ORIGINAL ARTICLE

Journal of Community Empowerment for Health (*JCOEMPH*) 2025, Volume 8, Number 3: 133-137
P-ISSN. 2655-0164, E-ISSN: 2654-8283

The relationship between nutritional status and fitness test performance of Atma Jaya University Marching Band Team

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Submitted: 2023-07-03
Revised: 2025-05-02
Accepted: 2025-08-21

ABSTRACT

Introduction: Nutritional status is one of the predictors of human energy balance. Adequate dietary intake plays an essential role in providing the body with necessary nutrients such as carbohydrates, protein, and fats which are converted into energy. The body's ability to produce sufficient energy is closely tied to its level of physical fitness, supporting bodily functions, physical activity, and overall well-being. To explore the correlation between dietary intake and fitness level, a multidisciplinary team of coaches, doctors, nutritionists, physiotherapists, and medical record professionals conducted a study on young adult members of the marching band team.

Methods: The study involved all 41 team members of the marching band. Nutritional intake was assessed through an online food frequency questionnaire, while the Cooper fitness test was administered directly under the supervision of fitness coaches in Yogyakarta.

Results: The Spearman Rank Correlation test revealed a negative correlation between Body Mass Index (BMI) with Cooper fitness test result ($r = -0.265$, $p = 0.047$). Total dietary protein intake showed a statistically significant positive correlation with Cooper fitness test result ($r = 0.287$ and $p = 0.034$). Other dietary components, including total energy intake, carbohydrates, fats, and hydration, also had positive correlations but statistically non-significant correlations with Copper test performance ($r = 0.238$, $p = 0.067$, $r = 0.038$, $p = 0.406$; $r = 0.065$, $p = 0.344$; $r = 0.062$, $p = 0.350$, respectively).

Conclusion: These findings highlight the importance of maintaining BMI and adequate protein intake to support muscle health and optimized fitness levels. However, the relatively weak correlations suggest that other factors may also influence individual performance on the Cooper fitness test.

Keywords: Dietary Intake, Cooper Test, Fitness, Nutritional Status, Protein.
Cite This Article: Wityadarda, C., Andani, G.A.S.D., Pareira, E.M.S., Parulian, A.A., Qomar, N., Utomo, D.A., Kion, R., Situmorang, N.S.F., Purba, E.P.S., Nada, P.A.V., Fafiani, S. 2025. The relationship between nutritional status and fitness test performance of Atma Jaya University Marching Band Team. *Journal of Community Empowerment for Health* 8(3): 133-137. DOI: 10.22146/jcoemph.86484

INTRODUCTION

Nutritional status refers to human health related to dietary patterns and nutrient intake as determined by the adequacy, balance, and variety of nutrients to meet the body's physiological needs. According to the World Health Organization (WHO), nutritional status is influenced by various factors such as economic, physiological, and sociocultural. The assessment of nutritional status requires assessing multiple factors such as anthropometric measurements (height and weight), biochemical markers, clinical assessment, dietary assessment (recall 24-hour, FFQ, or food diaries), and functional assessment. Nutritional status may vary across age groups, genders, and specific population groups, and maintaining adequate nutritional status is essential for supporting physical development, growth, and overall health.[1,2]

Body Mass Index (BMI), derived from anthropometric measurements, is commonly used to assess an individual's nutritional status. It is defined by dividing personal weight in kilograms by the square of their height in meters (kg/m^2). According to the WHO Classification for the Asian population: Underweight (BMI < 18.5 kg/ m^2), Normal weight (BMI 18.5> 23 kg/m^2), Overweight (BMI 23.0-27.5 kg/ m^2), obesity (BMI ≥ 27.5 kg/m^2).[3] Current research on College student in China shows that BMI correlates with their fitness performance.[4]

Dietary intake is one of the components that involves nutritional status assessment, typically measured in terms of energy

intake or calorie consumption from carbohydrates, fats, and proteins. All the components can be measured by the total amount of food and beverages consumed by an individual over specific periods of time. Food groups such as dairy products, fats, fruits, grains, proteins, vegetables, as well as fluids. Various methods to estimate dietary intake, such as food diaries, recall 24 hours, and food frequency questionnaires.[5]

Optimal dietary intake of macronutrients such as carbohydrates, proteins, and fats contributes to muscle repair, growth, and overall physiological adaptation to exercise. Carbohydrate intake can support glycogen uptake and regulation, protein intake supports muscle building and recovery, also increases immune function, and fat intake promotes energy utilization and hormonal balance. Thus, indicating proper dietary intake might have a correlation with fitness level for individuals.[6] Besides the macronutrients, hydration of each individual also involves their fitness level by maintaining intracellular and extracellular fluid of the body.[6,7]

Physical fitness to an individual's capacity to carry out physical tasks efficiently and with minimal fatigue. Through prolonged and demanding physical activity, differences in fitness levels become more evident. To assess physical endurance accurately, individuals must be tested under sustained effort.[8,9]

One other the established tools for measuring physical fitness is the Cooper test- a 12-minute running test developed by Dr. Kenneth Cooper in the 1960s. This test evaluates aerobic capacity by measuring the distance covered in 12 minutes, and it serves as an estimate of maximal oxygen consumption (VO2 max).[10]

The urgency of this research lies in the increasing need to promote healthy dietary habits and physical fitness among teenagers, particularly as sedentary lifestyles and poor eating patterns have become more common. Adolescents are at a critical stage of growth and development, making it essential to establish habits that will support long-term health outcomes. Including cardiovascular fitness and body composition.

Previous studies have highlighted the link between diet and physical fitness among young populations. For instance, a study conducted among Chinese college students revealed a significant association between BMI and physical fitness performance.[4] Another study among European adolescents found that higher fruit and vegetable intake was positively associated with cardiorespiratory fitness.[11,12] Moreover, protein intake was shown to be linked with better muscle function and aerobic capacity in adolescent endurance athletes.[13] These findings emphasize the important role of nutrition in supporting physical performance across different populations.[11–13]

The goal of this study is to investigate and provide insights into the relationship between nutritional status, dietary intake, and physical fitness performance among teenage members of a marching band team.

METHOD

This research was conducted using a cross-sectional study design during the period of May-June 2023, which was held on Atma Jaya Marching band team. Inclusion criteria for studies in this research are teenagers between 10-24 years old. Participants were excluded if they were outside the age range, were not members of the marching band team, did not complete the Food Frequency Questionnaire or Cooper test, did not provide consent, or had health conditions preventing them from safely participating in the fitness test. We used a total sampling to participate in this study. Ethical clearance register number is 039/UM3.06/2023 with protocol number M3.2306.027 from The Health Research Ethics Committee, Faculty of Universitas Jenderal Achmad Yani Cimahi.

The data collection was conducted at Universitas Atma Jaya Marching Band Team Yogyakarta. The Food Frequency Questionnaire is using online google form which contain several question body weight (kg), height (cm), water intake (ml/day), daily sweet beverages intake (1-2 cup/day), type of sweet beverages, frequency intake of main meal categories (1-2/ day), Carbohydrate (rice/potato/ noodles portion serving/day), protein (Chicken, egg, meat, etc.: portion serving/ day), Fat calculation taken from other components of dietary intake and snacks, favourite snacks and portion, intake of fruits and portion, intake of vegies/ day. Fitness test result was taken by using the Cooper test 12-minute run to calculate their VO2max, which can be categorized as a range of fitness level (1=very poor, 2= poor, 3= fair, 4=good).[8,10,14] Data-based food and nutrition calculation was conducted using manual calculation using the food conversion table and "Nutrisurvey". The Cooper test was taken under the supervision of the coaches and input into an online Google form by each member of the marching band team.

Data entry from questionnaires was calculated using SPSS to find the normality using Shapiro-Wilk and correlation using Spearman's rank correlation with significance $p \leq 0.05$ and R -1 to +1 to find the negative or positive correlation.

RESULT

Participants in this study were the Marching Band team from Universitas Atma Jaya, Yogyakarta, with a total of participants and data characteristics, and a Normality test on Table 1. The data distribution can be seen in Table 2. Meanwhile, the result of data normality can be seen in Table 3. The correlation analysis between variables can be seen in Table 3.

Table 1 shows the characteristics of 41 samples, which include the data of age, gender, and BMI when data collection was carried out. The result of the normality test was that BMI, intake of carbohydrates, and fat were normally distributed, while water intake, protein, energy, and Copper test were not normally distributed. So, the analysis taken for those variables is a non-parametric test Spearman Rank test.

Before calculating the correlation, a normality test was carried out on Dietary Intake (water intake, carbohydrate, protein, fat, energy), Nutritional Status (BMI), and the Cooper test, to determine whether the data are normally distributed or not. The results of the normality test are p>0,05, then the data is considered to be normally distributed; however, if the results are p<0,05, then the data is not considered to be normally distributed. (Table 1).

Table 1. The Characteristics of the Research Subject and The Result of the Normality Test with the Shapiro-Wilk Test

Subject Characteristics	N (People)	Mean	Std. Deviation	Shapiro-Wilk Test	
				sig.	Statistic
BMI (kg/m²)	41	21,4076	3,33675	0,135	0,958
Water Intake (ml)	41	1742,682	593,67089	0,024	0,936
Carbohydrate (gram)	41	220.7300	59,95355	0,947	0,988
Protein (gram)	41	52, 4093	18,05697	0,013	0,929
Fat (gram)	41	62, 7112	17,70691	0,088	0,953
Energy (kcal)	41	1615,0976	513,21705	0,007	0,920
VO_2max by categorized 1=very poor, 2= poor, 3= fair, 4=good	41	2,2439	0,48890	0,000	0,539

Table 2. The Distribution of VO_2max for Male and female (Values in ml/kg/min)

Gender				
	Male		Female	
Categories	F	Average (ml/kg/min)	F	Average (ml/kg/min)
Very Poor	0	0	0	0
Poor	12	26.04	20	19.2115
Fair	1	40.1	7	33.0857
Good	0	0	0	0
Excellent	1	66.94	0	0

*[8]

Table 3. The Results of the Correlation Test

		VO_2max
BMI (kg/m²)	**Spearman Rank**	-0,265
	sig.	0,047
	N	41
Water Intake (ml)	**Spearman Rank**	0,062
	sig.	0,350
	N	41
Carbohydrate (gram)	**Spearman Rank**	0,038
	sig.	0,406
	N	41
Protein(gram)	**Spearman Rank**	0,287
	sig.	0,034
	N	41
Fat (gram)	**Spearman Rank**	0,065
	sig.	0,344
	N	41
Energy (kcal)	**Spearman Rank**	0,238
	sig.	0,067
	N	41
VO_2 *max* 1=very poor, 2= poor, 3= fair, 4=good	**Spearman Rank**	1,000
	sig.	
	N	41

The results of the correlation analysis on the computerized system SPSS Version 26, showed a Basal Metabolic Index (BMI) with VO_2 *max* has a negative correlation (r = -0.265, p=0.047), while total dietary protein intake has a positive correlation and is statistically significant with Cooper fitness test result (r =0.287 and p = 0.034). Besides, other nutritional intakes such as total energy consumption, carbohydrates, fats, and hydration have a positive correlation with VO_2 *max* result (r =0.238, p=0.067, r=0.038, p=0.406; r= 0.065, p=0.344; r= 0.062, p=0.350).

DISCUSSION

The study revealed that nutritional status is associated with fitness performance, particularly when measured by the Cooper 12-minute run test. Higher BMI scores were linked to poorer performance, while greater dietary protein intake correlated with better outcomes. These findings align with previous research showing that excess body weight can impair cardiovascular efficiency and reduce aerobic capacity, highlighting the importance of maintaining a healthy body composition for endurance activity.[4,15] Furthermore, an endurance-based fitness assessment emphasizes the need for controlling the dietary intake to maintain body weight.

The positive correlation between dietary protein intake and Cooper Fitness Test supports the understanding that protein is crucial for muscle repair, growth, and endurance capacity, which in turn indirectly improves performance in aerobic exercise such as running.[16] Adequate protein intake is crucial for nutrition during the recovery phases to maintain muscle mass and prevent muscle loss.[17,18] Participants who are included in this research have a strenuous and extended period of training per week. Inadequate intake of protein may lead to suboptimal muscle recovery that also stated by them on the questionnaire; they are feeling more fatigued throughout the day. Previous research has emphasized that inadequate protein intake may impair muscle recovery, contributing to fatigue and decreased performance.[19] Although

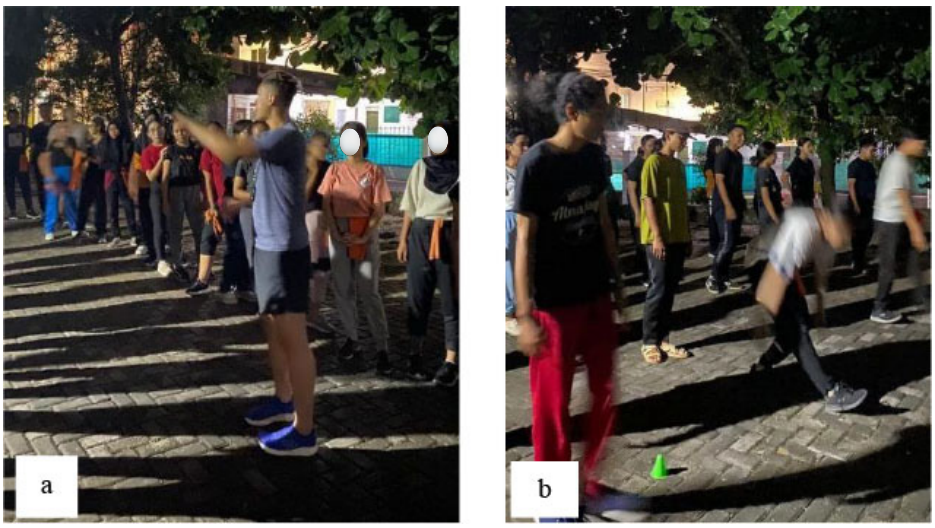

Figure 1. Universitas Atma Jaya Marching Band Team Yogyakarta. a) Instructions from the coach for the cooper test, b) Implementation of the cooper test.

a trend towards better performance was observed with higher intake of energy, carbohydrate, fat, and water intake, these correlations did not consistently reach statistical significance. These associations underscore the importance of maintaining adequate energy levels and macro-nutrient balances to support sustained effort and optimal performance in endurance activities. Consuming the right amount of carbohydrates provides the necessary fuel for aerobic metabolism, and fat serves as an additional source of energy.[17,20] Hydration is important for maintaining hydration and thermoregulation, which contributes to overall performance and endurance.[6,21]

Several limitations must be acknowledged. It is important to note that the lack of statistical significance of some correlations may be due to sample size, individual variability, or other confounding factors. Additionally, food intake was assessed using a self-report method, which may lead to some degree of measurement error and memory bias. Future studies will use larger samples and more accurate nutritional assessment methods. For example, food diaries and objective measurements may further clarify the relationship between these dietary factors and fitness test performance.

Despite these limitations, this study has practical implications for individuals, athletes and professionals involved in fitness training and performance optimization. Optimizing nutritional habits, such as consuming adequate protein, balancing energy intake, and maintaining adequate hydration, can have a positive impact on endurance performance in activities like the Cooper test. These insights guide personalized nutritional strategies to improve physical fitness and performance outcomes in endurance-based fitness assessments. This study, with a particular focus on the Cooper test, revealed a complex relationship between nutritional status and physical fitness test performance. The results highlight the negative correlation between BMI and test performance, highlighting the importance of maintaining a healthy weight. Furthermore, the observed positive associations between total dietary protein intake, total energy intake, carbohydrate, fat, and water intake with Cooper Fitness Test results indicate the importance of nutritional habits. These results enhance our understanding of the role of nutrition in endurance-based assessments and provide valuable insights for individuals seeking to improve physical fitness and perform well on similar physical fitness tests.

CONCLUSION

This study demonstrates a negative correlation between BMI and performance in the Cooper 12-minute test among members of a marching band team, emphasizing the importance of maintaining a healthy body composition to support cardiovascular and endurance fitness. Additionally, the findings suggest associated with better physical performance, underscoring the need for adequate protein consumption to support recovery and muscle maintenance in Individuals with regular training demands.

Although associations with total energy, carbohydrate, fat, and water intake were observed, the lack of strong statistical significance may be due to sample size limitations, dietary reporting bias, or other unmeasured variables. These findings suggest that nutrition alone does not fully explain variations in fitness levels, and that other lifestyle factors-such as sleep quality, stress, and socioeconomic conditions, also play an influential role

To strengthen future research with larger and more diverse populations should be studied using more rigorous and objective methods for dietary and VO2max direct measurement. In addition, nutrition education and a specific training program could be the focus for increasing the team members, personal coaches, and health practitioners to have a better understanding through implementing sport science on several aspects of the young generation. Thus, a better understanding will hopefully empower athletes and active individuals to enhance endurance, recovery, and overall physical fitness.

ACKNOWLEDGMENT

We would like to thank the Department of Nutrition Science, Faculty of Health Sciences, and Faculty of Vocational Studies, Universitas Santo Borromeus, Bandung Barat, Indonesia; the Physiology Department, Faculty of Medicine, Universitas Jenderal Achmad Yani; Crosslimit Training, and Marching Band Team Universitas Atma Jaya.

CONFLICT OF INTEREST

The authors declare there is no conflict of Interest.

RESEARCH FUNDING

The authors declare there is no conflict of Interest. This study did not receive any specific grants from any funding agencies.

AUTHOR CONTRIBUTION

CW contributed to creating a concept, content, design, literature review, manuscript preparation, and manuscript review. GASD contributed to handling ethical clearance, literature review, and manuscript review. EMSP contributed to the concept of the Fitness test, literature, and data analysis. AAP contributed to the analysed data and the statistical analysis. NQ, DAU, and RK were responsible for collecting the data and supervising the Marching Band Team. NSF, EPSP, PAVN, SF, FDN contributed to preparing the proposal, ethical clearance of the study.

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