 10 m to assess functional capacity in people with ID, where average values similar to those presented in this study were obtained for both tests[37].

In accordance with our results, other investigations have validated functional tests using indirect tests, as is the case of the validation of the 5R-STS in older adults with total hip arthroplasty[61], with an r value = 0.73 with the TUG test and an ICC of 0.98 with the step test. The study by Goldberg et al.[62] establishes a correlation between the previous tests with an r value = 0.64 in a sample of older adult women, similar to the values declared for the adult women in the present study ($r = 0.63$). Another study with similar characteristics carried out on a sample of patients with coronary artery disease showed positive correlations of the 5R-STS test of r value = 0.53 with the 6-minute functional walk test[63]. Likewise, the study by Sánchez-González et al.[64] validated the 10-meter walking speed test using the TUG test as a reference in a sample of adolescents with Down syndrome. In this study, the 5R-STS test has a high correlation with the handgrip, CMJ, agility 4 x 10 m and TUG tests, demonstrating that it is useful for measuring functional capacity, specifically lower extremity strength in the ID population. This is related to a previous study where associations were found between functional and dynamometric tests of hand pressure and trunk extensor strength[37]. Most of the concordance analyzes reported in the literature in people with ID are intra-rater reliability analyzes[20], contrasting the use of the same test, but at different moments in time[65], however the internal consistency analyzes cannot be contrasted with the results of the present study, as they are analysis methodologies applied to different functional tests.

This study has several limitations. It is a cross-sectional study with a convenience sample, and we did not consider the various syndromes associated with ID, nutritional status, or lifestyle habits and behaviors of participants[66]. Additionally, while analyses were stratified by sex, the female sample was smaller than the male sample, and the study included only adolescents and adults, excluding younger children. Furthermore, gold-standard tests were not used for correlation purposes. Despite these limitations, the study's sex-stratified data helps to address the gender gap in ID research and offers meaningful insights into functional differences between men and women with ID. The sample also represents a group that is under-researched and difficult to access, and the findings offer valuable groundwork for future research. Lastly, by using an accessible test, this study provides a practical opportunity for replication and further investigation into strength and functional capacity in individuals with ID.

Conclusion

The 5R-STS test shows significant correlations with the HGS, CMJ and agreement with the agility 4 x 10 m and TUG tests. This supports its validity as a simple, safe, and effective tool for assessing overall muscle strength and functional capacity in individuals with ID. Given its low cost, we recommend its use by professionals in educational and healthcare settings as a straightforward measure for monitoring preventive or therapeutic needs in adolescents and adults with ID.

Data availability

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

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Author contributions
C.F-V and C.S-S conceived, designed, and helped write and revise the manuscript; C.F-V, S.E-L, C.C-B and G. LS were responsible for coordinating the study, contributed to the intellectual content, and reviewed the manuscript. G.F, C.S-S, P.D-M, P.F-H and E.R-V helped write and revise the manuscript. All authors contributed to the study design, critically reviewed the manuscript, and approved the final version.

Declarations

Competing interests
The authors declare no competing interests.

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Additional information
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