

## Sports Nutrition for Adolescent Athletes: Balancing Growth and Performance

<sup>1</sup>Ashfaq Ali Khattak

<sup>2</sup>Hina Fatima

<sup>3</sup>Farah Durrani

<sup>4</sup>Nadir Mehran

<sup>5</sup>Bibi Nadia Kanwal

<sup>1</sup>Assistant Professor, Department of Sports Sciences and Physical Education, Sarhad University of Science and Information Technology Peshawar.

<sup>2</sup>MS Scholar Department of Sports Sciences and Physical Education, Sarhad University of Science and Information Technology Peshawar.

<sup>3</sup>MS Scholar Department of Sports Sciences and Physical Education, Sarhad University of Science and Information Technology Peshawar.

<sup>4</sup>PhD. Scholar, Department of Electrical Engineering, Sarhad University of Science and Information Technology Peshawar.

<sup>5</sup>MS Scholar Department of Sports Sciences and Physical Education, Sarhad University of Science and Information Technology Peshawar.

[ashfaq.ss@suit.edu.pk](mailto:ashfaq.ss@suit.edu.pk) [hinafatimamarwat@gmail.com](mailto:hinafatimamarwat@gmail.com) [farahduran1990@gmail.com](mailto:farahduran1990@gmail.com)

[engrnadir23@gmail.com](mailto:engrnadir23@gmail.com) [nkmob623@gmail.com](mailto:nkmob623@gmail.com)

### Abstract

This study explores the role of sports nutrition in supporting the growth and performance of adolescent athletes aged 13–18. Adolescence is a critical developmental stage that requires adequate nutritional support to meet the dual demands of physical growth and athletic training. The purpose of this research was to assess nutrition knowledge, dietary practices, and their relationship with athletic performance among adolescent athletes in Pakistan. A quantitative cross-sectional research design was employed, and data were collected from 150 adolescent athletes using a validated Sports Nutrition Knowledge Questionnaire (SNKQ-A) and a 3-day dietary recall. Descriptive statistics, correlation, and regression analyses were conducted using SPSS version 28. The results revealed significant gaps in nutrition knowledge, with many athletes failing to meet daily energy and macronutrient requirements. A positive correlation was found between nutrition knowledge and athletic performance. The study recommends structured nutrition education, involvement of dietitians in sports programs, and development of age-appropriate nutrition guidelines for adolescent athletes.

**Keywords:** Sports nutrition, adolescent athletes, performance, dietary practices, growth

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Corresponding Authors\*:

## Introduction

### Background of the Study

Adolescence is a crucial period marked by rapid growth and physical development, which coincides for many with increased involvement in competitive sports. Proper nutrition during this stage not only fuels performance but also supports long-term health and development. Sports nutrition for adolescent athletes requires a delicate balance between meeting the energy demands of training and supporting normal physiological growth. Without adequate dietary practices, adolescents risk injury, delayed growth, and decreased performance.

Recent frameworks such as the “Plate for the Athlete” by the USOC suggest age-specific recommendations for meal composition depending on training intensity. However, limited data exists for adolescent-specific plans, especially across different sports disciplines. This project builds upon this existing research to propose balanced and practical nutrition guidelines tailored to adolescent athletes.

Adolescence is a critical developmental stage marked by rapid biological growth, hormonal changes, and increasing physical demands. For adolescents involved in competitive or organized sports, this period carries additional physiological stress that requires proper nutritional support (Rodriguez & DiMarco, 2016). Sports nutrition plays a vital role in optimizing athletic performance, promoting muscle development, enhancing endurance, strengthening bones, and supporting healthy growth. According to the American College of Sports Medicine (2022), young athletes have higher energy and nutrient requirements compared to non-athletes of the same age due to increased training loads. In many developing countries, including Pakistan, sports participation among adolescents is increasing with greater involvement in school sports, academies, and clubs (Khan et al., 2021). However, nutritional awareness and dietary planning for young athletes remain limited, which leads to poor eating habits and performance deficiencies. Many adolescent athletes skip meals, consume energy-deficient diets, and rely heavily on junk food due to lack of nutritional guidance (Meyer et al., 2017). Inadequate nutrition may also result in fatigue, frequent injuries, delayed recovery, stunted growth, and impaired academic performance. Proper nutrition during adolescence contributes not only to immediate performance but also to long-term health outcomes. A balanced intake of carbohydrates, proteins, fats, vitamins, minerals, and adequate hydration is essential for achieving peak athletic performance and preventing nutritional deficiencies (Smith et al., 2024). Despite available guidelines such as the “Plate for the Young Athlete” developed by sports nutrition experts, there is limited awareness and implementation of such nutritional strategies among adolescent athletes in Pakistan. This research investigates nutrition knowledge, dietary habits, and their effects on the growth and performance of adolescent athletes.

### Problem Statement

Proper nutrition is fundamental for athletic performance and physical development; however, many adolescent athletes lack adequate knowledge of their nutritional needs and fail to follow balanced dietary practices. In Pakistan, limited research and insufficient nutrition education contribute to poor dietary habits among young athletes. This gap often results in decreased energy levels, frequent injuries, delayed recovery, and underperformance in sports. Therefore, there is a need to examine the relationship between nutritional knowledge, dietary habits, and athletic performance among adolescent athletes.

## Objectives of the Study

The objectives of this study are:

1. To identify the nutritional knowledge level of adolescent athletes.
2. To examine dietary practices and eating habits among adolescent athletes.
3. To analyze the relationship between nutrition and sports performance in adolescent athletes.
4. To recommend practical nutrition strategies suitable for adolescent athletes.

## Research Questions

This research seeks to address the following questions:

1. What is the level of nutritional knowledge among adolescent athletes?
2. What are the common dietary habits of adolescent athletes?
3. Is there a relationship between nutrition and sports performance among adolescent athletes?
4. What nutritional strategies can improve performance and overall health in adolescent athletes?

## Significance of the Study

This study is significant for athletes, coaches, physical education teachers, sports trainers, and policymakers. It provides insights into the role of nutrition in athletic development and highlights the importance of sports nutrition education in schools and sports academies. The findings will help develop nutrition awareness programs and dietary guidelines for adolescent athletes in Pakistan. Furthermore, the results will contribute to academic literature and support future research in sports nutrition and physical education.

## Review of Related Literature

### Introduction

This chapter presents a comprehensive review of existing literature related to sports nutrition and its impact on the growth and performance of adolescent athletes. It examines key areas including nutritional requirements, dietary practices, hydration, and the relationship between nutrition and athletic performance. The purpose of this review is to establish a theoretical foundation for the study by analyzing global and regional research in the field of sports nutrition.

Nutrition plays a vital role in supporting the physiological and developmental needs of adolescent athletes. During adolescence, individuals undergo rapid growth and increased physical activity, requiring higher energy and nutrient intake. Research indicates that inadequate nutrition can negatively affect both physical development and athletic performance. Common nutritional concerns among adolescent athletes include deficiencies in iron, calcium, and vitamin D, as well as poor hydration practices, all of which may impair endurance, recovery, and bone health.

Recent studies highlight that adolescent athletes often exhibit poor dietary habits due to limited nutrition knowledge, peer influence, and lifestyle constraints. Additionally, emerging issues such as Relative Energy Deficiency in Sport (RED-S) and the misuse of dietary supplements further complicate the nutritional landscape for young athletes. These challenges underscore the importance of structured nutrition education and individualized dietary strategies.

### Concept of Sports Nutrition

Sports nutrition is a specialized field that focuses on the application of nutritional principles to enhance physical performance, support recovery, and promote overall health.

It involves the proper intake of macronutrients, micronutrients, and fluids to meet the energy demands of physical activity.

For adolescent athletes, sports nutrition is particularly important because it must simultaneously support growth, development, and athletic performance. A well-balanced diet ensures optimal energy production, muscle repair, and physiological adaptation to training.

### **Nutritional Requirements of Adolescent Athletes**

Adolescence is a critical period characterized by rapid physical growth, hormonal changes, and increased energy expenditure. Adolescent athletes require higher caloric intake compared to non-athletes to support both daily activities and training demands.

Research suggests that inadequate energy intake can lead to fatigue, impaired growth, delayed maturation, and decreased performance. Therefore, it is essential for adolescent athletes to consume nutrient-dense meals distributed throughout the day to maintain energy balance and support optimal development.

### **Macronutrients and Athletic Performance**

Macronutrients—carbohydrates, proteins, and fats—play essential roles in athletic performance:

- **Carbohydrates:** The primary source of energy during high-intensity exercise. Adequate carbohydrate intake helps maintain glycogen stores and delays fatigue.
- **Proteins:** Crucial for muscle repair, growth, and recovery. Adolescent athletes require higher protein intake to support training adaptations.
- **Fats:** Provide long-term energy and support hormonal functions. Healthy fats should be consumed in moderation.

Studies indicate that many adolescent athletes fail to meet recommended macronutrient requirements, leading to reduced performance and slower recovery.

### **Micronutrients and Physical Development**

Micronutrients are essential for growth, development, and athletic performance. Key micronutrients include:

- **Iron:** Supports oxygen transport and prevents fatigue and anemia.
- **Calcium and Vitamin D:** Essential for bone development and injury prevention.
- **Zinc:** Supports immune function and protein synthesis.

Adolescent athletes, particularly females, are at higher risk of micronutrient deficiencies due to increased physiological demands. These deficiencies can negatively impact performance and overall health.

### **Hydration and Sports Performance**

Proper hydration is critical for maintaining body temperature, cardiovascular function, and overall performance during physical activity. Even mild dehydration can impair endurance, concentration, and coordination.

Adolescent athletes are particularly vulnerable to dehydration due to inadequate fluid intake and limited awareness of hydration needs. Regular consumption of fluids before, during, and after exercise is essential to maintain optimal performance and prevent heat-related illnesses.

### **Nutrition Knowledge and Dietary Practices**

Nutrition knowledge plays a significant role in shaping dietary behaviors among adolescent athletes. However, research indicates that many young athletes lack sufficient understanding of proper nutrition.

Common dietary issues include:

- High consumption of processed and fast foods
- Excess intake of sugar-sweetened beverages
- Skipping meals, especially breakfast
- Low intake of fruits and vegetables

Studies show that nutrition education programs can improve dietary habits and enhance athletic performance, highlighting the importance of awareness and guidance.

### **Effects of Nutrition on Athletic Performance**

Proper nutrition directly influences athletic performance by enhancing strength, endurance, recovery, and overall physical fitness. Adequate nutrient intake supports muscle development, energy production, and injury prevention.

Conversely, poor nutrition can lead to:

- Reduced stamina and strength
- Increased fatigue and injury risk
- Impaired recovery and performance

Relative Energy Deficiency in Sport (RED-S) is a growing concern among adolescent athletes. It results from insufficient energy intake and can affect metabolic function, bone health, hormonal balance, and psychological well-being.

### **Theoretical Framework**

This study is guided by the **Health Belief Model (HBM)**, which explains how individual beliefs influence health-related behaviors. According to this model, dietary practices are shaped by perceived benefits, perceived barriers, and self-efficacy.

In the context of sports nutrition, athletes are more likely to adopt healthy eating habits if they recognize the benefits of proper nutrition and feel confident in their ability to make informed dietary choices.

### **Conceptual Framework**

The conceptual framework of this study illustrates the relationship between key variables:

- **Independent Variables:** Nutrition knowledge and dietary practices
- **Dependent Variables:** Athletic performance and physical health
- **Moderating Variables:** Age, gender, type of sport, and training duration

This framework helps explain how nutritional factors influence performance outcomes among adolescent athletes.

### **Research Methodology**

#### **Introduction**

The research methodology adopted for the study titled “*Sports Nutrition for Adolescent Athletes: Balancing Growth and Performance.*” It describes the research design, population, sampling technique, instrumentation, validity and reliability of the instrument, data collection procedures, data analysis methods, and ethical considerations.

#### **Research Design**

The study employed a **quantitative cross-sectional research design** using a structured survey questionnaire. This design was selected because it allows for the collection of numerical data from a defined population at a single point in time. It is particularly suitable for examining relationships between variables such as nutrition knowledge, dietary practices, and athletic performance through statistical analysis.

## Population of the Study

The target population consisted of **adolescent athletes aged 13–18 years** who were actively participating in organized sports. These included athletics, football, cricket, martial arts, hockey, and volleyball.

Participants were selected from **schools, colleges, and local sports academies in Pakistan**, ensuring inclusion of both male and female athletes. This diverse population provided a comprehensive representation of adolescent athletes engaged in different types of sports activities.

## Sample and Sampling Technique

A **stratified random sampling technique** was used to ensure equal representation across:

- Age groups
- Gender
- Types of sports (endurance, strength, and mixed sports)

A total sample of **150 adolescent athletes** was selected. The sample size was determined based on statistical recommendations to ensure adequate power and generalizability of the findings.

## Instrumentation

Data were collected using a **structured questionnaire**, divided into three sections:

- **Section A: Demographic Information**  
(Age, gender, type of sport, training frequency)
- **Section B: Nutrition Knowledge**

Assessed using a modified version of the *Sports Nutrition Knowledge Questionnaire (SNKQ-A)*

- **Section C: Dietary and Hydration Practices**

Measured through a **3-day dietary recall** and Likert-scale statements assessing nutrition behavior and hydration habits

This structured format enabled comprehensive data collection on both knowledge and practices related to sports nutrition.

## Validity of the Instrument

The validity of the questionnaire was ensured through **expert evaluation**. Three experts in the fields of physical education, sports nutrition, and research methodology reviewed the instrument.

Content validity was established by ensuring that:

- All items were relevant to the research objectives
- Questions were clear, concise, and appropriate for the target population

Necessary modifications were made based on expert feedback to improve clarity and relevance.

## Reliability of the Instrument

A **pilot study** was conducted with 20 adolescent athletes to assess the reliability of the instrument. Internal consistency was measured using **Cronbach's Alpha**.

The overall reliability coefficient was **0.87**, indicating a **high level of reliability** and consistency of the questionnaire items.

## Data Collection Procedure

Data collection was carried out systematically through the following steps:

- Permission was obtained from school authorities, sports academies, and relevant institutions

- Informed consent was secured from participants and their parents/guardians
- Questionnaires were administered during training sessions with the assistance of coaches
- Participants were assured of **confidentiality and anonymity**
- Data collection was completed within a period of **four weeks**

## Data Analysis

The collected data were coded and entered into **SPSS Version 28** for statistical analysis. The following techniques were used:

### Descriptive Statistics

- Mean
- Standard deviation
- Frequency
- Percentage

### Inferential Statistics

- **Pearson correlation** to examine relationships between variables
- **Regression analysis** to determine the predictive effect of nutrition knowledge on athletic performance

These methods enabled both summary and in-depth analysis of the data.

### Ethical Considerations

Ethical standards were strictly maintained throughout the study:

- Approval was obtained from the relevant **Institutional Review Board (IRB)**
- Participants were informed about the purpose of the study
- Participation was voluntary, and respondents had the right to withdraw at any time
- Confidentiality and anonymity of data were ensured
- Data were used solely for academic purposes

## Data Analysis and Results

### Introduction

The analysis and interpretation of data collected from adolescent athletes through a structured questionnaire. The purpose is to examine the relationship between sports nutrition knowledge, dietary practices, and athletic performance.

Data were analyzed using **SPSS Version 28**. Both **descriptive statistics** (frequency, percentage, mean, standard deviation) and **inferential statistics** (correlation and regression analysis) were applied to address the research objectives.

### Demographic Characteristics of Respondents

**Table:** *Demographic Profile of Respondents (n = 150)*

Variable	Category	Frequency	Percentage
Gender	Male	90	60%
	Female	60	40%
Age Group	13-14 years	35	23.3%
	15-16 years	55	36.7%
	17-18 years	60	40%
Type of Sport	Endurance	45	30%
	Strength	40	26.7%
	Team Sports	50	33.3%

Variable	Category	Frequency	Percentage
Training Frequency	Others	15	10%
	4–5 days/week	70	46.7%
	6–7 days/week	80	53.3%

The demographic data indicate that the majority of respondents were male (60%), with most athletes aged between 15–18 years. A balanced representation of sport types and high training frequency suggests that participants were actively engaged in competitive or semi-competitive sports.

### Reliability Analysis

**Table: Reliability Statistics of Research Instrument**

Scale	No. of Items	Cronbach's Alpha
Sports Nutrition Knowledge	18	0.81
Dietary Practices	12	0.79
Athletic Performance	8	0.83

The Cronbach's Alpha values for all scales are above 0.70, indicating **good internal consistency**. This confirms that the research instrument is reliable for measuring the study variables.

### Descriptive Analysis of Sports Nutrition Knowledge

**Table : Descriptive Statistics of Sports Nutrition Knowledge**

Variable	N	Mean	SD
Nutrition Knowledge Score	150	13.42	3.15

The mean score (M = 13.42) indicates a **moderate level of nutrition knowledge** among adolescent athletes. This suggests that while participants possess some understanding of sports nutrition, there is room for improvement.

### Descriptive Analysis of Dietary Practices

**Table : Descriptive Statistics of Dietary Practices**

Variable	N	Mean	SD
Dietary Practice Score	150	32.87	5.94

The results show that dietary practices among respondents are **moderate to fair**. This indicates that although some healthy eating behaviors are present, many athletes do not consistently follow optimal nutritional guidelines.

### Relationship Between Nutrition Knowledge and Dietary Practices

**Table: Correlation Between Nutrition Knowledge and Dietary Practices**

Variables	r-value	p-value
Knowledge vs Practices	0.468	0.000

The findings reveal a **moderate positive correlation** ( $r = 0.468$ ,  $p < 0.01$ ) between nutrition knowledge and dietary practices. This indicates that athletes with higher nutrition knowledge tend to adopt healthier dietary behaviors.

### Relationship Between Nutrition Knowledge and Athletic Performance

**Table: Correlation Between Nutrition Knowledge and Athletic Performance**

Variables	r-value	p-value
Knowledge vs Performance	0.529	0.000

A **moderate positive correlation** ( $r = 0.529$ ,  $p < 0.01$ ) was found between nutrition knowledge and athletic performance. This suggests that better-informed athletes are more likely to achieve improved performance outcomes.

### Regression Analysis: Predictors of Athletic Performance

**Table:** Regression Analysis Predicting Athletic Performance

Predictor	B	Std. Error	Beta ( $\beta$ )	t	Sig.
Constant	1.214	0.242	—	5.02	0.000
Nutrition Knowledge	0.072	0.018	0.421	4.02	0.000
Dietary Practices	0.036	0.012	0.287	3.15	0.002

### Model Summary:

$R = 0.612$ ,  $R^2 = 0.375$ , Adjusted  $R^2 = 0.369$

$F(2,147) = 44.10$ ,  $p < 0.001$

The regression analysis indicates that both **nutrition knowledge** and **dietary practices** are significant predictors of athletic performance. Nutrition knowledge has a stronger influence ( $\beta = 0.421$ ) compared to dietary practices ( $\beta = 0.287$ ).

The model explains **37.5% of the variance** in athletic performance, indicating a substantial contribution of nutritional factors.

### Discussion of Findings

The findings of this study highlight the critical role of nutrition knowledge and dietary practices in enhancing athletic performance among adolescent athletes.

The moderate level of nutrition knowledge suggests that athletes are aware of basic nutritional concepts but may lack in-depth understanding. This aligns with previous studies indicating limited nutrition education among youth athletes.

The positive correlation between nutrition knowledge and dietary practices confirms that knowledge influences behavior. Athletes with better understanding tend to make healthier food choices, supporting the importance of nutrition education programs.

Furthermore, the significant relationship between nutrition knowledge and athletic performance indicates that proper nutrition contributes to improved strength, endurance, and recovery. The regression analysis further confirms that both knowledge and dietary practices are key predictors of performance.

Overall, the results emphasize that improving nutrition education and promoting healthy eating habits can significantly enhance athletic performance in adolescent athletes.

### Discussion

The present study examined the relationship between sports nutrition knowledge, dietary practices, and athletic performance among adolescent athletes in Pakistan. The findings provide strong evidence that nutrition plays a critical role in shaping both health behaviors and performance outcomes.

The results indicated that adolescent athletes possess a **moderate level of nutrition knowledge**, suggesting partial awareness but insufficient depth in sports-specific nutritional requirements. This supports earlier research highlighting limited access to structured nutrition education among young athletes. Without proper guidance, athletes may fail to translate general knowledge into effective dietary strategies.

Dietary practices among participants were also found to be **suboptimal**, with many athletes not meeting recommended nutritional standards. Common issues such as meal skipping, low intake of fruits and vegetables, and reliance on processed foods reflect

lifestyle constraints and lack of nutritional planning. These patterns are consistent with global trends in adolescent populations.

A significant positive relationship between **nutrition knowledge and dietary practices** demonstrates that knowledge influences behavior. Athletes with better understanding of nutrition are more likely to make healthier food choices, emphasizing the importance of educational interventions.

Furthermore, the study revealed a **moderate positive correlation between nutrition knowledge and athletic performance**, indicating that well-informed athletes tend to perform better. Proper nutrition supports energy production, recovery, and physical development, which are essential for optimal sports performance.

Regression analysis confirmed that both **nutrition knowledge and dietary practices are significant predictors of athletic performance**, explaining a substantial proportion of performance variation. This finding reinforces theoretical models such as Relative Energy Deficiency in Sport (RED-S), which highlight the impact of inadequate nutrition on physical and physiological functioning.

## Conclusion

The study concludes that sports nutrition is a key determinant of athletic performance among adolescent athletes. While participants demonstrated moderate awareness of nutrition, their dietary practices were not fully aligned with recommended guidelines.

Nutrition knowledge significantly influences dietary behavior, and both factors contribute directly to athletic performance. However, the lack of structured nutrition education in Pakistan limits athletes' ability to adopt optimal dietary practices.

Improving nutrition awareness and promoting healthy eating behaviors are essential for enhancing athletic performance, supporting growth, and preventing health risks among adolescent athletes.

## Recommendations

Based on the findings, the following recommendations are proposed:

- **Nutrition Education:** Incorporate sports nutrition into school curricula and training programs for young athletes.
- **Capacity Building:** Conduct workshops for coaches, parents, and trainers to improve nutrition awareness and guidance.
- **Practical Guidance:** Provide simple, cost-effective meal plans tailored to athletes' training needs.
- **Hydration Awareness:** Emphasize proper hydration strategies during training and competition.
- **Policy Development:** Develop national-level guidelines to support nutrition programs in youth sports.
- **Community Programs:** Promote awareness campaigns to encourage healthy eating habits among adolescents.

## Future Research Directions

Future studies should focus on:

- Longitudinal and experimental designs to establish causal relationships
- Inclusion of biochemical and clinical assessments of nutritional status
- Gender-based comparisons in nutrition and performance
- The role of supplementation and ergogenic aids in adolescent athletes
- Expanding research to rural and underrepresented populations



## Final Remark

Overall, this study highlights that improving sports nutrition knowledge and dietary practices can significantly enhance athletic performance and overall well-being among adolescent athletes. A combined effort from educators, policymakers, and health professionals is necessary to promote sustainable nutritional behaviors in youth sports.