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Physical fitness and future cardiovascular risk in argentine children and adolescents: an introduction to the ALPHA test battery

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ABSTRACT

Introduction. A high level of physical fitness is associated with cardiovascular health in children and adolescents. At present, there is no systematic implementation of a test battery to assess physical fitness at schools in Argentina. The main objective of this study was to implement the ALPHA test battery to determine the physical fitness of a sample made up of Argentine children and adolescents and to establish the proportion of subjects whose aerobic capacity is indicative of future cardiovascular risk.

Population and methods. A sample of 1867 participants (967 girls) aged 6 to 19.5 years old assessed using the ALPHA test battery. Four components of physical fitness were measured: 1) morphological component: height, body weight, and waist circumference; 2) musculoskeletal component: standing long jump test; 3) motor component: speed/agility test (4x10 m shuttle run); 4) cardiorespiratory component: course-navette 20 m, shuttle run test and estimation of maximal oxygen consumption. The 5th, 25th, 50th, 75th, and 95th percentiles were estimated for the main tests.

Results. The mean body mass index was 20.8 kg/m2, and 7.8% of participants were classified as obese. In addition, male participants had a better performance in all physical fitness tests when compared to girls (p< 0.001). An aerobic capacity indicative of cardiovascular risk was observed in 31.6% of all participants.

Conclusions. Argentine male children and adolescents included in the sample showed higher levels of physical fitness. Such differences increase with age. Approximately one every three participants had an aerobic capacity indicative of future cardiovascular risk.

Key words: *physical fitness, children, adolescents, course-navette 20 m test, cardiovascular risk.*

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INTRODUCTION

The assessment of physical fitness (PF) in the school setting is a field of research that first originated in the 1950's.[1]

However, the original concept regarding PF assessment at school has drastically changed over the past 20 years.[1,2] The focus went from performance-centered PF to health-related PF, thus modifying how the assessment of PF is understood and interpreted.[3-5]

An adequate PF assessment program would be effective to 1) encourage students, 2) know their PF level, 3) check their progress, 4) identify risk factors,[6,7] 5) design physical activity programs, and 6) promote health and physical education.[8] In addition, recent scientific evidence has confirmed that a high level of PF is strongly related to the cardiovascular, metabolic, musculoskeletal and mental health of children and adolescents.[9,10]

At school, PF is assessed using a physical fitness test battery (PF-TB). The advantages of PF-TB include that it allows to assess several subjects at the same time, takes little time, is safe, easily administered, and has a low cost, making it adequate for epidemiological studies.[11] No definition was found in the scientific literature on PF-TB. In our concept, PF-TB can be defined as a set of field tests for assessing different components of PF and which can be, individually or as a whole, related to sports performance (performance-related PF-TB) or to an individual's specific present and future health aspects (health-related PF-TB).

The most well-known PF-TB include EUROFIT, FITNESSGRAM, and the recently published ALPHA test battery.[12,13] The latest has been developed based on solid scientific evidence to provide a set of valid, reliable, feasible and safe tests which have been scientifically proven to be related to the present and future health of children and adolescents.[13,14]

Unfortunately, no valid and reliable PF-TB has been established as an indicator of health in children and adolescents in the Argentine public or private school system. Moreover, as per our knowledge, there is no published scientific study describing PF levels in relation to health in the Argentine pediatric population.

The main objective of this study was to implement the ALPHA test battery to determine the PF of a sample made up of Argentine children and adolescents and to establish the proportion of subjects whose aerobic capacity is indicative of future cardiovascular risk.

POPULATION AND METHODS

Study sample and design

The study was conducted between April 9th and October 30th, 2012 on a convenience sample made up of Argentine children and adolescents aged 6 to 19.5 years old. The study design was observational, descriptive and cross-sectional. The assessment was conducted in primary and secondary schools located in ten cities from five Argentine provinces (Entre Ríos, Mendoza, Buenos Aires, Misiones, and Santa Cruz). A total of 16 schools took part: ten public and six private schools, eight primary level schools, and two which were in rural areas. Geographic distribution was non-random. Participants had received medical clearance at the beginning of the school year, which was requested by schools for participation in physical education activities. Subjects with a clinical diagnosis of diabetes, asthma, musculoskeletal conditions or any other health problem limiting or preventing physical activity were excluded. A written informed consent was obtained from parents and students following a detailed explanation of study objectives. This research was approved by the Bioethics Committee of Universidad Adventista del Plata.

Procedures

Before starting the study, researchers and nine physical education teachers performed three theoretical-practical sessions so as to standardize the entire assessment process.[14,15] In addition, teachers administered the ALPHA test battery once at the different schools in order to become familiar with the tests.

Physical fitness assessment

The high priority version of the ALPHA test battery was applied, leaving out the handgrip strength test using a dynamometer, but including the speed/agility 4x10 m shuttle run test, proposed in the extended version.[13,15] The assessment was performed in the following order:

1) **Morphological component:** Weight, height and waist circumference were measured as per the established protocols.[14,15] Participants were weighed barefoot using a portable electronic scale OMROM HBF-500INT, with a 0.100 kg accuracy. Height was measured using a stadiometer (SECA 206). Participants were classified as overweight or obese as per Cole's criteria.[16] Waist circumference was measured using an anthropometric unstretchable tape (W606PM, Lufkin, US).
2) **Musculoskeletal component:** The standing long jump (SLJ) test was used as an indicator of lower limb strength. It consists of jumping the longest distance possible from a standing start (without racing ahead) and swinging both arms. The distance is measured from the take-off line to the point where the back of the heel nearest to the take-off line lands on the ground.
3) **Motor component:** The speed/agility 4x10 m shuttle run test was used as a comprehensive indicator of speed of movement, agility and coordination.[14] It consists of running back and forth between two lines 10 m apart taking three sponges alternately as quickly as possible. The total distance run is 40 m.
4) **Cardiorespiratory component:** This component was evaluated with the course-navette test (CN-20 m). It consists of running back and forth in both directions on a 20 m track marked between two separate lines. The rhythm is set by means of audio signals. The initial speed is 8.5 km/h^{-1} and is increased by 0.5 km/h^{-1} intervals every 1 minute, each called a stage. Subjects should step behind the 20 m line at the exact time that the audio signal or beep is heard. The test finishes when the subject stops because of fatigue or fails to reach the end line concurrent with the audio signal or beep on two consecutive occasions. Aerobic performance is expressed by the number of laps, i.e. the number of times a participant completes the 20 m track (1 lap = 20 m). Additionally, the complete stage as well as one stage and a half were recorded. For example, if a subject completed stage 4 and reached half of the following stage, it is indicated as 4.5 (when considering a stage and a half), while it is indicated as 4 when analyzing only the last completed stage.

   Aerobic capacity was determined using the maximal oxygen consumption ($V0_2$ max.), estimated as per Léger equation:[17] $V0_2$

max= 31.025 + 3.238 *V-3.248 *A + 0.1536 *V *A. Here, V accounts for velocity (in km/h-[1]) of the last completed stage and A accounts for the subject's age (in years). Participants were classified as having a healthy aerobic capacity if $V0_2$ max. was 42 mL/kg/min for boys and 35-40 mL/kg/min-[1] for girls, according to their age. Participants with lower values were classified as having an unhealthy aerobic capacity or as indicative of future cardiovascular risk, as established in the Fitnessgram® test.[2,7]

Each test was performed twice, except for the CN-20 m, which was conducted only once. For data analysis, the average value was used in the case of the morphological component, while the best performance value was used for the other tests.

Statistical analysis

Data were analyzed using the SPSS software, version 18.0, and expressed using average values and standard deviation (SD), unless otherwise indicated. The normality of variables was determined using the Kolmogorov-Smirnov test. The Mann-Whitney U, non parametric test was used to analyze differences between sexes, by age groups (6 to 12 year old children and 13 to 19 year old adolescents) and the aerobic capacity level (health vs. unhealthy). This was performed before confirming the lack of normality in some of the outcome measures of the study. The accepted level of significance was $p< 0.05$. To present percentile tables and curves for the main PF tests, smoothed percentile curves were determined by using the LMS procedure.[18] This analysis was performed with the LMS Chart Maker Light software, version 2.54. Given the low number of 6 to 10 year old and 18 to 19 year old participants, it was not possible to estimate percentile values for these age groups, here percentiles for 11 to 17 year old, male and female children and adolescents are presented.

RESULTS

A total of 1867 children and adolescents (967 girls) were assessed. During the study, none of the participants had discomfort, pain or muscle-joint injuries. *Table 1* shows the sample characteristics and the values obtained in the PF tests for children and adolescents. In both groups, male participants showed a better performance in PF tests. The proportion of subjects with an aerobic capacity indicative of future cardiovascular risk was 31.6%. An unhealthy aerobic capacity was observed in 11.5% of children and 49.1% of adolescents (< 0.001). Only the children group showed significant differences between male and female participants regarding the prevalence of an unhealthy aerobic capacity ($p < 0.001$).

Tables 2-4 show PF values in an Argentine youth sample, classified by age and sex, and expressed using the 5th, 25th, 50th, 75th and 95th percentiles. The 5th percentile (P5) for the stage and a half completion in the CN-20 m test ranged between 1.5-3.6 and between 1.3-1.6 for males and females, respectively *(Table 4).* Percentile curves depict a clear trend between increasing PF levels and increasing age among male participants *(Figure 1).* On the contrary, as far as female participants, curves show stability or a mild increase in PF levels with increasing age *(Figure 1).*

Table 5 shows that children with a healthy aerobic capacity have higher levels of lower limb strength (only females), and lower body mass index (BMI) and waist circumference (both males and females). In addition, the prevalence of overweight and obesity was lower in the group with a healthy aerobic capacity: 22.2% vs. 75.8% for male participants ($p= 0.001$) and 32.2% vs. 57.9% for female participants ($p= 0.027$). In turn, adolescents with a healthy aerobic capacity had a superior lower limb strength, higher speed/ agility, a lower BMI, a lower waist circumference (females only) and a lower overweight and obesity prevalence: 19% vs. 39.3% for male participants ($p= 0.001$) and 12.1% vs. 27.8% for female participants ($p= 0.001$).

DISCUSSION

This is the first published research study using the ALPHA test battery in a sample of 1867 Argentine children and adolescents. The ALPHA test battery was administered in ten cities from five provinces from across all cardinal points of Argentine (north, south, east and west). Up to this date, there has been no other similar published study in an Argentine pediatric population.

Tables 2-4 show the first percentiles of the ALPHA test battery (in the Argentine population) in order to interpret or score PF levels and allow comparisons with future studies. Different PF cut-off points were observed in the bibliography. On the one side, Ortega, et al. refer to the P_5 levels of PF as "pathological PF level"[19] or as a "warning sign,"[20] so that youth in or below the P_5 should be examined to determine whether they have a cardiovascular risk factor. On the other side, Silva indicated that, in the case of the number of stages completed in the

Table 1. *Differences by sex in physical fitness of Argentine children and adolescents*

Components	**All**			**Children aged 6 to 12 years old**							**Children aged 13 to 19 years old**						
of physical fitness				**Male**			**Female**			***P***	**Male**			**Female**			***P***
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**		**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	
Morphological																	
Age (years)	1867	13.1	3.0	416	10.5	1.7	463	10.5	1.7	0.971	484	15.5	1.5	504	15.4	1.5	0.835
Body weight (kg)	1738	51.3	15.7	382	40.7	13.8	427	42.3	13.9	0.046	441	63.5	12.6	488	56.5	9.8	0.001
Height (cm)	1741	155.3	15.5	381	143.3	13.4	430	144.3	13.4	0.093	442	170.0	8.8	488	161.1	6.5	0.001
BMI (kg/m^2)	1735	20.8	4.1	379	19.3	4.2	427	19.9	4.6	0.077	441	21.8	3.3	488	21.8	3.5	0.239
Waist circ. (cm)	870	67.5	10.7	146	61.9	9.6	199	61.7	8.2	0.514	178	73.5	10.9	347	70.0	9.7	0.001
Overweight (%)[a]	1735	20.5	----	379	20.1	-----	426	22.7	-----	0.129	441	22.7	-----	488	16.8	-----	0.057
Obesity (%)[a]	1735	7.8	----	379	11.1	-----	426	13.3	-----	0.135	441	3.9	-----	488	4.1	-----	0.063
Musculoskeletal																	
Standing long jump (cm)	1475	148.7	36.1	326	138.4	29.0	352	124.6	28.1	0.001	363	189.7	29.4	434	141.7	20.9	0.001
Motor																	
4 x 10 m (s)	1135	12.7	1.9	174	13.3	2.0	190	14.2	1.9	0.001	355	11.1	1.3	416	13.0	1.3	0.001
Cardiorespiratory																	
20 m laps (number)	1606	36.2	19.7	356	34.7	17.4	393	26.7	13.9	0.001	433	53.1	21.5	424	28.9	11.8	0.001
Complete stage (number)	1606	4.2	2.2	356	4.2	2.0	393	3.2	1.7	0.001	433	6.0	2.3	424	3.3	1.4	0.001
One stage and a half (number))	1606	4.3	2.2	356	4.2	2.0	393	3.3	1.6	0.001	433	6.2	2.2	424	3.6	1.4	0.001
Speed (km/h-1)[b]	1606	10.1	1.1	356	10.1	1.0	393	9.6	0.8	0.001	433	11.0	1.1	424	9.7	0.7	0.001
VO_2 max.mL/kg/min-1[c]	1606	41.5	6.4	356	45.8	4.5	393	43.3	4.0	0.001	433	42.6	6.1	424	35.0	4.6	0.001
Future CR (%)[d]	1606	31.6	----	356	18.5	-----	393	5.1	-----	0.001	433	46.7	-----	424	51.7	-----	0.143

N = number of assessed subjects. SD = standard deviation. BMI = body mass index. Waist circ. = waist circumference.
a The prevalence of overweight and obesity was estimated as per the criteria published by Cole.[16]
b It accounts for the speed reached in the last completed stage of course-navette 20 m test.
c Predictive maximal oxygen consumption using Léger equation.[17]
d Future CR (%) = future cardiovascular risk as per the reference criteria for aerobic capacity published by Fitnessgram®.[2]

TABLE 2. *Percentile values for lower limb strength test: standing long jump (cm)*

	N	Mean	SD	L	M	s	P_5	P_{25}	P_{50}	P_{75}	P_{95}
Female											
11 years old	124	133.2	27.5	1.617	135.6	0.188	88.2	117.6	135.6	152.2	174.2
12 years old	105	134.8	20.9	1.598	134.5	0.167	93.7	118.8	134.5	149.2	169.0
13 years old	95	134.8	18.6	1.493	135.8	0.153	99.1	121.4	135.8	149.5	168.2
14 years old	92	140.7	22.8	1.296	138.8	0.147	103.9	124.8	138.8	152.3	171.2
15 years old	62	143.8	20.2	0.984	142.1	0.146	108.2	128.2	142.1	156.1	176.2
16 years old	96	147.1	21.7	0.523	144.7	0.149	111.2	130.5	144.7	159.6	182.2
17 years old	68	140.8	21.9	-0.056	143.6	0.156	111.2	129.2	143.6	159.6	186.0
Male											
11 years old	84	139.3	26.7	1.593	138.1	0.185	91.2	120.2	138.1	154.8	177.0
12 years old	108	152.8	26.6	1.400	150.3	0.167	106.2	132.9	150.3	166.8	189.6
13 years old	68	161.5	25.6	1.250	161.7	0.150	120.2	145.0	161.7	177.9	200.6
14 years old	62	179.0	23.5	1.246	174.3	0.136	134.2	158.2	174.3	190.1	212.3
15 years old	92	194.9	23.0	1.516	189.2	0.124	148.2	173.0	189.2	204.7	225.9
16 years old	90	202.7	25.0	2.017	200.6	0.116	157.7	184.2	200.6	215.7	235.7
17 years old	36	206.0	29.4	2.608	208.0	0.111	162.2	191.3	208.0	222.8	241.6

Smoothing of percentiles was done by using the LMS procedure.18 N = number of assessed subjects. The total sample was made up of 1182 subjects. SD= standard deviation; L= asymmetry; M= median; S= variation coefficient.

TABLE 3. *Percentile values for the speed/agility test: 4x10 m (s)*

	N	Mean	SD	L	M	s	P_5	P_{25}	P_{50}	P_{75}	P_{95}
Female											
11 years old	51	13.3	1.8	-3.612	12.8	0.105	16.8	13.9	12.8	12.0	11.2
12 years old	51	13.3	1.5	-2.990	13.0	0.103	16.5	14.1	13.0	12.2	11.4
13 years old	85	13.2	1.3	-2.326	13.1	0.100	16.1	14.1	13.1	12.3	11.4
14 years old	86	13.1	1.5	-1.705	13.0	0.097	15.7	13.9	13.0	12.2	11.3
15 years old	61	13.1	1.2	-1.221	12.9	0.094	15.3	13.8	12.9	12.1	11.2
16 years old	96	12.8	1.1	-0.790	12.8	0.092	15.0	13.6	12.8	12.0	11.1
17 years old	67	12.9	1.2	-0.414	12.7	0.093	14.9	13.6	12.7	12.0	11.0
Male											
11 years old	29	12.2	1.8	-1.530	12.2	0.142	16.3	13.6	12.2	11.2	10.0
12 years old	51	12.4	2.1	-1.444	12.0	0.133	15.6	13.2	12.0	11.0	9.9
13 years old	48	11.6	1.1	-1.418	11.7	0.123	14.8	12.7	11.7	10.8	9.7
14 years old	62	11.6	1.5	-1.616	11.4	0.114	14.3	12.4	11.4	10.6	9.7
15 years old	91	11.2	1.3	-2.022	11.1	0.106	13.7	12.0	11.1	10.4	9.6
16 years old	96	10.7	1.1	-2.469	10.7	0.097	13.1	11.5	10.7	10.1	9.4
17 years old	41	10.9	1.1	-2.838	10.6	0.090	12.9	11.4	10.6	10.1	9.4

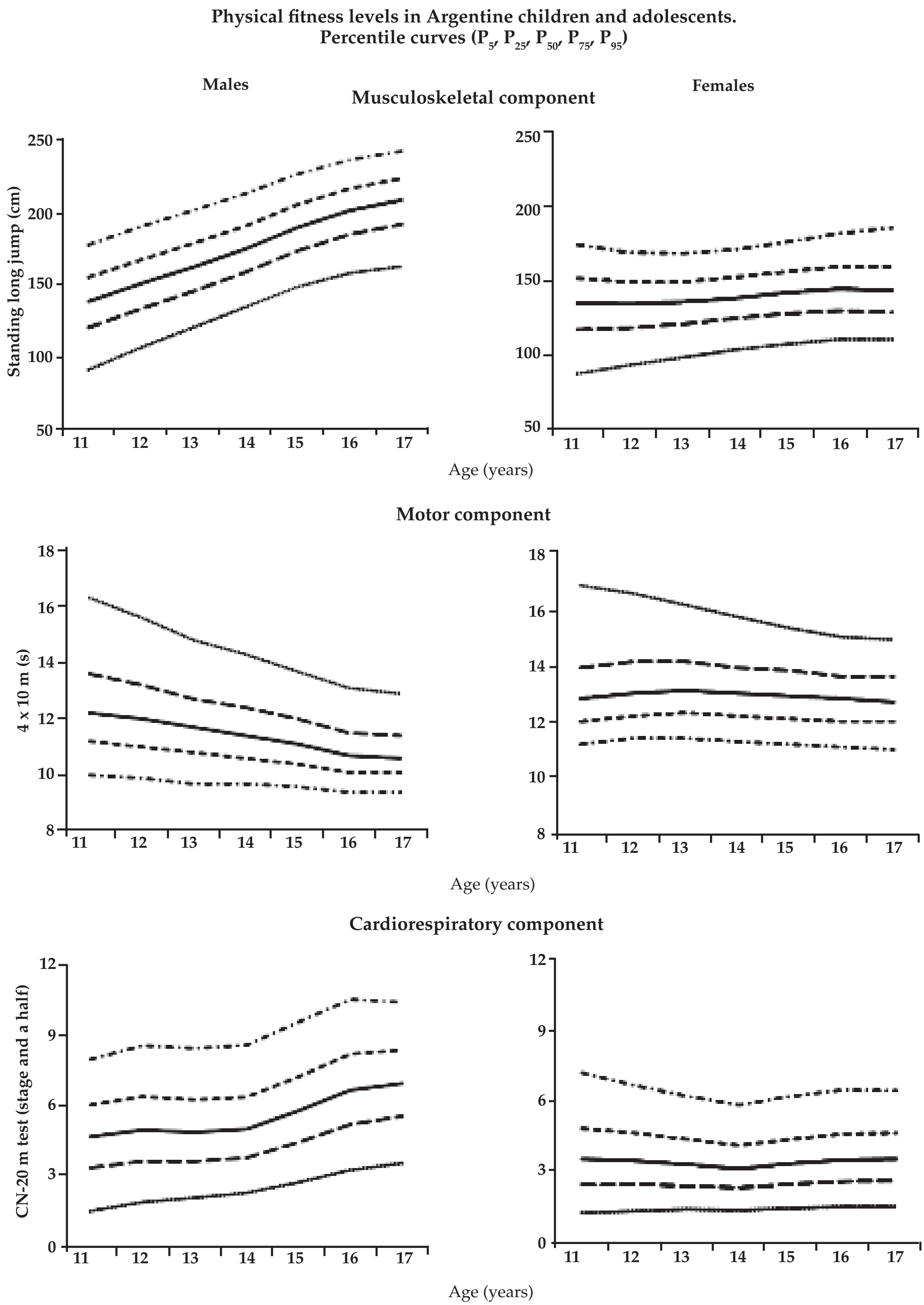
Smoothing of percentiles was done by using the LMS procedure.18 N = number of assessed subjects. The total sample was made up of 915 subjects. SD= standard deviation; L= asymmetry; M= median; S= variation coefficient.

TABLE 4. *Percentile values for course-navette 20 m test (stage and a half)*

	N	Mean	SD	L	M	s	P_5	P_{25}	P_{50}	P_{75}	P_{95}
Female											
11 years old	137	3.7	1.9	0.428	3.6	0.496	1.3	2.5	3.6	4.9	7.2
12 years old	106	3.8	1.4	0.429	3.5	0.457	1.4	2.5	3.5	4.6	6.7
13 years old	89	3.4	1.3	0.414	3.3	0.429	1.5	2.5	3.3	4.4	6.2
14 years old	95	3.4	1.5	0.384	3.2	0.417	1.4	2.4	3.2	4.1	5.8
15 years old	57	3.8	1.7	0.380	3.4	0.418	1.5	2.5	3.4	4.4	6.2
16 years old	95	3.6	1.5	0.413	3.5	0.417	1.6	2.6	3.5	4.6	6.5
17 years old	69	3.8	1.4	0.470	3.6	0.412	1.6	2.7	3.6	4.6	6.4
Male											
11 years old	90	4.6	1.8	0.953	4.7	0.419	1.5	3.4	4.7	6.0	8.0
12 years old	111	5.1	2.1	0.777	5.0	0.412	1.9	3.6	5.0	6.4	8.6
13 years old	78	5.1	2.1	0.628	4.9	0.399	2.1	3.6	4.9	6.2	8.4
14 years old	81	5.3	1.9	0.576	5.0	0.382	2.3	3.8	5.0	6.4	8.6
15 years old	110	6.3	2.1	0.635	5.8	0.360	2.7	4.4	5.8	7.2	9.5
16 years old	88	7.1	2.2	0.782	6.7	0.332	3.3	5.2	6.7	8.2	10.5
17 years old	53	6.5	2.1	0.975	7.0	0.300	3.6	5.6	7.0	8.4	10.4

Smoothing of percentiles was done by using the LMS procedure.18 N = number of assessed subjects. The total sample was made up of 1259 subjects. SD= standard deviation; L= asymmetry; M= median; S= variation coefficient.

FIGURE 1. *Percentile curves (from bottom to top: P5, P25, P50, P75, P95) of physical fitness in relation to health. Percentile curves were smoothed using the LMS procedure.18 CN-20 m= course-navette 20 m test*



CN-20 m, the 40th percentile was the most accurate cut-off point for the diagnosis of a high metabolic risk in Portuguese youth (aged 10 to 18 years old).[6] Future studies should focus on the validation of cut-off points for tests that assess the different PF components in the Argentine population.

Differences in PF levels among age and sex groups

In line with prior studies,[19-23] strength levels, speed/agility, performance, and aerobic capacity in this study were higher among male participants. The magnitude of such difference increased with age, and it was broader in the adolescent group (12.7% to 46.2%) than in the children group (5% to 22.8%). The reasons for a lower performance among children could be attributed to their lower muscle mass in relation to body weight and neuromuscular coordination.[24]

Other differences between sexes were observed in terms of speed reached in the CN-20 m test and the predictive VO_2 max. Such differences are similar to those reported in other studies conducted on children and adolescents.[17,25-29] Notwithstanding, greater differences in the predictive $V0_2$ max. were observed in young adults when compared to our study's children and adolescents[4,30]

Levels of physical fitness compared to other countries

A total of 19 studies (13 countries) compared PF levels by sex. Lower limb strength was assessed using the SL test in eight studies;[11,19-23,31,32] speed/agility was assessed using the 4x10 m in three studies,[19,20,21] and aerobic performance was assessed using the CN-20 m test in 17 studies.[5,6,11,17,19-21,23,25-29,31,33-35]

Strength levels in male participants were higher compared to two studies,[1,20] similar compared to five studies,[19,21-23,31] and lower compared to one study.[32] Strength levels in female participants were only mildly superior compared to two studies,[11,32] similar compared to two studies,[22,31] and lower compared to four studies.[19-21,23] In terms of speed/agility, the values for males were similar to those of three studies[19-21] while females' performance was lower than that of the three analyzed studies.[19-21]

Table 5. *Differences in the morphological. musculoskeletal and motor components between healthy aerobic capacity and unhealthy aerobic capacity groups in Argentine children and adolescents*

PF component	Parameter	Age group	Gender	Aerobic capacity Unhealthy	Aerobic capacity Healthy	*p* value
Morphological	BMI[b] (kg/m^2)	Children	Male	24.6 ± 4.9	18.3 ± 3.2	0.001
			Female	24.1 ± 5.1	19.7 ± 4.3	0.001
		Adolescents	Male	23.0 ± 3.8	21.1 ± 2.6	0.001
			Female	22.6 ± 3.7	20.6 ± 2.4	0.001
	Waist circumference (cm)	Children	Male	80.3 ± 11.6	60.9 ± 7.8	0.001
			Female	74.2 ± 11.9	62.1 ± 7.8	0.012
		Adolescents	Male	73.9 ± 12.6	73.5 ± 11.1	0.886
			Female	71.7 ± 10.6	68.2 ± 8.0	0.003
	Overweight and obesity (%)	Children	Male	75.8 (%)	22.2 (%)	0.001
			Female	57.9 (%)	32.2 (%)	0.027
		Adolescents	Male	39.3 (%)	19.0 (%)	0.001
			Female	27.8 (%)	12.1 (%)	0.001
Musculoskeletal	Standing long jump (cm)	Children	Male	138.4 ± 20.9	145.6 ± 21.3	0.686
			Female	109.5 ± 26.7	125.5 ± 28.3	0.020
		Adolescents	Male	179.9 ± 29.1	196.4 ± 28.3	0.001
			Female	136.7 ± 26.3	137.9 ±31.5	0.001
Motor	Speed/agility 4x10 m test (s)	Children	Male	12.9 ± 1.9	13.3 ± 2.1	0.331
			Female	14.9 ± 2.3	13.8 ± 1.7	0.173
		Adolescents	Male	11.4 ± 1.4	11.0 ± 1.2	0.009
			Female	13.3 ± 1.4	12.7 ± 1.1	0.001

Participants were grouped by age: children (6 to 12 years old) and adolescents (13 to 19 years old). sex and aerobic capacity level (healthy and unhealthy) as per the Fitnessgram® reference criteria.[2] Data were presented as average and standard deviation. except for overweight and obesity prevalence.
a. PF= physical fitness. b. BMI= body mass index.

In relation to aerobic performance, male participants showed higher levels compared to one study,[34] similar or mildly lower compared to six studies,[5,11,23,27,31,35] and lower compared to ten studies.[6,17,19-21,25,26,28,29,33] In the case of female participants, values were similar in relation to six studies,[5,11,23,31,34,35] and lower in relation to eleven studies.[6,17,19-21,25-29,33] Comparing physical performance allows to establish that this sample of Argentine children and adolescents has one of the lowest PF levels of all countries.

Aerobic capacity and future cardiovascular risk

When analyzing the total sample of the present study approximately 1 every 3 Argentine youth has an aerobic capacity indicative of future cardiovascular risk *(Table 1)*. However, the age group analysis showed that the proportion of adolescents with an unhealthy aerobic capacity was markedly superior (49.1%) in relation to the group of children (11.5%). These values were higher than those observed in Spanish adolescents[19] (19.3% ♂ and 17.3% ♀), in European adolescents[20] (38% ♂ and 43% ♀), in Australian children and adolescents[23] (29% ♂ and 23% ♀), and in American adolescents[7] (29% ♂ and 31% ♀).

These results should be considered with caution because certain factors, such as the $V0_2$ max. cut-off point, the equation applied to estimate $V0_2$ max. and the test used, which may affect classifications.[4] In relation to this, Secchi and García[4] demonstrated that the $V0_2$ max. predictive equation and the Fitnessgram® reference criteria[2,3] significantly modify the proportion of young adults with cardiometabolic risk. The data obtained in this study show that, in general, children and adolescents with a healthy aerobic capacity had a better PF *(Table 5)*. In addition, they had a lower waist circumference and a lower overweight and obesity prevalence, all factors related to an improved cardiovascular profile.[9,10] Such evidence demonstrates that Physical Education teachers play the role of health promoters for their students. Therefore, the school setting is exceptional to promote exercise habits and preserve cardiovascular health.[8]

One of the strengths of this study is that it assessed PF using the ALPHA test battery, with proven validity, reliability, applicability and relation to health in children and adolescents.[11-13] Among the study limitations it is worth mentioning that the sample is not representative and that the number of participants is relatively low to establish reference values for the Argentine pediatric population. However, given the lack of normative data regarding PF in this population, this study provides the first PF values using the ALPHA test battery in a population of Argentine students.

CONCLUSIONS

Argentine male children and adolescents in the sample showed greater levels of physical fitness. Such differences increase with age. Approximately one every three participants had an aerobic capacity indicative of future cardiovascular risk.■

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