



Analysis of Physical Fitness Among Elementary School Students in Coastal and Highland Areas Based on Gender

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ABSTRACT

The background of this study is based on differences in geographical location, physical activity, environmental conditions, and lifestyle between coastal and highland communities. This study aimed to determine the level of physical fitness among elementary school students living in coastal and highland areas. The coastal areas included Petanahan District (Karangrejo, Karanggadung, and Tegalretno Villages) and Ayah District (Pasir Village), while the highland areas included Pejagoan District (Watulawang Village) and Karangsambung District (Pujotirto Village). This research employed a survey method. The population consisted of all elementary school students aged 9-12 years, totaling 714 students. A sample of 222 students was selected using a simple random sampling technique. Data were collected using the Nusantara Student Fitness Test (Tes Kebugaran Pelajar Nusantara/TKPN). Data analysis was conducted using descriptive percentage analysis in SPSS version 21.0, supported by narrative interpretation. The results showed that the average physical fitness scores of students in both coastal and highland areas were categorized as good. However, differences were found in several physical fitness components. Male students in highland areas showed better performance in flexibility and cardiorespiratory endurance, whereas boys in coastal areas performed better in agility and cardiorespiratory endurance. Girls in highland areas excelled in cardiorespiratory endurance, while those in coastal areas demonstrated better flexibility and agility.

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INTRODUCTION

Physical fitness is widely recognised as a foundational determinant of quality of life across multiple levels-local, national, and international-given that adequate physical condition enables individuals to meet the demands of daily activity without undue fatigue. Conceptually, physical fitness denotes the body's capacity to adapt effectively to physiological workloads encountered in routine life (Kemendikbud, 2017). Within formal education, this capacity can be systematically developed through structured physical education instruction that provides students with purposeful engagement in sport and health-related activity (Kurnia & Zarwan, 2019). Fitness maintenance, however, is not confined to the school setting: habitual physical activity across a spectrum of intensities-encompassing organised sport, occupational movement, active commuting, and domestic tasks-also constitutes a significant contributor to overall fitness.

Global data highlight the scale of the physical inactivity challenge among children and adolescents. The Global Matrix 4.0 report documented that only 34-39% of children and young people worldwide achieve recommended daily physical activity levels (Aubert et al., 2022). In Indonesia, this translates to approximately 28 million of 83 million children meeting activity guidelines, while school-based physical education contributes only an estimated 20% increase in activity during school hours. Consequently, sedentary behaviour-defined as sustained physical inactivity in contexts such as screen-based entertainment and passive recreation-affects 67-73% of Indonesian children and adolescents, representing over 50 million individuals spending excessive time with digital devices, gaming consoles, or televisions (Aubert et al., 2022). These patterns have direct implications for physical fitness, health outcomes, and motor development among the school-aged population.

An individual's physical fitness level is closely linked to overall health status: high fitness is associated with reduced disease risk, superior cardiovascular function, healthy body composition, enhanced mental well-being, and a strengthened immune response (Keliat et al., 2019). Maintaining physical fitness through regular exercise and appropriate nutrition is accordingly recognised as a cornerstone of preventive health. Critically, geographical factors also modulate children's physical fitness profiles. Students in highland environments are exposed to lower atmospheric oxygen partial pressures, prompting physiological adaptations including elevated blood haemoglobin concentrations that enhance oxygen transport and utilisation-conditions that favour cardiorespiratory endurance (Hariyono & Hartati, 2013). Conversely, students in coastal and lowland environments may engage in different habitual physical activities-such as cycling as the primary mode of school commuting-that selectively develop other fitness components such as flexibility and agility.

Empirical evidence on fitness differences between coastal and highland populations is mixed. Fadli et al. (2020) reported superior physical fitness among coastal elementary school students compared with highland counterparts, while Fida & Chandra (2016) found no significant between-group differences at the junior high school level. This inconsistency suggests that factors beyond geography-including habitual physical activity patterns, nutritional status, and socioeconomic conditions-modulate the relationship between topography and fitness outcomes. Physical activity, encompassing any body movement produced by skeletal muscle that results in energy expenditure-from waking routines through to bedtime behaviours-constitutes a primary mediating variable in this relationship (Aziz & Febi, 2026). The present study addresses this evidence gap by comparing the physical fitness profiles of elementary school students in coastal and highland regions of Kebumen Regency, Indonesia, using the standardised Nusantara Student Fitness Test (TKPN), with analysis stratified by geographical region and gender. The findings are intended to provide an

evidence base for physical education practice and policy development in geographically diverse educational contexts.

METHODS

Research Design

A quantitative descriptive survey design was employed. Data were collected through direct physical fitness testing using the standardised TKPN instrument, conducted at each participating school with assistance from school physical education teachers.

Study Area and Participants

The study encompassed six schools across two topographically distinct regions of Kebumen Regency. Highland schools comprised SDN Watulawang (Pejagoan District, elevation $\approx$ 300-500 m asl) and SDN Kalipuru. Coastal schools comprised SDN 1 Karanggadung, SDN 2 Karanggadung, SDN 1 Karangrejo, and SDN Tegalretno (Petanahan District, $\approx$ 4 m asl) and SDN Pasir (Ayah District, $\approx$ 27 m asl). The total population comprised 714 elementary school students aged 9-12 years.

Sampling Procedure

Simple random sampling was employed to select 222 participants: 75 from highland schools and 147 from coastal schools. Gender distribution was approximately balanced in both regions. Mean participant age was 10.34 years ($SD = 0.94$), with 54 students aged 9, 58 aged 10, 90 aged 11, and 20 aged 12.

Research Instruments and Materials

Physical fitness was assessed using the Tes Kebugaran Pelajar Nusantara (TKPN), published by the Ministry of Youth and Sports of the Republic of Indonesia (Kemenpora, 2022). The TKPN is applicable to students aged 9-18 years and encompasses five components: (1) Body Mass Index (BMI), assessed via height and weight measurement; (2) Flexibility, assessed via the V-Sit and Reach test; (3) Muscular endurance, assessed via the Sit-Up test; (4) Agility, assessed via the Squat Thrust test; and (5) Cardiorespiratory endurance, assessed via the Progressive Aerobic Cardiovascular Endurance Run (PACER) test. The instrument has been standardised and validated on a national student sample by Kemenpora RI (2022). Equipment utilised included a calibrated weighing scale, tape measure, stopwatch, and cones.

Data Analysis

Data were analysed using descriptive percentage statistics in IBM SPSS Statistics version 21.0. Results are presented by overall fitness category and by individual fitness component, stratified by region and gender, with supporting narrative interpretation.

RESULTS

Physical fitness data were collected from 222 elementary school students across highland ($n = 75$) and coastal ($n = 147$) areas of Kebumen Regency using the TKPN instrument. Results are presented in two consolidated tables: Table 1 summarises overall fitness classifications and BMI distribution by region, and Table 2 presents the dominant fitness category for each component stratified by region and gender, enabling a concise cross-regional and cross-gender comparison.

Table 1. Overall Physical Fitness Classification and BMI Distribution by Region

Indicator	Highland (n = 75)	Coastal (n = 147)	Highland (%)	Coastal (%)
Excellent	5	31	6.7	21.1
Good	36	51	48.0	34.7
Fair	32	61	42.7	41.5
Poor	2	4	2.7	2.7
Very Poor	0	0	0.0	0.0
Mean Score (Category)	3.1 (Good)	3.2 (Good)	-	-
BMI Distribution				
Underweight	21	12	28.0	8.2
Normal weight	47	107	62.7	72.8
Overweight	4	12	5.3	8.2
Obese	3	16	4.0	10.9

As shown in Table 1, overall physical fitness in both regions was classified within the ‘good’ category. Highland students were predominantly distributed across the ‘good’ (48.0%) and ‘fair’ (42.7%) classifications, with only 6.7% reaching ‘excellent.’ Coastal students exhibited a somewhat broader distribution, with a notably higher proportion classified as ‘excellent’ (21.1%) and a slightly higher mean score (3.2 vs. 3.1). BMI profiles diverged markedly: highland students had a substantially higher underweight rate (28.0% vs. 8.2%), while coastal students showed higher rates of overweight (8.2% vs. 5.3%) and obesity (10.9% vs. 4.0%), reflecting the contrasting socioeconomic and nutritional conditions in each setting (BPS Kebumen, 2022; Dewi et al., 2022).

Table 2. Dominant Fitness Category per Component, Stratified by Region and Gender (%)

Component	Highland Male (dominant category)	Highland Female (dominant category)	Coastal Male (dominant category)	Coastal Female (dominant category)
Flexibility (V-Sit & Reach)	Excellent (31.7%)	Very Poor (47.1%)	Good (38.2%)	Good (33.8%)
Muscular Endurance (Sit-Up)	Poor (51.2%)	Very Poor (73.5%)	Poor (44.7%)	Poor (64.8%)
Agility (Squat Thrust)	Good & Excellent (58.6%)	Excellent (82.4%)	Excellent (42.1%)	Excellent (95.8%)
Cardiorespiratory Endurance (PACER)	Fair (41.5%)	Fair (50.0%)	Excellent (30.3%)	Fair (38.0%)

Table 2 reveals component-level fitness profiles that diverge meaningfully by both region and gender. The most striking pattern is the universal weakness in muscular endurance: across all four subgroups, the dominant category was ‘poor’ or ‘very poor,’ with highland females exhibiting the most severe deficit (73.5% ‘very poor’). In contrast, agility scores were the strongest component overall, with coastal females achieving the highest single-subgroup result across the entire study (95.8% ‘excellent’). Cardiorespiratory endurance was comparatively more developed among highland females (50.0% ‘fair’, no

students in 'poor' or 'very poor') than coastal counterparts. Flexibility showed the most complex regional and gender interaction, with highland males performing best (31.7% 'excellent') but highland females performing worst (47.1% 'very poor') across the entire sample.

DISCUSSION

Overall Fitness and the Limitations of a Single Classification

The finding that both highland and coastal students achieved a mean TKPN classification of 'good' might appear to suggest broadly equivalent fitness outcomes across geographical settings. However, this surface-level similarity conceals substantive component-level disparities that carry distinct practical implications for physical education practice and public health policy. A composite fitness score inevitably masks the heterogeneity of individual component profiles, and it is precisely at the component level that the most instructive geographical and gender-based patterns emerge. The data presented in Tables 1 and 2 collectively indicate that topographical setting, habitual physical activity patterns, altitude-induced physiological adaptation, and nutritional status interact in complex ways to shape differentiated fitness profiles among elementary school students in Kebumen Regency. These profiles cannot be adequately captured or addressed through undifferentiated, region-agnostic physical education programming (Fadli et al., 2020; Hariyono & Hartati, 2013).

Agility: The Role of Habitual Locomotion in Coastal Communities

The most pronounced between-region difference observed in this study was in agility, where coastal students-particularly females-demonstrated substantially superior performance. The near-universal 'excellent' classification among coastal girls (95.8%) is the most striking single finding in the dataset and warrants careful interpretation. Agility, as measured by the Squat Thrust test, reflects the capacity for rapid directional changes, lower-body explosive power, and whole-body coordination-capacities that are directly trained by the repeated, varied locomotor demands inherent in coastal daily life. Students in the coastal villages of Petanahan and Ayah districts typically commute to school by bicycle or on foot across relatively flat but varied terrain, a pattern of habitual physical activity that cumulatively provides substantial neuromuscular training to the lower extremities (Pramadewa et al., 2019; Rohman et al., 2021). Cycling in particular stimulates fast-twitch fibre recruitment through repeated pedal-stroke acceleration, develops hip and knee extensor strength, and reinforces dynamic balance under variable surface conditions, all of which translate directly to agility performance (Jaleha, 2022). The gender disparity within the coastal group, females outperforming males in the 'excellent' category (95.8% vs. 42.1%), is less expected and may reflect behavioural differences in leisure and commuting patterns, with coastal girls engaging more consistently in active transportation and informal outdoor play relative to coastal boys, who may devote a greater proportion of discretionary time to sedentary digital activities. Future studies should examine these gender-differentiated activity patterns more rigorously through objective measurement.

Cardiorespiratory Endurance: Altitude Adaptation and Aerobic Stimulation

Highland students' comparative advantage in cardiorespiratory endurance, particularly among females, is explicable through two interrelated mechanisms. The first is physiological: chronic exposure to the reduced atmospheric oxygen partial pressure characteristic of highland environments (300-500 m asl in Pejagoan and Karangsambung districts) stimulates erythropoietin release and subsequent erythropoiesis, resulting in elevated blood haemoglobin concentrations that enhance the oxygen-carrying and delivery capacity of the

circulatory system (Nurfazlina et al., 2016). This haematological adaptation enables greater oxygen supply to cardiac muscle, ventilatory musculature, and active skeletal muscle during sustained aerobic effort, directly improving PACER test performance. The second mechanism is behavioural: highland students who walk to school along inclined routes engage in incidental aerobic training that supplements formal physical education. Uphill ambulation at moderate gradients elevates heart rate and oxygen consumption to intensities consistent with moderate-to-vigorous physical activity, providing cumulative cardiorespiratory stimulus across the school week (Hariyono & Hartati, 2013; Jaleha, 2022). The absence of highland females in the 'poor' or 'very poor' cardiorespiratory categories is particularly notable and suggests that uphill walking may provide a more consistent aerobic stimulus for girls-who are more likely to walk than cycle to school in this setting-than for their male peers. Coastal males' relatively strong PACER performance (30.3% 'excellent') suggests that regular cycling, while primarily developing lower-extremity power and agility, also confers meaningful cardiorespiratory benefits, consistent with evidence that sustained cycling at moderate intensity provides adequate stimulus for aerobic development in children.

Flexibility: A Complex Interaction of Habitual Activity and Gender

Flexibility results revealed the most complex pattern of the study, with interactions between region and gender producing counterintuitive profiles at the subgroup level. Highland males demonstrated the highest proportion in the 'excellent' flexibility category (31.7%), while highland females exhibited the highest proportion in 'very poor' (47.1%)-a gender gap of exceptional magnitude within the same topographical context. This divergence likely reflects the differential physical activity profiles of highland boys and girls: highland males may engage more frequently in varied physical play, informal sport, and agricultural work that involves dynamic stretching of the posterior chain, whereas highland girls' activities-more frequently domestic and sedentary in highland socioeconomic contexts-afford less systematic stimulation of hamstring and lumbar flexibility. Among coastal students, flexibility was more evenly distributed across categories for both genders, with a higher proportion of coastal females reaching the 'good' band (33.8%) compared with highland females (17.6%). Cycling's contribution to flexibility through repetitive lengthening and contraction of the hamstring and hip flexor muscle groups likely accounts for this coastal female advantage (Jaleha, 2022; Tilaar & Ettema, 2017). These findings suggest that flexibility development in physical education should be gender-differentiated and contextually tailored: highland female students in particular represent a priority subgroup for targeted flexibility programming.

Muscular Endurance: A Shared Deficit Requiring Systematic Intervention

Across all four subgroups-highland male, highland female, coastal male, and coastal female-muscular endurance was the weakest fitness component, with dominant classifications of 'poor' or 'very poor' in every case. This cross-cutting deficiency is perhaps the most practically significant finding of the study, as it indicates a fitness gap that is not explained by geographical or gender differences but instead reflects a shared insufficiency in the stimulation of core and abdominal musculature through habitual daily activity across both settings. Habitual locomotor activities such as cycling, walking, and informal play do not systematically load the anterior trunk musculature in ways that develop sit-up endurance; structured muscular conditioning exercises are required to close this gap. The severity of the deficit among highland females (73.5% 'very poor') is particularly concerning and may compound the flexibility disadvantage already documented for this subgroup, given that core weakness is associated with reduced posterior chain mobility and elevated injury risk during

physical activity. The present findings align with reports of consistently low muscular endurance in Indonesian elementary school populations (Keliat et al., 2019) and underscore the need for both highland and coastal physical education curricula to explicitly incorporate progressive core strengthening activities, including planks, sit-ups, and functional stability exercises, as a routine component of each lesson.

BMI, Nutritional Status, and the Socioeconomic Mediation of Fitness

The contrasting BMI profiles of highland and coastal students introduce an important socioeconomic dimension into the interpretation of fitness disparities. Highland students' substantially higher underweight prevalence (28.0% vs. 8.2%) reflects the documented economic vulnerability of communities in Karangsambung and Pejagoan districts, highland areas of Kebumen Regency identified as poverty pockets characterised by rain-fed subsistence agriculture, low household income stability, and restricted access to diverse nutritional resources (BPS Kebumen, 2022). Conversely, coastal communities' higher rates of overweight (8.2%) and obesity (10.9%) may reflect greater access to processed and calorie-dense food through fishing-economy trade networks, combined with increasing digital sedentarism among the youth population. Both underweight and overweight states are independently associated with impaired physical fitness: undernutrition limits muscle mass accretion, reduces aerobic capacity, and diminishes the physical energy available for active participation in physical education, while excess adiposity increases the metabolic demand of weight-bearing exercise and is associated with reduced cardiorespiratory efficiency (Dewi et al., 2022; Prastyawan & Pulungan, 2022). These findings highlight that physical fitness disparities between highland and coastal communities cannot be fully addressed through physical education interventions alone: nutritional support programmes, food security initiatives, and holistic school health frameworks that integrate nutrition and physical activity components are required to produce sustainable improvements in children's physical fitness in both geographical settings.

Implications for Physical Education Practice and Policy

The differentiated fitness profiles documented in this study carry direct and specific implications for physical education practice in each geographical setting. In highland schools, where cardiorespiratory endurance is relatively strong but flexibility and muscular endurance—particularly among females—are severely deficient, physical education programmes should incorporate systematic stretching routines, yoga-based flexibility exercises, and progressive core strengthening as primary curriculum components. The pronounced gender gap in highland fitness profiles also suggests that gender-sensitive instructional approaches are warranted, ensuring that highland girls receive equitable opportunities for varied physical activity that addresses their specific developmental needs. In coastal schools, where agility is a clear strength but muscular endurance deficits are equally pronounced, strength and stability conditioning should be prioritised alongside continued support for the active locomotion patterns that naturally develop agility. At the policy level, physical education curricula in geographically diverse regions such as Kebumen Regency should be contextually adapted rather than uniformly applied: a single national curriculum framework may be insufficient to address the differentiated fitness needs of students whose daily physical activity environments differ as substantially as highland and coastal settings. Local education authorities are encouraged to conduct periodic TKPN assessments and use component-level results—rather than overall classifications alone—to guide targeted curriculum decisions, teacher training priorities, and school health resource allocation.

Limitations and Directions for Future Research

Several methodological limitations should be acknowledged. The cross-sectional survey design precludes causal inference: while geographical and lifestyle factors are proposed as explanatory mechanisms, the study cannot establish directional relationships between these variables and observed fitness outcomes. The exclusion of objective physical activity measurement-such as accelerometry-limits the precision with which habitual activity patterns can be characterised and linked to specific fitness components. The sample, while reasonably large for a regional survey, was drawn from a limited number of schools within a single regency; results may not generalise to highland or coastal communities with different altitudes, cultural practices, or economic profiles. Self-reported dietary data were also not collected, preventing a more refined analysis of nutritional pathways to fitness outcomes. Future research should address these limitations through longitudinal designs that track fitness trajectories across school years, objective physical activity monitoring, dietary assessment, and multi-regency samples that enable more robust cross-regional comparison. Intervention studies testing the effectiveness of contextually tailored physical education programmes-specifically those designed to address component-level deficits in highland and coastal populations-would represent a valuable and practically relevant extension of this work.

CONCLUSION

This study establishes that elementary school students in both coastal and highland areas of Kebumen Regency achieve mean physical fitness levels within the 'good' classification on the TKPN instrument. However, component-level analysis reveals distinct fitness profiles shaped by geographical setting, habitual physical activity, physiological adaptation, and nutritional status. Highland male students and highland females demonstrate advantages in flexibility and cardiorespiratory endurance respectively, attributable to altitude-induced haematological adaptations and habitual aerobic locomotion. Coastal students of both genders show superior agility, consistent with the greater variety and frequency of locomotor activities characteristic of coastal daily life. Muscular endurance is notably deficient across both settings, representing a shared priority for curriculum improvement. These findings provide evidence-based guidance for physical education teachers, curriculum developers, and local education policymakers in designing contextually appropriate fitness development programmes for students in geographically diverse regions of Kebumen Regency.

AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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