Original article

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Assessment of children's physical fitness and school health in the province of San Luis, Argentina

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ABSTRACT

Introduction. The assessment of physical fitness (PF), is useful strategy to know the current status of schoolchildren. Our primary objective was to measure the current health status and PF levels of schoolchildren in San Luis and to develop PF reference tables.

Population and methods. Schoolchildren aged 9 to 12 years (boys and girls) were assessed based on 2 health indicators: body mass index and blood pressure. PF was measured using the ALPHA-Fitness test battery. Blood pressure, body mass, height, foot and hand length, standing long jump, 30 m sprint, 4 × 10 m agility test, and 20 m shuttle run test were assessed. The body mass index (BMI) and biological maturation were estimated.

Results. A total of 15 548 schoolchildren were assessed. Average systolic blood pressure was 101 ± 10 mmHg and diastolic blood pressure, 66 ± 7 mmHg; BMI: 20.2 ± 4.3 kg/m^2. Average PF was, in the cardiorespiratory component, VO_2 max.: 39.87 ± 3.2 mL/kg/min and speed reached during the 20 m shuttle run test: 8.9 ± 0.6 km/h; in the musculoskeletal component, standing long jump: 120.6 ± 23.9 cm, 30 m sprint: 6.56 ± 0.85 s, 4 × 10 m agility test: 15.17 ± 1.82 s. The performance was better in the boys group ($p < 0.001$).

Conclusion. Blood pressure was normal. Fifty percent of the sample was overweight or obese as per their BMI. Both boys and girls showed low PF levels. PF reference tables for schoolchildren from San Luis were developed for the first time.

Keywords: *cardiovascular risk; physical functional performance; Argentina; stress test;* ***child.***

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INTRODUCTION

Physical fitness (PF) is one of the most relevant health indicators.[1] Moderate and high levels of PF, specifically cardiorespiratory fitness and muscle strength, are associated with a low risk for metabolic diseases.[1,2] More recent studies have demonstrated a relationship with other benefits: an increased bone mineral density, a better development of motor skills, a reduction of depression symptoms, and improved emotional, social, and cognitive well-being in children.[3–8] For these reasons, measuring PF levels at school age has been one of the most widely used strategies globally[9–12] to reflect the functional status of the different body organs, systems, and structures that are related to physical activity and exercise.[1]

According to the bibliography, the ALPHA-Fitness test battery[13] is recommended to assess PF in schoolchildren, which has been shown to be a safe, valid, reliable, and sensitive tool to measure health-related PF in child and adolescent populations.[14,15] In America, Argentina was the first country to implement the ALPHA-Fitness test battery.[9] A total of 1867 boys and girls from different provinces were assessed: Entre Ríos, Mendoza, Buenos Aires, Misiones, and Santa Cruz. This study allowed to develop, for the first time, reference tables (percentiles) for Argentine schoolchildren. A second study was carried out in the province of Neuquén in 4487 male and female schoolchildren aged 9 to 18 years.[12] In both studies, PF levels were low; 1 out of 3 boys and 2 out of 3 girls had low PF levels; the latter was the most affected group.

These studies have set an important national precedent; however, the Argentine territory is very large and the PF levels of the remaining 17 provinces, including San Luis, are still unknown. It is also worth noting that those studies were conducted before the World Health Organization had declared the health emergency caused by the COVID-19 pandemic. Argentina established a preventive and mandatory social isolation policy. Consequently, the habits and behaviors of schoolchildren changed, resulting in a notable decrease in physical activity (PA) habits and PF levels.[16–22] This situation increases the risk for metabolic diseases. All of the above has resulted in a great interest by the scientific community on a global scale. A document developed by 46 experts from different countries has been recently published, which includes a list of the top 10 international priorities for research and surveillance of PF in children and young people worldwide.[23] In addition, Argentina developed a document on the safety and importance of PA and sports in the pediatric population.[24]

For this reason, we proposed 2 objectives: to measure the current health status and PF levels of schoolchildren aged 9 to 12 years from San Luis and to develop PF reference tables. These tables may be used by schools and municipal and sports institutions; they will be useful for physical education, to promote health, identify students with risk factors, design physical activity programs, and select sports talents.

METHOD

DESIGN AND SAMPLE

Descriptive, quantitative, cross-sectional, observational study. The study population was made up of all male and female schoolchildren attending fourth, fifth, and sixth grade of public and private primary schools in the province of San Luis. The sample size was not calculated because we attempted to measure the total population (all schools at this level were visited). The inclusion criteria were aged between 9 and 12 years and attending fourth, fifth, or sixth grade. The exclusion criterion was having any illness or injury that would make it impossible to do PA.

Procedures

The study was developed in the province of San Luis between June and September 2022 under the project titled Mapa Deportivo Provincial (Provincial Sports Map). Twenty measurement teams were established, made up of physical education teachers, Red Cross technicians, and advanced students of both degrees. Each of the teams participated in 50 hours of theoretical and practical training. Then, a pilot test was conducted on 1000 schoolchildren to adjust technical issues, procedures, and data collection accuracy.

The study was conducted in accordance with the Declaration of Helsinki and Resolution 1480/11 by the Argentine Ministry of Health in relation to research in human beings. All schoolchildren had medical clearance and gave their assent and delivered the written informed consent of their parents. Prior to the assessments, schools received a ministerial resolution with all the accurate information. This study was approved by the Ethics Committee of Universidad de La Punta, San Luis, Argentina.

In addition, the project was assessed and endorsed jointly by the Ministry of Science

and Technology, the Ministry of Education, the Ministry of Health, and the Department of Sports of San Luis.

Students in whom hypertension and/or obesity were detected were immediately referred to the Ministry of Health, which contacted their families through its health care agents. In addition, parents were informed of this situation.

Blood pressure. Blood pressure was measured using pediatric cuffs and in accordance with the protocol proposed by the National School Health Program (Programa Nacional de Salud Escolar, PROSANE, Argentina).[25] Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were classified according to the PROSANE reference values based on age, weight, and height.[25] This measurement was conducted by Red Cross providers.

Morphological component. Body weight, standing and sitting height, arm span (distance between the ends of both arms), and foot and hand length were measured. Measurements were done in accordance with the protocols proposed by the International Society for the Advancement of Kinanthropometry.[26] Children were weighed barefoot using a portable electronic scale HBF-500INT (OMROM), with a 0.100 kg precision. Height was recorded using a stadiometer (SECA 206). Hand length was measured using a short-leg caliper, while foot length, using a long-leg caliper.[26] The body mass index (BMI) was estimated (BMI: kg/m^2). Participants were identified as being overweight or obese based on the Sociedd Argentina de Pediatría criteria.[27] The formula proposed by Malina et al.[28] was used to estimate the peak height velocity (PHV).

Musculoskeletal component. The standing long jump (SLJ) was used as an indicator of lower limb strength. It consists in jumping the longest distance possible from a standing start (without racing ahead), with both feet and swinging both arms. The distance is measured from the starting line to the point where the back of the heel nearest to the starting line lands on the ground.[9]

Speed component. The 30 m sprint was used. It consists of running the distance of 30 m in the shortest time possible. A hand-held stopwatch was used to record the time. Subjects were behind the starting line and held a split-stance standing position (one foot forward and one foot back).

Motor component. The 4 x 10 m speed/agility test was used. It consists in running back and forth between two lines 10 m apart taking 3 sponges alternately as quickly as possible. The total distance run is 40 m.[9]

Cardiorespiratory component. The 20 m shuttle run test was used.[29] It consists of running back and forth in both directions on a 20 m track marked between 2 separate lines. Aerobic performance was recorded using the final speed reached (FSR) in the last completed stage.[30] The following equation was used to estimate the VO_2 max.:

VO_2 max. = 31.025 + (3.238*S) - (3.248*S) + (0.1536*S*A)

S: speed as km/h^{-1}. A: age in years.

Two measurements were recorded for each test, except for the 20 m shuttle run test, which was assessed only once. The best performance result was used for data analysis, as suggested in the bibliography.[9]

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. Percentile charts were developed using the LMS method and the LMS Chart Maker Light software.[9,12] Descriptive statistics (mean and standard deviation) were subsequently implemented. The Mann-Whitney U, a non-parametric test, was used to determine significant differences among variables. A value of $p < 0.001$ (alpha) was accepted in all cases.

RESULTS

There are a total of 21 337 schoolchildren in fourth, fifth, and sixth grade in the province of San Luis. Measurements were performed in 15 548 (73%) of them. The remaining 27% accounts for 5789 schoolchildren who were not assessed: 4586 (21%) because they were absent on the day of measurement and 1203 (6%) because they did not meet the eligibility criteria.

Table 1 describes the anthropometric characteristics, blood pressure, and physical fitness of both groups in the sample.

All recorded variables showed statistically significant differences between sexes ($p < 0.001$), except for age and BMI. Boys showed a better PF level than girls ($p < 0.001$).

SBP was statistically better in the boys group ($p < 0.001$). Based on SBP classification,[25] 77% of all schoolchildren assessed was below the 90th percentile (75% of boys and 80% of girls); 10%, in the 90th percentile (11% of boys and 7.5% of

girls); 10%, in the 95th percentile (10% of boys and 12% of girls); and 1.6%, in the 95th percentile + 12 mmHg (2% of boys and 1% of girls).

Likewise, DBP was higher in the boys group ($p < 0.001$). Based on DBP classification,[25] 83% of all schoolchildren assessed was below the 90th percentile (83% of boys and 82% of girls); 10%, in the 90th percentile (9% of boys and 7% of girls); 9%, in the 95th percentile (10% of boys and 7% of girls); and 1%, in the 95th percentile + 12 mmHg (1% of boys and 1% of girls).

Table 2 describes the percent distribution based on the BMI classification. Such distribution was similar between sexes.

Table 1. Descriptive analysis of measured variables

VARIABLES	ALL			GIRLS			BOYS			*p* <
	N	Mean	SD	N	Mean	SD	N	Mean	SD	
Age (years)	15 548	10.8	0.9	7840	10.8	0.9	7708	10.8	0.9	0.439
Maturation as per PHV (years)	15 548	-1.7	1.0	7840	-1.1	0.9	7708	-2.4	0.7	0.001
Body mass (kg)	15 548	43.0	12.0	7840	43.3	12.0	7708	42.6	12.0	0.001
Height (cm)	15 548	144.8	8.8	7840	145.6	9.0	7708	144.1	8.6	0.001
Sitting height (cm)	15 548	76.8	4.7	7840	77.5	4.9	7708	76.0	4.3	0.001
Arm span (cm)	15 548	144.1	9.8	7840	144.8	10.0	7708	143.4	9.5	0.001
Hand length (cm)	15 548	15.8	1.1	7840	15.9	1.1	7708	15.6	1.1	0.001
Foot length (cm)	15 548	22.5	1.5	7840	22.3	1.4	7708	22.6	1.6	0.001
BMI (kg/m^2)	15 548	20.2	4.3	7840	20.1	4.2	7708	20.3	4.3	0.318
Systolic blood pressure (mmHg)	15 548	101.9	10.2	7840	101.5	10.4	7708	102.3	9.9	0.001
Diastolic blood pressure (mmHg)	15 548	66.0	7.1	7840	66.3	7.1	7708	65.7	7.1	0.001
Standing long jump (cm)	15 388	120.6	23.9	7750	114.1	22.3	7638	127.1	23.8	0.001
30 m sprint (s)	14 719	6.56	0.85	7418	6.7	0.8	7301	6.4	0.8	0.001
4 × 10 m agility test (s)	15 340	15.17	1.82	7719	15.5	1.8	7621	14.8	1.8	0.001
20 m shuttle run test (stages)	14 387	1.9	1.3	7241	1.6	0.9	7146	2.2	1.5	0.001
20 m shuttle run test (km/h)	14 387	8.9	0.6	7241	8.8	0.5	7146	9.1	0.7	0.001
20 m shuttle run test (m)	14 387	309.1	230.9	7241	248.5	171.1	7146	370.5	264.9	0.001
Estimated VO_2 max. (mL/kg/min)	14 387	39.8	3.2	7241	39.0	2.6	7146	40.6	3.6	0.001

SD: standard deviation.
p: significance level.
BMI: body mass index.
PHV: peak height velocity.
VO_2 max.: maximal oxygen consumption based on the 20 meter shuttle run test.

Table 2. Classification based on body mass index (BMI)[27]

BMI classification	Girls	Boys	Both
Severe malnutrition	n = 9 0.1%	n = 14 0.2%	23 0.1%
Moderate malnutrition	n = 59 0.8%	n = 47 0.6%	106 0.7%
Normal	n = 4030 51.4%	n = 3516 45.6%	7546 48.5%
Obesity	n = 1709 21.8%	n = 2352 30.5%	4061 26.1%
Overweight	n = 2033 25.9%	n = 1779 23.1%	3812 24.5%
Total	n = 7840 100%	n = 7708 100%	15 548 100%

n: number.
BMI: body mass index.

Table 3. Standards for anthropometric variables and physical fitness in the boys group

Age	n	L	M	S	p10	p25	p50	p75	p90
				Height (cm)					
9	1732	0.349	134.328	0.046	126	130	134	139	143
10	2266	0.536	139.675	0.046	131	135	140	144	148
11	3115	0.030	144.745	0.048	136	140	145	149	154
12	595	-0.971	155.527	0.057	144	150	156	162	168
				Body mass (kg)					
9	1732	-0.911	32.989	0.239	25	28	33	39	48
10	2266	-0.725	37.485	0.244	28	32	37	45	54
11	3115	-0.613	41.108	0.246	30	35	41	49	59
12	595	-0.521	49.028	0.250	36	42	49	58	71
				Arm span (cm)					
9	1732	0.534	132.801	0.055	123	128	133	138	143
10	2266	0.949	138.685	0.053	129	134	139	144	149
11	3115	0.687	144.365	0.054	134	139	144	150	155
12	595	0.512	155.474	0.062	143	149	155	162	169
				Standing long jump (cm)*					
9	1715	1.100	118.270	0.184	89	104	118	133	147
10	2250	1.077	121.347	0.182	92	107	121	136	150
11	3085	1.109	128.940	0.179	98	113	129	144	159
12	588	1.564	139.828	0.184	103	122	140	156	172
				30 m sprint (s)*					
9	1670	-0.813	7.150	0.118	6.17	6.63	7.15	7.75	8.46
10	2177	-0.672	6.876	0.113	5.96	6.39	6.88	7.43	8.05
11	3012	-0.761	6.570	0.112	5.70	6.11	6.57	7.09	7.70
12	559	-0.819	6.277	0.118	5.42	5.82	6.28	6.81	7.42
				4 × 10 m agility test (s)*					
9	1711	-1.327	15.556	0.112	13.58	14.49	15.56	16.82	18.36
10	2251	-1.377	15.024	0.109	13.16	14.02	15.02	16.22	17.67
11	3070	-1.552	14.367	0.109	12.60	13.41	14.37	15.52	16.94
12	589	-1.923	13.981	0.113	12.24	13.03	13.98	15.17	16.71
				Estimated VO_2 max. (mL/kg/min)*					
9	1592	-16.465	41.838	0.029	40.6	41.1	41.8	42.8	44.5
10	2091	-10.975	40.469	0.046	38.6	39.4	40.5	42.0	44.8
11	2829	-6.568	39.422	0.067	36.7	37.9	39.4	41.6	45.1
12	558	-2.438	37.044	0.109	32.7	34.6	37.0	40.1	44.3
				20 m shuttle run test (km/h)*					
9	1592	-16.462	8.669	0.030	8.4	8.5	8.7	8.9	9.3
10	2091	-11.472	8.779	0.044	8.4	8.6	8.8	9.1	9.7
11	2829	-7.376	8.954	0.060	8.4	8.6	9.0	9.4	10.1
12	558	-3.265	9.197	0.088	8.3	8.7	9.2	9.8	10.7

L: asymmetry (lambda).

M: median.

S: coefficient of variation (sigma).

n: number.

VO_2 max.: maximal oxygen consumption based on the 20 meter shuttle run test.

**Differences in the number of schoolchildren measured in the tests are mainly due to school operational and/or climatic reasons.*

Table 4. Standards for anthropometric variables and physical fitness in the girls group

Age	n	L	M	S	p10	p25	p50	p75	p90
				Height (cm)					
9	1776	-0.728	134.109	0.051	125	130	134	139	144
10	2310	0.368	140.576	0.051	131	136	141	145	150
11	3165	1.320	147.549	0.049	138	143	148	152	157
12	589	2.212	152.640	0.045	143	148	153	157	161
				Body mass (kg)					
9	1776	-0.850	32.723	0.235	25	28	33	39	47
10	2310	-0.572	37.380	0.244	28	32	37	44	54
11	3165	-0.378	42.810	0.244	31	37	43	51	61
12	589	-0.281	47.341	0.239	36	42	48	57	67
				Arm span (cm)					
9	1776	-0.432	132.162	0.059	122	127	132	138	143
10	2310	0.634	139.416	0.058	129	134	139	145	150
11	3165	1.693	147.053	0.055	136	142	147	152	158
12	589	2.692	152.600	0.051	142	148	154	159	163
				Standing long jump (cm)*					
9	1758	0.676	103.827	0.196	78	91	104	118	132
10	2286	0.756	109.589	0.191	83	96	110	124	138
11	3129	0.932	115.801	0.189	87	101	116	130	145
12	577	1.045	119.738	0.194	89	104	120	136	151
				30 m sprint (s)*					
9	1632	0.349	7.342	0.046	6.27	6.76	7.34	8.05	8.92
10	2148	0.536	7.067	0.046	6.04	6.51	7.07	7.74	8.56
11	2953	0.030	6.753	0.048	5.77	6.23	6.75	7.38	8.12
12	568	-0.971	6.529	0.057	5.57	6.01	6.53	7.14	7.87
				4 × 10 m agility test (s)*					
9	1759	-0.230	16.361	0.107	14.22	15.24	16.36	17.58	18.92
10	2272	-0.722	15.767	0.103	13.83	14.74	15.77	16.92	18.23
11	3115	-1.096	15.170	0.104	13.33	14.19	15.17	16.31	17.64
12	573	-1.391	14.825	0.108	13.00	13.84	14.82	15.99	17.41
				Estimated VO_2 max. (mL/kg/min)*					
9	1624	-3.95	40.95	0.07	39.4	39.8	40.3	41.1	43.0
10	2130	-3.95	40.95	0.07	37.6	38.0	38.7	40.3	42.5
11	2947	-3.51	39.54	0.08	35.7	36.2	37.0	39.0	41.5
12	540	-3.10	38.32	0.09	34.6	35.1	35.3	37.8	40.3
				20 m shuttle run test (km/h)*					
9	1624	-4.93	9.08	0.06	8.4	8.5	9.1	9.5	10.1
10	2130	-4.69	9.16	0.06	8.4	8.6	9.2	9.5	10.2
11	2947	-4.46	9.28	0.07	8.4	8.6	9.2	9.5	10.4
12	540	-4.22	9.40	0.07	8.3	8.7	9.3	9.5	10.6

L: asymmetry (lambda). M: median.

S: coefficient of variation (sigma).

n: number.

VO_2 max.: maximal oxygen consumption based on the 20 meter shuttle run test.

**Differences in the number of schoolchildren measured in the tests are mainly due to school operational and/or climatic reasons.*

Table 5. Physical fitness (PF) levels based on the classification as per the body mass index[27]

PF‡	Classification as per BMI*		
	Normal	Overweight	Obesity
Girls	n = 4030	n = 2033	n = 1709
SLJ (cm)	118 ± 22	112 ± 21	104 ± 20
30 m sprint (s)	6.5 ± 0.7	6.7 ± 0.8	7.1 ± 0.8
4 × 10 m agility test (s)	15.2 ± 1.7	15.5 ± 1.7	16.2 ± 1.8
VO_2 max. (mL/kg/min)	39.4 ± 2.7	38.7 ± 2.3	38.9 ± 2.5
	Normal	Overweight	Obesity
Boys	n = 3516	n = 1779	n = 2352
SLJ (cm)	135 ± 22	127 ± 22	114 ± 20
30 m sprint (s)	6.1 ± 0.8	6.3 ± 0.9	6.8 ± 0.8
4 × 10 m agility test (s)	14.3 ± 1.8	14.6 ± 1.7	15.6 ± 1.8
VO_2 max. (mL/kg/min)	41.7 ± 3.7	40.4 ± 3.7	38.8 ± 2.4

PF: physical fitness.

‡ Expressed as mean ± standard deviation.

BMI: body mass index.

SLJ: standing long jump.

VO_2 max.: maximal oxygen consumption based on the 20 meter shuttle run test.

**Participants with malnutrition were not included because they accounted for a small sample size (girls n = 67; boys n = 60).*

Table 3 shows the standards corresponding to boys' PF, as expressed in the 10th, 25th, 50th, 75th, and 90th percentiles. *Table 4* shows the standards corresponding to girls' PF, as expressed in the 10th, 25th, 50th, 75th, and 90th percentiles.

Table 5 describes PF test values based on the BMI. As observed, schoolchildren who had a healthy (normal) BMI had statistically significant higher values in PF levels, regardless of sex ($p < 0.001$). No differences in PF levels were noted between boys and girls who were classified as overweight and obese.

DISCUSSION

An assessment of current cardiovascular health status and PF levels in schoolchildren aged 9 to 12 years (both girls and boys) has been carried out for the first time in the province of San Luis. This study allowed to develop PF reference tables and is the study with the highest number of schoolchildren measured in this age group compared to national studies.[9,12] This is also the first study to assess PF after the COVID-19 lockdown. A limitation of this study is that the sample is not representative of the entire country.

In both groups (boys and girls), the performance in the PF tests increased with age; it was better in the boys group. Such differences between groups are consistent with other previously published studies.[9–12] The cardiorespiratory and musculoskeletal components were notably lower compared to national[9,12] and international studies.[10,13] In the morphological component, it was observed that 50% of the schoolchildren assessed were classified as overweight or obese, regardless of sex, which was higher than other previously published studies, mainly in the boys group.[9,12,31,32] Similar to other studies, schoolchildren who were classified as having a healthy BMI had a better performance in the PF tests.[9,12]

There are several reasons for the low performance in PF levels and the high number of subjects classified as overweight or obese, which are not necessarily related to the pandemic. Actually, studies conducted before the pandemic had already reported a reduction in PF levels[7,9,33] and a high BMI among girls.[12] Both boys and girls have a low level of PA, do not participate in extracurricular sports, spend a large part of the day sitting at school and during their leisure time, and spend, on average, more than 4 hours using screens.[17] The BMI of Argentine schoolchildren has also increased in the past 2 decades (2001–2011 and 2011–2021). This partially accounts for the increase in body weight in schoolchildren.[32]

During the pandemic, these characteristics were reinforced, as the decrease in PA time, the alteration in sleeping hours, and the increase in hours in front of screens intensified.[16,18,19,21,22,34] Pajek (2020) conducted a longitudinal study in 1500 male and female schoolchildren aged 11

to 13 years and reported a decrease in motor development resulting from decreased PA time during the pandemic.[22] Jarnic et al. reported a decrease in PF levels and an increase in post-pandemic body weight gain in children between 7 and 11 years of age.[34] A longitudinal study started prior to the pandemic conducted new measurements after the pandemic and found a decrease in PF, mainly the aerobic and musculoskeletal components.[22]

In relation to BP, the vast majority of schoolchildren were below the 90th percentile in both measurements, suggesting that most of the population has normal BP values. A proportion of the population was in the highest percentiles, indicating a higher risk for arterial hypertension. It is important to continue monitoring BP and promote healthy habits to prevent hypertension.

CONCLUSION

Most schoolchildren had healthy BP levels; a high percentage of them had high BMI values. In addition, PF test performance was always better in the boys group.

The first PF reference tables specific for children of San Luis have been developed, and this accounts for a major advance in PF assessment in this population. ■

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