

Physical fitness standards in students from the province of Neuquén, Argentina. Physical Fitness Assessment Plan study

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ABSTRACT

Introduction. At present, there is no information about the physical fitness (PF) of children and adolescents attending school in the province of Neuquén. The provincial Department of Sports developed the Physical Fitness Assessment Plan. The main objective of this study was to administer the ALPHA-Fitness test battery to the students of Neuquén in order to develop PF reference standards.

Population and methods. A total of 4487 male and female students of Neuquén aged 9-18.9 years were assessed based on four PF components of the high priority ALPHA-Fitness test battery: 1) morphological: body weight and height to estimate body mass index; 2) musculoskeletal: standing long jump test; 3) motor: 4x10 m speed/agility test; and 4) cardiorespiratory: 20-m shuttle run test (SRT).

Results. The mean body mass index was 22.9 ± 4.7 kg/m²; 25 % of participants were overweight and 12.7 %, obese. The mean values for the cardiorespiratory component were 4.3 ± 2.5 stages, 10.1 ± 1.2 km/h, maximal oxygen volume of 38.7 ± 6.7 mL/kg/min; standing long jump: 147.3 ± 34.6 cm; and for the motor component: 13.0 ± 1.5 s. Male participants had a better performance in PF tests ($p < 0.001$).

Conclusion. The study results provide the first PF standards for male and female children and adolescents of the province of Neuquén, Argentina.

Key words: Stress test, 20-m SRT, reference standards, ALPHA-Fitness.

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INTRODUCTION

Physical fitness (PF) is defined as a set of attributes that people acquire or develop and that allow them to do physical activity and exercise. Attributes refer to a complete range of physical qualities, such as aerobic capacity and power, muscle strength, balance, agility, speed, and flexibility. When assessed, these attributes reflect the performance status of different organs, systems, and structures related to physical activity and exercise.²

Recent studies have demonstrated that moderate and high levels of PF in children and adolescents, specifically cardiorespiratory fitness and muscle strength, decrease the risk for metabolic disorders, increase bone mineral density, reduce depression symptoms, improve emotional, social, and cognitive well-being, and increase motor competence, among other things.³⁻⁶

For this reason, several investigators consider that PF is one of the most important markers of health in children and adolescents³ and should be taken into account in school assessments in relation to health knowledge and promotion.⁷

The ALPHA-Fitness test battery has proven to be valid and reliable to measure PF in relation to health in children and adolescents.^{8,9} By way of clarification, the assessment consists in two stages: measurement and assessment. Measurement covers the administration of the ALPHA-Fitness test battery to obtain the information (performance) of the different PF components, whereas assessment consists in considering the values

obtained using reference standards.⁷For the second stage, it is necessary to have national, provincial and/or specific standards from the region where the test battery is administered.

In Argentina, only one study has published PF reference values;¹⁰ however, given the number of students assessed, it was not representative at a national level. Besides, that study did not include students of Neuquén. In addition to the above, we did not find evidence of any PF assessment program and/or any reference standards developed in the province of Neuquén. For these reasons, there is no current knowledge of PF characteristics in the students of Neuquén.

The main objective of this study was to administer the high priority ALPHA-Fitness test battery to a representative sample of students of Neuquén in order to develop reference standards. They may be useful for school, sports and/or municipal institutions to compare PF among different age groups, students, classes, schools, provinces, and countries.⁷ They may also help to make decisions to design physical activity programs and promote health and physical education at school.^{7,11}

POPULATION AND METHODS

Design and sample

The study was conducted between May 2nd, 2015 and September 30th, 2016. The sample was made up of children and adolescents aged 9-18.9 years living in the province of Neuquén, Argentina. The study design was observational, descriptive, and cross-sectional. For sample representativeness, the study population was divided into three regions: North, Center, and South. The following sample sizes were determined: The North region (n = 314) showed a 95 % reliability (precision error: 6 %); the Center region (n = 3089), a 99 % reliability (precision error: 3 %); and the South region (n = 1084), a 99 % reliability (precision error: 5 %). This resulted in a sample of 4173 subjects. A total of 42 public schools participated (15 primary schools and 27 secondary schools). The geographic distribution was based on operational feasibility. Rural schools and shelters were excluded (2nd stage: provincial project). All students obtained medical authorization for participation. Subjects with a clinical diagnosis (diabetes, asthma, musculoskeletal conditions or other) that limited their physical activity were not included in the study. Parents' and students' written informed consent was obtained. The project

was assessed and supported by the Department of Sports and the Ministry of Education of the province of Neuquén, and research ethical guidelines were approved and followed. The project was called Physical Fitness Assessment Plan (Plan de Evaluación de la Condición Física, PECF).

Procedures

Before starting the study, investigators, physical education teachers, and observers conducted four theoretical-practical sessions to review the testing protocol, the assessment methodology, and data collection methods to standardize the assessment process as per published protocols.⁹ In addition, before the study, teachers administered the ALPHA test battery at the schools so that students would get used to the tests.

Physical fitness assessment

The high priority ALPHA-Fitness test battery version⁹ was administered in the following order:

- 1) **Morphological component:** Body weight and height were measured in accordance with the specified protocols. Weight was recorded with the participants barefoot and wearing clothes (T-shirt and long pants) using a portable electronic scale (OMROM HBF-500INT), with a 0.100 kg precision. Height was recorded using a stadiometer (SECA 206). Body mass index (BMI: kg/m²) was estimated by dividing the subject's body weight by the square of the height in meters. Participants were identified as being overweight or obese based on Cole's criteria.¹²
- 2) **Musculoskeletal component:** The standing long jump (SLJ) was used as an indicator of lower limb strength. It consisted in jumping the longest distance possible from a standing start (without racing ahead), with both feet and swinging both arms. The distance was measured from the take-off line to the point where the back of the heel nearest to the take-off line landed on the ground.
- 3) **Motor component:** The 4 x 10 m speed/agility test was used. It consisted in running back and forth between two lines 10 m apart taking three sponges alternately as quickly as possible. The total distance run was 40 m.
- 4) **Cardiorespiratory component:** This was assessed using the 20-meter shuttle run test (20-m SRT), also known as course-navette.¹³ It consisted in running back and forth in both

directions on a 20 m track marked between two separate lines for as long as possible. The rhythm was set by means of audio signals. The initial speed was 8.5 km/h and was increased by 0.5 km/h intervals every 1 minute. Subjects had to step behind the 20 m line at the exact time that the audio signal or beep was heard. The test finished when the subject stopped because of fatigue or failed to reach the end line concurrent with the beep on two consecutive occasions. Test performance was recorded using the number of 20-m laps (1 lap = 20 m), the stage, and the final speed reached (FSR) in the last stage. The maximal oxygen volume (VO_{2max}) was estimated based on the following equation:¹⁴

$$VO_{2max} = 31.025 + 3.238 * S - 3.248 * A + 0.1536 * S * A$$

S: speed (km/h). A: age (years).

Two measurements were recorded for each test, except for the 20-m SRT, which was assessed only once. The best test performance was used for data analysis.

Statistical analysis

Data were analyzed using the SPSS 22.0 statistical software package. Before analysis, the Kolmogorov-Smirnov test (for normality)

and the Levene test (for homoscedasticity) were done. Then, descriptive statistics were established (mean, standard deviation, maximal and minimal values). The Mann-Whitney U, a non-parametric test, was used to determine significant differences among outcome measures (if normality was not established). A value of $p < 0.05$ (alpha) was accepted in all cases. Percentile tables were developed using the Least-Mean-Square algorithm (LMS) to smooth curves and with the LMS Chart Maker Light software, version 2.4. Due to the small number of participants (both males and females) in the 9-year-old group, tables were developed for age groups from 10 to 18 years.

RESULTS

A total of 4487 students were assessed (45 % were males and 55 %, females). Participants were considered children if they were aged 9.0 to 12.9 years and adolescents if they were between 13.0 and 18.9 years.¹⁰ The sample characteristics and the values obtained in the PF tests are detailed in Table 1.

Male participants had a better performance in PF tests ($p < 0.001$). Height, weight, and BMI were different between adolescent males and females. The number of overweight and obese participants was different in the child group.

TABLE 1. Differences in physical fitness levels of children and adolescents of Neuquén, Argentina, by sex

Physical fitness components	Physical fitness components																
	All			Children aged 9-12.9 years						Adolescents aged 13-18.9 years							
				Male			Female			P	Male			Female			P
N	Mean	SD	N	Mean	SD	N	Mean	SD	N		Mean	SD	N	Mean	SD		
Morphological																	
Age (years)	4487	14.7	2.2	462	11.5	0.8	493	11.6	0.8	0.128	1566	15.6	1.5	1966	15.6	1.5	0.130
Body weight (kg)	4434	58.7	15.2	458	46.7	13.9	486	47.1	13.1	0.343	1556	64.8	14.5	1934	59.4	13.1	0.001
Height (cm)	4444	159.3	10.5	458	147.4	9.1	487	148.3	8.8	0.023	1556	167.6	8.2	1943	158.3	6.2	0.001
BMI (kg/m ²)	4423	22.9	4.7	458	21.2	4.7	486	21.1	4.5	0.840	1551	23.0	4.5	1928	23.7	4.8	0.001
Overweight (%) ^a	1106	25.0	—	126	27.5	---	152	31.3	---	0.001	357	23.0	---	471	24.4	---	0.057
Obesity (%) ^a	562	12.7	—	84	18.3	---	60	12.3	---	0.001	184	11.9	---	234	12.1	---	0.063
Musculoskeletal																	
Standing long jump (cm)	4169	147.3	34.6	442	138.8	22.4	471	121.6	19.6	0.001	1475	178.1	30.4	1781	130.7	23.4	0.001
Motor																	
4 x 10 m (s)	3837	13.0	1.5	379	13.3	1.2	395	14.2	1.6	0.001	1432	12.01	1.3	1631	13.5	1.2	0.001
Cardiorespiratory 20-m SRT																	
20-m laps (no.)	4196	35.8	22.4	449	29.8	17.2	474	19.9	11.6	0.001	1500	53.4	23.6	1773	26.8	13.6	0.001
Complete stage (no.)	4196	4.3	2.5	449	3.4	2.0	474	2.4	1.4	0.001	1500	6.0	2.5	1773	3.2	1.6	0.001
Speed (km/h) ^b	4196	10.1	1.2	449	9.7	1.0	474	9.2	0.7	0.001	1500	10.9	1.2	1773	9.6	0.8	0.001
VO _{2max} (mL/kg/min) ^c	4196	38.7	6.7	449	42.1	4.9	474	39.5	3.6	0.001	1500	42.5	6.6	1773	34.4	5.0	0.001

N: number of assessed subjects; SD: standard deviation; BMI: body mass index. ^aThe prevalence of overweight and obesity was estimated based on Cole's criteria.¹⁶ ^bIt corresponds to the speed reached in the last complete stage of the 20-m SRT (course-navette 20 m). ^cThe maximal oxygen consumption was estimated based on the equation of Leger.¹⁸

Table 2 shows the PF standards for the cardiorespiratory component, and Table 3, for the musculoskeletal and motor components, classified by age and sex, expressed as 5th, 25th, 50th, 75th and 95th percentiles.

The percentile curves showed a mild halt and, in some cases, a reduction in the levels of PF among female participants (Figure 1).

On the contrary, PF levels increased among male participants (Figure 2).

DISCUSSION

Standards for the different PF components were developed, for a wide age range and both male and female students of Neuquén. These will allow physical education teachers to make decisions taking them as a reference and establish comparisons among different age groups, students, schools, provinces, and countries.

In the group of male participants, the cardiorespiratory component, the standing long jump test, and the 4 x 10 m speed test increased with age. Likewise, in the group of female participants, performance in the PF tests improved until 15 years old and then stabilized. This is probably because, in average, girls reach maturity before boys and, at 15 years, they are already in the final stage of maturation.¹⁵

Males showed a better PF performance, which was consistent with several studies.^{10,16-18} Such difference was the result of various morpho-functional, psychosocial, and physical activity habit factors.^{19,20}

Physical fitness levels in relation to other Argentine provinces

Only one study that had used the ALPHA-Fitness test battery in Argentina was found in

TABLE 2. Percentile values for the cardiorespiratory component (20-m SRT) in both males and females

FEMALE										MALE									
Age	N	L	M	S	P5	P25	P50	P75	P95	Age	N	L	M	S	P5	P25	P50	P75	P95
Stages (no.)										Stages (no.)									
10	119	-0.16	1.80	0.56	0.9	1.2	1.8	2.7	4.0	10	136	0.08	2.44	0.66	1.0	1.6	2.4	3.8	5.7
11	181	-0.06	2.01	0.56	1.0	1.4	2.0	2.9	4.3	11	160	0.27	2.94	0.61	1.2	1.9	2.9	4.3	6.1
12	172	0.03	2.27	0.55	1.1	1.6	2.3	3.3	4.7	12	149	0.45	3.58	0.56	1.5	2.4	3.6	5.0	6.8
13	319	0.11	2.54	0.55	1.2	1.7	2.5	3.6	5.1	13	248	0.61	4.38	0.51	1.8	3.0	4.4	6.0	7.7
14	344	0.18	2.70	0.53	1.3	1.9	2.7	3.8	5.3	14	349	0.74	5.27	0.46	2.3	3.7	5.3	6.9	8.7
15	391	0.23	2.92	0.52	1.4	2.0	2.9	4.1	5.5	15	307	0.87	6.10	0.41	2.9	4.5	6.1	7.8	9.6
16	306	0.27	3.08	0.50	1.5	2.2	3.1	4.3	5.7	16	257	0.99	6.65	0.37	3.4	5.0	6.7	8.3	9.9
17	295	0.30	3.13	0.49	1.5	2.2	3.1	4.3	5.7	17	256	1.10	7.02	0.33	3.9	5.5	7.0	8.5	10.0
18	118	0.33	3.13	0.47	1.5	2.2	3.1	4.2	5.6	18	73	1.22	7.14	0.30	4.2	5.7	7.1	8.5	9.9
Speed reached (km/h)										Speed reached (km/h)									
10	119	-6.25	8.96	0.06	8.4	8.7	9.0	9.4	9.9	10	136	-3.29	9.31	0.09	8.4	8.8	9.3	9.9	10.8
11	181	-5.61	9.05	0.06	8.5	8.7	9.1	9.5	10.1	11	160	-2.29	9.53	0.09	8.5	9.0	9.5	10.2	11.0
12	172	-4.98	9.17	0.07	8.5	8.8	9.2	9.6	10.3	12	149	-1.33	9.82	0.10	8.7	9.2	9.8	10.5	11.4
13	319	-4.39	9.29	0.07	8.6	8.9	9.3	9.8	10.5	13	248	-0.48	10.22	0.10	8.9	9.5	10.2	11.0	11.8
14	344	-3.87	9.37	0.07	8.6	9.0	9.4	9.9	10.6	14	349	0.24	10.66	0.11	9.2	9.9	10.7	11.5	12.3
15	391	-3.45	9.47	0.07	8.7	9.0	9.5	10.0	10.7	15	307	0.82	11.08	0.11	9.5	10.3	11.1	11.9	12.7
16	306	-3.14	9.55	0.08	8.7	9.1	9.6	10.1	10.8	16	257	1.26	11.36	0.11	9.7	10.5	11.4	12.2	12.9
17	295	-2.91	9.58	0.08	8.8	9.1	9.6	10.1	10.8	17	256	1.64	11.52	0.10	9.9	10.7	11.5	12.3	13.0
18	118	-2.73	9.59	0.08	8.8	9.1	9.6	10.1	10.8	18	73	1.98	11.55	0.10	9.9	10.8	11.5	12.3	13.0
Estimated VO _{2max} (mL/kg/min)										Estimated VO _{2max} (mL/kg/min)									
10	119	-5.66	41.27	0.06	38.7	39.9	41.3	43.1	45.6	10	136	-2.77	43.03	0.09	38.8	40.7	43.0	46.0	49.8
11	181	-4.82	39.89	0.07	37.0	38.3	39.9	42.0	45.0	11	160	-1.87	42.26	0.10	37.3	39.6	42.3	45.6	49.7
12	172	-3.99	38.65	0.08	35.3	36.8	38.7	41.1	44.5	12	149	-1.01	41.96	0.12	36.2	38.9	42.0	45.6	49.9
13	319	-3.23	37.44	0.09	33.8	35.4	37.4	40.1	43.8	13	248	-0.25	42.27	0.13	35.5	38.7	42.3	46.2	50.7
14	344	-2.57	36.04	0.10	32.0	33.8	36.0	38.9	42.7	14	349	0.36	43.00	0.14	35.2	39.0	43.0	47.3	51.8
15	391	-2.03	34.79	0.11	30.5	32.4	34.8	37.8	41.7	15	307	0.82	43.71	0.15	35.0	39.3	43.7	48.2	52.7
16	306	-1.62	33.45	0.12	28.9	30.9	33.5	36.6	40.6	16	257	1.14	43.69	0.16	34.4	39.1	43.7	48.2	52.7
17	295	-1.30	31.81	0.13	27.1	29.2	31.8	35.0	39.0	17	256	1.38	43.15	0.16	33.4	38.4	43.1	47.7	52.1
18	118	-1.03	30.08	0.14	25.2	27.4	30.1	33.3	37.3	18	73	1.58	41.90	0.17	32.0	37.1	41.9	46.4	50.6

the bibliography. That study was carried out in male and female children and adolescents aged 6-19 years ($n = 1867$) from five provinces (Mendoza, Entre Ríos, Buenos Aires, Santa Cruz, and Misiones).¹⁰ Compared to our study, similar average values were observed for the following: BMI (20.8 kg/m^2 versus 22.9 kg/m^2), overweight (20.5% versus 27.5%), SLJ (148.7 cm versus 147.3 cm), $4 \times 10 \text{ m}$ test (12.7 s versus 13.0 s), and 20-m SRT: number of laps (36.2 versus 35.8), speed (10.1 km/h versus 10.2 km/h), and $\text{VO}_{2\text{max}}$ (41.5 mL/kg/min versus 39.3 mL/kg/min).

The comparison of the 50th percentile in this study and in that by Secchiet al.,¹⁰ showed the following: the cardiorespiratory, musculoskeletal, and motor components were lower at all ages among the female participants of Neuquén. The males of Neuquén showed a worse performance in the cardiorespiratory component between 11 and 13 years, and similar values were observed between 14 and 17 years. In the musculoskeletal and motor components, values were slightly lower in all age groups.

Such differences, which were mainly observed in the group of female participants, may be due to different reasons: the number of assessed subjects ($n = 1867$ versus $n = 4480$), the number of participating schools (16 versus 42), and school characteristics (in the study by Secchi et al., 37% were private schools, while in our study, 100% were public schools).

Specifically in terms of overweight and obesity, our values were compared to those obtained in three other Argentine studies.^{10,21,22} Secchi et al.,¹⁰ observed differences in the percentage of obesity, which was higher in Neuquén (7.8% versus 18.3%), mainly in the adolescent group, for the group of male and female participants: 3.9% versus 11.9% and 4.1% versus 12.1% , respectively. Sapaget al.,²¹ found similar values in the children and adolescents of Neuquén ($n = 331$) aged 6-15 years; 20.8% were overweight and 22% , obese. Kovalskys et al.,²² observed similar overweight values (20.8%) in a sample of children and adolescents who attended a pediatric office visit ($n = 1289$) but lower obesity values (5.4%).

TABLE 3. Percentile values for the lower limb strength test (standing long jump) and agility/speed test (4×10) in both males and females

MALE										FEMALE									
Age	N	L	M	S	P5	P25	P50	P75	P95	Age	N	L	M	S	P5	P25	P50	P75	P95
Standing long jump (cm)										Standing long jump (cm)									
10	135	0.80	132.12	0.16	103.7	117.8	132.1	146.8	161.8	10	122	0.64	118.58	0.16	93.9	106.0	118.6	131.7	145.3
11	157	1.01	138.34	0.16	108.1	123.2	138.3	153.4	168.5	11	178	0.56	121.30	0.17	95.6	108.1	121.3	135.2	149.7
12	146	1.23	146.39	0.16	113.8	130.3	146.4	162.0	177.4	12	169	0.51	123.63	0.17	96.9	109.9	123.6	138.2	153.6
13	259	1.43	158.03	0.16	122.6	140.8	158.0	174.5	190.3	13	317	0.51	126.08	0.18	98.1	111.7	126.1	141.3	157.5
14	354	1.56	171.06	0.16	133.2	152.8	171.1	188.3	204.7	14	357	0.57	127.21	0.18	98.3	112.4	127.2	142.8	159.2
15	302	1.65	182.10	0.15	143.1	163.3	182.1	199.7	216.3	15	401	0.59	129.62	0.18	100.1	114.5	129.6	145.5	162.2
16	253	1.74	189.96	0.14	150.6	171.1	190.0	207.5	224.0	16	307	0.55	131.92	0.18	102.3	116.7	131.9	148.0	164.9
17	242	1.84	195.13	0.14	156.1	176.5	195.1	212.4	228.5	17	298	0.49	132.98	0.18	103.6	117.8	133.0	149.1	166.1
18	65	1.94	197.53	0.13	159.3	179.3	197.5	214.3	229.9	18	101	0.43	132.96	0.17	104.1	118.0	133.0	149.0	166.0
4 x 10 (s)										4 x 10 (s)									
10	119	-1.90	13.26	0.09	11.9	12.5	13.3	14.1	15.1	10	110	-2.15	14.34	0.10	12.8	13.5	14.3	15.4	16.8
11	133	-2.11	13.15	0.09	11.8	12.4	13.1	14.0	15.1	11	152	-1.92	13.97	0.10	12.4	13.1	14.0	15.0	16.2
12	123	-2.31	12.86	0.09	11.5	12.1	12.9	13.7	14.9	12	132	-1.73	13.67	0.10	12.2	12.9	13.7	14.6	15.8
13	251	-2.43	12.42	0.09	11.1	11.7	12.4	13.3	14.4	13	294	-1.63	13.52	0.09	12.1	12.7	13.5	14.4	15.5
14	343	-2.46	11.97	0.09	10.8	11.3	12.0	12.8	13.8	14	320	-1.62	13.44	0.09	12.0	12.7	13.4	14.3	15.3
15	296	-2.39	11.72	0.09	10.5	11.1	11.7	12.5	13.5	15	361	-1.62	13.37	0.09	12.0	12.6	13.4	14.2	15.2
16	249	-2.14	11.61	0.09	10.5	11.0	11.6	12.4	13.3	16	281	-1.55	13.33	0.09	12.0	12.6	13.3	14.2	15.1
17	229	-1.76	11.50	0.09	10.3	10.9	11.5	12.2	13.1	17	278	-1.41	13.36	0.09	12.0	12.6	13.4	14.2	15.1
18	64	-1.36	11.44	0.09	10.3	10.8	11.4	12.1	13.0	18	97	-1.23	13.42	0.09	12.1	12.7	13.4	14.2	15.2

Probably, such difference is due to the fact that the study was conducted 15 years ago, and that eating and physical activity habits may have changed.

Differences in physical fitness levels in relation to other countries of America

PF levels were compared by sex in a total of seven studies, all conducted in American populations (leaving out the study by Secchi et al.,¹⁰ mentioned above).

The levels of lower limb strength in both male and female participants were similar to those observed in two studies from Chile and Uruguay.^{16,23} The speed/agility levels in both male and female participants were similar to those found in a study from Uruguay.²³

The cardiorespiratory component outcomes in both male and female participants were similar to

those of three studies from Uruguay, Chile, and Colombia,^{16,23,24} but lower than those of three other studies from Canada,²⁵ Colombia (adjusted for altitude)¹⁷, and Colombia (ethnicity).²⁶

Lastly, it is worth noting a limitation of this study: rural schools were not included due to logistical reasons.

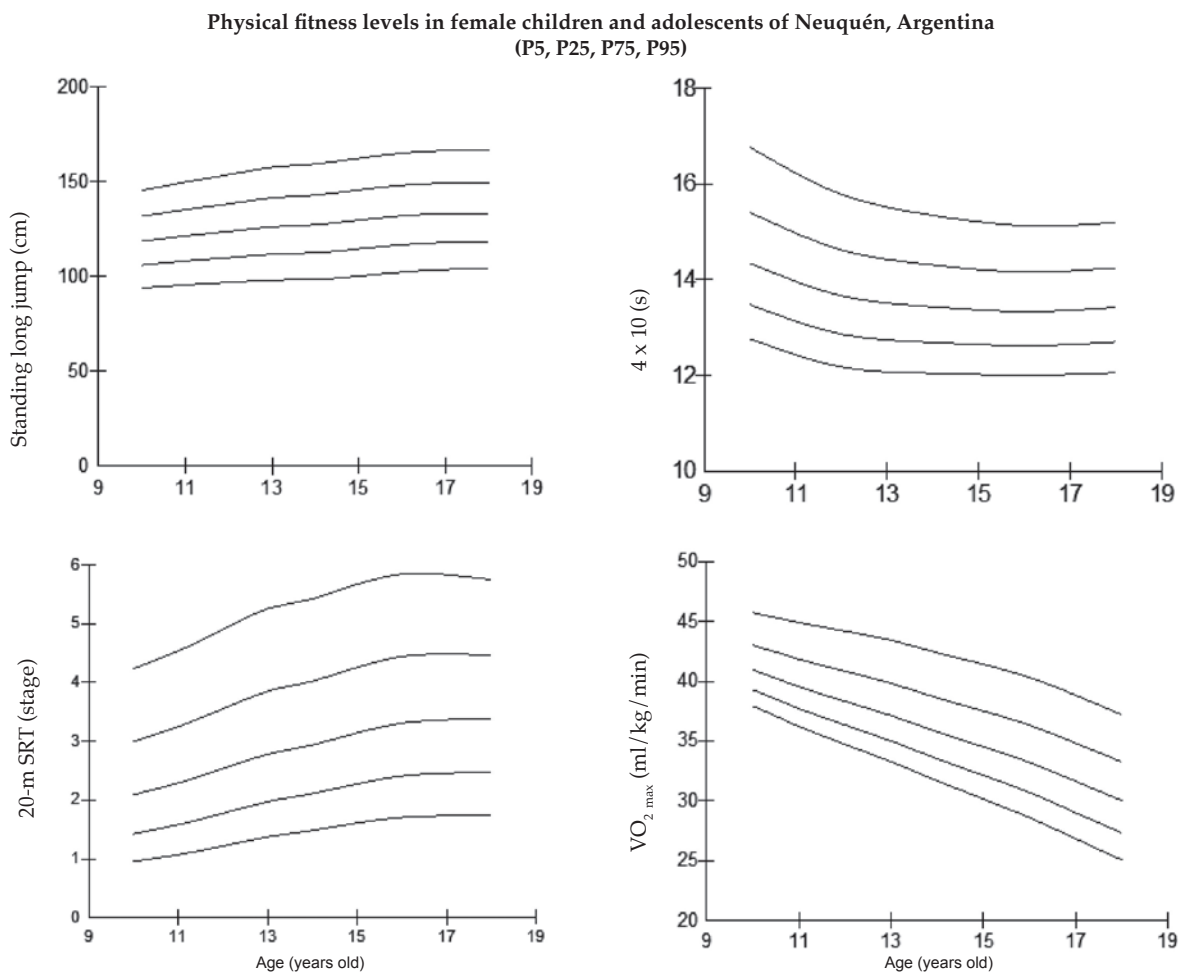
CONCLUSIONS

This study provides the first PF standards for male and female children and adolescents of the province of Neuquén, Argentina. ■

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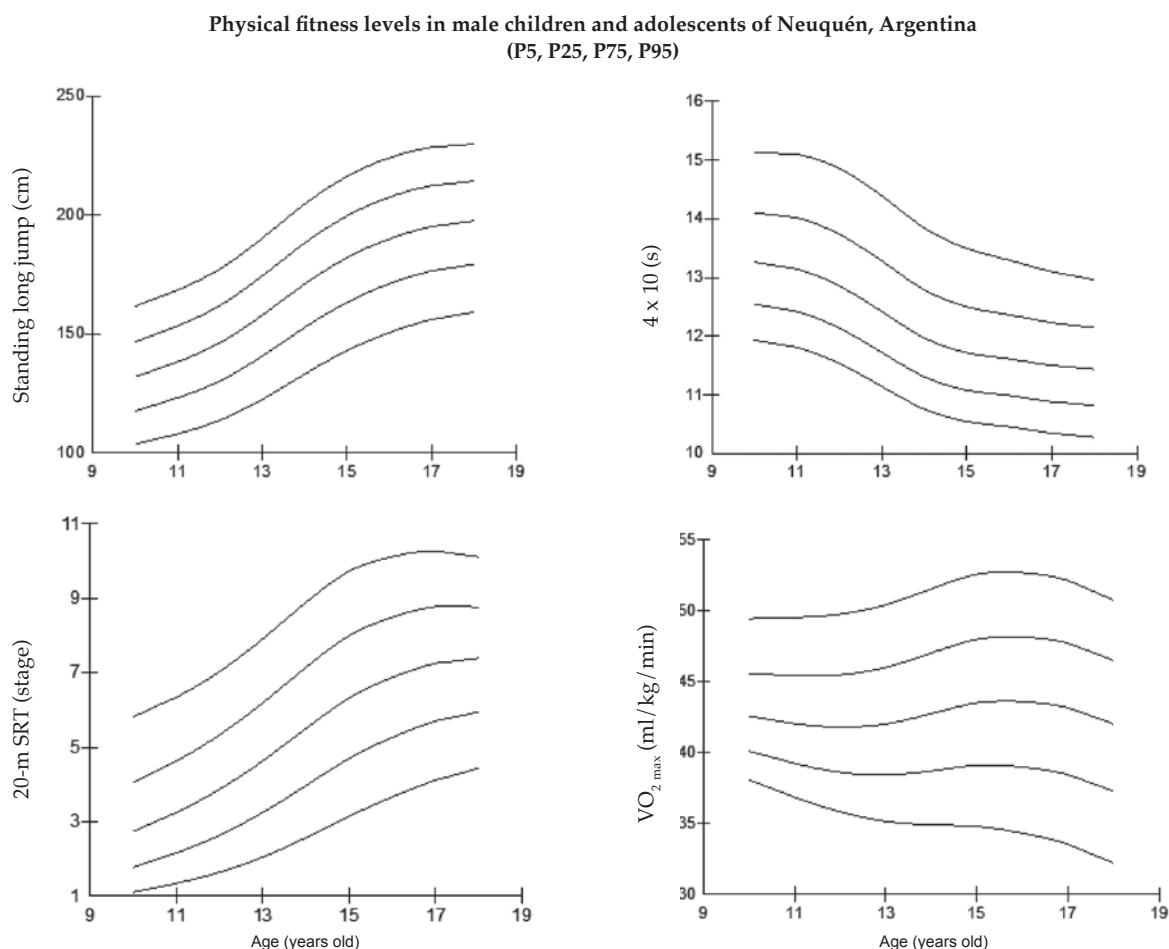
FIGURE 1. Percentile curve (bottom-up: P5, P25, P50, P75, P95) of physical fitness in relation to the health of female participants



REFERENCES

1. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep.* 1985; 100(2):126-31.
2. Castillo-Garzón MJ, Ruiz JR, Ortega FB, Gutiérrez A. Anti-aging therapy through fitness enhancement. *Clin Interv Aging.* 2006; 1(3):213-20.
3. Ortega FB, Ruiz JR, Castillo MJ, Sjöström M. Physical fitness in childhood and adolescence: a powerful marker of health. *Int J Obes (Lond).* 2008; 32(1):1-11.
4. Ortega FB, Campos D, Cadenas-Sanchez C, Altmäe S, et al. Physical fitness and shapes of subcortical brain structures in children. *Br J Nutr.* 2017; 27:1-10.
5. Steele RM, Brage S, Corder K, Wareham NJ, et al. Physical activity, cardiorespiratory fitness, and the metabolic syndrome in youth. *J Appl Physiol.* 2008; 105(1):342-51.
6. Burns RD, Brusseau TA. Muscular strength and endurance and cardio-metabolic health in disadvantaged Hispanic children from the U.S. *Prev Med Rep.* 2016; 9(5):21-6.
7. Secchi JD, García GC, Arcuri CR. Evaluación de la Condición Física en el ámbito escolar: un enfoque práctico para interpretar e informar resultados. *Enfoques.* 2016; 28(2):67-87.
8. España-Romero V, Artero EG, Jimenez-Pavón D, Cuenca-García M, et al. Assessing health-related fitness tests in the school setting: reliability, feasibility and safety; the ALPHA Study. *Int J Sports Med.* 2010; 31(7):490-7.
9. Ruiz JR, Castro-Piñero J, España-Romero V, Artero EG, et al. Field-based fitness assessment in young people: the ALPHA health-related fitness test battery for children and adolescents. *Br J Sports Med.* 2011; 45(6):518-24.
10. Secchi JD, García GC, España-Romero V, Castro-Piñero J. Condición física y riesgo cardiovascular futuro en niños y adolescentes argentinos: una introducción de la batería ALPHA. *Arch Argent Pediatr.* 2014; 112(2):132-40.
11. Secchi JD, García GC, Arcuri CR. ¿Evaluar la condición física en la escuela? Conceptos y discusiones planteadas en el ámbito de la educación física y la ciencia. *Enfoques.* 2016; 28(1):67-92.
12. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ.* 2000; 320(7244):1240-3.
13. García GC, Secchi JD. Test course navette de 20 metros con etapas de un minuto. Una idea original que perdura hace 30 años. *Apunts Med Esport.* 2014; 49(183):93-103.
14. Léger LA, Mercier D, Gadoury C, Lambert J. The multistage 20 metre shuttle run test for aerobic fitness. *J Sports Sci.* 1988; 6(2):93-101.
15. Lejarraga H, Orfila G. Estándares de peso y estatura para

FIGURE 2. Percentile curve (bottom-up: P5, P25, P50, P75, P95) of physical fitness in relation to the health of male participants



- niñas y niños argentinos desde el nacimiento hasta la madurez. *Arch Argent Pediatr*. 1987; 85(4):209-22.
16. Garber MD, Sajuria M, Lobelo F. Geographical variation in health-related physical fitness and body composition among Chilean 8th graders: a nationally representative cross-sectional study. *PLoS One*. 2014; 25(9):e108053.
17. Ramírez-Vélez R, Palacios-López A, Humberto Prieto-Benavides D, Enrique Correa-Bautista J, et al. Normative reference values for the 20 m shuttle-run test in a population-based sample of school-aged youth in Bogotá, Colombia: the FUPRECOL study. *Am J Hum Biol*. 2017; 29(1):4-14.
18. Bustamante A, Beunen G, Maia J. Valoración de la aptitud física en niños y adolescentes: construcción de cartas percentílicas para la región central del Perú. *Rev Peru Med Exp Salud Pública*. 2012; 29(2):188-97.
19. D'Angelo CP, Agüero A, Ghioldi M, Saco M, et al. Evaluación morfofuncional, psicosocial y de hábitos alimentarios de los alumnos de las Escuelas Públicas de la Ciudad de Buenos Aires. *Rev Asoc Méd Argent*. 2005; 118(1):9-22.
20. Santander MD. Sobre peso y obesidad y su relación con el sedentarismo y patrones de actividad física en adolescentes neuquinos. [Public Health Master Dissertation]. Buenos Aires: Facultad de Medicina de la Universidad de Buenos Aires; 2017.
21. Sapag M, Dioverti C, Paramio L, Petronace A, et al. Evaluación nutricional y de tensión arterial en niños de dos escuelas de población vulnerable de Cutral Co y Plaza Huincul: estudio cuantitativo y cualitativo. *Arch Argent Pediatr*. 2014; 112(4):337-44.
22. Kovalskys I, Bay L, RauschHerscovici C, Berner E. Prevalencia de obesidad en una población de 10 a 19 años en la consulta pediátrica. *Arch Argent Pediatr*. 2003; 101(6):441-7.
23. Gioscia G, Beretervide S, Bermúdez G, Quagliatta D. Valoración de la condición física en estudiantes de secundaria de Montevideo y área metropolitana, Uruguay. *Rev Univ Educ Fís Deporte*. 2017; 10:8-15.
24. Ramírez-Vélez R, García-Hermoso A, Agostinis-Sobrinho C, Mota J, et al. Pubertal Stage, Body Mass Index, and Cardiometabolic Risk in Children and Adolescents in Bogotá, Colombia: The Cross-Sectional Fuprecol Study. *Nutrients*. 2017; 9(7):E644.
25. Leger L, Lambert J, Goulet A, Rowan C, et al. Capacité aerobie des Québécois de 6 a 17 ans –Test navette de 20 metres avec paliers de 1 minute. *Can J Appl Sport Sci*. 1984; 9(2):64-9.
26. Ramírez-Vélez R, Correa-Bautista JE, Ramos-Sepúlveda JA, Piñeros-Sepúlveda JA, et al. Aerobic capacity and future cardiovascular risk in Indian community from a low-income area in Cauca, Colombia. *Ital J Pediatr*. 2017; 43(1):28.