

Correlation Between Diet Quality and Nutritional Status with Physical Fitness of Adolescent Indoor Handball Athletes at Handball Lembang Club

Aisya Putri¹, Ahmad Hisbullah Amrinanto^{✉23}, Widi Siti Rodhiah¹, Ksatriadi Widya Dwinugraha⁴, Putu Bunga Fitridewi⁵

¹Nutrition Study Program, Sekolah Tinggi Ilmu Kesehatan Bogor Husada, Indonesia

²Nutrition Study Program, Faculty of Sports and Health Education, Universitas Pendidikan Indonesia, Indonesia

³Nutrition and Culinary Innovation for Sustainable Health Research Group (NOURISH RG) Universitas Pendidikan Indonesia, Bandung, Jawa Barat, Indonesia

⁴Management of Food Service and Nutrition Study Program, College of Vocational Studies, IPB University, Indonesia

⁵Department of Nutrition, Poltekkes Kemenkes Bandung, Indonesia

Article Info

Article History:

Received : 27-08-2026

Approved : 13-09-2026

Published : 23-09-2026

Keywords:

Diet quality, nutritional status, physical fitness, handball, adolescent athletes

Abstract

Indoor handball is a high-intensity intermittent sport that places considerable physiological demands on adolescent athletes, making adequate diet quality and nutritional status critical for performance. This study aimed to analyze the correlation between diet quality and nutritional status with physical fitness among adolescent indoor handball athletes at Handball Lembang Club, West Bandung Regency, Indonesia. A cross-sectional observational design was employed with 32 athletes aged 16–18 years selected through total sampling. Diet quality was assessed using the Diet Quality Index-International (DQI-I) derived from a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ), while nutritional status was determined by body mass index-for-age (BMI/A) using WHO AnthroPlus software. Physical fitness was measured using the Indonesian Physical Fitness Test (TKJI) for ages 16–19 years. Data were analyzed using Spearman rank correlation. Results showed that the majority of athletes (68.8%) had good diet quality with a mean DQI-I score of 62.2 ± 7.32 , while 63% demonstrated good physical fitness. A significant positive correlation was found between diet quality and physical fitness ($r = 0.478$; $p = 0.006$), and a significant negative correlation between nutritional status and physical fitness ($r = -0.404$; $p = 0.022$). These findings indicate that better diet quality is associated with higher physical fitness, while higher BMI/A (overweight and obesity) is associated with lower physical fitness. Regular monitoring of diet quality and nutritional status, along with targeted nutrition education, is recommended to optimize athletic performance in adolescent handball players.

© 2026 Poltekkes Kemenkes Pontianak

✉ Correspondence address: Nutrition Study Program, Faculty of Sports and Health Education, Universitas Pendidikan Indonesia, Indonesia
Email: ahmadhisbullaha@upi.edu

1. INTRODUCTION

Indoor handball is a team sport characterized by high-intensity intermittent activity involving sprinting, jumping, rapid changes of direction, physical contact, and complex movement coordination during competition (Susanto, 2017). These characteristics require athletes to possess optimal physical capacities, including cardiorespiratory endurance, muscle strength, speed, agility, and adequate recovery ability to sustain performance during both training and competition. Consequently, meeting energy and nutritional requirements becomes a critical factor in supporting athlete performance and training adaptation (Povoas

et al., 2012; Ortega-Becerra et al., 2020). Nutritional adequacy in athletes should be evaluated not only in terms of total energy and nutrient intake but also through overall diet quality.

Diet quality reflects the degree to which an individual's dietary patterns conform to balanced nutrition guidelines and indicates the adequacy, diversity, and balance of daily food consumption (Mardiana et al., 2022). A high-quality diet may help fulfill macronutrient and micronutrient requirements to support energy metabolism, post-exercise recovery, immune function, and physiological adaptations resulting from intensive physical activity (Thomas et al., 2016; Amawi & Alkasasbeh, 2024). In adolescent athletes, nutritional adequacy is particularly critical as adolescence is a period of growth and development characterized by increased energy and nutrient requirements (Thomas et al., 2016).

Dietary imbalances in adolescent athletes may lead to impaired growth, decreased sports performance, increased risk of fatigue, and impaired post-exercise recovery (Bryl et al., 2025). Several studies have reported that adolescent athletes remain at risk of poor diet quality due to irregular eating patterns, low fruit and vegetable consumption, and high intake of foods rich in sugar and fat (Purcell et al., 2013; Falak et al., 2025). A good-quality diet has been associated with more optimal nutritional status (Malina & Geithner, 2011). Good nutritional status in athletes has been linked to better physical work capacity, body composition, and recovery ability, whereas undernutrition or overnutrition has been associated with reduced muscle efficiency, increased fatigue, and impaired sports performance (Maughan & Burke, 2012; Toselli, 2021).

Physical fitness is a key component of sports achievement as it reflects the body's ability to perform physical activity effectively without excessive fatigue (Yu et al., 2026). In handball athletes, physical fitness plays an important role in supporting playing performance during fast-paced and dynamic competitions. Research by Everett (2025) demonstrated that good diet quality is associated with improved aerobic capacity, muscle endurance, and athletic physical performance. Furthermore, optimal nutritional status has been associated with higher levels of physical fitness in adolescent athletes (Farsi, 2024).

Despite the extensive literature examining the relationship between nutritional factors and sports performance and physical fitness, previous studies among Indonesian adolescent athletes have largely focused on specific nutrient intakes or other nutritional factors in sports such as badminton (Sahara et al., 2019), basketball (Shofia et al., 2021; Nastiti & Firmansyah, 2023), and football. Meanwhile, studies involving handball athletes have predominantly examined physiological characteristics and match demands (Nikolaidis & Ingebrigtsen, 2013; Ortega-Becerra et al., 2020), rather than comprehensively investigating diet quality and nutritional status in relation to physical fitness. Therefore, research examining the correlation between diet quality and nutritional status with physical fitness specifically among adolescent handball athletes in Indonesia remains limited. This gap is particularly relevant because adolescent athletes are undergoing periods of rapid growth and development while simultaneously experiencing increased nutritional and physical demands associated with training and competition. Handball Lembang Club is one of the youth handball athlete development clubs in West Bandung Regency. Based on preliminary observations and interviews with coaches, systematic monitoring of athletes' diet quality and nutritional status had not been routinely conducted, leaving information regarding their nutritional and physical fitness conditions largely unavailable. Therefore, this study was conducted to analyze the correlation between diet quality and nutritional status with physical fitness among adolescent indoor handball athletes at Handball Lembang Club.

2. METHOD

This study employed a quantitative observational design with a cross-sectional approach. The study was conducted from January to July 2024 at Handball Lembang Club, West Bandung Regency. The study population consisted of 40 registered indoor handball athletes, 8 were excluded from the final sample: 3 athletes were excluded due to injury and 5 due to incomplete data/participation, resulting in a final sample of 32 athletes who met the inclusion and exclusion criteria. Inclusion criteria were: (1) indoor handball athletes aged 16–18 years; (2) regular training attendance of at least twice per week; (3) registered as active club members with adequate communication ability; and (4) willing to participate by signing informed consent and informed assent forms. Exclusion criteria included: (1) athletes sustaining injuries; (2) illness at the time of data collection; and (3) incomplete participation in the study or incomplete data.

The independent variables were diet quality and nutritional status, while the dependent variable was physical fitness. Dietary intake data were collected using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ), following standard dietary assessment methodologies (Gibson, 2005; Willett, 2013) and referencing previous research on adolescent athletes in Indonesia that employed a similar combination of instruments (Sahara et al., 2019). The SQ-FFQ was used to assess dietary habits through

face-to-face interviews conducted by trained enumerators; they recorded the frequency (daily/weekly/monthly) and portion size of each food item with the aid of a food photo album, which were subsequently converted into grams for nutrient analysis.

Food consumption data were analyzed using Microsoft Excel with nutrient composition data from the Indonesian Food Composition Table (TKPI) 2020, and fatty acid compositions referenced from the Singapore Food Composition System (FOCOS) and the United States Department of Agriculture (USDA) database. Diet quality was assessed using the Diet Quality Index-International (DQI-I) developed by Kim et al., (2003). The DQI-I comprises four main components: variety (0–20 points; overall food-group variety and protein-source variety), adequacy (0–40 points; vegetables, fruits, staple foods, dietary fiber, protein, iron, calcium, and vitamin C), moderation (0–30 points; total fat, saturated fat, cholesterol, sodium, and empty-calorie food), and overall balance (0–10 points; macronutrient ratio and fatty-acid ratio), with a maximum total score of 100. A higher DQI-I score indicates better diet quality. Diet quality was categorized as poor when the total score was ≤ 60 and good when the total score was > 60 (Kim et al., 2003; Tur et al., 2005; Mariscal-Arcas et al., 2007).

Nutritional status was determined based on body mass index-for-age (BMI/A). BMI/A z-scores were classified according to WHO growth reference standards for ages 5–19 years as severely thinness ($< -3SD$), thinness (-3 to $< -2SD$), normal (-2 to $+1SD$), overweight ($> +1$ to $+2SD$), and obese ($> +2SD$). Anthropometric measurements included body weight and height. Body weight was measured using a digital scale with a precision of 0.1 kg, while height was measured using a microtoise with a precision of 0.1 cm. Age, weight, and height data were then analyzed using WHO AnthroPlus 2007 software to obtain BMI/A categories. Additionally, body fat percentage was measured using Bioelectrical Impedance Analysis (BIA) with an Omron Body Fat Analyzer HBF-375 as supplementary body composition data. Physical fitness was assessed using the Indonesian Physical Fitness Test (TKJI) for ages 16–19 years, consisting of five test components: 60-meter sprint, flexed-arm hang for 60 seconds, sit-ups for 60 seconds, vertical jump, and a 1,000-meter run for females and 1,200-meter run for males. Each test component was scored according to TKJI classification and summed to obtain the total physical fitness score. Physical fitness categories were: excellent (22–25), good (18–21), moderate (14–17), poor (10–13), and very poor (5–9) based on the official Indonesian Physical Fitness Test (TKJI) guideline for ages 16–19 years (Depdiknas, 1999).

Data collection encompassed respondent characteristics, dietary intake, anthropometric measurements, and physical fitness data as the main study variables. Body fat percentage, measured using Bioelectrical Impedance Analysis (BIA), was collected as supplementary data to confirm body composition among athletes classified as overweight or obese based on BMI/A, and was not included as a variable in the primary correlation analysis. Data were collected through direct interviews and measurements by trained researchers and enumerators to minimize measurement bias. Statistical analysis was performed using SPSS. Univariate analysis was used to describe characteristics of respondents, diet quality, nutritional status, and physical fitness. Data normality was assessed using the Shapiro-Wilk test. As data were not normally distributed, bivariate analysis employed Spearman rank correlation to examine the correlations between diet quality and nutritional status with physical fitness. A p-value of < 0.05 was considered statistically significant. Participation was entirely voluntary, and confidentiality was maintained by anonymizing all respondent data. Prior to data collection, written informed consent and informed assent were obtained from all participants and their parents or legal guardians.

3. RESULTS AND DISCUSSION

Subject Characteristics

Subject characteristics provide a social and physical description of the study participants. Characteristics examined in this study included sex, school grade, pocket money, age, body weight, and height.

Table 1. Distribution of Subjects by Sex, School Grade, and Age

Characteristic	Total	
	n	%
Sex		
Male	18	56.3
Female	14	43.7
School Grade		
X	18	56.3
XI	6	18.8
XII	8	25.0
Age (years)		
16	21	65.6
17	9	28.1
18	2	6.3

Data source: Primary data

Subjects were adolescent indoor handball athletes aged 16–18 years coached at Handball Lembang Club. Of the 40 registered athletes, only 32 met the study criteria. Subjects were enrolled from various senior high schools in the Lembang area, West Bandung Regency. The majority were Grade X students (56.3%), while the smallest proportion were Grade XI students (18.8%). Subjects ranged in age from 16 to 18 years, with the largest proportion aged 16 years (65.6%) and the smallest aged 18 years (6.3%). This age range falls within the middle adolescence phase (14–18 years) (Berge et al., 2014). Regarding pocket money, body weight, and height characteristics (Table 2), daily pocket money ranged from IDR 15,000 to IDR 55,000 and was used by athletes for food, beverages, and transportation. The mean body weight was 58.2 kg and mean height was 161.4 cm.

Table 2. Distribution of Subjects by Pocket Money, Body Weight, and Height

Variable	Min	Max	Mean ± SD
Pocket Money (IDR)	15.000	55.000	31.062.5±10.166.2
Body Weight (kg)	44.7	102	58.2±12.4
Height (cm)	144.6	175.6	161.4±7.4

Data source: Primary data

Nutritional Status

Nutritional status reflects the state of health resulting from the balance between nutritional requirements and nutrient intake. Adequate energy and nutrient availability as reflected by measured physical fitness can determine an individual's nutritional status (Fernández-Lázaro & Seco-Calvo, 2023). Good nutritional status in adolescent athletes supports growth processes and enhances sports achievement. Nutritional status was assessed using BMI/A. Table 3 shows that the majority of subjects had normal nutritional status (n = 26; 81.3%), while 15.6% (n = 5) were classified as overweight and 3.1% (n = 1) as obese, consistent with findings Shofia et al., (2021) in which most adolescent athletes had normal BMI/A. For subjects classified as overweight or obese, body fat percentage was additionally measured to provide descriptive, supporting data for interpreting the elevated BMI/A classification.

Table 3. Distribution of Athletes' Nutritional Status

Nutritional Status	n	%
Normal	26	81.3
Overweight	5	15.6
Obese	1	3.1
Total	32	100.0

Data source: Primary data

Based on body fat percentage measurements, subjects with overweight and obese nutritional status were found to have overfat and obese body fat categories (Table 4). consistent with findings by Nastiti & Firmansyah (2023) stating that athlete body fat percentage should remain within a normal range. Therefore, athletes classified as overweight or obese tended to have excess body fat percentage.

Table 4. Body Fat Percentage of Subjects with Overweight and Obese Nutritional Status

Subject	BMI/A z-score	Nutritional Status Category	Body Fat (%)	Body Fat Category
205	3.33	Obese	35.5	Obese
210	1.70	Overweight	21.0	Overfat
113	1.56	Overweight	21.1	Overfat
119	1.60	Overweight	21.2	Overfat
121	1.84	Overweight	22.4	Overfat
227	1.58	Overweight	22.7	Overfat

Data source: Primary data

Diet Quality

Diet quality is an assessment of dietary intake quality that reflects an individual's eating patterns. Diet quality was assessed using the Diet Quality Index-International (DQI-I) obtained through the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) method. The distribution of subjects by diet quality category is shown in table 5.

Table 5. Distribution of Athletes' Diet Quality

Diet Quality	n	%
Good	22	68.75
Poor	10	31.25
Total	32	100

Data source: Primary data

Table 5 shows that 68.8% (n = 22) of subjects had good diet quality and 31.3% (n = 10) had poor diet quality, with female subjects demonstrating a higher proportion of good diet quality than males. This is consistent with findings by Colillas-Malet et al., (2024) who reported that female adolescents exhibit healthier eating behaviors and pay greater attention to health factors in food selection compared to male adolescents. Female adolescents more frequently regulate their dietary patterns to maintain an ideal body shape, making them more selective in food choices (Hamaliyah & Dewi, 2024). Furthermore, female adolescents consistently consume fruits and vegetables more frequently than their male counterparts, while male adolescents tend to prefer fast food, sweetened beverages, and high-fat foods, which diminish overall diet quality (Sisay et al., 2024). DQI-I component scores are presented in Table 6.

Table 6. DQI-I Component Scores of Study Subjects

Component	Min	Max	Mean ± SD
Variety			
Overall food group variety	9	15	12.4 ± 1.98
Protein source variety	1	5	3.8 ± 1.12
Total variety			16.2 ± 3.10
Adequacy			
Vegetables	3	5	3.8 ± 1.11
Fruits	1	5	3.5 ± 1.02
Staple foods	0	3	1.2 ± 0.63
Dietary fiber	3	5	4.1 ± 1.01
Protein	3	5	4.3 ± 0.98
Iron	5	5	5.0 ± 0.00
Calcium	1	5	3.0 ± 0.51
Vitamin C	3	5	4.9 ± 0.35
Total adequacy			29.7 ± 5.50
Moderation			
Total fat	0	6	3.5 ± 2.03

Component	Min	Max	Mean $\pm$ SD
Variety			
Saturated fat	0	6	3.2 $\pm$ 2.40
Cholesterol	0	6	4.0 $\pm$ 2.71
Sodium	0	6	0.4 $\pm$ 1.48
Empty calorie food	0	6	1.6 $\pm$ 2.28
Total moderation			15.7 $\pm$ 11.14
Overall Balance			
Macronutrient ratio	0	6	3.1 $\pm$ 2.27
Fatty acid ratio	0	4	0.6 $\pm$ 1.29
Total overall balance			3.7 $\pm$ 3.56
DQI-I Total			62.2 $\pm$ 7.32

Data source: Primary data

The mean total DQI-I score of 62.2 ± 7.32 out of a maximum of 100 falls within the 'good' diet quality category based on the cut-off applied in this study (>60), although the score is only marginally above this threshold, indicating that several components particularly moderation and overall balance still require improvement. The total variety score of 16.2 indicated that most subjects consumed various food groups including vegetables, fruits, and protein sources, although staple food variety remained limited. This limitation suggests that most subjects remained dependent on rice as their primary carbohydrate source. Food diversity is an important indicator of diet quality as it enhances both macronutrient and micronutrient adequacy. Recent research has demonstrated that greater food diversity is associated with better vitamin and mineral sufficiency and overall diet quality in adolescents (Russo et al., 2023; Jenkins et al., 2023). The adequate protein source variety observed in this study indicates that subjects obtained protein from both animal and plant sources. Diversification of protein sources is important because each food source provides different amino acid profiles, vitamins, minerals, and bioactive components that can optimally support adolescent growth and health (Rao & Poonia, 2023).

Regarding adequacy, Table 4 shows that scores for staple food adequacy were low, while iron and vitamin C adequacy scores were relatively high. The low staple food score was likely attributable to limited variety in complex carbohydrate sources, as most subjects consumed rice daily without meeting DQI-I recommendations for carbohydrate source diversity. This pattern is consistent with studies of adolescents in Asia, which generally show that dietary patterns lack diversity and are dominated by a single staple food (Ochola & Masibo, 2014). Despite this, scores for vegetables, fruits, dietary fiber, protein, iron, and vitamin C were relatively high, suggesting that most subjects consumed important micronutrient-rich foods. Regular fruit and vegetable consumption has been associated with higher diet quality and reduced risk of chronic diseases in adulthood (Aune et al., 2017; Russo et al., 2023).

The very low sodium moderation score indicated that most subjects had high sodium intake, likely derived from processed and ultra-processed foods such as instant noodles, bread, and biscuits frequently consumed by adolescents. This consumption pattern is consistent with global trends showing increased ultra-processed food consumption among adolescents. Recent studies found that ultra-processed food consumption correlates with high sodium, added sugar, and saturated fat intake and reduces overall diet quality (Lane et al., 2024). The low empty calorie food score similarly reflects high energy contributions from nutrient-poor foods such as biscuits, sugar, margarine, and instant beverages. This finding warrants attention as consumption of ultra-processed foods (UPFs) has been associated with increased risk of numerous non-communicable diseases, including obesity, metabolic syndrome, hypertension, type 2 diabetes mellitus, cardiovascular disease, cancer, depression, functional gastrointestinal disorders, asthma, frailty, and all-cause mortality. The underlying mechanisms include high sugar, fat, salt, and energy content, low fiber and micronutrient content, and the presence of food additives and processing by-products that can induce inflammation and metabolic dysfunction (Chen et al., 2020).

The overall balance score of 3.7 indicates that macronutrient distribution and fatty acid balance among subjects remained suboptimal, likely due to high consumption of processed foods and limited food source variety. Imbalanced dietary patterns may result in excessive saturated fat intake and inadequate unsaturated fatty acid intake, which is important for cardiometabolic health (Lichtenstein et al., 2021). In adolescent athletes, the balance of carbohydrate, protein, and fat intake is critical because it influences energy availability, recovery, body composition, and physical performance (Desbrow et al., 2014; Thomas et al., 2016).

Physical Fitness

Physical fitness is defined as the body's ability to perform daily activities effectively without excessive fatigue while retaining energy reserves for additional activities (Bull et al., 2020). It is an important component of sports performance as it reflects the capacity of the cardiovascular, respiratory, neuromuscular, and metabolic systems to optimally support physical activity. Athletes with higher physical fitness levels tend to sustain training and competition intensity for longer periods compared to those with lower fitness levels (Guthold et al., 2019). Therefore, physical fitness is one of the primary determinants of sports performance and achievement. The distribution of subjects' physical fitness is presented in table 7.

Table 7. Distribution of Athletes' Physical Fitness

Physical Fitness Level	n	%
Excellent	0	0.0
Good	20	62.5
Moderate	11	34.4
Poor	1	3.1
Very poor	0	0.0
Total	32	100.0

Data source: Primary data

Table 7 illustrates the distribution of subjects according to their physical fitness level. The majority of subjects were classified as having a good level of physical fitness (62.5%; n = 20), followed by a moderate level (34.4%; n = 11). Only 3.1% (n = 1) of the subjects were categorized as having a poor level of physical fitness, while none were classified as having excellent or very poor fitness levels. Prior to correlation analysis, the physical fitness score had a median of 18 (IQR: 16–19). This finding indicates that the majority of subjects had a relatively favorable level of physical fitness. The result is consistent with Jatmiko & Syaukani (2023), who reported that the majority of adolescent athletes had a good level of physical fitness. The high proportion of athletes with good physical fitness in this study indicates that most subjects possessed adequate physiological capacity to support training and competition activities. Good physical fitness is generally achieved through a combination of structured training, adequate training frequency, optimal recovery, and nutritional intake meeting athletes' requirements (Thomas et al., 2016).

Good physical fitness plays an important role in sustaining sports performance as it is closely related to the body's ability to generate energy, transport oxygen to tissues, and accelerate recovery after physical activity. Athletes with higher fitness levels exhibit better cardiovascular and respiratory system efficiency, enabling improved oxygen transport and utilization to muscle tissues. These conditions allow athletes to sustain training intensity for longer periods, enhance aerobic endurance, and delay fatigue during competition (Mazaheri et al., 2021).

Correlation Between Diet Quality and Physical Fitness

Optimal performance during training and competition is greatly influenced by the adequacy and quality of daily nutritional intake. Diet quality is an indicator that reflects the extent to which an individual's dietary patterns align with nutritional recommendations and are capable of meeting nutritional requirements to support health and physiological function. In athletes, good diet quality plays an important role in providing energy, maintaining metabolic function, supporting training adaptation, accelerating recovery, and enhancing physical work capacity and sports performance (ACSM, 2016).

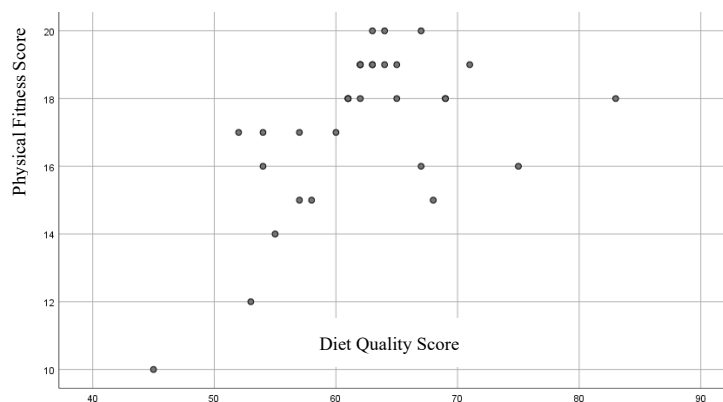


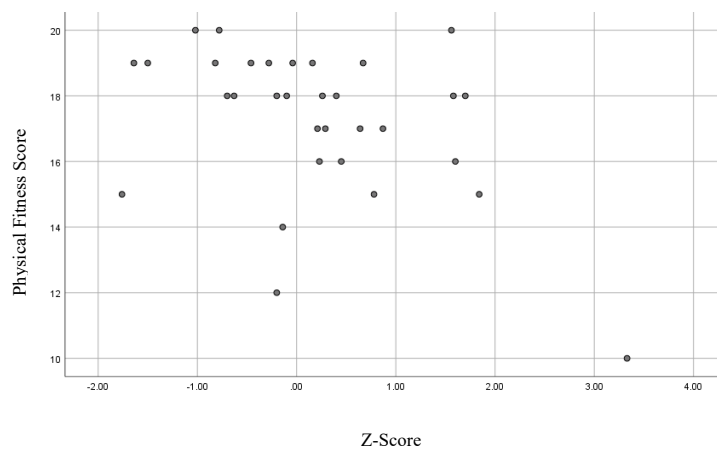
Figure 1. Correlation Between Diet Quality and Physical Fitness

Spearman correlation analysis revealed a significant correlation between diet quality and physical fitness among indoor handball athletes at Handball Lembang Club ($p = 0.006$) with a moderate correlation strength ($r = 0.478$). These results indicate that higher diet quality scores are associated with better physical fitness levels. This finding is consistent with numerous studies demonstrating that better diet quality is associated with higher cardiorespiratory capacity, endurance, and physical performance in adolescent athletes (Howe et al., 2015; Sahara et al., 2019). Good diet quality is generally characterized by adequate consumption of complex carbohydrates, high-quality protein, healthy fats, vitamins, and minerals. Carbohydrates serve as the primary energy source during moderate-to-high intensity physical activity, while protein is essential for muscle tissue repair and adaptation following training. Micronutrients such as iron, vitamin C, vitamin D, calcium, and magnesium contribute to oxygen transport, muscle contraction, energy metabolism, and bone health maintenance, all of which are necessary to support athletes' physical fitness (Maughan & Burke, 2012). In this study, athletes with better diet quality tended to have higher fitness levels, which may be associated with more adequate nutrient intake supporting physiological adaptation to training. Conversely, poor diet quality may cause energy deficits and specific nutrient deficiencies that ultimately reduce aerobic capacity, accelerate fatigue onset, and impair post-exercise recovery (Howe et al., 2015).

Additionally, DQI-I scores in this study revealed that sodium intake, empty calorie food consumption, and nutrient balance were the components most in need of improvement. These components may affect energy metabolism efficiency and overall health quality. High consumption of ultra-processed foods rich in sodium, added sugar, and saturated fat has been associated with reduced diet quality and physical performance in adolescents (Lane et al., 2024). Therefore, improving diet quality through diverse food consumption, adequate intake of fruits, vegetables, and high-quality protein sources, and limiting ultra-processed food consumption represents an important strategy for enhancing athletes' physical fitness. Overall, the results of this study indicate that diet quality is associated with athletes' physical fitness, and that better dietary practices tend to be linked with a greater likelihood for athletes to achieve optimal physical condition. Given the cross-sectional design of this study, these findings should be interpreted as an association rather than evidence that diet quality determines or causes improvements in physical fitness.

Correlation Between Nutritional Status and Physical Fitness

Analysis revealed a significant correlation between nutritional status and physical fitness among indoor handball athletes at Handball Lembang Club ($p = 0.022$) with a negative correlation direction and moderate correlation strength ($r = -0.404$). These results indicate that a higher BMI-for-age (BMI/U) z-score is associated with a lower physical fitness score among the subjects in this study. This finding is consistent with research demonstrating that increased body mass index is associated with reduced aerobic capacity, cardiorespiratory endurance, and physical performance in athletes (Bhattachar et al., 2023). A higher BMI-for-age (BMI/U) z-score generally reflects prolonged positive energy balance, leading to increased body fat stores, which may reduce movement efficiency and increase physiological workload during physical activity (García-Hermoso et al., 2020).



p-value = 0.022; $r = -0.404$

Figure 2. Correlation Between Nutritional Status and Physical Fitness

This finding is also consistent with studies by Nikolaidis (2013) and Nikolaidis & Ingebrigtsen (2013), which showed that increased body mass index and body fat accumulation are associated with reduced aerobic capacity, cardiorespiratory endurance, and physical performance in athletes. Excess body fat stores may reduce the body's ability to efficiently utilize oxygen during physical activity. Adipose tissue does not directly contribute to force production but adds to total body mass that must be moved during sports activity. Consequently, athletes require greater energy to produce the same movement compared to athletes with more ideal body composition (Guthold et al., 2019), resulting in increased energy expenditure, accelerated fatigue, and reduced performance during training and competition. Beyond increasing mechanical body load, excess body fat may also affect cardiorespiratory function. Individuals with high body fat percentages tend to have lower relative aerobic capacity because maximum oxygen consumption (VO_{2max}) is calculated per unit body weight. As body fat proportion increases, relative VO_{2max} tends to decline, reducing the body's capacity to supply oxygen to muscles during physical activity (ACSM, 2016).

In handball athletes, optimal physical condition is critically important as the sport demands a combination of endurance, speed, agility, strength, and the ability to perform high-intensity intermittent activities. Athletes with normal nutritional status and more ideal body composition generally exhibit better movement efficiency and can sustain performance for longer periods compared to overweight or obese athletes (Povoas et al. 2012). Nevertheless, nutritional status is not the sole determinant of physical fitness. Training frequency, training intensity, sleep quality, recovery, hydration, and diet quality also contribute to an athlete's level of physical fitness. Therefore, efforts to improve physical fitness must be conducted comprehensively through optimal nutritional status management, high-quality dietary practices, and structured, sustained training programs.

This study has several limitations. The cross-sectional design precludes causal inferences regarding the correlations between diet quality, nutritional status, and physical fitness. Additionally, diet quality assessment using SQ-FFQ may introduce recall bias due to reliance on respondents' ability to recall food consumption patterns. The study also did not account for several factors that may influence physical fitness, including training frequency and intensity, sleep quality, hydration status, and biological maturation level. Future research is recommended to employ longitudinal designs while incorporating these factors to achieve a more comprehensive understanding of these correlations.

4. CONCLUSION

This study demonstrated significant correlations between diet quality and nutritional status with physical fitness among adolescent indoor handball athletes at Handball Lembang Club. Diet quality showed a positive correlation with physical fitness, indicating that better athlete diet quality is associated with better physical fitness levels. Conversely, nutritional status showed a negative correlation with physical fitness, indicating that progression toward overweight and obese nutritional status tends to be accompanied by declining physical fitness. These findings suggest that diet quality and nutritional status are factors associated with physical fitness in adolescent handball athletes. Based on these results, coaches, athletes, and club management are recommended to conduct regular monitoring of diet quality and nutritional status, and to implement nutrition education focused on improving dietary quality, reducing ultra-processed food consumption, and maintaining optimal body composition to support physical fitness and sports performance.

5. ACKNOWLEDGEMENT

The authors extend their gratitude to Handball Lembang Club, West Bandung Regency, for granting permission, support, and facilities during the research. Appreciation is also expressed to all athletes who volunteered as respondents and participated in the data collection process. The authors further acknowledge the assistance of enumerators and all parties who supported the measurement and data processing procedures, enabling the completion of this study.

REFERENCE

- ACSM. (2016). Nutrition and Athletic Performance. *Journal of the American Collage of Sport Medicine*. 543–568. <https://doi.org/10.1249/MSS.0000000000000852>
- Amawi. A.. & Alkasasbeh. W. (2024). *Athletes ' nutritional demands : a narrative review of nutritional requirements*. January. 1–17. <https://doi.org/10.3389/fnut.2023.1331854>
- Aune. D.. Giovannucci. E.. Boffetta. P.. Riboli. E.. Vatten. L. J.. & Tonstad. S. (2017). Fruit and vegetable intake and the risk of cardiovascular disease . total cancer and all- cause mortality — a systematic review and dose- response meta-analysis of prospective studies. *International Journal of Epidemiology*. 46(3). 1029–1056. <https://doi.org/10.1093/ije/dyw319>
- Berge. J. M.. Jin. S. W.. Hannan. P.. & Neumark-Sztainer. D. (2014). Structural and Interpersonal Characteristics of Family Meals: Associations with Adolescent BMI and Dietary Patterns. *J Acad Nutr Diet*. 113(6). 816–822. <https://doi.org/10.1016/j.jand.2013.02.004>
- Bhattachar. S.. Chawla. A.. Sikri. G.. & Patrikar. S. (2023). Body fat content correlates with maximum aerobic capacity in healthy sedentary Indian males. *Medical Journal Armed Forces India*. 79(1). 93–100. <https://doi.org/10.1016/j.mjafi.2021.09.004>
- Bryl. E.. Demuth. A.. Ratajczak. J.. Czerniak. U.. Płoszka. J.. Lewandowska. M.. Bilska. A.. & Antosiak-cyrak. K. (2025). *Determinants of Diet Quality in Young Football Players from Pozna n* . 1–15.
- Bull. F. C.. Al-. S. S.. Biddle. S.. Borodulin. K.. Buman. M. P.. Cardon. G.. Carty. C.. Chaput. J.-P.. Chastin. S.. Chou. R.. Dempsey. P. C.. Dipietro. L.. Ekelund. U.. Firth. J.. Friedenreich. C. M.. Garcia. L.. Gichu. M.. Jago. R.. Katzmarzyk. P. T.. ... Willumsen. J. F. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *BMJ*. 54. 1451–1462. <https://doi.org/10.1136/bjsports-2020-102955>
- Chen. X.. Zhang. Z.. Yang. H.. Qiu. P.. Wang. H.. Wang. F.. & Zhao. Q. (2020). Consumption of ultra-processed foods and health outcomes : a systematic review of epidemiological studies. *Nutrition Journal*. 19(86). 1–10. <https://doi.org/https://doi.org/10.1186/s12937-020-00604-1>
- Colillas-Malet. E.. Bosque-Prous. M.. Esquiús. L.. Gonz. H.. Lafon-Guasch. A.. Fortes-Muñoz. P.. Espelt. A.. & Aguilar-Mart. A. (2024). Relationship between Diet Quality and Socioeconomic and Health-Related Factors in Adolescents by Gender. *Nutrients*. 16(139). 1–16. <https://doi.org/https://doi.org/10.3390/nu16010139>
- Depdiknas. (1999). *Tes Kesegaran Jasmani Indonesia Pusat kesegaran Jasmani dan Rekreasi (TKJI)*. Pusat Kesegaran Jasmani dan Rekreasi.
- Desbrow. B.. McCormack. J.. Burke. L. M.. Cox. G. R.. Fallon. K.. Hislop. M.. Logan. R.. Sawyer. S. M.. Shaw. G.. Star. A.. Vidgen. H.. & Leveritt. M. (2014). Sports Dietitians Australia Position Statement : Sports Nutrition for the Adolescent Athlete. *International Journal of Sport Nutrition and Exercise Metabolism*. 24. 570–584. <https://doi.org/https://doi.org/10.1186/s12937-020-00604-1>
- Everett. S. (2025). *Optimizing Performance Nutrition for Adolescent Athletes : A Review of Dietary Needs . Risks . and Practical Strategies*.
- Falak. F.. Ahmad. A. M. R.. Mahmood. H.. Malik. Z. I.. Shah. S. H. B. U.. Abid. J.. & Irfan. M. (2025). Diet quality and its associated factors among adolescents in high schools of Rawalpindi and Islamabad. *Frontiers in Public Health*. 13(1651903). <https://doi.org/10.3389/fpubh.2025.1651903>
- Farsi. D. J. (2024). Diet Quality and Physical Activity and Their Association with BMI and Dental Caries Among High School Adolescents: A Cross-Sectional Study. *Children*. 11(1282). <https://doi.org/https://doi.org/10.3390/children11111282>
- Fernández-Lázaro. D.. & Seco-Calvo. J. (2023). Nutrition . Nutritional Status and Functionality. *Nutrients*. 15. 1944. <https://doi.org/https://doi.org/10.3390/nu15081944>
- García-Hermoso. A.. Izquierdo. M.. Alonso-Martínez. A. M.. Faigenbaum. A.. Olloquequi. J.. & Ramírez-Vélez. R. (2020). Association between Exercise-Induced Changes in Cardiorespiratory Fitness and Adiposity among Overweight and Obese Youth : A Meta-Analysis and. *Children*. 7(0147). 1–13. <https://doi.org/doi:10.3390/children7090147>
- Gibson. R. S. (2005). *Principles of Nutritional Assessment (2nd ed.)*. Oxford University Press.
- Guthold. R.. Stevens. G. A.. Riley. L. M.. & Bull. F. C. (2019). Articles Global trends in insufficient physical activity among adolescents : a pooled analysis of 298 population-based surveys with 1 · 6 million

- participants. *The Lancet child and Adolescent Health*. 4642(19). 1–13. [https://doi.org/10.1016/S2352-4642\(19\)30323-2](https://doi.org/10.1016/S2352-4642(19)30323-2)
- Hamaliyah, S., & Dewi, R. K. (2024). Body Image . Kualitas Diet dan Hubungannya pada Status Gizi Remaja Putri di SMAN 10 Padang Tahun 2023. *J Gizi Dietetik*. 3(2). 107–113. <https://doi.org/doi.org/10.25182/jigd.2024.3.2.107-113>
- Howe, A. S., Skidmore, P. M. L., Parnell, W. R., Wong, J. E., Lubransky, A. C., & Black, K. E. (2015). Cardiorespiratory fitness is positively associated with a healthy dietary pattern in New Zealand adolescents. *Public Health Nutrition*. 19(7). 1279–1287. <https://doi.org/10.1017/S1368980015002566>
- Jatmiko, A. B., & Syaekani, A. A. (2023). *Survei tingkat kebugaran jasmani atlet remaja akademi basket rookie*. 6(1). 119–135. <https://doi.org/10.29408/porkes.v6i1.7823>
- Jenkins, M., Jefferds, M. E. D., Aburto, N. J., Ramakrishnan, U., Martorell, R., & Addo, O. Y. (2023). What Do United States Adolescents Eat ? Food Group Consumption Patterns and Dietary Diversity from a Decade of Nationally Representative Data. *Current Developments in Nutrition*. 7(8). 101968. <https://doi.org/10.1016/j.cdnut.2023.101968>
- Kim, S., Haines, P. S., Siega-riz, A. M., & Popkin, B. M. (2003). The Diet Quality Index-International (DQI-I) Provides an Effective Tool for Cross-National Comparison of Diet Quality as Illustrated by China and the. *J Nutr*. 133. 3476–3484.
- Lane, M. M., Gamage, E., Du, S., Ashtree, D. N., McGuinness, A. J., Gauci, S., Baker, P., Lawrence, M., Rebholz, C. M., Srouf, B., Touvier, M., Jacka, F. N., Neil, A. O., Segasby, T., & Marx, W. (2024). Ultra-processed food exposure and adverse health outcomes : umbrella review of epidemiological meta-analyses. *BMJ*. 384. e077310. <https://doi.org/10.1136/bmj-2023-077310>
- Lichtenstein, A. H., Appel, L. J., Vadiveloo, M., Hu, F. B., & Kris-etherton, P. M. (2021). 2021 Dietary Guidance to Improve Cardiovascular Health : A Scientific Statement From the American Heart Association. *Circulation*. 144. e472–e487. <https://doi.org/10.1161/CIR.0000000000001031>
- Mardiana, Lestari, Y. N., & Prameswari, G. N. (2022). Jurnal Kesehatan Masyarakat. *Jurnal Kesehatan Masyarakat*. 17(3). 444–452. <https://doi.org/https://doi.org/10.15294/kemas.v17i3.33711>
- Mariscal-Arcas, M., Romaguera, D., Rivas, A., Feriche, B., Pons, A., Tur, J. A., & Olea-Serrano, F. (2007). Diet quality of young people in southern Spain evaluated by a Mediterranean adaptation of the Diet Quality Index-International (DQI-I). *British Journal of Nutrition*. 98. 1267–1273. <https://doi.org/10.1017/S0007114507781424>
- Maughan, E. R. J., & Burke, L. M. (2012). Sports Nutrition : More than Just Calories -Triggers for Adaptation. *Journal of Sports Science and Medicine*. 11(358). 2012.
- Mazaheri, R., Schmied, C., & Niederseer, D. (2021). Cardiopulmonary Exercise Test Parameters in Athletic Population : A Review. *Journal of Clinical Medicine*. 10. 5073. <https://doi.org/https://doi.org/10.3390/jcm10215073>
- Nastiti, Y. S. T., & Firmansyah, F. (2023). Hubungan antara Status Gizi dan Persen Lemak Tubuh dengan Kebugaran Jasmani pada Atlet Bola Basket Universitas Muhammadiyah Surakarta. *Health Information*. 15(2). 1–9.
- Nikolaidis, P. T. (2013). Body mass index and body fat percentage are associated with decreased physical fitness in adolescent and adult female volleyball players. *Journal of Research in Medical Sciences*. 22–26.
- Nikolaidis, P. T., & Ingebrigtsen, J. (2013). Physical and Physiological Characteristics of Elite Male Handball Players from Teams with a Different Ranking. *Journal of Human Kinetics*. 38. 115–124. <https://doi.org/10.2478/hukin-2013-0051>
- Ochola, S., & Masibo, P. K. (2014). Dietary Intake of Schoolchildren and Adolescents in Developing Countries. *Annals of Nutrition & Metabolism*. 64(Supp; 2). 24–40. <https://doi.org/10.1159/000365125>
- Ortega-Becerra, M., Belloso-Vergara, A., & Pareja-Blanco, F. (2020). Physical and Physiological Demands During Handball Matches in Male Adolescent Players by. *Journal of Human Kinetics volume*. 72. 253–263. <https://doi.org/10.2478/hukin-2019-0111>
- Povoas, S. C. A., Seabra, A. F. T., Ascensao, A. A. M. R., Magalhaes, J., Soares, J. M. C., & Rebelo, A. N. C. (2012). Physical and Physiological Demands of Elite Team Handball. *Journal ofStrength and Conditioning Research*. 26(12). 3365–3375.
- Purcell, L. K., Society, C. P., & Sports, P. (2013). *Sport nutrition for young athletes*. 18(4). 200–202.
- Rao, V., & Poonia, A. (2023). Protein characteristics . amino acid profile . health benefits and methods of extraction and isolation of proteins from some pseudocereals — a review. *Food Production, Processing and Nutrition*. 5(37). 1–17. <https://doi.org/10.1186/s43014-023-00154-z>
- Russo, M. Dello, Formisano, A., Lauria, F., Ahrens, W., Bogl, L. H., Eiben, G., Henauw, S. De, Hebestreit, A., Intemann, T., Hunsberger, M., Lissner, L., Molnar, D., Pala, V., Papoutsou, S., Santaliesstra-Pasisas, A. M., & Russo, P. (2023). Dietary Diversity and Its Association with Diet Quality and Health Status of European Children, Adolescents, and Adults: Results from the I.Family Study. *Foods*. 12(4458). 1–18. <https://doi.org/https://doi.org/10.3390/foods12244458>
- Sahara, M. P., Widyastuti, N., & Candra, A. (2019). Kualitas Diet dan Daya Tahan (Endurance) Atlet

- Bulutangkis Remaja di Kota Semarang. *Journal of Nutrition College*. 8(1). 29–37.
- Shofia, A., Setiawan, D. P., Amin, N., Nilawati, I., & Fadly, S. (2021). Hubungan Status Gizi dengan Kekuatan Otot Lengan Atlet Bola Basket. *Nutrizone*. 01(01). 1–5.
- Sisay, B. G., Lacy, K. E., Mcnaughton, S. A., & Leech, R. M. (2024). Comparison of snack characteristics by diet quality findings from a nationally representative study of Australian adolescents. *Scientific Reports*. 14. 23663. <https://doi.org/https://doi.org/10.1038/s41598-024-75386-1>
- Susanto, E. (2017). Pengembangan Tes Keterampilan Dasar Olahraga Bola Tangan Bagi Mahasiswa. *Jurnal Penelitian dan Evaluasi Pendidikan*. 21(1). 116–125. <https://doi.org/10.21831/pep.v21i1.15784>
- Thomas, D. T., Erdman, K. A., & Burke, L. M. (2016). Position of the Academy of Nutrition and Dietetics. Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. *Journal of the Academy of Nutrition and Dietetics*. 116(3). 501–528. <https://doi.org/10.1016/j.jand.2015.12.006>
- Tur, J. A., Romaguera, D., & Pons, A. (2005). The Diet Quality Index-International (DQI-I): is it a useful tool to evaluate the quality of the Mediterranean diet? *British Journal of Nutrition*. 93. 369–376. <https://doi.org/10.1079/BJN20041363>
- Willett, W. C. (2013). *Nutritional Epidemiology (3rd ed.)*. Oxford University Press.
- Yu, Y., Zhang, X., Zhang, N., & Qu, Y. (2026). Fatigue protocols and athletic performance : a systematic review with a focus on ecological relevance. *Frontiers in Physiology*. 17. 1816311. <https://doi.org/10.3389/fphys.2026.1816311>