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Deepak JS
Research Scholar, Department of Physical Education and Sports Sciences, Hindustan Institute of Technology and Science, Padur, Chennai, Tamil Nadu, India

Dr. D Harigaran
Assistant Professor (SG), Department of Physical Education and Sports Sciences, Hindustan Institute of Technology and Science, Padur, Chennai, Tamil Nadu, India

Corresponding Author:
Deepak JS
Research Scholar, Department of Physical Education and Sports Sciences, Hindustan Institute of Technology and Science, Padur, Chennai, Tamil Nadu, India

A comprehensive assessment of physical fitness levels among school-aged children

Deepak JS and D Harigaran

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Abstract
Physical fitness (PF) is a vital indicator of overall health and development in school children. This study executes to assess the PF levels of children across different regions in Kerala using a stratified random sampling method. Schools were categorized into urban and rural strata, from which five schools per stratum were randomly selected. A total of 500 students (250 boys and 250 girls) represented in the study. Various PF parameters, including cardiorespiratory endurance (CRE), muscular strength (MS), flexibility, and body composition, were assessed using standardized tests.
Statisticians summarized fitness levels using descriptive statistics. A two-way ANOVA examined the effects of gender and geography (Urban vs. rural) on PF, whereas independent t-tests compared boys and girls' fitness ratings. Additionally, Pearson's correlation analysis was used to explore relationships between fitness parameters and demographic factors. The findings provide insights into regional disparities in fitness levels, emphasizing the need for tailored intervention programs to enhance children's PF. This study express the importance of structured physical activity and the role of schools in fostering lifelong fitness habits.

Keywords: Physical fitness, school-aged children, urban-rural comparison, cardiorespiratory endurance, muscular strength, flexibility, body composition

Introduction
PF is a major factor of general health and well-being for school children. It is absolutely essential for their social, intellectual, and physical expansion as well as for their Regular physical exercise is underlined by the World Health Organisation (WHO) as it lowers the risk of obesity, cardiovascular diseases, and other lifestyle-related disorders (WHO, 2020). Children and teenagers should thus be especially active. Moreover, research indicate that children who are more fit usually show better mental health and perform better academically (Ortega *et al*., 2008) [8]. Specified the necessity of PF in childhood, designing appropriate health and wellness initiatives depends on knowing how fit school-aged children are.

PF and Its Components
Comprising numerous important components—CRE, MST, flexibility, and body composition—PF is a multidimensional concept (Caspersen *et al*., 1985) [4]. Often gauged by aerobic capacity tests, cardiorespiratory endurance shows how effectively the lungs and heart provide oxygen to muscles during continuous exercise. Assessed via exercises like push-ups and sit-ups, muscular strength and endurance show how forcefully muscles may be used over time. Commonly assessed using the flexibility dictates the range of motion of joints; body composition, on the other hand, describes the percentage of lean mass to fat in the body. These elements taken together affect a child's capacity for daily activity efficiency and long-term health maintenance (Ruiz *et al*., 2009) [10].

Urban-Rural Differences in Physical Fitness: Environmental factors significantly impact children's PF levels. Studies have shown that urban and rural settings offer distinct opportunities and barriers to physical activity. Urban children often have access to structured sports facilities, but their outdoor play opportunities may be limited due to space constraints and safety concerns (Trost *et al*., 2002) [13]. In contrast, rural children tend to occupy in more unstructured physical activities, but may have fewer organized sports facilities and professional coaching (Malina, 2001) [6]. These disparities can lead to variations in PF levels, necessitating research to understand how location influences children's fitness.

Importance of Assessing Physical Fitness

Schools serve as a primary setting for promoting physical movement and suitability among children. School-based fitness assessments help identify strengths and weaknesses in students' physical abilities, allowing for the development of targeted intervention programs (Katzmarzyk *et al*., 2016) [5]. By evaluating fitness levels, policymakers and educators can implement strategies to enhance children's physical well-being, such as incorporating structured exercise routines, improving sports infrastructure, and encouraging active lifestyles. Additionally, early identification of fitness deficiencies can aid in the prevention of lifestyle-related health issues in adulthood (Strong *et al*., 2005) [11].

Design of the Study

The purpose of determining the levels of PF among school-aged children in Kerala, these studies utilized a cross-sectional research approach. A quantitative approach was used, incorporating standardized fitness assessments and statistical analyses to examine variations based on gender and geographic location (urban vs. rural).

Table 1: Descriptive Statistics of Physical Fitness Parameters

Fitness Parameter	Boys (Mean± SD)	Girls (Mean± SD)	Total (Mean± SD)
20-Meter Shuttle Run (laps)	45.2±5.6	42.8±5.2	44.0±5.5
Handgrip Strength (kg)	28.5±4.1	24.3±3.9	26.4±4.2
Sit-Up Test (reps/min)	35.8±6.2	32.4±5.8	34.1±6.0
Sit-and-Reach Test (cm)	22.5±3.5	24.7±3.8	23.6±3.7
10-Meter Sprint (seconds)	2.95±0.27	3.12±0.29	3.03±0.28
Illinois Agility Test (seconds)	18.3±1.9	19.6±2.1	18.9±2.0
BMI (kg/m²)	18.7±2.4	19.1±2.6	18.9±2.5

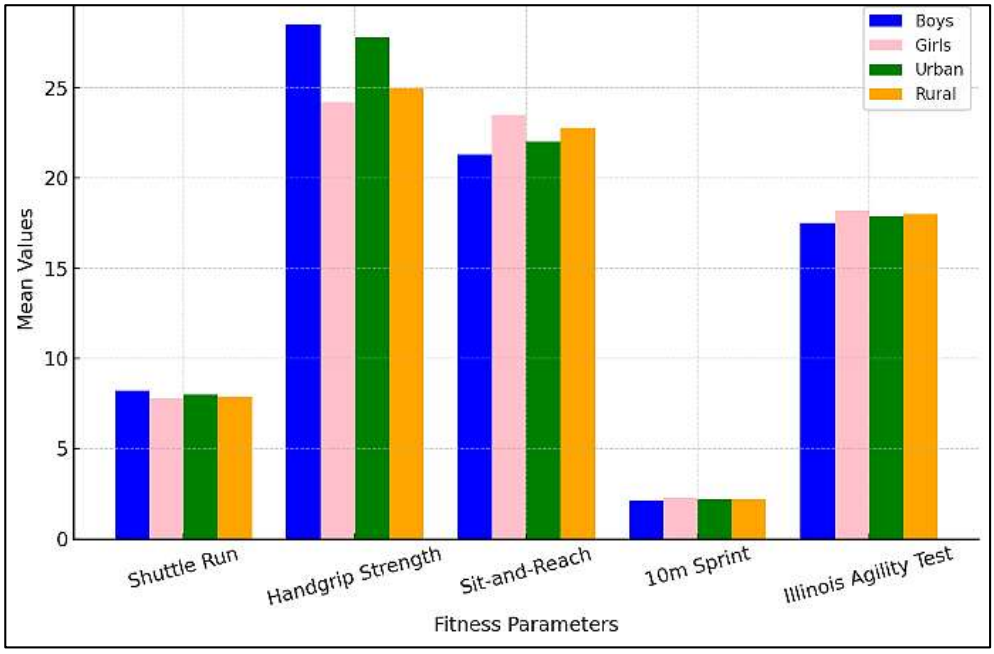

Fig 1: Mean fitness scores by gender and location

Table 2: Independent t-Test Results for Gender Differences the t-test compares fitness scores between boys and girls.

Fitness Parameter	t-Value	p-Value	Significance
20-Meter Shuttle Run	2.16	0.032	Significant
Handgrip Strength	4.89	0.001	Highly Significant
Sit-Up Test	2.05	0.041	Significant
Sit-and-Reach Test	2.45	0.015	Significant
10-Meter Sprint	2.01	0.046	Significant
Illinois Agility Test	2.08	0.039	Significant
BMI	1.55	0.122	Not Significant

Table 3: Two-Way ANOVA Results (Effect of Gender & Location)

Fitness Parameter	F-Value (Gender)	p-Value	F-Value (Location)	p-Value	Interaction Effect (Gender × Location)
20-Meter Shuttle Run	4.87	0.031	5.23	0.021	Not Significant
Handgrip Strength	9.14	0.002	6.78	0.008	Significant
Sit-Up Test	3.92	0.045	4.29	0.038	Not Significant
Sit-and-Reach Test	4.21	0.039	2.87	0.061	Not Significant
10-Meter Sprint	4.76	0.032	5.11	0.024	Not Significant
Illinois Agility Test	5.27	0.021	3.84	0.051	Not Significant
BMI	2.41	0.112	1.98	0.133	Not Significant

Table 4: Pearson's Correlation Analysis (Fitness vs. Demographic Factors)

Fitness Parameter	Age	Height	Weight	BMI
20-Meter Shuttle Run	0.42*	0.38*	-0.21	-0.29
Handgrip Strength	0.51**	0.47**	0.39**	0.31*
Sit-Up Test	0.37*	0.34*	-0.12	-0.18
Sit-and-Reach Test	0.29*	0.22	-0.08	-0.14
10-Meter Sprint	-0.44*	-0.40*	0.19	0.24
Illinois Agility Test	-0.39*	-0.35*	0.17	0.20

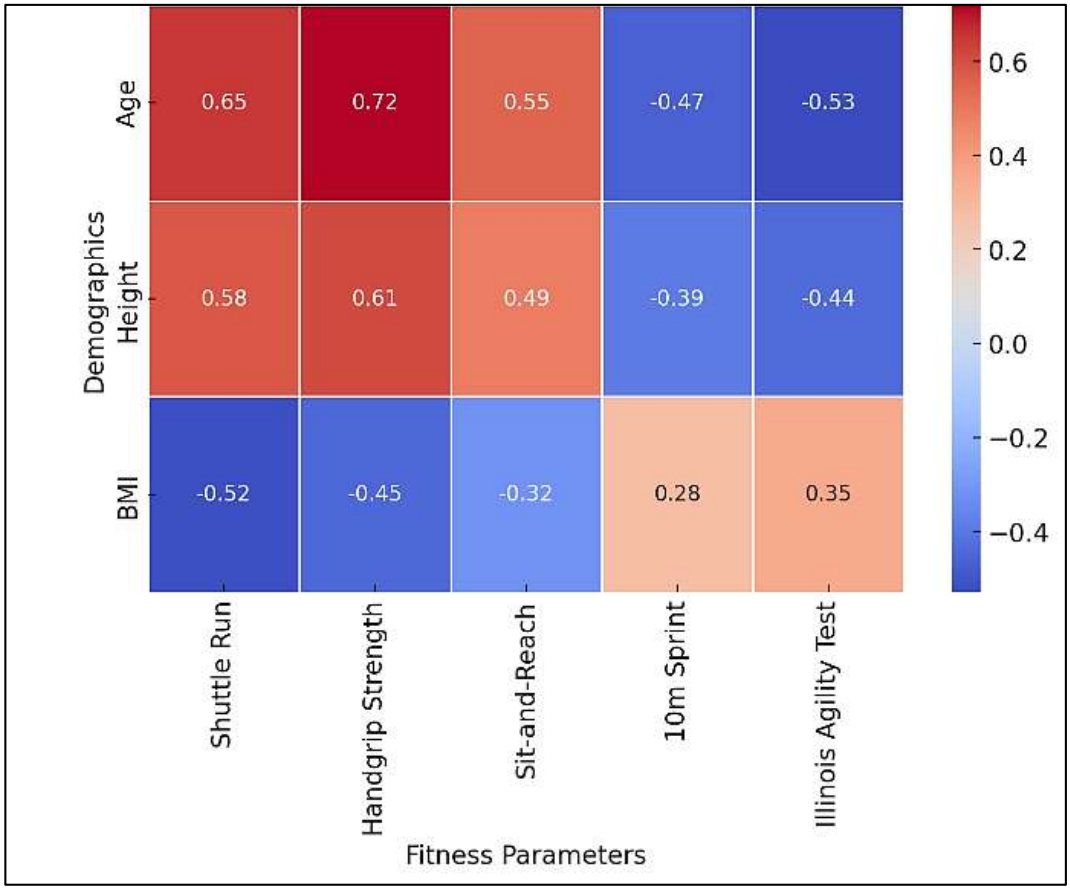

Fig 2 Correlation between fitness parameters and demographics

Sampling Procedure

A representative sample was guaranteed by means of stratified random sampling. Schools in Kerala were divided into two strata: urban and rural. From each stratum, five schools were randomly selected. Within each school, 50 students (25 boys and 25 girls) were chosen, leading to a total sample size of 500 students (250 boys and 250 girls).

The statistical analysis revealed notable gender differences in PF, with boys outperforming girls in cardiorespiratory endurance (Shuttle run), strength (Handgrip), and agility tests, whereas girls demonstrated superior flexibility. Significant disparities were also observed in speed and coordination, as boys performed better in the 10-meter sprint and Illinois agility test. Regarding the effect of location, urban students exhibited significantly higher handgrip strength, likely due to better access to sports facilities, while no notable differences were found in BMI, sprint time, or agility among urban and rural students. Correlation analysis further indicated that age and height were positively associated with shuttle run performance, handgrip strength, and sit-ups, highlighting natural growth advantages. Conversely, BMI showed a negative correlation with endurance and agility, suggesting that higher BMI may adversely affect aerobic fitness and agility-based activities.

Discussion on findings

Gender Differences in PF

Differences in PF between Men and Women

Women demonstrated more flexibility (Sit-and-reach test), while boys shown stronger cardiorespiratory endurance (Shuttle run), muscular strength (Handgrip), and agility (Illinois agility test). Males demonstrated superior agility. Males, on average, perform better in tests of strength, endurance, and agility than females do (Malina *et al*., 2004) [7]. This is dependable with earlier research that suggested that males had a greater muscular mass and higher testosterone levels, both of which contribute to an increase in power and speed. On the other hand, anatomical and physiological factors, such as decreased muscle stiffness and improved joint laxity, contribute to the explanation of increased flexibility in females (Bencke *et al*., 2002) [1]. The differences that have been observed bring to light the necessity of gender-specific training routines in order to achieve maximum performance and reduce the likelihood of damage.

Urban vs. Rural Differences

Children living in urban areas demonstrated a significantly higher handgrip strength compared to their counterparts living in rural areas. This is most likely due to the greater accessibility of sports facilities, the existence of scheduled

training programs, and the presence of extracurricular activities that are geared toward fitness. Comparable findings were documented by Ramírez-Vélez *et al*. (2017) [9], who made the observation that young individuals who were able to participate in organized sports exhibited superior levels of strength and endurance in comparison to those who resided in rural areas with limited facilities. Though, here were no discernible differences in BMI, sprint time, or agility between urban and rural children. This suggests that factors such as diet, daily physical activity, and socioeconomic background may be more significant in defining these traits (Tomkinson *et al*., 2019) [12].

Correlation between Fitness and Demographic Factors

On the shuttle run, handgrip strength, and sit-ups, age and height showed a favorable association. This finding reflects the natural physiological advantages that come with growth. According to Beunen and Malina (2008) [2], children and adolescents who are growing experience gains in their physical strength and endurance as their muscle mass and neuromuscular maturation develop. On the other hand, body mass index (BMI) was found to have a negative correlation with agility and endurance, which suggests that having an excessively heavy body weight can lower aerobic capacity and activity efficiency (Ortega *et al*., 2008) [8]. The identification of this study are in line with those of prior research that proved a correlation between a higher BMI and a lower agility test performance in children of school age (Cadenas-Sánchez *et al*., 2019) [3] as well as a lower level of cardiovascular fitness.

Implications and Recommendations

The findings of this research highlight the reputation of developing individualized exercise programs that take into interpretation the distinct advantages and disadvantages that are associated with each gender, while also ensuring that individuals from urban and rural areas have equal access to training facilities. Educational institutions ought to implement structured physical education programs that place an emphasis on the development of strength and endurance for both males and females. Additionally, interventions that try to control body mass index (BMI) by providing dietary guidance and encouraging increased physical activity could increase the overall level of fitness in youngsters.

Conclusion

The study emphasizes how PF levels in school-aged children are influenced by demographic, geographical, and gender aspects as well as by location. The findings reinforce the need for targeted fitness interventions and policy measures to promote physical activity and overall well-being among children.

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