Body Mass Index (BMI) and Macronutrient Needs of Students Aged 14–15 Years

I Kadek Hendra Sastrawan[1A-E], Hendra Mashuri[2B-D*], I Ketut Semarayasa[3D]

[1,2,3] Universitas Pendidikan Ganesha, Bali, Indonesia

hendrasastrawan2310@gmail.com[1], hendra.mashuri@undiksha.ac.id[2*],
ketut.semarayasa@undiksha.ac.id[3]

ABSTRACT

This study aims to analyze body mass index (BMI) status and macronutrient requirements among students aged 14–15 years at SMP Negeri 2 Bangli. The research employed a quantitative descriptive design using a survey method. The study population consisted of all Grade IX students, with a sample of 63 students from classes IX A and IX C, comprising 27 female students (43%) and 36 male students (57%). Data were collected through anthropometric measurements to determine BMI and calculations of daily energy and macronutrient needs. The results showed that 4 students (6%) were classified as severely underweight, 6 students (10%) as mildly underweight, 39 students (62%) had a normal BMI, 2 students (3%) were mildly obese, and 12 students (19%) were severely obese. These findings indicate that although most students had a normal BMI, a considerable proportion experienced nutritional imbalance, including both undernutrition and overnutrition. The average daily energy requirement of the students was 2954.63 kcal. Based on macronutrient distribution guidelines, energy needs were divided into 60% carbohydrates, 15% protein, and 25% fat. Accordingly, the average carbohydrate requirement was 1772.78 kcal or 443.19 grams per day, protein requirement was 443.19 kcal or 110.80 grams per day, and fat requirement was 738.66 kcal or 82.07 grams per day. In conclusion, while the majority of students at SMP Negeri 2 Bangli exhibited a normal BMI, the presence of abnormal BMI conditions highlights the need for greater attention to balanced nutrition. Collaborative efforts between schools and families are essential to ensure adequate nutritional intake and support optimal growth and health among adolescents.

AUTHORS' CONTRIBUTION

A. Conception and design of the study;
B. Acquisition of data;
C. Analysis and interpretation of data;
D. Manuscript preparation;
E. Obtaining funding

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INTRODUCTION

Indonesia is the largest archipelagic country in the world with a population of 281.6 million, making it the fourth most populous country globally (Badan Pusat Statistik, 2024). Along with rapid demographic growth, Indonesia continues to face complex public health challenges, one of which is the triple burden of malnutrition, encompassing undernutrition, micronutrient deficiencies, and overnutrition. This condition poses a serious threat to

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hendra.mashuri@undiksha.ac.id[2*]

human resource quality, particularly among adolescents, who represent a strategic demographic group for national development (Rasyid et al., 2022; Rahayu et al., 2023).

Adolescence, defined by the World Health Organization as the age range of 10–19 years, is a critical transitional period characterized by rapid physical growth, hormonal changes, and increased nutritional demands. During this phase, inadequate or excessive nutritional intake may disrupt growth trajectories, impair cognitive function, and increase the risk of chronic diseases later in life (Sawyer et al., 2018; Telisa & Eliza, 2020). National data from the Survey Kesehatan Indonesia (2023) indicate that adolescents aged 13–15 years in Indonesia experience a dual nutritional problem: underweight conditions coexist with overweight and obesity, both among male and female adolescents.

Malnutrition among adolescents is strongly associated with irregular eating patterns, poor food choices, and lifestyle behaviors. Adolescents tend to prefer high-energy, low-nutrient foods such as fried snacks, sugar-sweetened beverages, and ultra-processed foods, while neglecting balanced meals rich in protein, fiber, vitamins, and minerals (Fauzan et al., 2023; Supriadi Nurjannah & Fitrianingsih, 2023). These unhealthy dietary patterns are further reinforced by peer influence, school food environments, and exposure to social media marketing, which collectively shape adolescents' food preferences and consumption behaviors.

Field observations at SMP Negeri 2 Bangli reveal similar conditions. Students frequently consume fast food and packaged drinks during school breaks in uncontrolled portions, and many habitually skip breakfast. These behaviors are associated with decreased concentration, fatigue, sleepiness during class, and reduced enthusiasm for physical activity. Such symptoms suggest not only suboptimal dietary intake but also a mismatch between nutritional status and physical activity demands, which may negatively affect learning outcomes and physical development.

Nutritional status is a fundamental indicator of individual health and reflects the long-term balance between nutrient intake and energy expenditure. One of the most widely used indicators for assessing adolescent nutritional status is the Body Mass Index (BMI), which provides a practical and cost-effective screening tool for identifying underweight, normal weight, overweight, and obesity (Muchtar et al., 2022; de Onis et al., 2019). In addition to BMI, understanding macronutrient requirements including carbohydrates, proteins, and fats is essential to ensure optimal growth and support daily physical activities.

Macronutrient needs are commonly estimated through components such as Basal Metabolic Rate (BMR), Specific Dynamic Action (SDA), physical activity levels, sports participation, and growth-related energy demands (Alkaririn et al., 2022; Hills et al., 2019). Recent studies emphasize that adolescent nutritional assessment should not rely solely on anthropometric indicators but must also consider individualized energy and nutrient requirements based on activity patterns and developmental stages (Story et al., 2021).

In the educational context, Physical Education (PJOK) is recognized as a strategic platform for promoting healthy lifestyles, physical fitness, and nutritional awareness among students. Physical education teachers are expected to play a dual role: facilitating structured physical activity and monitoring students' growth and health

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status through basic assessments such as BMI measurement and fitness evaluation (Semarayasa et al., 2021; Mashuri, 2022). Several Scopus-indexed studies highlight that integrating nutrition education and health monitoring into physical education curricula can significantly improve students' nutritional literacy and physical well-being (Cale & Harris, 2018; Dudley et al., 2020).

Despite these advances, evidence from Indonesian schools indicates that the implementation of nutritional assessment and education within PJOK remains inconsistent. Many teachers focus predominantly on motor skills and sports techniques, while aspects related to nutritional status monitoring and individualized activity prescription receive limited attention (Sari et al., 2021).

Although numerous studies have examined adolescent nutritional status in Indonesia, most research has focused on prevalence rates of undernutrition or obesity using cross-sectional survey data. There is limited empirical evidence that simultaneously analyzes BMI profiles and macronutrient requirements within the school setting, particularly at the junior high school level. Furthermore, existing studies rarely contextualize nutritional assessments within the framework of physical education practice, where such data could directly inform instructional design and extracurricular recommendations.

Another critical gap lies in the practical application of nutritional assessment by PJOK teachers. While policy documents emphasize the importance of holistic student development, field evidence suggests that BMI measurement and macronutrient calculations are seldom conducted in routine school practice. This disconnect between theoretical recommendations and actual implementation limits the potential of schools to function as effective agents of nutritional surveillance and early intervention.

At SMP Negeri 2 Bangli, no systematic assessment of students' BMI and macronutrient needs has been conducted, and students demonstrate low awareness of their nutritional requirements relative to their physical activity levels. This local condition reflects a broader national challenge and underscores the need for context-specific empirical data that can support evidence-based interventions at the school level.

Based on the identified problems and research gaps, this study aims to determine the Body Mass Index (BMI) and macronutrient requirements of students aged 14–15 years at SMP Negeri 2 Bangli. Specifically, the study seeks to: (1) describe the nutritional status of students based on BMI classification, (2) estimate individual macronutrient needs considering basal metabolism and physical activity levels, and (3) provide evidence-based recommendations for physical education learning, extracurricular activity planning, and nutritional guidance.

The novelty of this study lies in its integrative approach, combining anthropometric assessment (BMI) with macronutrient requirement analysis within the context of school-based physical education. Unlike previous studies that treat nutritional status and physical activity as separate domains, this research positions PJOK as a strategic medium for linking nutrition assessment with movement tasks and health-oriented learning. The findings are expected to contribute practical insights for students, teachers, schools, and parents in optimizing adolescent growth, learning readiness, and long-term health outcomes.

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METHODS

This study uses a quantitative descriptive research type using a survey method. Quantitative research is a research method that uses numbers in data collection and then briefly explained related to the phenomenon being studied. The population of this study was all 144 students of grade IX of SMP Negeri 2 Bangli, with 65 females and 79 males. The sampling technique used was cluster random sampling, where classes were selected randomly and the classes used were grades IX A and C. The sample of this study amounted to 63 people, 27 females and 36 males.

Table 1.
Demographics of Research Subjects

Research Subject Category	Sum	Average Age	Average Weight	Average Height	Percentage
Woman	27	14,15	51,07	151,59	43%
Man	36	14,36	58,86	161,67	57%
N	**63**				**100%**

The research instruments used were the Cerinnity ZT scale and a questionnaire for non-sports and sports physical activity. The research procedure began with weight and height measurements, followed by filling out a questionnaire based on the activities undertaken by the students. Data were analyzed using the formulas basal metabolic rate (BMR), specific dynamic action (SDA), energy from non-sports physical activity, energy from sports activity, and macronutrient requirements.

RESULTS AND DISCUSSION
Result

This study began with height and weight measurements to determine the body mass index (BMI) of students. Based on the measurement results, 4 (6%) students were found to be severely underweight, 6 (10%) students were mildly underweight, 39 (62%) students were in the normal or ideal category, 2 (3%) students were mildly obese, and 12 (19%) students were in the severe obesity category. From these findings, the majority of students at SMP Negeri 2 Bangli were in the normal or ideal category.

Table 2.
Demographics of Body Mass Index

BMI	Category	Frequency	Percentage
Severe Thinnes	<17,0	4	6%
Underweight	17,0-18,4	6	10%
Ideal	18,5-25,0	39	62%
Overweight	25,1-27,0	2	3%
Obesity	27,0>	12	19%
Total		**63**	**100%**

After measuring the BMI, the next step is to measure the energy needs of the basal metabolic rate (BMR) and specific dynamic action (SDA) of students at SMP Negeri 2 Baling. Calculating the BMR energy needs is done to determine the minimum energy

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needed by students to support life, or the energy needed in conditions without doing any activity. Meanwhile, calculating the SDA is the energy needed by the body for metabolic processes derived from food and drink. The average BMR energy requirement of students at SMP Negeri 2 Bangli is 1484.19, the average SDA energy requirement is 148.42, so the average basic energy requirement (BMR + SDA) is 1632,61.

Table 3.
Calculation of BMR, SDA, and Basic Energy Needs

	BMR	SDA	Basic Energy Needs
Mean	1484,19	148,42	1632,61
SD	201,63	20,16	221,79
Min	1209,5	120,95	1330,45
Max	2137,1	213,71	2350,81

The next step is calculating non-exercise activity energy, which is the additional energy the body needs to perform activities outside of exercise, such as cleaning the house, climbing stairs, working in the office, and so on. This additional energy is categorized as light, moderate, and heavy, with men and women having different exercise activity values.

Table 4.
Distribution of Non-Sports Physical Activity

Gender	Category	Score	Frequency
	Light	1.55	6
Woman	Currently	1.7	19
	Heavy	2	2
	Light	1.56	8
Man	Currently	1.76	28
	Heavy	2.1	0
Total			**63**

Based on the calculation of additional energy from non-sports physical activities, the majority of students at SMP Negeri 2 Bangli are in the moderate category. The average energy requirement for non-sports physical activities is 2784.08. Then the calculation of sports energy is obtained from the calculation of sports physical activities carried out by students based on the duration of exercise and the number of times exercise is done in a week. From the results of the calculation of sports activity energy, it is known that the average energy requirement for sports activities is 539.49. Therefore, the average total energy requirement analysis is 2861.15.

Table 5.
Energy Calculation of Non-Sports and Sports Physical Activities

	Non-Sport Energy	Sport Energy	Activity energy
Average	2784,08	539,49	2861,15
SD	420,92	93,48	439,67

Because the students of SMP Negeri 2 Bangli are in their growth period, or under 19 years old, additional energy is needed to maximize their growth. It is known that the majority are 14 years old (43) and the rest are 15 years old (20).

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Table 6.
Table 6. Age distribution of SMP Negeri 2 Bangli Students

Age	Score	Frequency
10-14 Years	2 cal/kg BW	43
15 Years	1 cal/kg BW	20
16-18 Years	0,5 cal/kg BW	0
>19	0 cal/kg BW	0
Total		**63**

Based on the calculation of additional energy based on the growth age of students at SMP Negeri 2 Bangli, the average additional energy is 93.48. Therefore, the average daily energy requirement is 2954.63.

Table 7.
Calculation of Additional Energy for Growth Age Athletes

	Age	Activity Energy	Additional Energy	Total Energy Every Day
Average	14,27	2861,15	93,48	2954,63
SD	0,44	439,67	33,05	458,83

The next step is calculating energy needs based on macronutrients, namely carbohydrates, fat, and protein. The proportion of macronutrients to total daily energy needs is: 60% carbohydrates, 25% fat, and 15% protein. The average carbohydrate requirement for students at SMP Negeri 2 Bangli is 1772.78 kcal or 443.19 grams. The average fat requirement is 738.66 kcal or 82.07 grams. The average protein requirement is 443.19 kcal or 110.80 grams.

Table 8.
Macro Nutrion Needs of SMP Negeri 2 Bangli Students

	Macro Nutrion Needs					
	Carbohydrate		Fat		Protein	
	kkal	gram	kkal	gram	kkal	gram
Average	1772,78	443,19	738,66	82,07	443,19	110,80
SD	275,30	68,82	114,71	12,75	68,82	17,21

Discussion

Adolescence is a transitional phase that is highly vulnerable to nutritional issues because it is marked by rapid and simultaneous biological, psychological, and social changes. Hormonal instability, increased curiosity, and the tendency to experiment with various foods without considering their nutritional value put adolescents at risk for nutritional imbalances, both in the form of malnutrition and overnutrition (Hafiza, 2020). The findings of this study reinforce the view that changes in consumption patterns at the age of 14–15 contribute directly to variations in students' body mass index (BMI) and daily energy requirements.

Physiologically, adolescent nutritional needs increase with accelerated growth in height, increased muscle mass, maturation of organ systems, and the demands of more complex physical and cognitive activities. Hartanti et al. (2024) emphasized that adolescence requires greater energy and macronutrient intake than childhood, as energy is used not only for activity but also for growth and development. In this context, the basic energy requirement (BMR) found in students at SMP Negeri 2 Bangli—with an

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average of 1632.61 kcal—shows quite wide metabolic variation, reflecting differences in body composition, activity levels, and individual growth rates.

The results showed that when basic energy requirements were combined with non-exercise and exercise physical activity, students' total daily energy requirements increased significantly to an average of 2954.63 kcal per day. This figure indicates that most students fall into the moderate physical activity category, consistent with the findings of Asifah et al. (2025) who stated that moderate physical activity dominates the activity patterns of junior high school students. However, this increase in energy requirements is not always accompanied by a balanced consumption pattern, potentially leading to a mismatch between energy intake and needs.

This imbalance is reflected in the finding of students with undernutrition and overnutrition. Malnutrition in adolescents is generally caused by inadequate nutritional intake, irregular eating patterns, and a lack of understanding of balanced nutrition (Lestari et al., 2023). This condition results in a thinner body or a smaller body size compared to peers, which in turn increases susceptibility to infectious diseases and other health problems. Binuko et al. (2022) showed that students with poor nutritional status are at higher risk of worm infections, which can hinder physical growth and development. Furthermore, the findings of Nurazizah et al. (2022) regarding the increased risk of anemia in adolescent girls with an underweight BMI confirm that nutritional problems in adolescents are multidimensional and interconnected.

Furthermore, cases of overnutrition found in some students cannot be ignored. Overweight and obesity during school age are generally caused by the consumption of foods high in fat and sugar without adequate physical activity (Muchtar et al., 2023). This pattern reflects the transition to a sedentary lifestyle among modern adolescents, making an increase in BMI difficult to avoid. Thus, the results of this study confirm that adolescent nutritional problems are not only about undernutrition but also overnutrition, both of which pose risks to health and academic performance.

The implications of suboptimal nutritional status are not limited to physical aspects but also directly impact the learning process. Trinursari et al. (2022) stated that poor nutritional status can reduce students' concentration capacity, learning endurance, and motivation. This is reinforced by Setyawan et al. (2022), who found that students with poor nutritional status tend to experience drowsiness, fatigue, and decreased academic performance. In the context of physical education, these impacts are even more significant because learning PJOK demands high levels of physical readiness, energy, and focus. Ridho et al. (2025) emphasized that inadequate nutritional status will hinder student engagement in physical activity and reduce the effectiveness of PJOK learning.

From a physical education (PJOK) learning perspective, the findings of this study have strategic implications. First, BMI and macronutrient requirement data can be used by PJOK teachers as a basis for differentiating movement tasks. Students with undernutrition require adjusted activity intensity to avoid excessive fatigue, while students with overnutrition require more structured activities to safely and sustainably increase energy expenditure. Second, these results emphasize the importance of

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integrating functional nutrition education into PJOK learning, not just through theoretical material but through hands-on practice such as recording physical activity, estimating energy requirements, and reflecting on daily diets.

In the context of school-age coaching, particularly in extracurricular sports activities, an understanding of energy and macronutrient requirements is crucial. Students aged 14–15 are in a phase of rapid growth and therefore require an average additional energy intake of 93.48 kcal per day, as found in this study. Without adequate energy intake, sports training can potentially lead to chronic fatigue, decreased performance, and even the risk of injury. Therefore, school coaches need to use energy and macronutrient requirement data as a basis for developing training loads, frequency, and duration appropriate to students' biological conditions.

Furthermore, the macronutrient distribution found—with the dominant need for carbohydrates as the primary energy source—indicates that nutritional intake should be directed to support physical activity and learning. Carbohydrates play a crucial role in maintaining muscle glycogen availability, fat serves as a long-term energy reserve, and protein supports tissue growth and repair. This finding aligns with research by Saputro et al. (2025), which indicates that school students' macronutrient needs are relatively consistent, but implementation is highly dependent on education and supervision within the school and family environment.

Overall, this discussion confirms that nutritional status, BMI, and macronutrient needs are not simply indicators of health, but key factors influencing the effectiveness of physical education (PJOK) learning and coaching for school-age sports. Therefore, a collaborative approach between PJOK teachers, coaches, schools, and parents is essential to ensure that physical activity and learning align with students' biological needs. This approach is expected to not only improve fitness and academic achievement but also lay the foundation for a healthy lifestyle that will last into adulthood.

CONCLUSION

Based on the results of research data, the average BMI of students at SMP Negeri 2 Bangli has not fully reached the ideal BMI. The majority of students are at the ideal BMI of 39 (62%), however, there are 4 (6%) students classified as severely underweight, 6 (10%) as mildly underweight, 2 (3%) as mildly obese, and 12 (19%) as overweight students. The average carbohydrate requirement is 1772.78 kcal or 443.19 grams per day, the average protein requirement is 443.19 kcal or 110.80 grams per day, and the average fat requirement is at 738.66 kcal or 82.07 grams per day. Most students at SMP Negeri 2 Bangli do have an ideal BMI, but there are still students who experience an abnormal BMI, either undernutrition or overnutrition. This condition needs to be given attention, both in the school environment and at home, so that students can fulfill balanced nutrition so that normal nutritional status is achieved.

ACKNOWLEDGMENT

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Body Mass Index (BMI) and Macronutrient Needs of Students Aged 14-15 Years
I Kadek Hendra Sastrawan[1A-E], Hendra Mashuri[2B-D*], I Ketut Semarayasa[3D]
hendra.mashuri@undiksha.ac.id[2*]

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