

Assessing the impact of gender and body mass index on motor competence: a cross-sectional analysis of children

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Abstract

Background and Study Aim Fundamental motor skills in children serve as the basis for constructing more complex movement patterns. Therefore, the quality of mastering these skills, relative to children's age, largely determines success. These skills are influenced by both gender and weight status. This study aimed to analyze gender differences and the relationship between BMI and motor competence in school-aged children.

Material and Methods A cross-sectional study was conducted among 260 children (130 boys and 130 girls) aged 9–13 years from three schools in Mumbai, India. Motor competence was evaluated using the Basic Motor Skills Assessment Scale. The scale assessed locomotor skills, object control, and turning and rolling. Anthropometric data were collected to calculate BMI, categorized as normal, overweight (≥ 85 th percentile), and obese (≥ 97 th percentile). Extracurricular physical activity habits were assessed through a structured questionnaire. Statistical analyses included chi-square tests, t-tests, and one-way ANOVA with Scheffé post hoc comparisons ($p < 0.05$).

Results Among the sample, 19.2% were overweight and 11.6% were obese. Boys showed significantly greater engagement in extracurricular physical activity than girls ($t = 3.214$, $p = 0.002$). Boys preferred team-based sports, while girls favored individual activities. Significant intragender differences in locomotor and turning/rolling skills were found among boys. Normal-weight boys outperformed both overweight ($p = 0.002$) and obese peers ($p = 0.001$, 0.019 , respectively). Obese boys also showed significantly lower turning and rolling competence than overweight boys ($p = 0.011$). In object control, normal-weight boys and girls both demonstrated superior performance compared to obese counterparts ($p = 0.018$ for boys; $p = 0.010$ for girls). Among girls, no significant differences were observed in locomotor or turning/rolling skills across BMI categories.

Conclusions Gender and BMI significantly impact motor competence in children. Interventions should consider these factors to support inclusive physical development and target the needs of overweight and obese children.

Keywords: fundamental motor skills, body mass index, gender differences, motor competence, school-aged children.

Introduction

Motor competence is a critical component of children's physical development and overall health, forming the foundation for engagement in physical activity and influencing both current and future participation in active lifestyles. Primary education represents a pivotal stage in this developmental process, providing the first formal setting for systematic instruction and the acquisition of fundamental skills [1]. During this period, children

encounter structured learning environments where they begin to develop core competencies in literacy, numeracy, and social interaction [2]. These early educational experiences contribute to a broader goal: nurturing well-rounded individuals capable of meaningful societal contribution [3]. Central to this holistic development is moral education, which supports children in navigating ethical dilemmas and making responsible choices [4]. Accordingly, primary education addresses a wide spectrum of developmental domains, including intellectual growth, interpersonal abilities, emotional well-being, and motor competence [5, 6]. Within this framework, physical education plays a key role by

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fostering fundamental motor skills essential for an active and healthy lifestyle [7]. Importantly, these motor skills are closely associated with cognitive and socio-emotional development, reinforcing their importance in promoting overall child well-being [8].

The development of motor skills encompasses a broad spectrum of movements, including locomotor skills such as running, jumping, and skipping, and manipulative skills such as throwing, catching, and kicking [9]. Mastery of these foundational skills enables individuals to participate confidently in a variety of physical activities and sports, thereby fostering a sustained commitment to an active lifestyle [10]. These fundamental motor skills serve as the basis upon which more complex and task-specific movements are built, facilitating effective interaction with the physical environment [11, 12]. Universally observed across individuals, they constitute the essential groundwork for acquiring advanced and specialized motor competencies. Motor skill development is a dynamic and progressive process shaped by experiential learning and the maturation of the central nervous system [13]. This process unfolds through distinct developmental stages, commonly referred to as the initial, elementary, and mature phases, each characterized by specific qualitative and quantitative features that reflect evolving motor abilities [14]. Therefore, it is crucial to provide children with diverse and structured movement experiences to support optimal motor development [15]. A lack of such experiences may hinder motor progression and contribute to coordination challenges [13]. Multiple factors influence this developmental trajectory, including genetic predispositions, physical and neurological maturation, and external conditions such as environmental enrichment, quality of life, nutrition, and hygiene [12, 13, 16]. These determinants include intrinsic biological attributes as well as sociocultural and psychological influences that interact to shape motor development [17, 18].

The quality and diversity of experiences during childhood play a critical role in shaping motor development. Opportunities for exploration, experimentation, and repeated practice act as key drivers of motor skill refinement and progression [19]. A decline in basic motor skill proficiency has been consistently associated with an increasingly sedentary lifestyle, as highlighted in multiple studies [20, 21]. Broader societal trends, including technological advancement, social change, and shifts in dietary patterns, have collectively altered human behavior and contributed to adverse health outcomes, most notably the increasing prevalence of overweight and obesity [22]. The widespread adoption of household technologies has unintentionally encouraged sedentary habits by reducing the need for physical effort in routine tasks [23]. These behavioral transformations have

been further amplified by social developments that continue to replace physical activity with convenience-based alternatives in daily life. Industrialized food production, characterized by high levels of fats and carbohydrates, along with a decline in physical activity, has also been implicated in the rising incidence of overweight and obesity [24, 25, 26, 27, 28]. In contrast, cultural factors such as gender identity have been shown to exert a significant influence on motor development, underscoring the importance of sociocultural context in shaping motor behavior [29].

The relationship between childhood obesity and the acquisition of fundamental motor skills constitutes a critical area of research in pediatric health and motor development [8]. Fundamental motor skills, including locomotor, manipulative, and stability components, serve as foundational elements for more advanced movement patterns and are essential for active participation in diverse physical activities [30]. Social cognitive theory provides a framework for understanding how individuals develop gender identity through the continuous interaction of personal experiences and sociostructural influences. These factors shape gender-related behaviors via motivational and self-regulatory mechanisms [31]. Gender identity is constructed through culturally and historically embedded ideas, beliefs, and societal norms that define expected roles for men and women [32]. These roles influence behaviors deemed acceptable and typical within a given society. The development of motor skills in specific sports often occurs within cultural contexts that reflect and perpetuate gender stereotypes. These narratives shape patterns of participation, performance expectations, and social perceptions [33]. Such outcomes are not solely attributable to biological differences but emerge from the complex interplay of societal norms, historical inequalities, and the influential role of media representation [34].

Research indicates that males typically show a preference for contact sports, while females are more likely to engage in activities with an aesthetic emphasis, such as dance or gymnastics [35]. Although these preferences may appear benign, they can create challenges for girls who wish to participate in traditionally male-dominated sports. Such choices may be perceived as inconsistent with societal expectations of femininity, potentially leading to social stigmatization and the attribution of a “masculine” identity [36]. In response, girls often opt for activities that align more closely with culturally accepted feminine norms [37]. Recent developments in the field of physical activity have led to a gradual dissociation of certain forms of exercise from rigid gender classifications. This has contributed to the emergence of shared spaces that integrate both masculine and feminine elements [37]. However,

despite this progress, data consistently show that females continue to participate less frequently in sports compared to males [37, 38]. Significant differences persist in the types of activities preferred, with males tending toward ball sports and females gravitating toward artistic disciplines such as rhythmic gymnastics and figure skating [39, 40]. These gender-based distinctions in physical activity preferences and motor competence reflect a complex interplay of sociocultural expectations and biological predispositions [41]. Furthermore, research suggests that gender differences exist in motor competence, with males generally exhibiting higher proficiency in object control skills than females [39].

An analysis of current research demonstrates that the development of motor competence is influenced by a combination of biological, psychological, and sociocultural factors. Scholars consistently highlight the significant impact of both gender and body mass index on children’s acquisition of motor skills and their preferences for physical activity. Although these associations have been the subject of numerous studies, there remains

a gap in understanding the specific ways in which these variables interact, particularly within varied cultural and educational contexts.

In light of this, the present study aims to investigate the influence of gender and body mass index on motor competence in school-aged children. This research seeks to enhance our understanding of the multidimensional factors that shape physical development during a critical period of growth.

Material and methods

Participants

This study adopted a descriptive, cross-sectional quantitative design involving a total of 260 school-aged children, comprising 130 boys and 130 girls, aged between 9 and 13 years. Participants were recruited from three educational institutions in Mumbai, India, selected through convenience sampling based on institutional accessibility and willingness to participate. An overview of the participant selection process is presented in Figure 1.

Ethical approval was obtained prior to the commencement of the study, and written informed

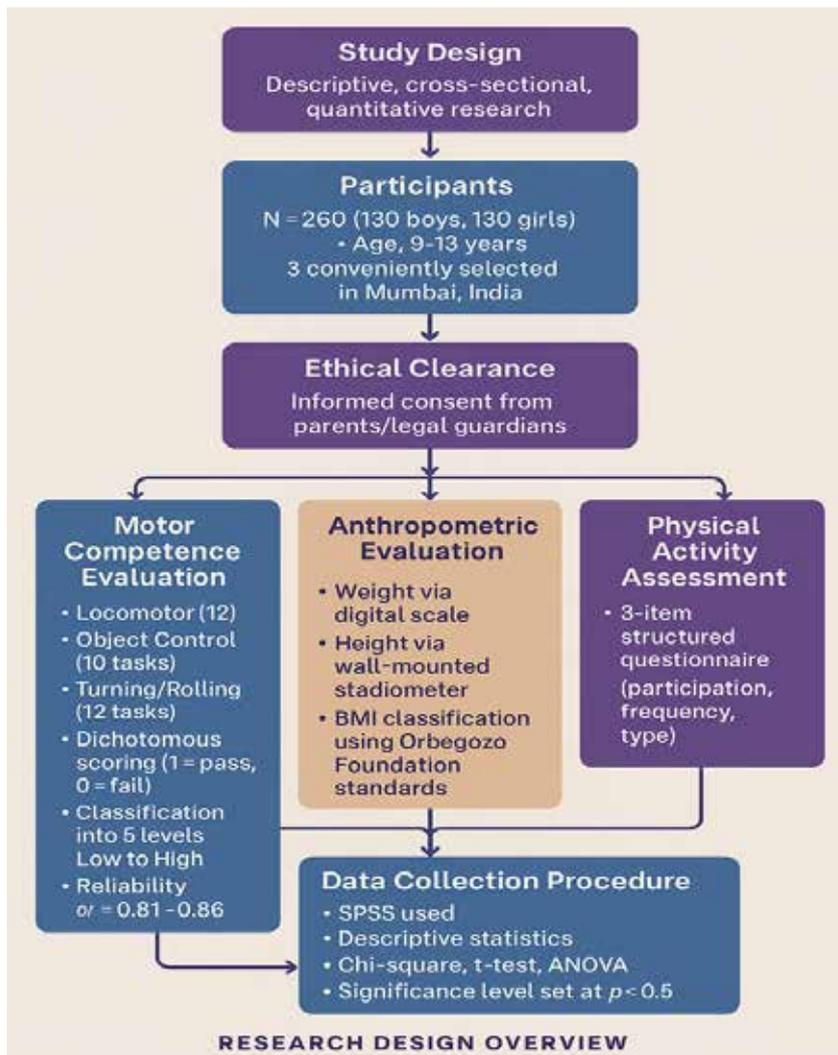


Figure 1. Flow Diagram

consent was collected from the parents or legal guardians of all participants in accordance with established ethical research guidelines.

Assessment Tools and Variables

Motor Competence Measurement. Motor competence was assessed using the Basic Motor Skills Assessment Scale developed by Fernández et al. [42]. This standardized instrument includes three core domains: locomotor skills (12 tasks), object control skills (10 tasks), and turning and rolling (12 tasks). Each task was scored dichotomously, with 1 indicating successful or appropriate execution and 0 indicating unsuccessful or inappropriate execution. This scoring system enabled the classification of motor competence levels based on performance. The internal consistency of the instrument was validated through Cronbach's alpha coefficients, which were 0.81 for locomotor skills, 0.84 for turning and rolling, and 0.86 for object control. These values demonstrate high reliability across the assessed domains. Participants' total motor competence scores were categorized into five levels, following the normative criteria established in the original framework: Low, Low Average, Medium, Medium High, and High.

Anthropometric Assessment. Height and weight were measured using calibrated instruments, including a digital electronic scale for body weight and a wall-mounted stadiometer for height. All assessments were conducted with participants wearing light clothing and no footwear to ensure accuracy. Body Mass Index (BMI) was calculated using the standard formula: weight in kilograms divided by height in meters squared (kg/m^2). To determine overweight and obesity status, the BMI values were compared with age- and sex-specific percentile thresholds established by the Orbegozo Foundation growth charts [43]. According to these criteria, overweight was defined as a BMI at or above the 85th percentile, and obesity as a BMI at or above the 97th percentile.

Physical Activity Profile. Information on participants' extracurricular physical activity habits was collected using a brief structured questionnaire consisting of three items. The questionnaire inquired whether the child engaged in physical activity outside school hours, the frequency of such participation per week, and the type or nature of physical activity performed.

Data Collection Procedure. All assessments were conducted on school premises during regular school hours. Prior to testing, participants received standardized instructions and demonstrations for each motor competence task to ensure full comprehension. The tasks were administered in a fixed sequence. In cases where a participant failed an initial attempt, a second attempt was permitted. If a participant failed three consecutive tasks within

a given domain, the assessment for that domain was discontinued.

Anthropometric measurements (height and weight) were recorded first. These were followed by the administration of motor competence tasks and, subsequently, the completion of the physical activity questionnaire. All procedures were carried out by trained personnel to ensure accuracy and standardization in data collection.

Procedural Framework

Following the acquisition of informed consent from parents or legal guardians, the data collection process was initiated. This process included the assessment of motor competence, the measurement of anthropometric parameters (height and weight), and the evaluation of participants' extracurricular physical activity patterns.

The data collection was conducted in a structured and sequential manner, as outlined below:

- **Pre-assessment Orientation:** Prior to testing, all participants received a clear explanation regarding the purpose and nature of each assessment to promote transparency and encourage active participation.
- **Anthropometric Measurements:** Height and weight were measured under standardized conditions, with participants wearing a T-shirt and shorts and no footwear. Measurements were obtained using a calibrated electronic scale and a fixed wall-mounted stadiometer to ensure precision and consistency.
- **Motor Skills Assessment:** Participants then completed the Basic Motor Skills Assessment Scale. Each motor task was demonstrated beforehand to ensure comprehension and proper execution. Tasks were administered in a fixed sequence consistent with the original structure of the scale.
 - Each attempt was scored using a binary scale (1 = successful execution; 0 = unsuccessful).
 - If a participant failed a task on the first attempt, a second attempt was permitted.
 - If three consecutive tasks were failed, the motor skills assessment for that individual was discontinued in accordance with the testing protocol to ensure consistency and reduce participant discomfort.
- **Assessment of Physical Activity Habits:** After completing the physical and motor assessments, participants answered a short questionnaire designed to gather information about the frequency, type, and nature of their extracurricular physical activity.

All assessments were conducted during school hours under the supervision of trained personnel to ensure ethical standards, child safety, and the reliability of collected data.

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics for Windows, Version 26.0. Descriptive statistics, including means, standard deviations, and percentages, were used to summarize participant characteristics and study variables. To examine group differences, chi-square tests (χ^2) were applied to categorical variables, while independent samples t-tests were used to assess differences between two groups. For comparisons involving more than two groups, a one-way analysis of variance (ANOVA) was conducted. When significant effects were identified, Scheffé post hoc analysis was applied to determine specific between-group differences. The threshold for statistical significance was set at $p < 0.05$.

Results

Table 1 presents the demographic characteristics of the 260 participants, with an equal distribution between boys ($n = 130$) and girls ($n = 130$). The majority of participants (69.2%) had a Body Mass Index (BMI) within the normal range. In contrast, 19.2% were classified as overweight and 11.6% as obese, based on the percentile thresholds

established by the Orbegozo Foundation growth charts. Regarding physical activity habits, 73.1% of the children reported participating in extracurricular physical activities, indicating a generally active study sample.

The analysis of anthropometric data revealed distinct patterns in BMI classification among participants. As shown in Table 2, 19.2% of children were categorized as overweight and 11.6% as obese. Among boys, 20.0% were overweight and 13.1% were classified as obese, while among girls, 18.5% were overweight and 10.0% obese. Although these distributions suggest slightly higher rates among boys, no statistically significant gender-based difference was found in overall BMI classification ($\chi^2 = 1.785, p = 0.410$). However, further analysis by age and gender revealed a statistically significant difference among 9-year-olds, with boys presenting a higher combined prevalence of overweight and obesity compared to girls ($\chi^2 = 8.499, p = 0.014$).

As indicated, although BMI distributions across most age groups did not show statistically significant gender-based differences, the deviation observed at age 9 merits further investigation. This result highlights a potential early-age gender disparity in weight status that may inform targeted interventions.

Table 1. Demographic Characteristics of the Participants (N = 260)

Variable	Category	n	Percentage (%)
Gender	Boys	130	50.0
	Girls	130	50.0
Age (years)	9	50	19.2
	10	60	23.1
	11	65	25.0
	12	50	19.2
	13	35	13.5
Weight Status (BMI Percentile)	Normal Weight (<85th percentile)	180	69.2
	Overweight (85th–96th percentile)	50	19.2
	Obese (≥ 97 th percentile)	30	11.6
Participation in Extracurricular Physical Activity	Yes	190	73.1
	No	70	26.9

Table 2. Classification of the Sample According to Gender, Age, and BMI (N = 260)

Age	Normopeso Boys n (%)	Normopeso Girls n (%)	Sobrepeso Boys n (%)	Sobrepeso Girls n (%)	Obeso Boys n (%)	Obeso Girls n (%)	χ^2	p
9	20 (62.5)	18 (56.3)	8 (25.0)	10 (31.3)	4 (12.5)	4 (12.5)	1.873	0.392
10	24 (64.9)	20 (58.8)	8 (21.6)	10 (29.4)	5 (13.5)	4 (11.8)	0.991	0.609
11	22 (68.8)	24 (75.0)	6 (18.8)	5 (15.6)	4 (12.5)	3 (9.4)	1.105	0.575
12	18 (60.0)	20 (66.7)	7 (23.3)	6 (20.0)	5 (16.7)	4 (13.3)	0.598	0.742
13	16 (59.3)	17 (65.4)	6 (22.2)	5 (19.2)	5 (18.5)	4 (15.4)	0.547	0.762

As illustrated in Figure 2, the proportion of normal-weight children remained consistently higher across all age groups, with boys showing a slight predominance. Overweight and obesity were more prevalent among girls in the younger age groups, whereas the prevalence of obesity among boys showed a gradual increase with age.

Regarding extracurricular physical activity, 26.9% of girls reported no participation in sports activities, compared to 11.5% of boys. Results from the independent samples t-test indicated that boys participated in physical activity significantly more frequently than girls ($t = 3.214, p = 0.002$). Analysis of sport type preferences revealed that boys predominantly favored team-based sports such as football and cricket, while girls showed a greater inclination toward individual activities such as dance and yoga. A chi-square test confirmed a statistically significant association between gender and type of sport chosen ($\chi^2(2) = 59.374, p = 0.001$). In the assessment of motor competence specific to the running skill domain, no significant differences were observed between genders. Both boys and

girls demonstrated comparable proficiency, with no statistically meaningful variation ($p > 0.05$).

An intragender analysis was conducted to evaluate the effect of BMI category on locomotor skill levels among boys and girls. As shown in Table 3, boys with a normal BMI demonstrated significantly higher levels of locomotor competence compared to their overweight and obese peers. Results from a one-way ANOVA, followed by Scheffé post hoc tests, revealed significant differences between boys with normal BMI and those classified as overweight ($p = 0.002$) or obese ($p = 0.001$). However, no statistically significant difference was found between the overweight and obese groups.

As illustrated in Figure 3, boys with normal BMI demonstrated significantly higher levels of locomotor skill compared to their overweight and obese counterparts. Among girls, although locomotor performance tended to decline with increasing BMI, the observed differences were not statistically significant.

In contrast, no statistically significant differences in locomotor competence were observed across BMI

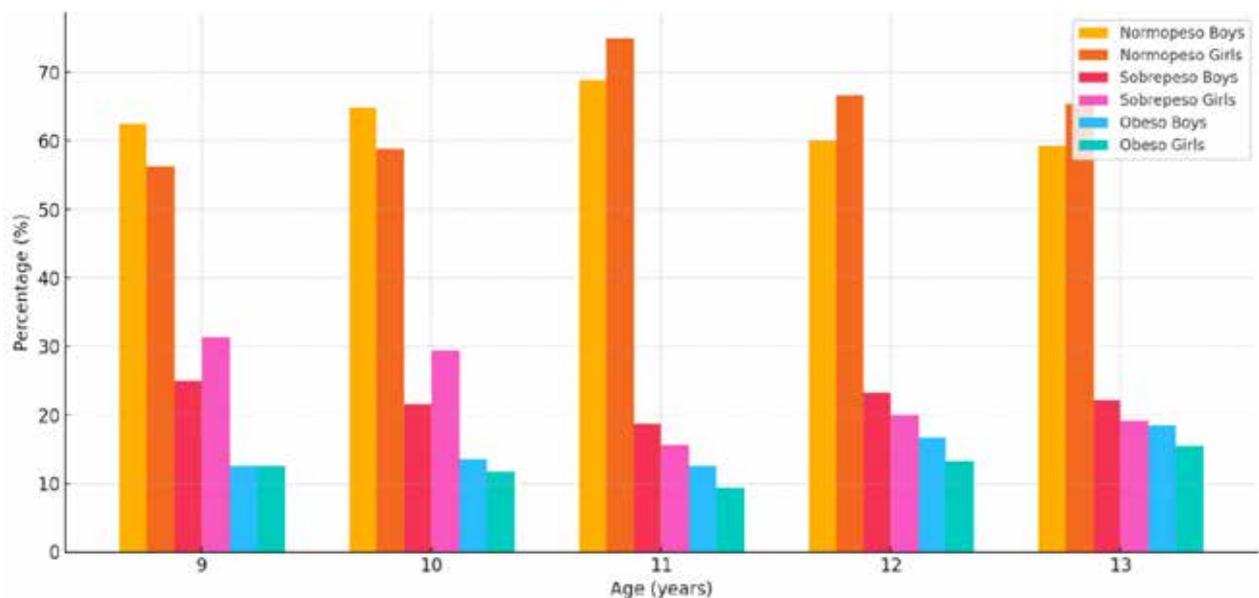


Figure 2. Distribution of BMI Categories by Age and Gender

Table 3. Intragender Differences in Locomotor Skill Level According to BMI Category

Dependent Variable	(I) BMI	(J) BMI	Mean Difference (I-J)	Standard Error	p-value
Locomotor Skills Level (Boys)	Normal	Overweight	0.695	0.188	0.002*
	Normal	Obesity	0.953	0.221	0.001*
	Overweight	Obesity	0.258	0.263	0.638
Locomotor Skills Level (Girls)	Normal	Overweight	0.154	0.197	0.721
	Normal	Obesity	0.482	0.303	0.211
	Overweight	Obesity	0.328	0.327	0.318

*Significant at $p \leq 0.05$.

categories among girls, although those with normal BMI exhibited slightly higher average performance. These findings suggest that BMI exerts a more pronounced influence on motor competence in boys than in girls within this sample.

As shown in Table 4, the analysis revealed that among boys, those with a normal BMI demonstrated significantly higher object control skills compared to their obese counterparts ($p = 0.018$). A similar pattern was observed among girls, with those in the normal BMI category outperforming obese girls in object control tasks ($p = 0.010$). These findings indicate that higher BMI is associated with decreased proficiency in object control skills for both genders, highlighting the influence of weight status on motor skill development.

As illustrated in Figure 4, intragender differences in object control skill levels across BMI categories are evident for both boys and girls. Statistically significant differences ($p \leq 0.05$) were observed between the normal-weight and obese groups within each gender, with obese participants demonstrating substantially lower performance. These results underscore the association between higher BMI and reduced motor skill proficiency, particularly when comparing normal-weight to obese children.

Further intragender analysis based on BMI

categories revealed that girls with obesity demonstrated significantly lower object control abilities compared to their peers with normal weight. A one-way ANOVA, followed by post hoc testing, indicated a statistically significant difference between normal-weight and obese girls ($p = 0.026$). However, no significant differences were found between overweight girls and those in either the normal-weight or obese categories. In contrast, the same analysis conducted among boys did not yield statistically significant differences in object control scores across BMI categories. Nonetheless, boys with normal BMI exhibited slightly higher mean performance than their overweight and obese peers.

Lastly, in the assessment of the turning and rolling motor skill domain, both boys and girls showed generally low performance levels. The chi-square test indicated no significant gender differences ($p > 0.05$), suggesting that this motor skill poses a similar level of difficulty for children regardless of gender.

As shown in Table 5, significant intragender differences in turning and rolling skills were identified among boys, particularly between the normal-weight and obese, as well as overweight and obese groups ($p \leq 0.05$). These findings indicate a decline in performance with increasing BMI.

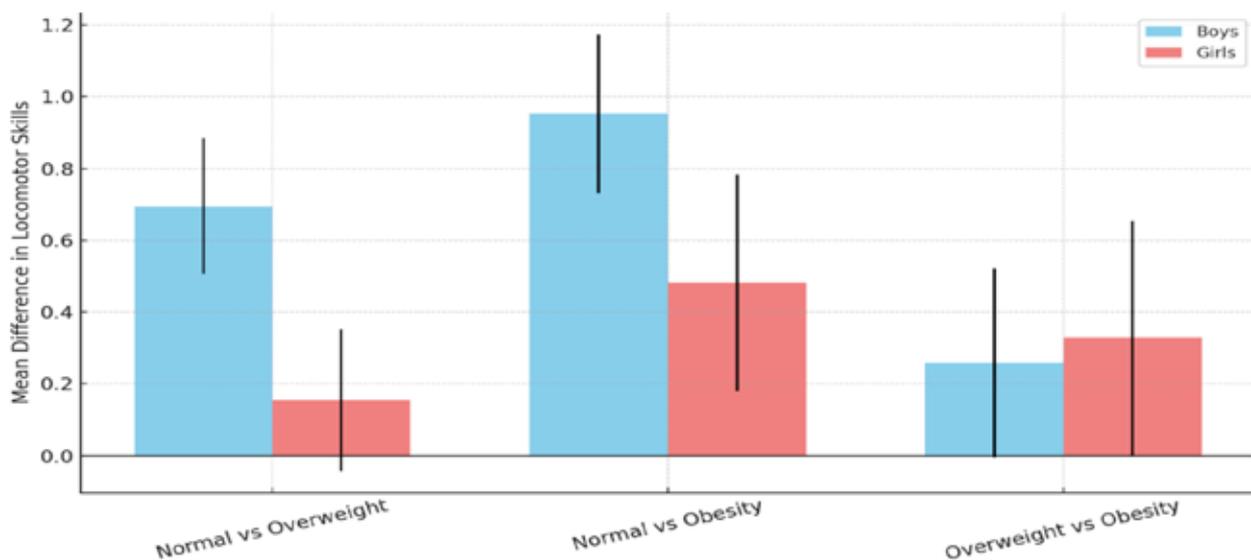


Figure 3. Locomotor Skill Performance by BMI Category and Gender

Table 4. Intragender Differences in Object Control Skill Level by BMI Category

Dependent Variable	(I) BMI	(J) BMI	Mean Difference (I-J)	Standard Error	p-value
Object Control Level (Boys)	Normal	Overweight	0.420	0.190	0.045*
	Normal	Obese	0.610	0.230	0.018*
	Overweight	Obese	0.190	0.260	0.470
Object Control Level (Girls)	Normal	Overweight	0.300	0.170	0.080
	Normal	Obese	0.800	0.270	0.010*
	Overweight	Obese	0.500	0.290	0.090

Significant at $p \leq 0.05$

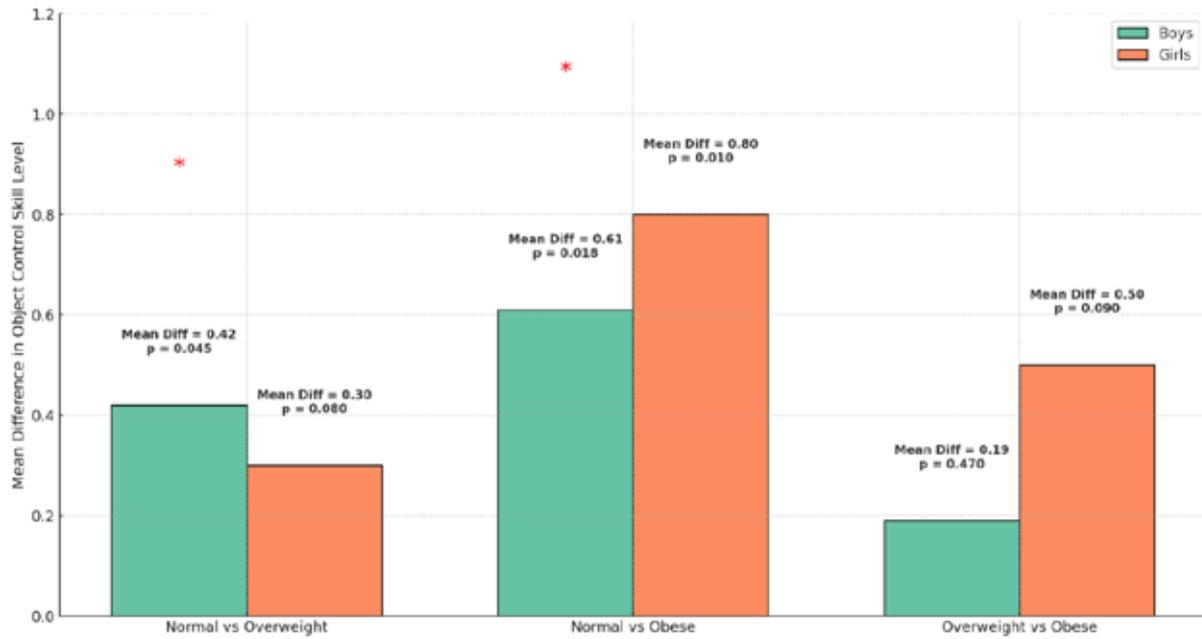


Figure 4. Intragender Differences in Object Control Skill Levels Across BMI Categories

Table 5. Intragender Differences in Turning and Rolling Skill Level by BMI Category

Dependent Variable	(I) BMI	(J) BMI	Mean Difference (I-J)	Standard Error	p-value
Turning and Rolling (Boys)	Normal	Overweight	-0.125	0.172	0.710
	Normal	Obesity	0.620	0.210	0.019*
	Overweight	Obesity	0.745	0.243	0.011*
Turning and Rolling (Girls)	Normal	Overweight	0.058	0.188	0.942
	Normal	Obesity	0.675	0.289	0.072
	Overweight	Obesity	0.595	0.312	0.148

Significant at $p \leq 0.05$

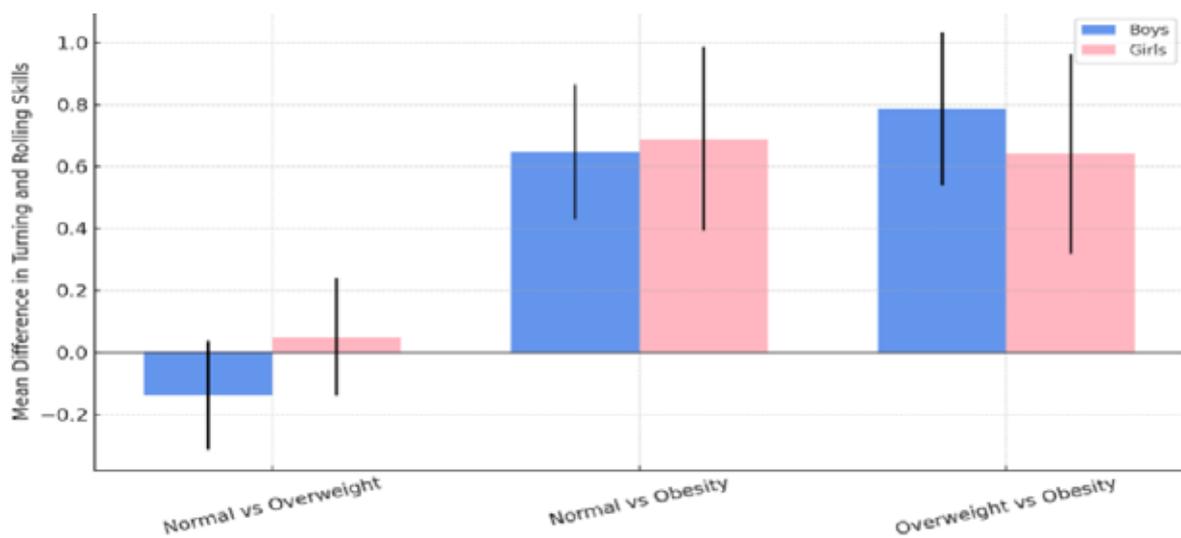


Figure 5. Intragender Differences in Turning and Rolling Skill Levels Across BMI Categories

Among girls, none of the comparisons reached statistical significance, although a marginal trend was observed between the normal-weight and obese categories. Overall, the data suggest that BMI has a more pronounced impact on motor coordination

in boys than in girls, particularly in tasks requiring postural control and whole-body movement, such as turning and rolling.

As illustrated in Figure 5, obese boys performed significantly worse in turning and rolling skills

compared to their normal-weight peers. Among girls, although a decline in performance was observed with increasing BMI, the differences did not reach statistical significance.

Among girls, although obese participants demonstrated lower average performance in turning and rolling skills, no statistically significant differences were observed between BMI groups ($p > 0.05$). This indicates a non-significant trend, suggesting that excess body weight may negatively affect performance, though not to a statistically detectable extent within this sample.

In contrast, boys exhibited significant differences in performance across BMI categories. Boys with normal weight significantly outperformed their obese peers ($p = 0.014$), and a statistically significant difference was also found between the overweight and obese groups ($p = 0.008$). These findings suggest that increasing levels of excess weight are associated with progressively reduced performance in turning and rolling tasks among boys.

Discussion

The primary aim of this study was to examine the influence of gender and body mass index (BMI) on motor competence among school-aged children. The results revealed that BMI significantly affected motor performance, particularly among boys, with higher weight status associated with lower proficiency in locomotor, object control, and turning and rolling skills. In contrast, girls showed less pronounced and mostly non-significant differences across BMI categories. Gender differences were also observed in physical activity patterns and sport preferences, reinforcing the multifactorial nature of motor development.

Basic motor skills such as running, jumping, turning, and object control are fundamental actions common to all individuals and are essential for the development of more complex motor abilities [12, 13, 44]. These skills evolve progressively throughout childhood, influenced by environmental factors and advancing from basic patterns to more structured and purposeful movements [5, 13, 16]. The findings of Fernández-García et al. [29] support the present study by confirming that both gender and weight status significantly affect motor competence in primary school children. Consistent with our results, their study reported that boys outperformed girls in object control tasks, while overweight boys demonstrated reduced performance in locomotor and turning skills. These similarities reinforce the case for targeted interventions that address specific subgroups.

In line with previous research, boys in our sample exhibited overall higher motor competence compared to girls [12, 45, 46]. This trend may be partly explained by differing levels of engagement in physical activity. A greater proportion of girls in our

study reported no participation in extracurricular sports, which is consistent with earlier studies highlighting lower physical activity levels among girls [46, 47]. Additionally, object control skills appeared to be a domain with marked gender differences, where boys significantly outperformed girls. This observation supports findings reported in prior studies [45, 48].

Our results are further corroborated by international research from the United States, Spain, Japan, and Australia, all of which identified superior performance among boys in object manipulation tasks such as throwing and catching [40, 48, 49].

A clear pattern also emerged in sport preferences, with boys favoring team-based sports such as football and basketball, while girls showed a preference for individual activities such as yoga and dance. This discrepancy may reflect gender-based differences in motivation and socialization within the context of sport. As noted by previous research [50], understanding the underlying factors that influence children's sport participation preferences is essential for promoting inclusive and engaging physical education environments.

The relationship between weight status and motor competence was clearly evident in our results. Children with obesity performed significantly worse than their normal-weight peers in several motor tasks, particularly those involving locomotor actions. These findings support previous studies that associate excess body weight with mechanical limitations and reduced movement efficiency [20, 51, 52]. Our observations, especially the reduced performance of obese children in tasks requiring stride-based movement, suggest that biomechanical constraints in the lower limbs may hinder motor execution [53, 54].

Tasks that involved obstacle negotiation and motor planning appeared especially challenging for overweight and obese participants, possibly due to diminished joint mobility and reduced motor control. These difficulties are consistent with findings indicating impaired knee flexion and altered postural adaptation in overweight children during movement tasks [55]. This may reflect a compensatory strategy aimed at increasing stability by limiting the range of joint articulation [55, 56].

Locomotor skills such as running, jumping, and hopping show mixed findings in the literature. Some studies report that boys tend to perform better in these tasks, particularly with respect to speed and power, while girls may perform better in activities requiring precision and control [57]. However, other studies have found no significant gender differences in locomotor performance, suggesting that these skills may be less sensitive to gender-specific influences [58, 59].

Regarding object control, the results revealed particularly low competence levels among obese

girls. This deficit may be attributed to limited exposure to developmentally appropriate physical experiences during early childhood, which are critical for the refinement of coordination-based skills such as throwing and catching [60, 61]. Object control relies not only on physical attributes such as strength and direction but also on precise eye-hand coordination, a component likely diminished in children with low physical literacy and sedentary behavioral patterns.

Lastly, the analysis of turning and rolling skills revealed generally low proficiency among both boys and girls, with the lowest performance observed in children classified as overweight or obese. Although the literature on the specific association between turning and rolling abilities and BMI is limited, our findings suggest that these motor actions, which require dynamic balance, core strength, and body orientation control, are negatively influenced by excess body weight. Body Mass Index (BMI) has been shown to significantly affect motor competence in school-aged children. Higher BMI levels are frequently associated with reduced motor competence, particularly in tasks that demand coordination, balance, and object control [62, 63]. Previous studies have demonstrated that balance-focused interventions can improve dynamic stability, thereby supporting the need for targeted programs aimed at enhancing motor competence in children. The relationship between BMI and motor competence may also be influenced by gender [64]. Some studies have reported that the negative impact of elevated BMI on motor performance is more pronounced in girls than in boys. For instance, research using the TGMD-2 test found that girls with higher BMI levels performed significantly worse in both locomotor and manipulative skills compared to boys with similar BMI levels [65, 66]. Furthermore, the findings of [67] reinforce the present results by confirming consistent strength-assessment accuracy among girls aged 10 to 12, which aligns with our observation of relatively stable motor competence across BMI categories in girls.

These findings indicate that gender-specific interventions may be necessary to address the motor competence challenges experienced by children with higher BMI levels. Biomechanical adaptations, such as reduced knee flexion aimed at lowering the center of gravity, may inadvertently limit the fluidity and accuracy required for effective execution of motor tasks.

Study Limitations and Future Directions

Several limitations should be acknowledged when interpreting the findings of this study. First, the cross-sectional design does not allow for causal inferences between BMI, gender, and motor competence. Longitudinal studies are needed to

determine the direction and stability of these relationships over time.

Second, the study sample was geographically limited to urban schools in Mumbai, which may reduce the generalizability of the results to rural populations or different cultural contexts. Future research should aim to include more diverse populations across regions and socioeconomic backgrounds.

Third, motor competence was assessed using an observational scale based on binary scoring, which, while practical and reliable, may lack the sensitivity to detect subtle qualitative differences in movement execution. Incorporating biomechanical analysis tools or motion capture systems in future studies could provide a more detailed understanding of movement patterns and compensatory strategies, particularly in children with obesity.

Finally, self-reported physical activity data may be subject to bias or inaccuracy. Future studies should consider using objective activity monitors to improve the validity of physical activity measurements.

Despite these limitations, the findings highlight important gender- and BMI-related disparities in motor competence and support the need for tailored interventions. Future research should explore the effectiveness of school-based motor skills programs that are adapted to children's weight status and gender-specific needs.

Conclusions

This study highlights the influence of gender and weight status on fundamental motor skills among school-aged children in Mumbai. While boys and girls demonstrated comparable abilities in locomotor and turning/rolling tasks, boys showed significantly higher competence in object control skills. Girls, particularly those classified as obese, exhibited the lowest performance in this domain.

Intragender analysis revealed that boys with normal BMI outperformed their overweight and obese peers in both locomotor and turning skills. Among girls, weight status primarily affected object control performance. These findings emphasize the need for early identification of motor skill deficits and targeted interventions, especially for children with excess weight.

The results also highlight gender-specific patterns in sport participation and preferences, reinforcing the importance of inclusive physical activity programs that address diverse developmental needs. Enhancing access to quality movement experiences during the primary school years may contribute to the development of core motor competencies and foster healthier, more active lifestyles.

Furthermore, gender differences in motor competence were evident, with boys generally excelling in object control tasks, and girls more

often demonstrating strengths in fine motor activities. BMI emerged as a significant factor, with higher levels associated with reduced motor competence, particularly in skills requiring balance and coordination. Collectively, these findings underscore the importance of promoting physical activity and healthy lifestyle behaviors to support motor development in school-aged children.

Suggestions

Based on the findings of this study, several key recommendations are proposed. First, it is essential to implement targeted motor skill programs by developing and integrating specialized interventions that enhance object control and locomotor skills, particularly for overweight and obese children. Second, promoting gender-inclusive physical activities is recommended through the design of physical education curricula that offer a diverse range of options, including both team-based sports and individual exercises, to reflect and support gender-specific preferences. Finally, early screening and continuous monitoring of motor competence should be adopted in school settings to

identify at-risk children. Timely and individualized interventions should be provided to ensure sustained motor development and the promotion of healthy movement patterns.

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Conflict of Interest

The authors declare that there are no conflicts of interest related to this study.

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