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ORIGINAL

PERCENTILE OF PHYSICAL CONDITION IN CHILDREN AND ADOLESCENTS FROM CUENCA - ECUADOR: ALPHA-FIT BATTERY

PERCENTILES DE LA CONDICIÓN FÍSICA EN NIÑOS Y ADOLESCENTES DE CUENCA - ECUADOR: BATERÍA ALPHA-FIT

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ABSTRACT

The physical condition was evaluated and the normative reference values were obtained using the Alpha-Fit Battery. The main objective of this study was to establish the percentiles, their respective curves and differences between the sexes for the tests, thus providing an instrument that facilitates the evaluation of physical condition. With a sample of 604 children and adolescents (9-12 years old) with a normal body mass index (BMI) and no conditions that affect their physical performance. A significant difference was evidenced, with a higher average in women, in the measurements of body composition (BMI, height, body weight and skin folds). As well as higher averages in men in the long jump, 20-m shuttle run and shuttle run 4 x 10m. Likewise, there were higher averages in the long jump, shuttle run 4 x 10m and handgrip, as age increased, regardless of sex.

KEYWORDS: Alpha-Fit, Physical Condition, Children and Adolescents, Body Composition, Cardiovascular Capacity.

RESUMEN

A través de la Batería Alpha-Fit, se evaluó la condición física y obtuvo los valores normativos referenciales. El objetivo principal de este estudio fue establecer los percentiles, sus respectivas curvas y las diferencias entre sexos para las pruebas, brindando así un instrumento, que facilite la evaluación de la condición física. Con una muestra de 604 niños y adolescentes (9-12 años) con un índice de masa corporal (IMC) normal y ninguna condición que afecte su desempeño físico. Se evidencio una diferencia significativa, con mayor promedio en las mujeres, en las medidas de composición corporal (IMC, estatura, peso corporal y pliegues cutáneos). Así como promedios mayores en los hombres en las pruebas de salto de longitud a pies juntos, ida y vuelta 20m y agilidad/velocidad 4x10m. Igualmente, se presentaron mayores promedios en las pruebas de salto de longitud a pies juntos, agilidad/velocidad 4x10m y de presión manual conforme aumenta la edad, independientemente del sexo.

PALABRAS CLAVE: Alpha-Fit, Condición física, Niños y Adolescentes, Composición corporal, Capacidad cardiorrespiratoria.

INTRODUCTION

The study of the ability to perform physical activity based on physiological and fitness qualities has been relevant in recent decades in children and adolescents. Physical condition is predictable, since it relates various health indicators to the emergence of noncommunicable diseases in adulthood (Cairney et al., 2019). Physical fitness, defined as the ability to perform physical activity, considering physiological qualities (Ortega et al., 2008), is evaluated primarily by laboratory tests and by battery tests (Paineau et al., 2008; Ruiz et al., 2008; Santos & Mota, 2011). The latter are the most used in epidemiological studies due to the possibility of evaluating multiple health-related components of physical condition in many individuals over short periods of time (Panneau et al., 2008; Ruiz et al., 2008).

Out of the approximately fifteen field physics test batteries for the assessment of physical fitness in children and adolescents, Eurofit (1988), Fitnessgram (2004) and Alpha-Fit Battery (2010) are among the most widely used (Castro-Piñero et al., 2010; Kolimechkov, 2017). The Alpha-Fit battery was created as a public health monitoring instrument to unify the measurement of physical condition throughout the European Union, through a set of valid, reliable, and feasible tests (Santos & Mota, 2011). The Alpha-Fit Battery evaluates 4 components of physical fitness, whose scientific evidence suggests are more associated with the health status of children and adolescents: body composition, cardiorespiratory capacity, musculoskeletal capacity, and motor capacity (Santos & Mota, 2011).

Research related to the evaluation of physical condition in children and adolescents is scarce in Latin America; and in the case of Andean cities, it is almost zero (Rivera et al., 2014). Most research has been limited to evaluating the validity and reliability of physics test batteries created in different regions (Ramirez-Vélez et al., 2015). As for the Ecuadorian child population, there are not rigorous population studies that establish normative reference values to evaluate physical condition. Establishing normative reference values allows individuals to be classified based on position measures or referential percentiles, in addition to being the basis for planning future studies that evaluate the relationship between physical condition and other health indicators (Ortega et al., 2011; G. Silva et al., 2012). The characterization of physical condition in children is pivotal to design health monitoring and intervention programs aimed at improving the quality of life (World Health Organization, 2019). In addition, it is important that this type of study be carried out in cities that are at altitudes above 2000 meters above sea level, especially in Andean countries which have similar physical, social and environments (Raimann & Verdugo, 2012). Thus, the objective of this study was to establish and compare the normative values, disaggregated by sex and age, of the Alpha-Fit Battery in children and adolescents with adequate weight in Ecuador.

MATERIAL AND METHODS

Design and Context

This study is part of the REDU-EDPA project, which aimed to relate individual and environmental factors to the health of students. A descriptive cross-sectional observational study was conducted in 20 public and private schools in urban and peri-urban areas of Cuenca-Ecuador. Cuenca is the third most important and populated city of Ecuador, located in the Andean region at an altitude of approximately 2560 m.a.s.l. In 2019, it had a low poverty (4.1%) and unemployment rate (4.5%) and is therefore considered an emerging city with high indicators of basic service, health, and safety (Feijoo et al., 2019; Lombeida et al., 2019; Terraza et al., 2016).

Participants

The first step of the study was to select the schools to obtain participants. The inclusion criteria for the schools to be chosen were to have at least 90 students who regularly attend grades five through eight (9-12 years of age) and belong to the urban or peri-urban area of the city. Out of the 111 schools that met these criteria, 20 were selected according to the walker index (The International Physical Activity and the Environment Network, Kerr et al., 2013) and the socio-economic situation of the surrounding schools (Quality of Life Index (QLI); Molina & Osorio, 2014). From the schools chosen, the study subjects were selected from a systematic sampling and the final sample included 1028 students from 9 to 12 years. Molina-Cando et al. (2021) detail the sample selection process.

The children's tutors then completed the PAR-Q questionnaire (Thomas et al., 1992) to identify health problems that limit the normal development of physical activity in children. From the questionnaire, children with chronic diseases and children who do not regularly attend physical education classes were excluded. A sub-sample of 604 students who did not have any disability or disease and who were classified with a normal body mass index (BMI) based on their sex, age, and anthropometric measurements (WHO, 2007) was used. Percentiles were determined from this sub-sample to avoid miscalculation of the normative reference values of the population (Nieto-López et al., 2020; Rosa et al., 2020)

Ethical considerations

The study's research protocol, data collection instruments, and informed consent were approved by the Bioethics Committee of the University of San Francisco de Quito - Ecuador (2017-090E). Informed consent and settlements were obtained from each participant and their legal representatives, respectively.

Procedure

The extended version of the Alpha-Fit Battery was applied (Ruíz et al. 2011; Santos & Mota, 2011), excepting the measurement of pubertal development as it is considered invasive (Salgado et al., 2018). Participating children were asked to take the tests without prior physical activity. A 10-minute warm-up was performed before the physical tests. Each test and the component it measures is detailed below, following the order defined in the Alpha-Fit protocol.

Anthropometric measurements. Weight, height, abdominal circumference, and subscapular and tricipital folds were measured according to the methodology of the International Society for the Advancement of Kinanthropometry (Stewart et al., 2011). BMI (kg/m^2) was calculated from weight (DRY electronic scale 803

Germany) and height (dry stadiometer 213 Germany). Waist circumference (cm) was measured with a non-elastic tape (LUFKIN W606PM); and the subscapular (mm) and tricipital (mm) skin folds were determined with a caliper (HARPENDEN).

Manual grip test. The upper gear force was determined by a hand dynamometer by holding both hands (TKK 5101 Grip D). The highest value of each hand is recorded, and the two values are averaged.

Standing long jump test. The force of the lower gear train was determined by a longitudinal run-out. The child makes a double jump with both feet together trying to reach the greatest distance possible and it is recorded in centimeters (cm).

4X10m speed and agility test. The time to run 10 meters 4 times in a row (total distance traveled of 40 m), at a maximum speed possible was recorded in seconds (sec); the test was carried out in duplicate, and the shortest time was recorded as an indicator of the speed and agility of the participant.

Round-trip test 20m. Aerobic and cardiorespiratory capacity are determined by the maximum oxygen volume (VO_2max) measured by a validated Course-Navette test (Ortega et al., 2008). It consists of a series of 20-meter round-trip runs, guided by beeps that indicate when to run. The initial speed of the signal is 8.5 km/h and is increased by 0.5 km/h/min per driveshaft. The test ends when the child is unable to reach a second consecutive time on one of the lines with the audio signal or when the child stops due to fatigue; the number of laps reached is recorded. The VO_2max is calculated using the Leger equation based on the number of laps, age and gender of the participant and is expressed as ml/kg/minute (Leger et al., 1988).

Statistical methods

The registration of anthropometric data was performed using the KoboToolbox platform (Harvard Humanitarian Initiative, 2016). The physical tests were recorded in physical templates and the Epidata 3.1 software was used to double check and correct errors. In the Stata program V.12.0, the main descriptive statistics and the differences by sex were calculated for each of the physical condition variables using the Student's T-parametric test and the Wilcoxon Rank-sum non-parametric test, according to the distribution of the variables. Percentile curves were estimated for each sex in the RStudio program, using the LMS method using asymmetry (L), mean (M), and variability (S) considering deviations from normality.

RESULTS

From the subsample of 604 students with a normal BMI and no conditions that could affect their regular physical activity, the mean age was 10.4±1.1 years, 53% (n=322) were women, and 52% (n=316) attended public schools. Table 1 shows that women had higher averages for most body composition variables: body mass index (17.2±1.7 in women versus 16.9±1.4 in men, *p*=0,012), body weight (33.7±6.4 in women versus 32.4±6 in men, *p*=0,010), height (139.2±8.9 in women versus 137.9±8.9 in men, *p*=0,018), and subscapular skin folds (9±3.1 in women versus 6.9±1.9 in men, *p*<0,001) and tricipital (12.4±3.2; 10.7±3.2, *p*<0.001).

On the other hand, in the physical condition tests (Table 1), men performed better in all the tests, except in the manual grip strength test, in which, despite having higher averages, no significant differences were found (10.9±3.9 in men, versus 10.3±3.5 in women, *p*<0,141). Similarly, no differences were found between percentages of men and women categorized with a healthy aerobic capacity level (65.9% in men, versus 59.6% in women, *p*=0.112).

Table 1. Description of anthropometric and fitness measurements

Variables		Total			Male			Female			P value
		N	Mean (SD)	Median (RI)	N	Mean (SD)	Median (RI)	N	Mean (SD)	Median (RI)	
Anthropometry	Age (years)	604	10.4 (1.1)	10 (2)	282	10.4 (1.2)	10 (2)	322	10.4 (1.1)	10.5 (2)	0.865[A]
	Abdominal circumference (cm)	603	61.99 (4.8)	61.7 (7)	281	61.6 (4.5)	61.4 (6.7)	322	62.3 (4.95)	62.1(7.3)	0.114[B]
	BMI	604	17.1 (1.6)	17 (2.4)	282	16.9 (1.4)	16.8 (2.2)	322	17.2 (1.7)	17.2(2.7)	0.012[B]
	Body weight (kg)	604	33.1 (6.2)	32.2 (8.7)	282	32.4 (6)	31.4 (8)	322	33.7 (6.4)	33(9.6)	0.010[B]
	Height (cm)	604	138.6 (8.9)	138.4 (12.6)	282	137.9 (8.9)	137.6 (12.4)	322	139.2 (8.9)	139.5(12.5)	0.018[B]
	Subscapular fold (mm)	603	8 (2.9)	7.5 (3.6)	281	6.9 (1.9)	6.4(2.6)	322	9 (3.1)	8.4(3.7)	<0.001[B]
	Tricipital fold (mm)	603	11.6 (3.3)	11.3 (4.4)	281	10.7 (3.2)	10.4 (4.2)	322	12.4 (3.2)	12.1(4.5)	<0.001[B]
Physical Condition	Manual pressure force (kg)	604	10.6 (3.7)	10 (4.5)	282	10.9 (3.9)	10.3 (4.3)	322	10.3 (3.5)	10(4.5)	0.141[B]
	Standing long jump (cm)	602	124.7 (17.9)	124.6 (21.8)	282	130.2 (17.4)	130 (20.8)	320	119.9 (16.9)	119(20.6)	<0.001[B]
	Agility speed 4x10m (sec)	601	13.4 (1.1)	13.3 (1.4)	282	13.1 (1)	13 (1.3)	319	13.8 (1.1)	13.6(1.4)	<0.001[B]
	20m round trip (VO2 max ml/kg/min)	591	41.4 (3.1)	9 (1)	279	42.2 (3.3)	9.5 (0.5)	312	40.6 (2.7)	9(0.5)	<0.001[B]
	20m round trip (speed km/h)	591	9.1 (0.6)	41.1 (4.3)	279	9.3 (0.6)	41.5 (4.9)	312	8.98 (0.5)	40.3(3.4)	<0.001[B]

N = Sample size; **SD** = Standard deviation; **IR** = Interquartile range; **BMI** = Body mass index; [A] **P-value** = Calculated from parametric Student's t-test; [B] **P-value** = Calculated from non-parametric Wilcoxon Rank-sum test.

Table 2 shows the variation of anthropometric measurements disaggregated by sex and age. The evolution of the variables is evident, in most cases it increases according to the age.

Table 2. Description of anthropometric measurements disaggregated by age and sex

Total (years)	N	Height (cm)	Weight (kg)	BMI	Abdominal circumference (cm)	Trypital fold (mm)	Subscapular fold (mm)
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
9	161	130.63(5.3)	27.82(3.2)	16.26(1.2)	59.0(3.4)	11.0(2.8)	7.2(2.4)
10	153	136.50(7.1)	31.27(4.7)	16.7(1.4)	61.13(4.57)	11.15(3.3)	7.45(2.6)
11	170	142.50(7.2)	35.90(5.5)	17.59(1.6)	63.80(4.7)	12.37(3.3)	8.83(3.2)
12	120	146.58(6.9)	38.47(5.5)	17.82(1.5)	64.60(4)	12.14(3.6)	8.60(2.8)
FEMALE							
9	78	131.09(5.4)	27.87(3.2)	16.18(1.1)	58.82(3.2)	9.94(2.6)	6.36(1.6)
10	75	135.37(5.9)	30.33(4.1)	16.49(1.3)	60.27(4.2)	10.27(3)	6.37(1.8)
11	66	141.19(8.3)	34.96(5.8)	17.41(1.3)	63.51(4.4)	11.74(3.4)	7.36(1.9)
12	63	146.22(7.8)	37.83(5.4)	17.61(1.3)	64.67(3.6)	11.21(3.5)	7.50(2.2)
MALE							
9	83	130.21(5.3)	27.77(3.2)	16.35(1.3)	59.08(3.7)	11.80(2.7)	7.98(2.6)
10	78	137.60(8.0)	32.18(5.1)	16.91(1.5)	61.95(4.8)	12.01(3.4)	8.48(2.7)
11	104	143.32(6.3)	36.50(5.2)	17.70(1.7)	63.98(4.9)	12.77(3.1)	9.76(3.6)
12	57	146.97(5.7)	39.17(5.6)	18.05(1.7)	64.53(4.4)	13.17(3.5)	9.81(3.0)

N = Sample size; **SD** = Standard deviation; **K** = Coefficient of kurtosis; **A** = Coefficient of asymmetry.

Tables 3-5 show the percentiles (5,15,25,50,75,80,95,99), as well as the coefficients of asymmetry, kurtosis, and central trend measurements of manual pressure tests, standing long jump test, test speed and agility 4x10m and the 20m round trip test differentiated by age (9-12 years) and sex.

Table 3. Percentiles of musculoskeletal capacity - manual pressure test (kg). N=604

Female (years)	N	Mean	SD	K	A	P5	P15	P25	P50	P75	P80	P95	P99
9	83	7.36	1.76	2.15	0.15	4.75	5.50	6.00	7.00	8.75	9.05	10.45	11.25
10	78	9.59	3.00	3.89	0.54	4.98	6.71	7.43	9.50	11.50	11.75	15.53	19.25
11	104	11.46	3.12	3.28	0.48	6.81	8.43	9.25	11.25	13.50	14.00	17.18	20.93
12	57	13.55	3.14	2.65	0.02	7.75	10.85	11.62	13.25	15.75	16.25	19.10	20.25
Male (years)													
9	78	8.41	2.21	4.53	0.96	5.48	6.25	6.758	8.00	10.00	10.25	12.12	16.00
10	75	9.89	2.66	3.61	0.37	5.75	7.35	8.00	10.00	11.75	12.2	14.55	18.50
11	66	11.95	3.81	7.47	1.74	7.08	9.00	9.68	11.12	13.50	14.00	18.98	27.25
12	63	14.09	4.41	3.97	1.01	9.00	9.65	11.00	13.50	15.75	17.15	23.45	27.25

N = Sample size; **SD** = Standard deviation; **K** = Coefficient of Kurtosis; **A** = Coefficient of Asymmetry.

Table 4. Percentiles of musculoskeletal capacity – standing long jump test (cm). N=602

Female (years)	N	Mean	SD	K	A	P5	P15	P25	P50	P75	P80	P95	P99
9	83	110.48	14.07	3.52	-0.57	83.08	96.72	103.6	112.30	120.60	123.42	130.76	143.00
10	77	120.22	16.20	2.87	-0.18	94.36	102.56	108.65	120.80	131.1	134.32	148.37	156.90
11	103	123.25	15.54	4.22	0.42	98.46	109.06	113.8	121.8	133.48	135.78	148.2	180.36
12	57	127.04	18.28	3.63	0.59	96.61	107.87	115.65	126.2	135.50	143.56	170.92	179.50
Male (years)													
9	78	121.77	15.12	3.05	-0.10	94.23	107.00	111.30	121.75	131.57	134.24	147.59	158.90
10	75	127.12	14.35	2.52	-0.24	103.36	108.58	119.80	129.00	137.60	140.44	149.54	154.20
11	66	132.71	15.84	3.88/	0.60	106.98	117.69	123.40	131.25	139.05	144.58	164.23	181.50
12	63	141.72	18.16	3.13	-0.03	108.66	125.44	129.00	142.50	153.40	153.4	170.00	185.30

N = Sample size; **SD** = Standard deviation; **K** = Coefficient of Kurtosis; **A** = Coefficient of Asymmetry.

Table 5. Percentile of motor capacity - 4x10m (sec) test. N=601

Female (years)	N	Mean	SD	K	A	P5	P15	P25	P50	P75	P80	P95	P99
9	82	14.41	1.11	2.74	0.34	16.48	15.55	15.2	14.35	13.60	13.46	12.71	12.00
10	77	13.93	1.04	4.03	0.86	16.14	14.90	14.40	13.80	13.20	13.10	12.39	12.10
11	103	13.42	0.88	3.34	0.53	15.14	14.34	14.00	13.3	12.8	12.60	12.00	11.60
12	57	13.16	0.85	8.64	1.88	14.73	13.80	13.45	13.10	12.7	12.50	12.09	11.80
Male (years)													
9	78	13.63	1.06	8.94	1.48	15.70	14.33	14.1	13.7	12.87	12.80	12.29	11.20
10	75	13.10	0.89	2.83	0.19	14.7	14.06	13.70	13.10	12.50	12.30	11.50	11.40
11	66	12.85	0.84	2.34	0.38	14.40	13.99	13.52	12.70	12.20	12.04	11.60	11.40
12	63	12.48	0.82	3.32	0.30	14.0	13.30	13.00	12.40	11.8	11.7	11.32	10.4

N = Sample size; **SD** = Standard deviation; **K** = Coefficient of kurtosis; **A** = Coefficient of asymmetry.

Table 6. Percentiles of aerobic capacity - 20 m (VO_2max. Ml/kg/min) round trip test. N=591

Female (years)	N	Mean	SD	K	A	P5	P15	P25	P50	P75	P80	P95	P99
9	78	42.78	1.64	2.99	0.62	41.06	41.06	41.06	43.37	43.37	43.37	45.68	47.99
10	74	41.09	2.21	3.86	1.08	39.12	39.12	39.12	41.51	41.51	43.89	46.28	48.67
11	103	39.76	2.42	3.27	0.83	37.18	37.18	37.18	39.64	42.10	42.10	44.57	47.03
12	57	38.40	2.46	2.15	0.32	35.23	35.23	36.50	37.77	40.32	40.32	42.86	42.86
Male (years)													
9	77	44.18	2.67	2.25	0.41	41.06	41.06	41.06	43.37	45.68	45.68	48.22	50.30
10	74	42.57	2.76	2.38	0.50	39.12	39.12	41.51	41.51	43.89	46.28	48.67	48.67
11	65	41.46	3.20	3.03	0.66	37.18	37.18	39.64	42.10	43.34	44.57	48.76	49.50
12	63	40.05	2.98	4.15	0.68	35.23	37.77	37.77	40.32	40.32	42.86	45.40	50.48

N = Sample size; **SD** = Standard deviation; **K** = Coefficient of kurtosis; **A** = Coefficient of asymmetry.

The curves of the Manual Pressure, standing long jump, and 4x10m Speed and Agility tests (Figure 1 to 3) show higher levels of fitness as age increases, no matter the gender. This increase is mainly evident in the manual pressure test in male percentiles above the median (P50) and generally in women in the 4x10m speed and agility test. While the 20 m round-trip test (Figure 4) shows lower performance in older participants. As for the curves of the manual pressure force test and the standing long jump test, there is a turning point at the age of 10 years in the case of women, from which an even greater physical performance is observed.

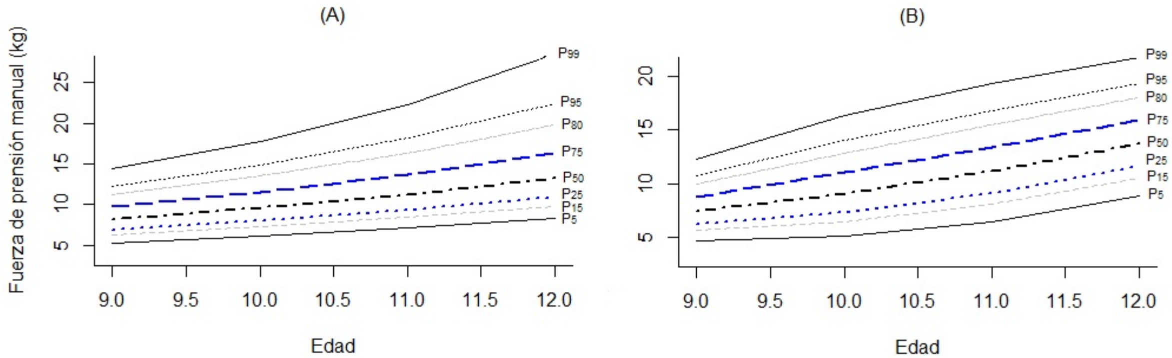

Figure 1. Percentile of curves musculoskeletal capacity - manual pressure strength test (kg) (A-men) (B-women).

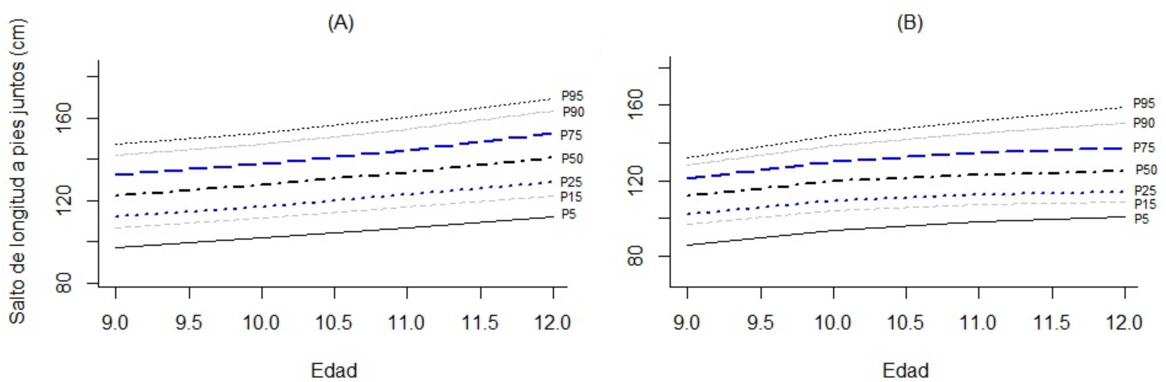

Figure 2. Percentile of curves musculoskeletal capacity – standing long jump test (cm) (A-men) (B-women).

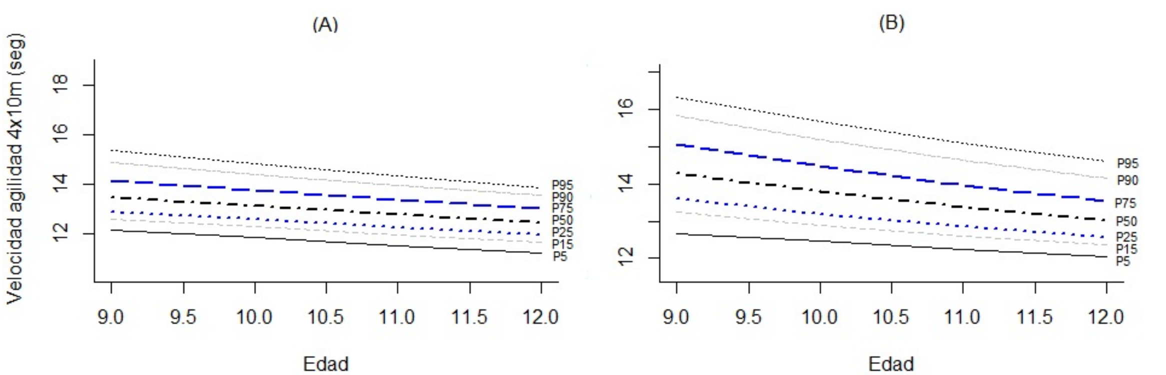

Figure 3. Percentile of motor capacity curves - test 4x10m (sec) (A-men) (B-women).

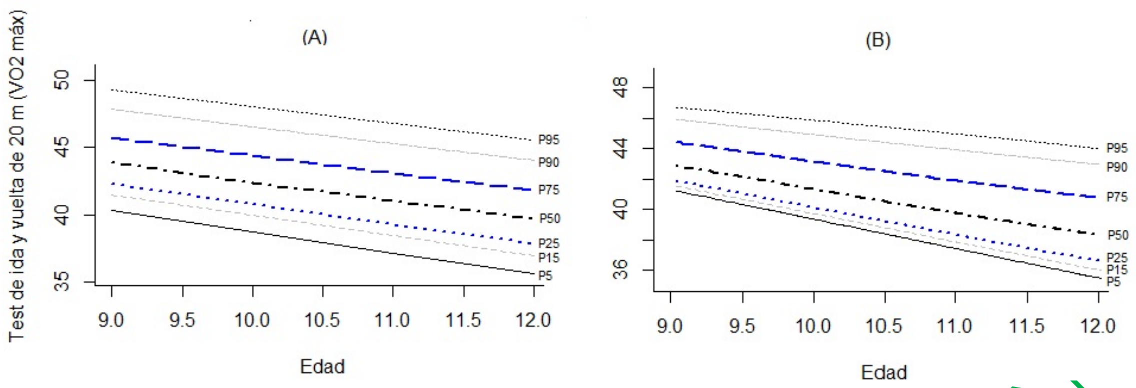

Figure 4. Percentile of cardiorespiratory capacity curves - round-trip test 20 (VO_2max) (A-men) (B-women).

DISCUSSION

The objective of this study was to establish and compare the normative values of the Alpha-Fit Battery in children and adolescents displeasing by sex and age with normal weight in Ecuador, based on a review of the available evidence. As for the authors, this study is the first in Ecuador to report the normative values of physical condition in children and adolescents, according to sex and age. These values are the base for improving the interpretation of physical condition by categorizing and comparing individual measurements with the normative reference values of a healthy population. Gender differences from fitness tests and body composition measurements are also presented. This assessment is useful for identifying children at risk of developing unfavorable health conditions secondary to poor physical condition or harmful body composition (De Miguel-Etayo et al., 2014).
Regarding the body composition results, all measurements showed higher averages in women (BMI, height, body weight, and the tricipital and subscapular skin folds), except for the abdominal circumference measurement for which no differences were found. Similarly, studies in Brazil (Silva et al., 2016) and Canada (Tremblay et al., 2010) report higher averages in women than in men; Palomino-Devia et al. (2017) found in Colombia a significant difference with a higher average among men. In terms of BMI, higher values in women have been widely observed by studies in countries like Ecuador, such as Mexico (Cruz et al., 2017) and Argentina (Secchi et al., 2014). The Alpha-Fit battery takes BMI data as a parameter for assessing the body composition of the individual due to its relevance to determining health risk (Suárez & Sánchez, 2018), and because it has simple and standardized measurement processes (Ruiz et al., 2011). The main limitation is that BMI does not distinguish between fat-free mass and fat mass; however, it allows for great precision and accuracy as it is a more familiar method for the person recording the measurements for its determination (Artero et al., 2011).

In percentile analysis, curves show better physical condition in most tests as age increases. This difference is more visible in tests of manual pressure and standing long jump that measure musculoskeletal capacity. Similarly, in the curves of the manual pressure tests and standing long jump, a turning point is observed at the age of 10 years (especially for women), after which performance improves; this is in line with several studies that have reported a positive relationship of physical condition and age in musculoskeletal capacity. Several studies conclude that peak yields are reached around 15 years (Moro et al., 2016; Parra et al., 2020; Tambalis et al., 2016). This behavior can be explained by the increase in the cross-section of normal muscle in the prepubertal stage, due to the presence of growth hormone which generates greater muscle growth and bone mass development (Rowland & Others, 1996). Similarly, an increase in blood volume and heart size promotes oxygen conduction from the lungs by increasing physical performance (Soares et al., 2014). The last system to influence puberty is the nervous system: it was thought that the brain had already reached almost its adult size or final maturity by adolescence, but today it is known that the brain does not complete its maturation until the age of 25-30 and much of its development occurs at puberty. There is rapid neuronal-glial growth and the formation of new synaptic connections (Iglesias, 2013). In other words, puberty generates major changes in the bone, muscle, and neurological systems, producing a leaner body at the end of growth with better response capacity, leading to an individual with greater physical capacity to perform physical activity (Güemes, Gonzáles & Hidalgo; 2017). In the case of cardiorespiratory capacity in which no increase was seen with age, higher performance in younger ages has also been reported in previous studies in older samples (De Miguel-Etayo et al., 2014; Kolimechkov et al., 2019) and it might be explained by a greater participation in physical activities and a lower sedentary lifestyle in early ages (Rodriguez Torres et al., 2020). Another factor that could explain these results is that until the first 10 years of age, physical education classes are usually spontaneous and not organized. In contrast, children over 10 and adolescents often prefer more organized activities, but in smaller numbers. For effective physical education classes in different age groups, it is suggested that physical education dynamics should be according to the physiological age of children; physical and energetic attrition varies with age, hence activities (Bar-Or & Rowland, 2004).

Regarding gender differences in physical condition tests, men performed better in all tests, except for the manual pressure force test, which concluded that there were no differences. This result is clearly visible on the steeper slopes of men curves, especially at ages 11 and 12. In the Latin American context, a similar study conducted by Lopes et al. (2019) in children and adolescents in Brazil demonstrates better performance in men on long-jump and round-trip tests. A study in Colombia (Palomino-Devia & González-Jurado, 2017) and another in Argentina (Secchi et al., 2014) found higher averages in men in all physical condition tests, coinciding with the results of the present study. Gender differences in tests related to musculoskeletal and motor capacity are explained mainly by physical differences, such as muscle mass, while those related to aerobic resistance are explained by physiological differences, such as mechanical efficiency (Catley & Tomkinson, 2013; Parra et al., 2020; López-Benavente et al. 2020). One aspect to consider in terms of gender is that girls often report low sport activity compared to boys (Salazar, Valencia, Elizondo & Valdivia; 2008), especially in the Latin American context where gender stereotypes marked in physical education classes often lead to girls being marginalized and discriminated against to the point of assuming fewer physical activities (Guerrero and Fierro 2014; Méndez-Giménez et al. 2018). A reduction in physical activity in girls would imply an increased risk of chronic diseases in adulthood. It is therefore necessary to promote physical activity in children and adolescents to adopt regular physical activity habits that often determine physical activity in adulthood (McNamee, Timken, Coste, Tompkins & Peterson; 2016).

As for the differences in physical condition with countries in the region such as Colombia (Ramos et al., 2016) and Argentina (Santander et al., 2019) and other continents such as the European Union (Kolimechkov, Petrov & Alexandrova, 2019), it can be seen in Table 7 that for all the tests (except for the standing long jump test), Ecuador obtained the least favorable values. It is important to remember that each zone has its individual, environmental and social characteristics that influence the development of individuals (Ramos et al., 2016). However, differences in physical condition can be explained in the greater presence of policies or strategies that promote physical activity such as: development of media campaigns that encourage physical activity and good nutrition; physical activity interventions in various settings, both in schools and in communities; and infrastructure policies that provide spaces and physical implements that allow activities such as walks, marathons, etc., with security and accessibility (Heath et al., 2012).

Table 7. Reference values (50th percentile or median) of different countries/regions of different studies.

Age (years)	Girls				Boys			
	Ecuador n=604	Colombia n=7268	Argentina n=4173	European Union n=2,779,165	Ecuador n=604	Colombia n=7268	Argentina n=4173	European Union n=2,779,165
Manual pressure force (kg)								
9	7	-	-	13.6	8	-	-	14.9
10	9.5	13.4	-	16.1	10	14.1	-	17.7
11	11.25	15.3	-	18.6	11.12	15.6	-	20.6
12	13.25	18.1	-	21.1	13.5	17.5	-	23.4
Standing long jump test (cm)								
9	112.3	-	-	120.5	121.7	-	-	131.8
10	120.8	102	118.6	125.4	129	118	131.2	138.8
11	121.8	107	121.3	130.4	131.25	123	138.3	145.8
12	126.2	110	123.6	135.3	142.5	126	146.4	158.8
Agility speed 4x10m (sec)								
9	14.35	-	-	13.6	13.7	-	-	13
10	13.8	13.3	14.3	13.3	13.1	13.8	13.3	12.5
11	13.3	13.2	14	13.3	12.7	13.8	13.1	12.5
12	13.3	12.6	13.7	13	12.4	13.4	12.9	12.3
20m Round trip (VO_2max ml/kg/min)								
9	43.37	-	-	45.3	43.37	-	-	46.8
10	41.51	-	43.1	45.1	41.51	-	43	46.9
11	39.64	-	42	43.5	42.1	-	42.3	45.8
12	37.77	-	41.1	42	40.32	-	42	40.32

Although there are studies in other Latin American countries, they determine the referential values of children and adolescents using other batteries, making it difficult to compare (Cossio-Bolaños & Arruda, 2009). In addition, there are other cases where the same battery is used, but the data divided by age and gender are not presented (Cruz et al., 2017; Solis-Urra et al., 2021). Although this use of battery diversity is changing, De La Cruz (2020) reports that 60% of studies applying batteries use the Alpha-Fit battery. Battery selection depends on the region or country where the test will be performed. Therefore, to improve comparability between methods, it is necessary to continue with processes for standardization and consensus among methods that wish to assess physical capacity. Based on the comparison of results, it is possible to contribute to the creation of educational and health policies that improve the health of children and adolescents (Marques et al., 2021).

As for differences between regions, compared to Europe where studies have covered larger geographical areas (Kolimechkov et al., 2019; Tomkinson et al., 2018), studies in Latin America are limited to smaller areas and populations (Cossio-Bolaños & Arruda, 2012; Ramos-Sepúlveda et al., 2016; Secchi et al., 2014). Moreover, the lack of generalized parameters in Latin America, as well as the lack of methodological rigor have made it difficult to compare results and generate referential normative values representative of larger geographical areas. Existing evidence shows that physical performance is lower in Latin American populations compared to those in European regions (Bustamante et al., 2014; Cossio-Bolaños & Arruda, 2012; Kolimechkov, 2017; Olds et al., 2006; Secchi et al., 2014; Tomkinson et al., 2018).

Limitations of this study include the limited sample size, which, although representative for the objective of the research, was reduced by including only participants with a normal BMI. However, the behavior of the tests is similar to those studies with larger and similar samples (Lopes et al., 2019; Palomino-Devia & González-Jurado, 2017). Another limitation was the selection of schools of the urban and peri-urban areas belonging only to the city of Cuenca, which generalize results only for this age group studied in these zones. Also, it is worth noting the fact that the city is located at a considerable altitude (2560 m) which could mainly influence the cardiorespiratory performance of the sample. However, it is important to remember that the city of Cuenca shares similar contexts (height, socioeconomic status, anthropometric characteristics, etc.) with some cities that make up the Andean region. In future studies, it is necessary to expand the age range, the regions studied and the sample size to obtain representative references of larger populations. This study is an initial reference point that reflects the situation in children and adolescents in terms of physical condition and body composition, useful for evaluating physical condition and for measuring the impact of public health interventions or programs.

CONCLUSION

This study established normative values of the Alpha-Fit Battery in children and adolescents disaggregated by age and gender in Ecuador. The results show that women have higher averages regarding body composition, and that there is better physical condition as age increases and among men compared with women. It is also noted that children in Ecuador have lower normative values compared to children and adolescents in the Latin American region, as well as in other parts of the world. This demonstrates that by using commonly applied batteries such as

Alpha-Fit, health situations of interest such as low physical condition in the study population can be quickly observed. It is recommended to continue establishing the reference percentiles for different countries and regions, considering greater age range and age groups to improve health monitoring systems, and serve as an indicator to suggest changes at the environmental/political level that contribute to improving the physical condition of children/adolescents and consequently their short- and long-term health.

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