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ORIGINAL RESEARCH

Reference Values in the 6-Minute Walk Test in Chilean Children Aged 3–10 Years and Relationship With Cardiometabolic Risk

Pedro A. Latorre Román,[1] Cristian Martínez Salazar,[2] Juan A. Párraga Montilla,[1] José Carlos Cabrera-Linares,[1] Karina E. Andrade-Lara,[1] Alejandro Robles Fuentes,[3] and José Miguel Espinoza Silva[2]

[1]Departamento Didáctica de la Expresión Musical, Plástica y Corporal, Universidad de Jaén, Spain; [2]Departamento de Educación Física, Deportes y Recreación Universidad de La Frontera, Temuco, Chile; [3]Ayuntamiento de Santiago Pontones, Jaén, Spain

Purpose: The aim of this study was to evaluate the performance of healthy Chilean children aged 3–10 years in the 6-minute walking test (6MWT) and cardiometabolic risk variables and to determine sex- and age-specific reference values. ***Methods:*** This study involved 1165 healthy children (age = 6.36 [1.70] y old). The 6MWT was used to evaluate exercise performance. Furthermore, anthropometric measures were collected, like weight, height, body mass index, waist circumference, and skin folds. Resting heart rate and blood pressure (BP) were also evaluated. ***Results:*** The prevalence of overweight and obesity was 35.0% and 25.4% in preschoolers and 29.0% and 36.2% in school-age children, respectively, showing significant differences ($P < .05$) between age groups. The distance walked (6-min walk distance) increased significantly year on year at ages from 3 to 10 years. According to the regression analysis, 6MWT performance was positively related to age, systolic BP, and height, whereas it was negatively related to $\sum 4$ skinfold fat, resting heart rate, diastolic BP, and waist circumference. ***Conclusions:*** This study provides a reference equation and an age- and sex-adjusted percentile curve to assess the predicted 6MWT performance in a cohort of prepubertal Chilean children. The 6-minute walk distance depends mainly on age; however, other variables, such as resting heart rate, BP, skinfold fat, and waist circumference, add significant information and should be taken into account.

Keywords: gait, growth, health, field test

Key Points

- The distance covered during the 6-minute walking test depends mainly on age.
- Resting heart rate, blood pressure, skinfold fat, and waist circumference add relevant information about children's health status.
- The equation can predict 6-minute walking test performance in Chilean children.
- Reference values for Chilean children have been provide in this study.

The importance of physical activity for health is well known, and research has noted both physical and psychological benefits when children participate in physical activities (1,2). Moreover, evidence shows that higher levels of sedentary behavior are associated with the following poor health outcomes in children and adolescents: increased adiposity, cardiometabolic risk (CMR), autonomic nervous system dysfunction, and low cardiorespiratory fitness (CRF; 3,4). In this context, the prevalence of obesity among children and adolescents (aged 2–18 y) is an important public health problem (5). In particular, childhood obesity is a common phenomenon in Chilean children; the prevalence of overweight/obesity in Chilean children (≥5 y old) has been estimated at 30% to 44% and is higher in girls than in boys (6).

Particularly, physical fitness, adiposity, and the distribution of BF during childhood have shown a high correlation with cardiovascular health in adulthood (7). Moreover, it should be noted that a lower BF implies a greater fitness level (8). Hence, physical fitness is considered as a powerful marker of health in both early childhood and later life (9–11). The physical fitness components more related to health are: cardiorespiratory capacity, musculoskeletal capacity, and body composition. Particularly, cardiorespiratory capacity is strongly associated with health even at early ages as it is a determinant of cardiovascular risk in children (12). It is noteworthy that one half of boys and two thirds of girls aged 12–15 years do not have healthy CRF, and only one in 5 youth with obesity have healthy CRF (13). This indicates the importance of assessing the capability of respiratory systems as a negative CRF in early life stages is associated with adverse cardiovascular indicators (14). In fact, the CRF has been identified as an important indicator of cardiometabolic health, and evidence-based CRF cut-off points have been established for avoiding cardiovascular disease risk in children and adolescents (15). Thus, an individual's response to exercise is an important clinical assessment tool as it offers a complex assessment of respiratory, cardiac, and metabolic

Latorre Román https://orcid.org/0000-0002-0517-3627
Salazar https://orcid.org/0000-0002-9216-1826
Montilla https://orcid.org/0000-0002-0250-0717
Andrade-Lara https://orcid.org/0000-0001-9804-1318
Silva https://orcid.org/0000-0002-0439-900X
Cabrera-Linares (jccabrer@ujaen.es) is corresponding author, https://orcid.org/0000-0002-1059-5154

systems (16). In this regard, exercise testing can be valuable for evaluating exercise aptitude, determining disease prognosis, and estimating therapeutic interventions as well as for appropriate individual prescription of therapeutic exercise for treating chronically ill children (17).

The current gold standard for determining aerobic response to exercise is the maximum incremental cardiopulmonary exercise test. Specifically, in children, the Leger test (24) is usually used (13). However, as most daily activities are accomplished at submaximal intensities, it has been proposed that submaximal tests give a different representation of exercise performance (16). The 6-minute walk test (6MWT) is a simple, everyday test that evaluates the integral responses of all the systems involved during exercise, including the pulmonary and cardiovascular systems, systemic circulation, peripheral circulation, blood, and muscle metabolism (19). The 6MWT is increasingly used as a measure of functional exercise performance in children. Administration of the test requires minimal equipment, training, and time. Also, it can be conducted in schools or other pediatric clinical settings; in particular, it is increasingly used as a functional measure for children with several pathologies (17). In healthy children, the 6MWT is a reliable and valid functional test for evaluating exercise tolerance and endurance (16). In addition, the 6MWT could be a useful measure to screen changes over time and assess the effects of interventions to increase functional capacity (20). However, despite its recognized usefulness in adults, the 6MWT is not commonly used in the pediatric population due to the lack of standardized protocols, established reference values, and reference equations (21). Therefore, obtaining reference values in the pediatric population is especially necessary in view of the influence of factors such as development stage, age (22), and anthropometric variables on 6MWT performance (20). There is no global reference value for the 6MWT in pediatric populations as performance can vary widely depending on local conditions and population and anthropometric measures (23). This is the reason why prediction equations for performance in the 6MWT developed for children in a country may not be appropriate for those in other countries (20). In this regard, 6MWT performance is associated with sex, continent, and anthropometric variables, although the predictive variables determine a low percentage of normal distance walked in children and adolescents (25). Further research is needed to obtain reference values for the 6MWT for every world region and ethnicity (22). In Chilean children, we only found the study of Gatica et al (16); however, this study had a very small number of participants, and it was conducted more than a decade ago. In this regard, the main object of this study was to evaluate the performance of healthy Chilean children aged 3–10 years from a population-based sample in the 6MWT and its relationship with the CMR and to determine sex- and age-specific reference values.

Methods

Participants

A priori sample size was calculated using G*Power software (26). The following parameters were selected: moderate effect size ($f = 0.250$), α level of .05, power level of 0.95, 5 groups, 1 measurement, and critical $F = 2.402$. The minimum sample size was determined to be 302 participants. This cross-sectional study included a cohort of 1165 healthy children (608 girls) aged 3–10 years (age = 6.36 [1.70] y old); the participants were selected by convenience from several schools in the Araucania region (Chile) in both urban and rural areas. Inclusion criteria involved being free from physical and/or intellectual disabilities, and to that end, the parents of the enrolled children provided a document in which they stated that their children were free of physical and intellectual disabilities. Children who were on medication, with chronic or acute disease, or for whom no signed informed consent was received were excluded from testing and analysis. The participants were divided into 2 groups: preschool children (n = 623, 50.1% girls) and elementary school children (n = 542, 54.6% girls). The study was carried out following the norms of the Declaration of Helsinki (2013 version) and was approved by the Ethics Committee of the University of Jaen.

Materials and Testing

Anthropometric Variables

Body mass (in kilograms) was measured using a weighing scale (Seca 899), and body height (in meters) was measured with a stadiometer (Seca 222). The body mass index (BMI) was calculated by dividing body mass (in kilograms) by body height^2 (in meters). The 85th and 95th percentiles of the study by Sobradillo et al (35) were used to classify children as overweight or obese, respectively, based on BMI. Waist circumference (WC) was measured at the height of the navel using a nonelastic ergonomic circumference measuring tape (Seca 201; range 0–150 cm; accuracy: 1 mm). The waist-to-height ratio (WHR) as a measure of CMR was obtained by dividing the WC (in centimeters) by the body height (in centimeters) and was used as a tool to estimate the accumulation of fat in the central zone of the body; a WHR of 0.5 is generally accepted as a universal cut-off for central obesity in children (28). The percentage of BF was evaluated from bicipital, tricipital, subscapular, and suprailiac measurements using the Slaughter equation (26). The assessment was carried out with a skinfold caliper model 102 to 602 L.

Exercise Performance

The 6MWT was performed according to a previously standardized protocol (19). It consists of recording the distance (in meters) that the participants are able to walk in the 6MWT. The track of 6MWT was composed of a 30-m long straight, flat, and hard surface corridor without obstacles. The participant had to walk as fast as possible (without running). During the test, the children were constantly encouraged to achieve maximum performance. They were informed that the purpose of the test was to find out how far they could walk in 6 minutes, and they were instructed to walk the greatest distance possible at their own pace during the allotted time. Hopping, skipping, running, and jumping were not allowed during the test. Only standardized phrases of encouragement (eg, "keep going" and "you are doing well") and announcement of the time remaining were given to the participants. Height is usually present in all prediction equations for the distance walked by healthy children (29). The result obtained in the 6MWT was divided by height because leg length was not evaluated.

To measure the blood pressure (BP, diastolic and systolic) and resting heart rate (RHR), a digital portable (OMRON model HEM 7114) device was used.

Procedure

All the experiments were conducted in the school's sports facilities, in the morning, at least 3 hours after the last meal; children were asked to refrain from strenuous physical activity on the day prior to measurement. Prior to exercise testing, anthropometric variables were recorded, and BP and RHR were measured after 10 minutes in a seated position and with spontaneous breathing. To stabilize the heart rate (HR), children were instructed to abstain from speaking or moving during the examination period. Subsequently, the children were divided into small groups to perform the 6MWT. After completing the test, all the subjects immediately (within 10 s) sat passively on a chair placed adjacent to the sports court, and their BP was measured again.

Statistical Analysis

Data were analyzed using SPSS (version 22.0) for Windows and the R statistical program with the Generalized Additive Model for Location, Scale and Shape package. Tests of normal distribution and homogeneity (Kolmogorov–Smirnov and Levene test, respectively) were conducted on all data periods after the analyses. Descriptive data are reported in terms of means and standard deviation. Differences in anthropometric characteristics, CMR, and 6MWT performance were analyzed using an analysis of variance. In addition, to verify the relationship between HR parameters, CRF, and anthropometric variables, partial correlation analysis and a simple linear regression analysis (adjusted by age and sex) were used. The magnitude of correlation between measurement variables was designated as: <0.1 (trivial), 0.1 to 0.3 (small), 0.3 to 0.5 (moderate), 0.5 to 0.7 (large), 0.7 to 0.9 (very large), and 0.9 to 1.0 (almost perfect) (18). The percentile curve was calculated as a function of age, stratified by sex, using the Lambda, mu, sigma, power exponential method, assuming a Box–Cox power exponential distribution, which is a generalized model of the Lambda, mu, sigma method. This method was implemented in the Generalized Additive Model for Location, Scale and Shape package in R software. The significance level was set at $P < .05$.

Results

In the prevalence of CMR, significant differences between preschool and elementary school pupils ($P < .05$) were found among girls (56.3% vs 43.7%) but not among boys (59.4% vs 40.6%). The prevalence of overweight and obesity was 35.0% and 25.4%, respectively in preschoolers and 29.0% and 36.2% in school-age children, with significant differences ($P < .001$) between whole groups. Furthermore, preschools girls showed lower values of overweight and obesity than elementary school girls (36.5% and 22.8% vs 30.1% and 36.1%, respectively, $P = .001$). In the whole sample, the total joint prevalence of overweight and obesity was 62.6%.

The anthropometric and cardiovascular parameters and the 6-minute walk distance (6MWD) distributed by age and sex are shown in Table 1. Most parameters analyzed showed significant differences between age groups in both boys and girls. Significant increases in the distance walked year on year were recorded from 3 to 10 years: from 3 to 4 years = 28 m, from 4 to 5 years = 64 m, from 5 to 6 years = 38 m, from 6 to 7 years = 39 m; a modest increase was observed from 7 to 8 years = 10 m, followed by a larger increase from 8 to 9 years = 42 m, and finally, from 9 to 10 years = 21 m (Figure 1). Pearson correlation analysis showed significant correlations of 6MWD with WHR ($r = -.197$, $P < .001$), BMI ($r = -.124$, $P < .001$), and $\sum 4$ skinfold fat ($r = -.140$, $P < .001$); furthermore, 6MWD/height displayed better correlations with WC ($r = -.219$, $P < .001$) and with $\sum 4$ skinfold fat ($r = -.213$, $P < .001$). According to the regression analysis, 6MWD was positively related to age, systolic BP, and height, whereas it was negatively related to $\sum 4$ skinfold fat, RHR, diastolic BP, and WC [(6MWD = 176.416 + 22.567 × age (y) + 2.790 × height (cm)] − 0.439$\sum 4$ skinfold fat (mm) − 0.340 RHR (beats min^{-1}) − 0.732 diastolic BP (mm Hg) + 0.370 systolic BP (mm Hg) − 1020 WC (cm). $R^2 = .515$, standard error = 60.94 m.

The scatter plot for 6MWD and age is shown in Figure 2. A significantly positive association was seen between the 2 variables, which were similar in both sexes. The R^2 for the model was .442 for boys and .534 for girls.

Finally, the second, 10th, 25th, 50th, 75th, 90th, 98th, and 99.6th percentile curves were computed for 6MWT performance according to sex and age (Figure 3 and Table 2).

Discussion

The main objective of this study was to evaluate the performance of healthy Chilean children aged 3–10 years from a population-based sample in the 6MWT, examining the relationship between 6MWD, age, sex, and anthropometric variables and determining sex- and age-specific reference values. So far as we know, this is the first study to provide reference values for the 6MWT in Chilean children of 3–10 years of age. The main findings of this study showed that: (1) there were no significant differences between boys and girls in 6MWD in either preschool or school-age children, (2) there was a significant age-related increase in 6MWD, and (3) CMR parameters were negatively correlated with 6MWD.

Overall, and in agreement with Lammers et al (21), the distance walked correlated with age, and no significant difference was observed between boys and girls. The distance walked increased significantly year on year from 3 to 7 years, with further modest increases observed beyond 7 years of age.

The values for distance walked in the 6MWT were lower than those found by Geiger et al (17) both in preschool (492.75 [75.82] m vs ≈ 519.20 [52.4] m) and in school-age children (594.53 [64.82] m vs ≈ 621.42 [60.9] m) but higher than those obtained by Lammers et al (vs ≈ 422 [40] and vs ≈ 493.25 [43]) in White children (31). A notable contrast is observed with a study in Chilean children by Téllez et al, who found higher values than the present study in school-age children, with all values above 600 m (32).

I.E., Several studies (30, 33–35) support the view that children who are obese may be less active and show a poor performance in the 6MWT. Regarding weight status and CMR, the findings of the current study showed a weak association with 6MWT performance. The present findings seem to be consistent with other research that has not found a clear relationship between weight status and 6MWT performance (20). Likewise, a previous study indicated that anthropometric characteristics were not correlated with 6MWD in children aged 7 and 8 years (36). Moreover, another study revealed that, using multiple regression analysis, 26% of the variance in 6MWD could be attributed to the participant's age, WHR, and sex; WHR was the only significant contributor to 6MWD ($P = .001$) in children aged 8–12 years (37). Furthermore, previous research showed that age, weight, and BMI were positively correlated with 6MWD, whereas waist and hip circumferences were negatively correlated with 6MWD for both genders; thus, the combination of age, height, BMI, and hip circumference explained 69% of the 6MWD variability in the equation for the whole population (38). Others considered that age, height, nutritional status, and HR variation were determinants of 6MWT performance (39). In addition, 6MWT performance was negatively associated with sedentary time, controlling for age and height (40).

Table 1 Anthropometrics, Cardiovascular Parameters, and 6MWD of the Participants Separated by Age and Sex

	Preschool children, mean (SD)				School-age children, mean (SD)			
	All	Boys	Girls	*P*	All	Boys	Girls	*P*
Age	5.00 (0.89)	5.05 (0.87)	4.96 (0.91)	.208	7.91 (0.87)***	7.89 (0.91)***	7.92 (0.84)***	.609
Body weight, kg	23.30 (5.07)	23.48 (4.77)	23.11 (5.36)	.369	34.30 (8.49)***	33.60 (7.39)***	34.88 (9.27)***	.079
Height, m	1.13 (0.08)	1.14 (0.08)	1.12 (0.07)	.004	1.30 (0.07)***	1.30 (0.06)***	1.30 (0.07)***	.989
BMI, kg/m^2	18.05 (2.50)	17.97 (2.38)	18.14 (2.61)	.496	20.07 (3.60)***	19.71 (3.22)***	20.37 (3.87)***	.012
WC, cm	56.44 (5.86)	56.49 (5.25)	56.52 (6.05)	.959	63.87 (7.97)***	63.88 (7.47)***	63.86 (8.37)***	.975
WHR	0.50 (0.04)	0.50 (0.04)	0.50 (0.05)	.044	0.49 (0.05)**	0.49 (0.05)	0.49 (0.05)**	.881
Systolic BP, mm Hg, at rest	98.73 (11.89)	99.19 (11.63)	98.27 (12.14)	.343	101.18 (12.17)***	101.74 (12.40)*	100.73 (11.98)*	.331
Diastolic BP, mm Hg, at rest	61.11 (11.74)	60.62 (11.10)	61.57 (12.34)	.293	62.34 (10.82)	62.34 (11.32)	62.34 (10.39)	.996
Systolic BP, mm Hg, postexercise	106.60 (12.98)	106.92 (13.15)	106.30 (12.83)	.559	115.41 (13.19)****	115.39 (13.30)***	115.43 (13.14)***	.976
Diastolic BP, mm Hg, postexercise	65.20 (13.06)	64.09 (12.92)	66.28 (13.14)	.028	67.34 (11.34)**	66.98 (11.96)**	67.64 (10.81)	.535
ΔSystolic BP, mm Hg,	7.89 (15.18)	7.76 (15.57)	8.01 (14.81)	.837	14.15 (14.84)***	13.65 (15.99)***	14.57 (13.82)***	.482
ΔDiastolic BP, mm Hg	4.12 (16.49)	3.53 (15.58)	4.70 (17.34)	.362	4.88 (15.02)	4.63 (16.61)	5.09 (13.57)	.739
RHR, beats min^{-1}	88.73 (13.15)	88.81 (12.97)	88.65 (13.35)	.873	83.50 (12.07)***	82.93 (11.45)***	83.97 (12.56)***	.344
Bicipital, mm	6.67 (2.41)	6.35 (2.37)	6.98 (2.42)	.001	8.36 (3.62)***	7.73 (3.82)***	8.88 (3.37)***	<.001
Tricipital, mm	11.42 (3.54)	10.86 (3.50)	11.98 (3.49)	<.001	14.06 (4.85)***	13.01 (4.89)***	14.93 (4.65)***	<.001
Subscapular, mm	8.28 (4.23)	7.52 (3.87)	9.03 (4.44)	<.001	11.85 (6.26)***	10.45 (5.58)***	13.02 (6.55)***	<.001
Suprailiac, mm	10.14 (5.24)	9.08 (4.86)	11.20 (5.40)	<.001	15.65 (7.57)***	14.52 (7.99)***	16.58 (7.08)***	.002
∑4 skinfold fat, mm	36.51 (13.94)	33.80 (13.25)	39.21 (14.12)	<.001	49.94 (20.30)***	45.73 (20.14)***	53.43 (19.79)***	<.001
Body fat, %	18.08 (5.14)	17.10 (5.14)	19.07 (4.97)	<.001	22.15 (6.79)***	20.79 (7.15)***	23.29 (6.26)***	<.001
6MWD, m	492.75 (75.82)	497.36 (75.78)	488.19 (75.71)	.107	594.53 (64.82)***	595.40 (68.00)***	593.81 (62.17)***	.795
6MWD/height, m	433.62 (63.03)	433.04 (68.59)	434.19 (57.07)	.805	456.81 (52.82)***	456.26 (58.86)***	457.26 (47.31)***	.843

Abbreviations: 6MWD, 6-minute walk distance; BMI, body mass index; BP, blood pressure; RHR, resting heart rate; WC, waist circumference; WHR, waist-to-height ratio.
*,**,***Significant differences with preschool children $P < .05$, $P < .01$, $P < .001$, respectively.

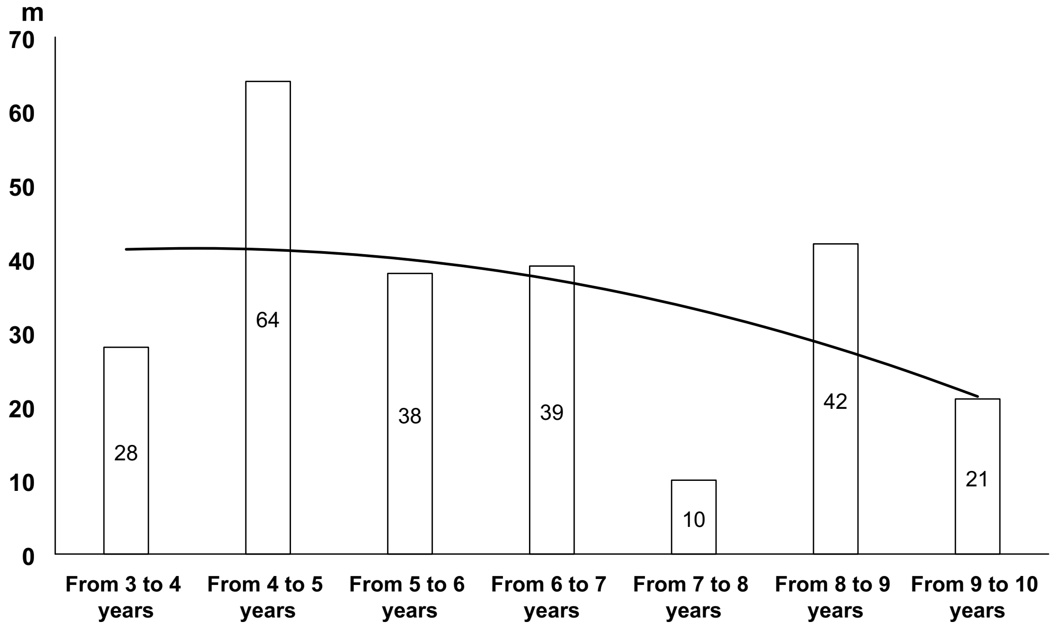

Figure 1 — Increases in distance achieved in the 6-minute test in meters from age 3 to 10 years.

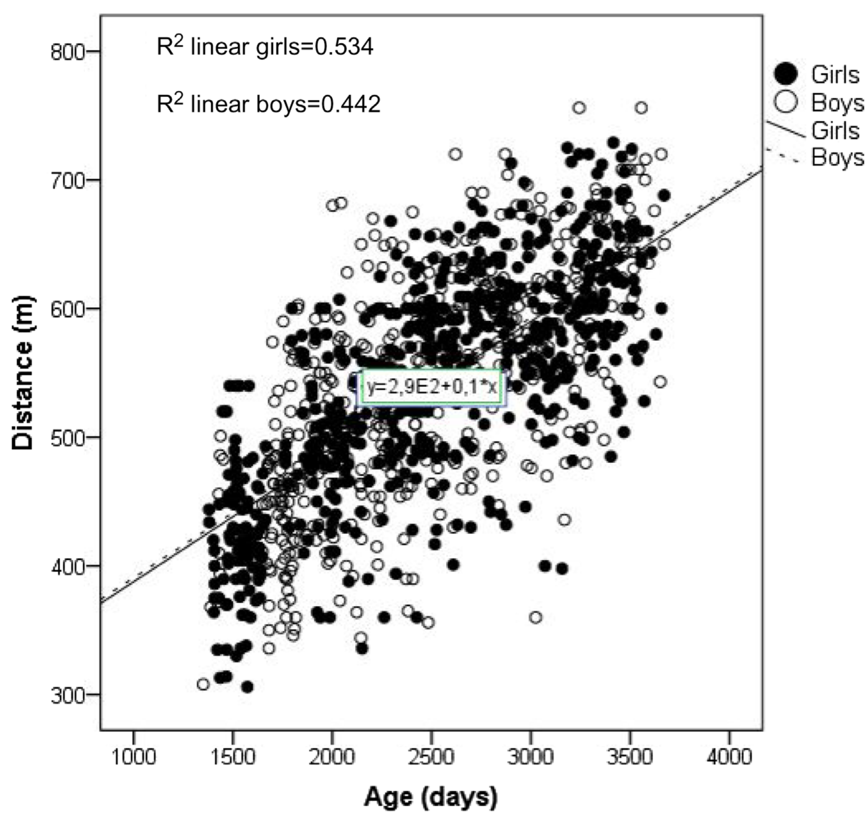

Figure 2 — Scatter plot for 6-minute walking distance according to age and sex.

Thus, CMR factors were negatively correlated with 6MWD: For each 10-m increase in the 6MWD, a reduction of about 9% in the prevalence of CMR clustering was expected (40).

Moreover, the distance covered in the 6MWT increased with children's age, weight, and height, growth in height being the most important predictor of change in distance covered in the 6MWT (17). In this regard, a cross-sectional study suggests that there is a rapid increase in the distance walked in children aged 4–7 years of age, with a further slower increase up to 11 years of age, and no significant difference between boys and girls. In the study cited, the

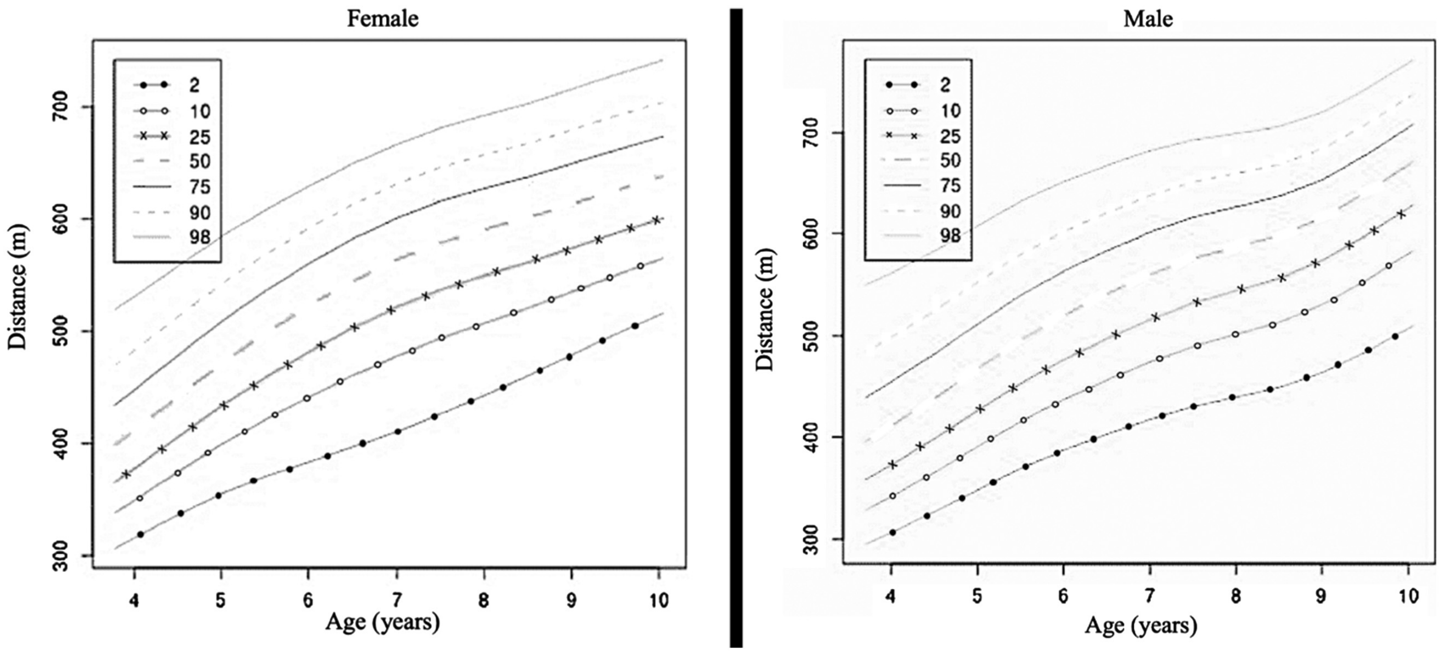

Figure 3 — Second, 10th, 25th, 50th, 75th, 90th, 98th, and 99.6th percentile curves for 6-minute walk test performance according to sex and age.

Table 2 Second, 10th, 25th, 50th, 75th, 90th, 98th, and 99.6th Percentile Curves for 6MWT Performance According to Sex and Age

	6MWD, m													
	C2		C10		C25		C50		C75		C90		C98	
Age, y	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
3.5	294.73	306.77	328.07	338.18	357.98	365.28	395.70	398.15	439.02	434.20	483.69	469.65	549.88	519.27
4	306.40	316.03	341.71	349.40	372.86	377.73	411.45	411.51	454.82	447.87	498.51	482.95	561.42	530.98
4.5	326.66	336.45	365.44	374.70	398.70	405.90	438.73	441.71	482.23	478.70	524.57	512.98	583.10	557.93
5	348.17	355.29	390.71	399.35	426.14	433.63	467.61	471.38	511.30	508.82	552.57	542.26	607.74	584.49
5.5	369.25	370.55	415.62	421.37	453.11	458.77	495.80	498.19	539.53	535.76	579.75	568.21	632.04	607.88
6	387.32	383.64	437.23	441.56	476.39	481.79	519.80	522.55	563.14	560.08	602.07	591.63	651.52	629.28
6.5	403.11	396.81	456.34	460.71	496.82	503.10	540.58	544.76	583.23	582.20	620.77	613.11	667.50	649.39
7	417.78	410.96	474.20	478.28	515.77	521.75	559.65	563.77	601.48	601.04	637.64	631.51	681.88	666.97
7.5	430.23	426.60	489.52	493.90	531.84	537.23	575.50	579.03	616.30	616.04	651.00	646.24	692.82	681.35
8	439.74	443.13	501.41	507.50	544.08	549.67	587.13	590.77	626.65	627.43	659.78	657.51	699.19	692.63
8.5	449.34	460.56	513.27	520.69	556.15	561.21	598.55	601.39	636.82	637.72	668.50	667.83	705.77	703.26
9	463.69	479.26	530.34	535.17	573.72	574.03	615.82	613.34	653.26	649.45	683.91	679.73	719.60	715.74
9.5	483.91	497.53	553.82	549.76	598.07	587.08	640.29	625.54	677.32	661.43	707.33	691.90	741.99	728.53
10	507.23	514.70	580.46	563.74	625.66	599.62	668.10	637.24	704.88	672.85	734.43	703.45	768.30	740.63
10.5	510.14	516.62	583.76	565.33	629.06	601.05	671.53	638.57	708.28	674.15	737.78	704.76	771.56	742.00

Abbreviations: 6MWD, 6-minute walking distance; 6MWT, 6-minute walking test.

mean 6MWD increased by 37 m between the ages of 4 and 5 years, by 43 m between 5 and 6 years, and by 25 m between 6 and 7 years of age; beyond 7 years of age, the distance walked did not increase significantly from 1 year to the next, but there was a significant overall increase between 7 and 11 years (31). In accordance with the present results, the findings reported by Lammers et al (31) showed a rapid increase in the distance achieved from 3 to 7 years, with a further, slower increase up to 10 years.

According to Klepper and Muir (19), the discrepancies in reported 6MWD among several studies (21,31,32) may be due, in part, to cultural differences between countries with respect to physical activity and fitness or to the high prevalence of overweight and obesity found both in the present study and in (14), with totals of 62.6% and 46% overweight and obese children, respectively. In addition, although the American Thoracic Society has published a guideline to standardize 6MWT, these very different results may be due to the variations in methodological information during the performance of 6MWT, especially in relation to the level of encouragement during the test. Therefore, further research on this topic needs to be undertaken before the association between CMR and 6MWT performance is more clearly understood.

Finally, in the current study, the results found by the regression model were comparable with results from other countries (21,41,42). In a review, Mylius et al (29) indicated the following prediction equation for 6MWD = (4.63 × height (cm)) − (3.53 × weight (kg)) + (10.42 × age) + 56.32 yields, with the highest R^2 value (.6). In most of the studies indicated by Mylius et al (22), the following variables were indicated as predictive variables of 6MWD: age, height, HR, and weight. In the current study, the variables that showed predictive power for performance in the 6MWT were: age, height, skinfold fat, WC, RHR, and BP.

There are some limitations that should be mentioned: (1) The cross-sectional nature of our present study did not allow us to detect a cause-and-effect relationship between 6MWT performance and children's growth, which would need to be measured in a long-term longitudinal study; (2) we did not examine other factors that may have contributed to 6MWT performance such as habitual physical activity level and physical fitness. However, the strength of this study was that a large sample of children was studied, drawn from both rural and urban schools over a large geographical area.

In practical terms, reference percentile values from this study provide much-needed comparative data for teachers, coaches, and physicians who wish to use the simple, low-cost 6MWT to monitor exercise performance in children. Moreover, the extreme lower percentiles can be used as a warning signal of the need to conduct additional tests to identify possible disorders. The 6MWT proved to be safe, easy to perform, and highly acceptable to children. It provides a simple and inexpensive means of measuring functional exercise capacity in Chilean children, even those of young age, and might be of value when conducting comparable studies.

In conclusion, this study provides a reference equation and an age- and sex-adjusted percentile curve to assess the predicted 6MWT performance in a cohort of prepubertal Chilean children. The 6MWD depends mainly on age; however, other variables, such as RHR, BP, skinfold fat, and WC, add significant information and should be taken into account; however, the current study does not make clear the associations between 6MWD and CMR factors in this population. Reference equation allow the 6MWD to be predicted and may help to better assess and compare outcomes between children. In addition, the reference values that we have established for Chilean children could be used to monitor healthy gait development.

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