
BODY MASS INDEX AND AGILITY AMONG BADMINTON EXTRACURRICULAR PARTICIPANTS AT SMAN 1 KEDIRI

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Abstract

Agility is a key physical component in badminton because players must accelerate, decelerate, change direction, maintain balance, and return to a ready position within a very short time. This study aimed to analyze the relationship between body mass index (BMI) and agility among students participating in a badminton extracurricular program at SMAN 1 Kediri. A quantitative correlational design was used with total sampling involving 30 active participants. BMI was obtained from direct measurements of body weight and height and recalculated using the formula body weight in kilograms divided by height in meters squared. Agility was measured using the Illinois Agility Run Test and recorded in seconds. Data were analyzed using IBM SPSS Statistics through descriptive statistics, Shapiro–Wilk normality testing, scatterplot examination, and Spearman correlation because agility time was not normally distributed. The participants had a mean BMI of $21.75 \pm 3.13 \text{ kg/m}^2$ and a mean agility time of 18.74 ± 2.58 seconds. The BMI data were normally distributed ($p = 0.147$), whereas agility time was not normally distributed ($p < 0.001$). Spearman correlation showed a significant positive relationship between BMI and agility time ($\rho = 0.667$; $p < 0.001$). Because agility performance was evaluated based on completion time, this positive correlation indicates that higher BMI tended to be associated with longer test completion time and lower agility performance. These findings suggest that BMI monitoring can be used as an initial component of physical condition evaluation in school-based badminton training, although agility should also be interpreted alongside speed, lower-limb strength, balance, coordination, and training experience.

Keywords: Body mass index, Agility, Badminton, Extracurricular sport, Illinois Agility Run Test.

INTRODUCTION

Badminton is one of the most popular sports in Indonesia and is widely practiced by students through school extracurricular programs. At the school level, badminton extracurricular activities are not only a medium for developing interests and talents but also a structured setting for improving physical fitness, movement skills, discipline, cooperation, and student character. The game is characterized by rapid rallies, explosive movement, and repeated displacement to several

court areas within a short time. Players are required to accelerate, decelerate, lunge, move laterally, step backward, and return to a ready position to respond to the direction and speed of the shuttlecock. Therefore, physical preparation is a relevant aspect of badminton development, including among students who participate in extracurricular training rather than formal competitive athlete pathways.

The movement characteristics of badminton place agility as a central component of performance. In game sports, agility refers to the ability to move the whole body rapidly while changing direction or speed in response to a sport-specific stimulus (Sheppard & Young, 2006). In badminton, agility is closely related to footwork because the player must reach the shuttlecock from different corners of the court while maintaining body control before executing a stroke. Good agility allows a player to move efficiently, stabilize the body during hitting actions, and recover quickly to the central or ready position. Previous reviews of badminton performance have also emphasized that the sport demands a combination of anthropometric, physiological, biomechanical, and technical capacities (Phomsoupha & Laffaye, 2015), while match-play analysis has shown that badminton involves intermittent high-intensity actions that require repeated rapid movements (Faude et al., 2007).

One body-related factor that may influence agility is body mass index (BMI). BMI is calculated by dividing body weight in kilograms by the square of height in meters and is often used as a practical indicator of the relationship between body mass and stature. In school-aged participants, BMI interpretation must be conducted carefully because adolescents are still experiencing growth and changes in body composition. The World Health Organization provides BMI-for-age references for individuals aged 5–19 years, and Indonesia has national child anthropometric standards through the Ministry of Health Regulation Number 2 of 2020. Nevertheless, in correlational sport studies, numerical BMI values can still be used to examine whether body proportionality is associated with physical performance indicators such as agility.

Theoretically, a relatively high BMI may increase the mechanical load that must be moved during rapid acceleration, braking, and direction changes. Greater body mass relative to height may require higher lower-limb force production, increase energy cost, and slow movement transitions. In contrast, a very low BMI may reflect insufficient body mass or muscle development to support explosive movements. For this reason, proportional body composition is important in badminton development, especially among school extracurricular participants whose training background, nutritional patterns, and physical conditions may vary considerably. BMI does not directly measure fat mass, muscle mass, or neuromuscular quality; however, it remains useful as an accessible initial screening indicator for teachers and coaches.



Empirical studies have supported the relevance of BMI and agility relationships in sport contexts. Apriliningtias and Ningrum (2020) reported a relationship between BMI and agility among futsal players, indicating that body proportionality is associated with the ability to change direction. Kasidu et al. (2021) highlighted the importance of agility in small-ball games in physical education learning. In badminton, Khakim et al. (2024) found that BMI and speed were related to agility among PB Bolang athletes, with speed and BMI contributing substantially to agility performance. Wattimena et al. (2025) also reported variation in BMI status among badminton athletes, ranging from underweight to mildly overweight categories. These findings suggest that BMI is relevant not only in team invasion sports but also in racket sports that rely on efficient footwork.

Despite these indications, studies that specifically examine the relationship between BMI and agility among senior high school badminton extracurricular participants remain limited, particularly in the context of SMAN 1 Kediri. In training practice, coaches and physical education teachers often observe differences in students' ability to chase the shuttlecock, change direction, and recover to the ready position. Such differences should not be evaluated only through general observation. They need to be supported by standardized measurements of body weight, height, and agility performance so that training decisions are based on evidence.

The present study was therefore conducted to analyze the relationship between BMI and agility among badminton extracurricular participants at SMAN 1 Kediri. Specifically, the study aimed to describe participants' BMI, describe their agility performance, and test whether BMI is significantly related to agility test time. The research hypothesis stated that BMI is associated with agility among badminton extracurricular participants. The results are expected to contribute practically to school-based badminton coaching by supporting the use of BMI monitoring and standardized agility testing as part of physical condition evaluation. The findings may also provide a basis for designing more appropriate footwork, balance, lower-limb strength, and change-of-direction training programs for students.

METHODOLOGY

Research design

This study used a quantitative correlational design. The design was selected because the purpose of the study was to determine whether there was a relationship between two variables without providing a specific training intervention or experimental treatment. The independent variable was body mass index, while the dependent variable was agility among badminton extracurricular participants. The conceptual model of the study positioned BMI as variable X and



agility as variable Y. Because agility was measured as completion time in seconds, a lower score indicated better agility performance. Consequently, the direction of the correlation required careful interpretation: a positive relationship between BMI and agility time would indicate that higher BMI is associated with longer test completion time and therefore lower functional agility performance.

Participants

The study was conducted at SMAN 1 Kediri among students who actively participated in the school badminton extracurricular program. The population included all registered participants who attended training routinely. Based on the original data analyzed in the study, the sample consisted of 30 participants, including 21 male students and 9 female students. The participants were 15–18 years old, with a mean age of 16.30 ± 1.06 years. A total sampling technique was used, meaning that all extracurricular participants who met the eligibility criteria were included as research subjects.

The inclusion criteria were active participation in the badminton extracurricular program, willingness to complete the measurement procedures, healthy condition during data collection, absence of injury, and permission from the school and/or parents according to the applicable school procedure. Students who were absent, ill, or injured during data collection were not included in the analysis. The use of total sampling was appropriate because the population size was limited and the study intended to represent the actual condition of the badminton extracurricular group at the school.

Instrument and Measurement Procedures

BMI was measured using body weight and height data. Body weight was measured in kilograms using a body scale, while height was measured in centimeters and converted into meters for calculation. BMI was calculated using the formula $BMI = \text{body weight (kg)} / \text{height}^2 (\text{m}^2)$. During data cleaning, BMI values were recalculated from the original height and weight variables to ensure consistency with the operational definition and to avoid bias caused by discrepancies in the initial BMI column. The corrected BMI value was used as the main variable in the statistical analysis.

Agility was measured using the Illinois Agility Run Test. This test was selected because it assesses the ability to run quickly, change direction, and maintain body control while moving through a standardized course. The equipment used included a flat testing area, cones or course markers, measuring tape, stopwatch, whistle, recording sheets, and writing instruments. Test results were recorded in seconds. A faster completion time indicated better agility, whereas a longer completion time indicated lower agility performance.

Data collection began with coordination with the school and the badminton extracurricular



coach to determine the testing schedule, location, number of participants, and technical procedures. Participants received an explanation of the study purpose and measurement process before the test was conducted. Body weight was measured without shoes and without carrying additional objects. Height was measured with participants standing upright, looking forward, and keeping their heels in contact with the floor.

Before the agility test, participants performed a warm-up to reduce injury risk and to prepare the body for high-intensity movement. The researchers explained the Illinois Agility Run Test course and demonstrated the procedure. Participants then completed the test according to the start signal, and completion time was recorded from the start until the participant crossed the finish line. When two timekeepers were available, the recorded score could be determined from the average of the two measurements or the best time, provided that the procedure was decided consistently before testing.

Statistical analysis

The data were analyzed using IBM SPSS Statistics. The first step was checking data completeness and consistency, including recalculating BMI from body height and weight variables. The second step was descriptive analysis to obtain frequency, percentage, minimum, maximum, mean, standard deviation, median, and category distribution. The third step was normality testing using the Shapiro–Wilk test because the sample size was less than 50 participants.

If both variables were normally distributed, the relationship between variables would be tested using Pearson correlation. However, if at least one variable was not normally distributed, the primary hypothesis test would use Spearman correlation. The significance level was set at 0.05. The strength of the correlation coefficient was interpreted as follows: 0.00–0.199 very low, 0.20–0.399 low, 0.40–0.599 moderate, 0.60–0.799 strong, and 0.80–1.000 very strong. Because agility was expressed as time, the interpretation focused not only on statistical direction but also on the practical meaning of longer or shorter completion time.

RESULTS

The original dataset consisted of 30 participants. The sample included 21 male participants (70.0%) and 9 female participants (30.0%). Participant age ranged from 15 to 18 years, with a mean of 16.30 ± 1.06 years. Before conducting the main analysis, BMI was recalculated from the original body height and weight variables. This step was required because differences were found between several values in the initial BMI column and the values obtained using the BMI formula. The main analysis therefore used the corrected BMI values to maintain consistency with the operational definition of the study.



Table 1. Participant characteristics based on the original data

Characteristic	Value	Percentage
Number of participants	30	100.0%
Male	21	70.0%
Female	9	30.0%
Age range	15–18 years	—
Mean age	16.30 ± 1.06 years	—

The mean corrected BMI of the participants was $21.75 \pm 3.13 \text{ kg/m}^2$, with a minimum value of 16.79 kg/m^2 and a maximum value of 28.49 kg/m^2 . The mean agility test time was 18.74 ± 2.58 seconds, with the fastest time of 15.48 seconds and the slowest time of 27.42 seconds. Because agility was measured as completion time, a smaller value represented better agility performance. The descriptive statistics of the main variables are presented in Table 2.

Table 2. Descriptive statistics of the study variables

Variable	Mean	SD	Minimum	Maximum	Unit
Age	16.30	1.06	15	18	years
Body height	166.08	7.15	155.40	178.40	cm
Body weight	60.01	9.62	44.90	87.10	kg
Corrected BMI	21.75	3.13	16.79	28.49	kg/m^2
Agility	18.74	2.58	15.48	27.42	seconds

The practical BMI category distribution showed that 5 participants (16.7%) were in the low BMI category, 21 participants (70.0%) were in the normal category, 4 participants (13.3%) were in the excess BMI category, and no participant was classified in the obesity category. These categories were used only as a practical description of the sample distribution. For adolescent health interpretation, BMI-for-age references should be considered because students are still in a growth period. The agility distribution based on the internal category of the original data showed an equal distribution across good, moderate, and poor categories, with 10 participants (33.3%) in each category.

Table 3. Distribution of practical BMI categories based on corrected BMI

Practical BMI category	Frequency	Percentage
Low	5	16.7%
Normal	21	70.0%



Practical BMI category	Frequency	Percentage
Excess	4	13.3%
Obesity	0	0.0%

Table 4. Distribution of agility categories based on the original data

Internal agility category	Frequency	Percentage
Good	10	33.3%
Moderate	10	33.3%
Poor	10	33.3%

The Shapiro–Wilk normality test showed that corrected BMI was normally distributed ($W = 0.948$; $p = 0.147$), whereas agility time was not normally distributed ($W = 0.757$; $p < 0.001$). Because one of the variables did not meet the normality assumption, Spearman correlation was used as the primary test to examine the relationship between BMI and agility time.

Table 5. Shapiro–Wilk normality test results

Variable	W statistic	Sig.	Decision
Corrected BMI	0.948	0.147	Normal
Agility time (seconds)	0.757	<0.001	Not normal

Spearman correlation showed a significant positive relationship between corrected BMI and agility test time ($\rho = 0.667$; $p < 0.001$; $n = 30$). The coefficient of 0.667 indicated a strong relationship. The positive direction means that participants with higher BMI tended to require a longer time to complete the agility test. Functionally, this indicates that higher BMI was associated with lower agility performance because the agility outcome was measured by completion time.

Table 6. Spearman correlation between BMI and agility

Variable relationship	Spearman's rho	Sig. (2-tailed)	N	Interpretation
Corrected BMI and agility time	0.667	<0.001	30	Strong, positive, significant

As an additional check, Pearson correlation produced $r = 0.563$ with $p = 0.001$; however, this result was not used as the main basis for hypothesis testing because agility time was not normally distributed. The scatterplot pattern also showed an upward tendency, indicating that agility test time tended to increase as BMI increased.



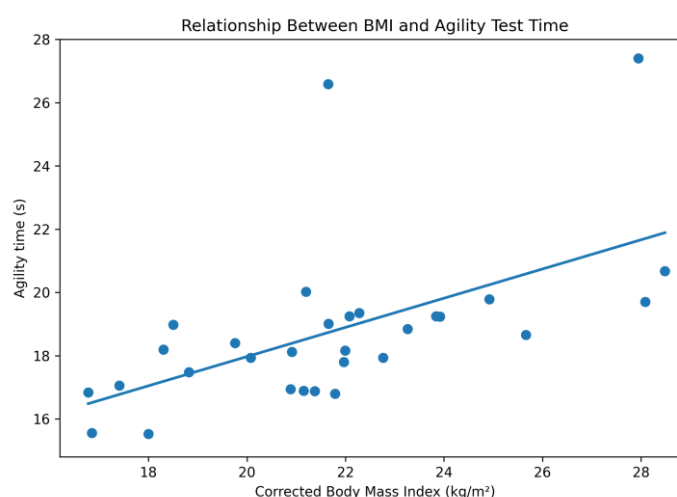


Figure 1. Scatterplot of corrected BMI and agility test time.

DISCUSSION

The findings showed that corrected BMI had a positive and significant relationship with agility test time among badminton extracurricular participants at SMAN 1 Kediri. The Spearman correlation coefficient of 0.667 indicates a strong relationship, while $p < 0.001$ confirms that the relationship was statistically significant. Because agility was measured in seconds, a positive relationship does not mean better agility. Instead, it means that participants with higher BMI tended to spend more time completing the Illinois Agility Run Test, which functionally indicates lower agility performance.

This finding can be explained through the movement demands of badminton. Badminton requires players to move quickly to different court areas while repeatedly performing acceleration, deceleration, lateral steps, backward movement, lunges, and recovery to the ready position. When body mass is relatively high in relation to height, the mechanical load on the lower limbs increases. The body must generate greater force to initiate movement, stop the body, and change direction. This additional mechanical demand may extend the time needed to complete an agility course. Therefore, the present result is consistent with the theoretical assumption that body proportionality can influence change-of-direction performance.

The present finding is in line with Apriliningtias and Ningrum (2020), who reported a relationship between BMI and agility among futsal players. Although futsal and badminton differ in rules, playing area, and technical demands, both require rapid changes of direction and balance control. The finding also supports Khakim et al. (2024), who reported that BMI and speed were related to agility among badminton athletes. This suggests that the BMI–agility relationship is relevant not only in team sports but also in racket sports where footwork efficiency strongly

influences performance.

In the context of school extracurricular programs, these findings have practical implications for physical education teachers and badminton coaches. BMI monitoring can be used as an initial indicator to evaluate participants' physical condition before designing training programs. Participants with relatively high BMI may require training that improves movement efficiency, lower-limb strength, balance, and change-of-direction ability. Training methods that may be applied include ladder drills, shuttle runs, shadow badminton, lunge drills, directional reaction drills, and bodyweight lower-limb strengthening. These exercises should be implemented progressively and adapted to the students' fitness level to reduce injury risk and improve motor quality.

Nevertheless, BMI should not be interpreted as the only determinant of agility. Agility is a multifactorial ability influenced by sprint speed, lower-limb power, muscular strength, coordination, balance, playing experience, footwork technique, court condition, warm-up quality, and motivation during testing. BMI also cannot distinguish between fat mass and lean mass. A participant with higher BMI may have greater muscle mass, while another participant with similar BMI may have a higher proportion of fat mass. Therefore, although the relationship found in this study was significant, coaches should use BMI together with other physical tests to obtain a more comprehensive evaluation.

Interpretation of BMI among adolescents also requires caution. Senior high school students are still experiencing growth in height, body mass, and body composition. As a result, practical BMI categories should not be equated directly with adult BMI standards. For health-related interpretation, BMI-for-age and sex-specific references are more appropriate. In this study, numerical BMI was used for correlational analysis, whereas the practical BMI categories were used only to describe the sample distribution. This distinction is important so that the findings are not misinterpreted as clinical classification.

The study has several limitations. The sample size was relatively small because it was limited to the badminton extracurricular participants at one school. The correlational design also prevents causal interpretation. It cannot be concluded that high BMI directly causes lower agility; the study only demonstrates that BMI is associated with agility time in this sample. In addition, the study did not measure other physical variables such as lower-limb strength, sprint speed, dynamic balance, endurance, flexibility, body composition, or training experience, all of which may influence agility. Future studies should include these variables, use larger samples, compare male and female participants more deeply, or apply longitudinal and intervention designs to clarify the factors that determine badminton agility among students.



CONCLUSION

Based on the analysis of the original data, badminton extracurricular participants at SMAN 1 Kediri had a mean BMI of 21.75 ± 3.13 kg/m² and a mean agility test time of 18.74 ± 2.58 seconds. The Shapiro–Wilk test showed that agility time was not normally distributed, so the hypothesis was tested using Spearman correlation. The results indicated a significant positive relationship between BMI and agility test time ($\rho = 0.667$; $p < 0.001$). Because agility was measured based on completion time, this positive relationship means that participants with higher BMI tended to record longer agility test times and therefore lower agility performance. The study contributes to school-based badminton coaching by showing that BMI monitoring can be included as an initial component of physical condition evaluation. However, BMI should not be used as the sole basis for evaluating agility because change-of-direction performance is also influenced by speed, lower-limb strength, coordination, balance, footwork technique, and training experience. Coaches are encouraged to combine BMI monitoring with structured agility, footwork, balance, and lower-limb strengthening exercises. Further research should include additional physical and body-composition variables and use larger or longitudinal samples to provide a more comprehensive explanation of agility performance in badminton.

CONFLICT OF INTEREST

The authors declare no conflict of interest in the preparation of this article.

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