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Profiling Metabolic Health, Nutritional Status, and Physical Performance in Basketball Athletes During a Training Phase

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ABSTRACT

Physiological condition and nutritional status are key factors influencing athletic performance, particularly in sports that demand speed and endurance such as basketball. Monitoring random blood glucose levels and nutritional status provides an overview of athletes' metabolic readiness during training periods. This study aimed to describe the profile of random blood glucose, nutritional status, and speed among male adolescent basketball players aged 12–14 years during the training period at Sahabat Basketball Club Makassar. This research employed a qualitative observational method with a cross-sectional design, involving 36 male adolescent basketball athletes selected through purposive sampling. Data collected included height and weight to determine Body Mass Index (BMI), random blood glucose (mg/dL) measured using a glucometer, and 20-meter sprint speed (seconds). Descriptive analysis was performed using Microsoft Excel. The athletes' mean BMI was 20.1 ± 4.0 kg/m^2, with most (61.1%) categorized as normal nutritional status. The mean random blood glucose level was 95.1 ± 12.8 mg/dL, and the mean 20-meter sprint time was 3.41 ± 0.16 seconds. Athletes with normal nutritional status showed faster sprint times compared to underweight or overweight peers. Most adolescent basketball athletes exhibited normal nutritional status and random blood glucose levels that supported optimal speed performance. Regular monitoring of nutritional and metabolic parameters is recommended to maintain physical readiness and enhance athletic performance during training.

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INTRODUCTION

Basketball is a sport that requires a combination of aerobic and anaerobic capacity, physical endurance, and high movement speed. Basketball athletes are expected to maintain excellent physical condition to adapt to the demanding training intensity, particularly during dense preparation periods leading up to competitions. In the context of youth athlete development, monitoring physiological status and nutritional condition becomes essential to ensure that the training adaptation process progresses optimally

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without causing excessive fatigue or metabolic disturbances. One commonly used indicator to assess metabolic readiness is random blood glucose levels, while nutritional status reflects the balance between energy intake and expenditure, which is closely related to speed components as a key determinant of athletic performance (Amawi, 2024).

Random blood glucose represents the concentration of circulating glucose in the bloodstream at a specific point in time, regardless of fasting status. Glucose serves as the primary energy source for muscle activity during physical exertion (Bustamante, et. al. 2024). Among athletes, maintaining stable blood glucose levels is essential, as it influences the body's capacity to rapidly generate energy during training or competition. Low blood glucose levels may reduce endurance and concentration, while excessively high levels may indicate disturbances in carbohydrate metabolism or a stress response to intensive training. Therefore, monitoring random blood glucose can serve as one of the parameters for evaluating the physiological readiness of athletes during training periods (Muñoz, et. al. 2023).

In addition to metabolic aspects, nutritional status also plays a crucial role in supporting athletic performance. Optimal nutritional status, which can be indicated by the balance between body weight and height (such as through the Body Mass Index or BMI), contributes to movement efficiency, muscle strength, and reaction speed. Athletes with inadequate nutritional status are at risk of experiencing fatigue, reduced muscle mass, and slower post-training recovery. Conversely, excessive nutritional status may increase mechanical load on the joints and reduce movement speed. During the developmental phase of 12–14 years of age, maintaining nutritional balance is particularly important because the body undergoes significant physiological changes, requiring energy and nutrient intake to be adjusted according to training intensity (Nehme, et. al. 2022).

Speed is one of the primary components of performance in basketball athletes, as the sport demands explosive movements such as short sprints, rapid changes in direction, and quick reactions to the ball or opponents. Speed is influenced by various factors, including muscle strength, body composition, and the availability of energy derived from blood glucose (Zimmer, et. al. 2024). Athletes with stable blood glucose levels and good nutritional status tend to demonstrate more optimal sprint performance because their energy systems can function efficiently. Conversely, imbalances in nutritional status or fluctuations in blood glucose may result in delayed reactions and reduced speed performance (Oliveira, et. al. 2024).

Based on this background, it is important to conduct a study examining the profile of random blood glucose, nutritional status, and speed performance among adolescent basketball athletes during the training period. Such an investigation is expected to provide insights into the relationship between metabolic condition and physical performance in young athletes who are still undergoing biological development and the formation of fundamental sports abilities. The findings of this research are anticipated to serve as a foundation for coaches, sports nutrition specialists, and athlete development practitioners in designing more targeted training programs and nutritional interventions, thereby improving performance without compromising long-term health.

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METHODS

This study employed a qualitative observational method with a cross-sectional design. This approach was selected to obtain a comprehensive overview of random blood glucose levels, nutritional status, and speed performance of adolescent basketball athletes at a single point during their routine training period. Through this design, each variable was measured simultaneously without providing any intervention to the research subjects, allowing the findings to reflect actual conditions in the field. The study was conducted at the Sahabat Basketball Club in Makassar, one of the youth athlete development clubs in the region. The location was chosen based on the characteristics of participants that met the study criteria, namely adolescent basketball athletes who regularly trained under structured coaching. Data collection was carried out during the regular training schedule, ensuring that the process did not interfere with the athletes' practice sessions.

The sampling technique used in this study was purposive sampling, in which participants were selected based on specific considerations aligned with the research objectives. The inclusion criteria consisted of: (1) adolescent basketball athletes aged 12–14 years, (2) actively participating in the training program at the Sahabat Basketball Club Makassar, and (3) willing to participate as research respondents with parental or guardian approval. A total of 36 athletes met all inclusion criteria and were selected as the study sample. Data collection consisted of anthropometric measurements, random blood glucose assessment, and a 20-meter sprint speed test. Anthropometric measurements included height (cm) and body weight (kg) using standard measuring instruments, followed by the calculation of Body Mass Index (BMI) to determine nutritional status based on established categories. Random blood glucose examination was conducted using a portable glucometer with capillary blood samples collected from the fingertip after light exercise. Speed performance was assessed using a 20-meter sprint test, during which completion time was recorded in seconds using a digital stopwatch.

All measurement data were processed and analyzed using Microsoft Excel. Descriptive statistical analysis was conducted to present data distribution in the form of mean, standard deviation, minimum and maximum values, as well as the percentage distribution of nutritional status categories and random blood glucose levels. The results were displayed in tables and narrative form to provide a comprehensive description of the physiological condition and physical performance of the adolescent basketball athletes participating in the study. Based on this design and methodology, the study is expected to provide a clear and representative depiction of the relationship between nutritional status, random blood glucose levels, and sprint performance among adolescent basketball athletes during the training period at the Sahabat Basketball Club Makassar.

RESULTS AND DISCUSSION

This study involved 36 male adolescent basketball athletes aged 12 to 14 years who actively trained at the Sahabat Basketball Club Makassar. Based on the collected data, the basic characteristics obtained included height, body weight, Body Mass Index (BMI), random blood glucose levels, and 20-meter sprint time.

Table 1.
Descriptive Frequency Distribution

Variables	Mean ± SD	Minimum	Maximum
Age (Old)	13,0 ± 0,8	12	14
Height (cm)	158,4 ± 8,2	140	180
Weight (kg)	48,2 ± 9,6	30	80
IMT (kg/m^2)	20,1 ± 4,0	12,1	31,5
Random Blood Glucose (mg/dL)	95,1 ± 12,8	72	125
Time to Sprint 20 m (second)	3,41 ± 0,16	3,12	3,69

Based on these results, the mean BMI value of 20.1 kg/m^2 indicates that, in general, the adolescent athletes in this study were within the normal nutritional status category. The relatively wide BMI range (12.1–31.5 kg/m^2) suggests the presence of athletes with both undernutrition and overweight conditions. Meanwhile, the mean random blood glucose level of 95.1 mg/dL remained within the normal range (70–120 mg/dL) according to general blood glucose guidelines. This suggests that most athletes had a stable metabolic condition during the training period, with no indications of significant hypoglycemia or hyperglycemia. The average 20-meter sprint time of 3.41 seconds reflects good speed performance for this age group. This speed demonstrates the lower limb explosive power and efficient energy utilization during short anaerobic activity (Mettler, et. al. 2022). Based on the BMI classification used, the distribution of nutritional status is presented in Table 2.

Table 2.
Proportion of Nutritional Status Categories

Categorized	Total (n)	Percentation (%)
Underweight	6	16,7
Normal	22	61,1
Overweight	8	22,2
Total	**36**	**100**

From the table, it can be seen that the majority of athletes (61.1%) had a normal nutritional status, indicating a balance between energy intake and metabolic demands during training. A total of 22.2% of athletes were classified as overweight, which may be attributed to variations in body composition or increased muscle mass resulting from intensive training. Meanwhile, 16.7% of athletes fell into the underweight category, which may negatively affect endurance and muscle strength if not supported by adequate nutritional intake. With respect to random blood glucose levels, most athletes demonstrated values within the normal range (70–120 mg/dL). Only a small proportion showed levels above 120 mg/dL, which may represent a temporary response to physical activity or food consumption prior to training. This finding is consistent with the statement of Guyton & Hall (2016), who noted that physical exercise can temporarily elevate blood glucose levels due to increased glycogen mobilization and the action of counter-regulatory hormones such as adrenaline.

Descriptive analysis indicated that athletes with normal nutritional status tended to record faster sprint times compared to those in the underweight or overweight categories.

This finding supports the theory that balanced nutritional status contributes to more efficient energy metabolism and optimal muscle strength. The average sprint time among athletes with normal nutritional status was approximately 3.38 seconds, while those in the underweight group showed slightly slower results (3.46 seconds) and overweight athletes recorded an average of around 3.49 seconds. This pattern suggests that both underweight and overweight conditions can negatively affect speed performance, either through increased body load or reduced relative muscle mass. Furthermore, random blood glucose levels demonstrated a tendency to correlate positively with sprint performance (Capra, et. al. 2024). Athletes with glucose levels within the optimal range (90–110 mg/dL) showed relatively faster sprint times compared to those with lower values. This aligns with exercise physiology principles, which state that adequate glucose availability supports rapid glycolysis for energy production during high-intensity anaerobic activities such as sprinting (Desbrow, 2021).

Glucose is the primary substrate for energy production during muscle contraction, particularly throughout moderate- to high-intensity exercise. After being consumed or released from glycogen stores, glucose enters the circulation and is taken up by muscle cells through the GLUT-4 transporter. Physical activity increases the translocation of GLUT-4 to the muscle cell membrane through an insulin-independent mechanism involving activation of AMP-activated protein kinase (AMPK). This is consistent with the findings of Kido et al. (2023), which demonstrated that post-exercise activation of AMPKγ3 enhances muscle glucose uptake to replenish energy stores following training. Therefore, the normal blood glucose levels observed in the majority of athletes indicate efficient metabolic function, whereby glucose is mobilized and utilized optimally by the muscles without causing hyperglycemia or premature fatigue (Zimmer, et. al. 2024). Meanwhile, overweight athletes or those with slightly elevated glucose levels tended to exhibit slower sprint performance, which may be associated with mild insulin resistance that reduces the efficiency of glucose uptake into muscle tissue compared to athletes with normal BMI (Fernández, et. al. 2022).

The 20-meter sprint performance in basketball athletes is primarily supported by the rapid activity of the phosphagen (ATP-PCr) system and anaerobic glycolysis. During explosive muscle contractions, existing ATP stores within muscle fibers can only supply maximal energy for approximately 1 to 2 seconds, after which the body rapidly engages ATP resynthesis through phosphocreatine breakdown (Eid, et. al. 2024). PCr donates a high-energy phosphate group via the creatine kinase reaction to rapidly replenish declining ATP levels. As energy demands increase and PCr reserves diminish, the muscle shifts to anaerobic glycolysis, the process of converting glucose or glycogen into pyruvate to generate ATP without requiring oxygen. This glycolytic contribution becomes crucial in maintaining muscle force and sprint acceleration.

Therefore, stable blood glucose levels have a direct role in supporting ATP regeneration during high-intensity activity. When blood glucose is low, the supply of energy substrates to muscle tissue is reduced, leading to diminished power output and impaired sprint performance. The findings of this study show that athletes with stable blood glucose levels were able to maintain more consistent sprint performance than those experiencing

glucose fluctuations, reinforcing the importance of adequate biochemical energy availability in supporting speed performance on the court.

Although sprint performance does not fully represent aerobic endurance capacity, the biochemical adaptations developed through regular training still contribute significantly to the efficiency of glucose utilization by muscle tissue. Consistent physical training increases the activity of various oxidative enzymes within the mitochondria, such as citrate synthase and components of the electron transport chain, thereby enhancing the ability of muscles to generate ATP through glucose oxidation. In addition, training promotes an increase in muscle glycogen stores, capillary density, and insulin sensitivity, accompanied by elevated expression of GLUT-4 as the primary glucose transporter in muscle cells. Muñoz et al. (2023) reported that structured exercise enhances the expression of AMPK, GLUT-4, and key glycolytic enzymes, thereby improving glucose oxidation and post-exercise energy recovery. These adaptations enable adolescent athletes to maintain muscular performance for longer durations with reduced fatigue, even though dominant activities such as sprinting rely more heavily on anaerobic energy systems (Hecht, et. al. 2023).

Nutritional status within the normal category provides the most ideal condition for athletes, as it reflects a balance between muscle mass, energy reserves, and metabolic demands during both training and competition. Conversely, in the overweight group, sprint performance tends to decline because the body must carry a greater mechanical load, resulting in less efficient acceleration. In addition, glucose utilization in muscle cells becomes less efficient and insulin activity is suboptimal due to increased adipose tissue, which contributes to reduced cellular sensitivity to the hormone (Gruska, et. al. 2024). This condition may limit the rapid availability of ATP during high-intensity activity. On the other hand, athletes with underweight nutritional status may have lower muscle mass and glycogen reserves, thereby limiting their capacity to generate maximal power in short-duration efforts. Thus, the findings of this study support modern exercise physiology theory, which emphasizes that metabolic status, glucose availability, and body composition interact closely in determining muscle work quality and physical performance, including sprint speed in adolescent athletes (Heidorn, et. al. 2021).

Overall, the findings of this study indicate that good nutritional status and stable blood glucose levels play an essential role in supporting sprint performance among adolescent basketball athletes. These conditions reflect optimal metabolic readiness and efficient energy system function during training. The results are consistent with previous studies stating that balanced energy intake and well-regulated blood glucose levels are key factors in maintaining physical performance in young athletes (Kido, et. al. 2023). For coaches and sports nutritionists, these findings underline the importance of regular monitoring of nutritional and physiological conditions, particularly during the developmental phase of adolescence. Appropriate nutritional interventions, proper meal planning before and after training, and well-structured training programs can help maintain performance and prevent excessive fatigue (Martinez, 2024). Furthermore, this study is expected to serve as a foundation for planning more effective and sustainable athlete development programs for adolescent basketball players.

CONCLUSION

This study demonstrates that most male adolescent basketball athletes aged 12–14 years at the Sahabat Basketball Club Makassar exhibit normal nutritional status, random blood glucose levels within the normal range, and good speed performance. Athletes with normal nutritional status tend to achieve faster sprint times compared with those categorized as underweight or overweight. Stable blood glucose levels also support optimal speed performance. Therefore, regular monitoring of nutritional status and blood glucose is essential to maintain physical readiness and enhance athlete performance throughout the training period.

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