

Age and gender specific normative physical fitness values among school going children: A cross-sectional analytical study

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Abstract

Objective: To determine age- and gender-specific normative values for physical fitness among school-going children.

Method: The cross-sectional, analytical study was conducted from September 2021 to May 2022 in Alipur, Pakistan, and comprised school-going children of either gender aged 10-17 years. Physical fitness was assessed using the Assessing Levels of Physical Activity health-related fitness test battery, morphological component, waist circumference, hand grip strength measurement of right and left hands, 4x10m shuttle run test for motor fitness assessment and 20min shuttle test for cardiorespiratory fitness assessment. Data was analysed using SPSS 29.

Results: Of the 500 subjects, 250(50%) were boys with mean age 13.35 ± 2.02 years, and there were as many girls with mean age 13.40 ± 2.08 years ($p > 0.05$). Boys showed higher values in handgrip strength (right hand: 36.3kg, left hand: 33.7kg), standing long jump (155.5cm), and maximum rate of oxygen consumption (45.2mL/kg/min) than the girls, who had higher triceps (14.03mm) and subscapular skinfold thicknesses (9.11mm) ($p < 0.05$). Percentile-based age-specific normative data was also significant ($p < 0.05$).

Conclusion: Male and female children showed significant differences across physical fitness values, and these values provided a clinical endpoint in determining health problems in future.

Keywords: Physical fitness, Reference values, Predictive, anthropometry, Grip strength. (JPMA 75: 1067; 2025)

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Introduction

Physical fitness is a multidimensional domain that consists of health-related components of cardiorespiratory fitness (CRF) and musculoskeletal fitness (MSF), which are considered strong determinants of health among youth.¹ CRF and MSF are the main indicators that show strong association with cancer, cardiovascular and cerebrovascular diseases independent of weight and levels of physical activity.² The World Health Organisation (WHO) estimates that physical inactivity significantly increases the incidence of numerous severe chronic diseases, leading to 1.9 million deaths worldwide.³⁻⁵

The physical fitness of an individual is measured by using normative referenced percentiles by comparing it with age- and gender-matched individuals within the same population. Physical fitness levels among children can be predicted based on factors, such as their lifestyle, CRF, overall health, and mental status. These fitness levels play a crucial role in determining the risk of chronic diseases, including obesity, cardiovascular diseases (CVDs) and

metabolic risks.⁶⁻⁹ Physical fitness levels among adults are evaluated worldwide using standardised test batteries, like Fundación Colombiana de Percepción de Condición Física en Jóvenes (FUPRECOL),¹⁰ European Fitness Testing Battery (EUROFIT),¹¹ Canadian Physical Activity, Fitness & Lifestyle Approach (CPAFLA)¹² and Assessing Levels of Physical Activity (ALPHA).¹³ Physical fitness is correlated with the wellbeing of children's health status as it represents prosperity and comfort.¹⁴ Physical activity leads to reduction in the level of pro-inflammatory cytokines, and the chance of many secondary systematic and physical deformities among overweight children which ultimately improve cardiorespiratory function, quality of life, physical fitness, academic achievements and mental health.¹⁵

Pakistan is a developing country with a very high crude birth rate.¹⁶ About 44% of the total population is aged <19 years.¹⁷ In the best of our knowledge, there are no population-specific normative reference standards for the said age group. The current study was planned to determine the physical fitness normative values among school-going children.

Subjects and Methods

The cross-sectional, analytical study was conducted from September 2021 to May 2022 in Alipur, Muzaffargarh, Pakistan. The subjects were enrolled from the Alipur Public Higher Secondary School, the Asif Saleem Higher Secondary School, and the Government Girls High School.

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After approval from the ethics review committee of Riphah International University, Lahore, The sample size was calculated using Epitool to detect small effects (Cohen's f-squared, $f^2=0.20$) with statistical power 0.80 and alpha 0.05.¹⁸ The sample was raised using non-probability convenience sampling technique, and written informed consent was obtained from both parents of each participant. Those included were school-going children of either gender aged 10-17 years (corresponding to grade 5-10) who were present at the time of data collection. Children suffering from any systemic illness, such as flu, cough, sore throat, fever, or any physical deformities were excluded.

Demographic data, including age and gender, was obtained from the records after permission from the school management concerned. Subsequently, ALPHA was used for assessing morphological, musculoskeletal and cardiorespiratory components addressing physical fitness.¹³

In morphological components, height and weight were assessed through portable stadiometer (Portable Stadiometer- Model 67310, USA) and weighing machine (Beurer Diagnostic bathroom scale, Germany), respectively. Waist circumference was measured through non-elastic tape, while skinfold thickness of triceps and subscapularis was measured through skinfold calliper (Holtain Tanner / Whitehouse Skinfold Calliper – Model 610ND, USA) respectively.¹⁹ A hand dynamometer (CAMRY Digital Hand Dynamometer Grip Strength Measurement, Hong Kong) was used for upper body strength and lower body strength, while standing long jump distance was measured using a tape. These measures represented the musculoskeletal component.^{20,21} Cardiorespiratory components included 4x10m shuttle run test to estimate coordination, agility and speed of movement.²² The maximum rate of oxygen consumption (VO_{2max}) was assessed through 20m shuttle run test, using the equation; $VO_{2max}=31.025\pm 3.238 *V-3.248 *A+0.1536$ where V was the velocity (km/h-1) of the last completed stage, and A was the subject's age (in years).¹⁰

Data was analysed using SPSS 29. For better comparison, children were divided into seven age strata. Further, 3rd, 10th, 25th, 50th, 75th and 90th percentile values for waist circumference, body mass index (BMI), triceps skinfold, subscapular skinfold, handgrip, standing long jump test, 4x10m shuttle run, and 20m shuttle run test, were noted for boys and girls separately along the seven age strata. Independent sample t test was used to compare differences across physical fitness parameters. $P<0.05$ was considered significant.

Results

Of the 500 subjects, 250(50%) were boys with mean age 13.35 ± 2.02 years, and there were as many girls with mean age 13.40 ± 2.08 years ($p>0.05$). There were significant differences in anthropometric and physical fitness parameters with respect to gender (Table 1). Percentile values for anthropometric and physical fitness parameters for each age category for male and female subjects were noted in detail (Table 2).

Table-1: Comparison of morphological, musculoskeletal and cardiorespiratory components across gender

Variables	Total (n=500)	Male (n=250)	Female (n=250)	p-value
Age (years)	13.49±2.05	13.35±2.02	13.40±2.08	0.759
Height (m)	1.56±0.102	1.59±0.12	1.540±0.75	0.001
Weight (kg)	48.28±8.56	49.20±9.71	47.20±7.10	0.009
BMI (kg/m ²)	19.48±1.40	19.20±1.34	19.77±1.41	0.001
Waist circumference (cm)	69.91±5.26	72.20±4.23	67.60±5.02	0.001
Triceps skinfold thickness (mm)	11.12±3.27	8.21±1.03	14.03±1.43	0.001
Subscapular skinfold thickness(mm)	7.88±1.74	6.66±0.92	9.11±1.47	0.001
Hand grip strength -Right hand (kg)	34.83±2.02	36.30±7.73	33.40±7.57	0.001
Hand grip strength -Left hand (kg)	32.18±7.70	33.71±7.39	30.45±7.67	0.001
Standing long jump (cm)	142.20±19.8	155.50±18.57	128.80±9.22	0.001
4 X 10m shuttle run test (sec)	14.27±1.26	13.58±1.21	14.75±1.04	0.001
VO_{2max} (m.kg.min ⁻¹)	42.91±4.32	45.20±4.22	40.62±3.01	0.001

Discussion

The current study aimed at determining the physical fitness normative values among school-going children. It was found that the physical fitness was highly gender specific as boys had greater morphological, musculoskeletal and cardiorespiratory components compared to the girls of same age, except for triceps, subscapularis skin folds and 4x10m shuttle run test.

An earlier study also reported similar findings. Among children aged 10-14 years, girls showed better results in 20m shuttle run test than boys, and among those aged 15-18 years, the results were opposite. Boys showed better results in curl-up and push-up tests.²³ Similarly boys showed better CRF than girls, and the performance of older children were better than younger ones among both boys and girls. In speed agility and shuttle test, lack of performance was found in older children than younger ones. In long standing jump and frontal throws of basketball, the performance of boys was more significant than of girls, and older children performed better than younger ones ($p<0.05$).²³

A study in primary schoolchildren concluded that in all tests, boys performed better than girls. Also, older children performed better than younger ones.²⁴ Another study also supported the current findings, but the performance of girls was better in flexibility test than boys ($p<0.001$).²⁵

Table 2: Comparison of morphological, musculoskeletal and cardiorespiratory components across gender

	Age Category	Male (n)	Mean ±SD	P3	P10	P25	P50	P75	P90	Female (n)	Mean ±SD	P3	P10	P25	P50	P75	P90
4X 10 m shuttle run test (sec)	10.0-10.9	31	14.90±0.56	14.00	14.07	15.00	15.01	15.05	15.08	31	15.6±1.51	10.07	15.07	16.01	16.03	16.06	16.07
	11.0-11.9	30	14.90±0.56	12.00	14.00	14.09	15.02	15.04	16.02	23	5.28±1.70	10.03	12.03	15.07	16.00	16.02	16.03
	12.0-12.9	28	14.50±0.56	14.00	14.01	14.03	14.09	15.01	15.05	41	15.01±0.95	12.02	14.02	15.00	15.06	15.09	16.04
	13.0-13.9	28	13.67±0.48	13.00	13.01	13.05	14.00	14.02	14.09	20	14.83±0.39	14.02	14.09	15.00	15.01	15.03	15.05
	14.0-14.9	51	12.78±0.81	11.56	12.00	12.08	13.02	13.07	13.09	53	14.72±0.63	13.62	14.00	14.04	15.00	15.04	15.09
	14.0-14.9	44	12.69±0.85	12.00	12.00	12.05	12.09	13.05	14.02	43	14.17±0.40	13.38	14.00	14.02	14.05	14.09	15.01
	16.0-17.0	38	12.82±0.86	11.24	12.00	12.05	13.00	13.07	14.05	39	14.05±0.15	14.00	14.00	14.01	14.02	14.06	14.09
	10.0-10.9	31	52.32±0.62	51.08	51.27	52.00	52.08	53.00	53.02	31	39.25±0.54	38.10	39.00	39.01	39.10	40.00	40.01
	11.0-11.9	30	50.60±0.99	48.00	49.17	50.04	51.00	51.05	52.04	23	39.1±0.55	38.00	38.06	39.00	39.03	39.08	40.00
	12.0-12.9	28	46.38±1.80	42.05	44.90	45.05	46.05	47.76	48.05	41	38.64±0.72	38.00	38.02	38.05	38.09	39.03	39.81
Vo2 max (ml.kgmin ⁻¹)	13.0-13.9	28	42.85±0.69	42.05	42.06	42.09	43.00	43.06	44.00	20	38.28±1.09	37.09	37.09	38.00	38.05	38.07	39.90
	14.0-14.9	51	43.36±0.60	43.00	43.00	43.01	43.07	44.00	44.00	53	42.11±3.04	37.03	37.08	38.01	44.00	44.01	45.00
	15.0-15.9	44	44.10±1.90	38.36	41.50	44.00	45.00	45.05	46.00	43	45.29±0.57	44.01	45.00	45.00	45.05	46.00	46.00
	16.0-17.0	38	39.66±1.44	37.17	38.00	38.76	39.08	41.00	42.00	39	38.68±1.74	36.27	37.00	37.07	38.01	40.00	44.03
	10.0-10.9	31	28.4±4.94	20.05	22.06	24.03	27.09	34.00	35.81	31	23.9±2.98	19.00	20.00	21.05	24.05	27.00	28.10
	11.0-11.9	30	28.8±3.9	23.05	23.08	28.59	34.09	35.78	37.18	23	24.7±3.06	18.04	20.43	22.07	25.01	27.04	29.04
	12.0-12.9	28	32.23±4.72	23.05	23.08	28.59	34.09	35.78	37.18	41	29.84±3.12	23.30	25.25	27.05	31.00	32.53	33.07
	13.0-13.9	28	34.04±4.18	23.05	27.57	33.00	35.07	37.06	38.03	20	31.63±2.08	27.04	29.01	30.04	32.04	33.01	34.93
	14.0-14.9	51	39.42±5.69	23.59	29.09	39.08	42.00	43.01	44.00	53	33.08±2.51	29.41	31.52	33.03	35.00	36.61	29.41
	15.0-15.9	44	40.20±5.85	25.02	29.52	38.31	42.03	44.00	45.08	43	38.1±3.95	28.39	33.04	36.07	38.03	40.05	43.61
Hand grip strength right hand(kg)	16.0-17.0	38	44.51±6.60	28.01	31.86	42.53	46.50	49.30	51.03	39	45.57±3.78	35.24	40.01	43.09	46.03	49.00	50.00
	10.0-10.9	31	26.6±4.61	19.01	20.26	23.00	26.01	32.00	33.06	31	21.2±3.40	16.03	18.40	20.00	20.10	25.00	25.00
	11.0-11.9	30	26.86±3.89	19.01	21.18	23.76	27.01	31.00	31.90	23	22.2±2.77	15.07	18.40	20.00	23.00	24.09	25.03
	12.0-12.9	28	29.53±4.79	20.03	20.93	25.55	31.05	33.00	35.06	41	26.76±2.97	20.29	23.00	24.07	27.03	29.03	30.01
	13.0-13.9	28	31.35±4.32	20.01	24.56	31.00	32.03	35.01	35.05	20	28.69±3.16	24.00	25.12	26.32	28.53	30.76	32.04
	14.0-14.9	51	36.75±5.64	21.01	25.01	37.00	39.01	40.02	41.03	53	30.18±2.70	25.00	26.04	28.53	30.02	32.07	34.00
	15.0-15.9	44	37.47±5.74	23.01	27.05	35.27	40.00	41.02	42.55	43	35.35±4.69	25.33	29.05	34.00	35.03	37.05	42.60
	16.0-17.0	38	41.23±6.50	25.17	29.70	37.77	42.03	45.32	48.05	39	42.44±4.99	27.80	36.03	40.03	43.07	46.03	47.00
	10.0-10.9	31	64.2±3.28	60.00	60.07	61.00	63.00	67.00	68.00	31	62.58±2.41	60.00	60.04	61.00	62.00	64.00	66.80
	11.0-11.9	30	68.03±2.17	64.00	65.10	66.00	68.00	69.30	71.00	23	63.09±2.21	60.00	60.40	62.00	63.00	64.00	65.60
Waist circumference (cm)	12.0-12.9	28	72.21±1.52	69.00	70.00	71.00	73.00	74.00	74.00	41	65.27±3.81	60.00	61.00	62.50	64.00	67.00	72.80
	13.0-13.9	28	72.46±1.37	70.00	70.90	71.25	72.00	73.75	74.10	20	66.90±3.90	62.00	63.10	64.00	65.52	69.75	73.80
	14.0-14.9	51	74.68±1.71	70.56	72.00	74.00	75.00	76.00	77.50	53	68.64±4.38	60.62	63.00	66.00	68.00	71.02	75.20
	15.0-15.9	44	74.84±1.85	70.35	72.50	74.00	75.00	76.00	77.50	43	71.30±4.10	65.00	66.40	68.00	71.00	75.00	77.60
	16.0-17.0	38	75.29±1.75	71.17	72.90	74.00	75.00	76.28	77.10	39	71.73±4.05	64.20	66.00	68.06	73.00	75.00	77.00
	10.0-10.9	31	68.3±0.99	5.48	6.40	6.49	6.56	6.60	6.62	31	12.19±0.23	11.91	11.93	12.06	12.19	12.27	12.34
	11.0-11.9	30	6.87±0.99	5.30	6.38	6.57	6.60	6.63	6.63	23	12.34±0.14	12.01	12.21	12.29	12.33	12.41	12.52
	12.0-12.9	28	9.21±0.94	6.55	6.61	9.37	9.56	9.65	9.67	41	12.81±0.45	12.22	12.30	12.40	12.80	13.15	12.5
	13.0-13.9	28	9.18±0.33	8.57	8.70	8.90	9.16	9.44	9.65	20	13.70±0.30	13.13	13.40	13.40	13.70	13.97	14.1
	14.0-14.9	51	8.61±0.21	8.27	8.34	8.42	8.65	8.70	8.91	53	14.36±0.27	14.01	14.10	14.10	14.20	14.65	14.7
Triceps skinfold thickness (mm)	15.0-15.9	44	8.34±0.14	8.14	8.17	8.23	8.31	8.41	8.61	43	15.13±0.30	14.79	14.80	14.90	15.00	15.42	15.6
	16.0-17.0	38	8.20±0.06	8.10	8.12	8.16	8.21	8.25	8.30	39	16.28±0.31	15.66	15.70	16.10	16.5	16.53	16.6
	10.0-10.9	31	5.44±0.17	5.19	5.22	5.27	5.40	5.63	5.66	31	6.91±0.109	6.78	6.79	6.83	6.90	6.97	7.10
	11.0-11.9	30	5.69±0.16	5.17	5.35	5.68	5.73	5.79	5.84	23	7.41±0.24	7.07	7.10	7.14	7.51	7.56	7.72
	12.0-12.9	28	6.09±0.06	5.97	6.02	6.05	6.08	6.11	6.21	41	8.02±0.27	7.66	7.76	7.82	7.88	8.23	8.43
	13.0-13.9	28	6.42±0.16	6.20	6.21	6.31	6.37	6.56	6.70	20	8.81±0.27	8.43	8.45	8.51	8.93	8.06	9.11
	14.0-14.9	51	6.67±0.16	6.33	6.45	6.59	6.67	6.77	6.82	53	9.54±0.23	9.19	9.25	9.30	9.62	9.76	9.83
	15.0-15.9	44	7.26±0.22	6.54	7.13	7.19	7.26	7.32	7.41	43	10.22±0.27	9.87	9.97	10.01	10.07	10.51	10.67
	16.0-17.0	38	8.29±0.34	7.36	7.55	8.21	8.40	8.56	8.60	39	11.31±0.57	10.67	10.75	11.05	11.37	11.43	11.47
	Subscapular skinfold thickness (mm)																

Similarly, it was established that boys scored better in cardiorespiratory fitness, muscular endurance, speed, flexibility and agility than girls. Flexibility was better in girls than boys.²⁶

Based on the current findings, it is recommended that a routine assessment of physical fitness should be conducted in early years as a method to diagnose health-related issues early. This will not only help in improving the academic performance of students but will also shift the management approach from treatment to prevention of disorders.

The current study has limitations. Data was collected from a specific geographical location, which may have affected physical fitness levels owing to factors such as urbanisation and local environment. Besides, flexibility was not measured as it was beyond the scope of the ALPHA protocol. Additionally, nutritional status was not recorded which could be a confounding factor in interpreting anthropometric measurements.

Conclusion

Boys were found to have a higher level of physical fitness compared to girls across all age groups. The percentile values can provide a clinical endpoint in comparing individual values with a norm-based reference values for Pakistani children in determining health problems.

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Author Contribution:

SM: Concept, design, drafting, revision and agreement to be accountable for all aspects of the work.

DH: Concept, design, drafting, revision, final approval and agreement to be accountable for all aspects of the work.

SK: Data acquisition, analysis, interpretation and agreement to be accountable for all aspects of the work.

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