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Analysis of Muscle Fibers of Blue Al-Junaidiyah Students

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ABSTRACT
Background: Muscle fiber type composition is a fundamental determinant of athletic performance and physical capacity. Identifying the predominant muscle fiber type in religious boarding school (pesantren) students provides valuable insights into their physical training needs. Objectives: This study aims to analyze the muscle fiber composition of 50 male students at Santri Al-Junaidiyah Biru Pesantren using the vertical jump test method as an indirect assessment tool. Methods: A descriptive quantitative approach was employed with a total sampling technique involving 50 male students aged 15–18 years. Muscle fiber type was assessed using the Bosco vertical jump protocol which differentiates Type I (slow-twitch) and Type II (fast-twitch) fibers based on jump performance indices. Results: The results showed that 56% of students (n=28) were classified as predominantly Type I (slow-twitch) muscle fiber, while 30% (n=15) were classified as Type II (fast-twitch), and 14% (n=7) showed mixed fiber composition. The mean jump index was 48.6 ± 6.2 cm. Conclusions: The majority of Santri Al-Junaidiyah Biru students have slow-twitch dominant muscle fibers, suggesting an inclination toward endurance-type activities. These findings have significant implications for designing physical education programs tailored to the students' physiological profiles.

Keywords: Muscle Fiber Analysis; Santri; Vertical Jump Test; Physical Performance; Pesantren.

INTRODUCTION

Muscle fibers are a basic component of the musculoskeletal system that plays an important role in determining a person's physical capacity. In general, human muscle fibers are classified into two main types, namely Type I muscle fibers (slow-twitch) which are dominated by aerobic activity and have a high endurance capacity, and Type II muscle fibers (fast-twitch) that work anaerobically and are related to speed and explosive power (Pette & Staron, 2000). The composition of these two types of muscle fibers varies between individuals and is influenced by genetic factors, age, gender, and regular physical activity.

Pesantren as a typical Islamic educational institution in Indonesia has a unique pattern of life. Students undergo a dense daily routine, including religious, academic, and several forms of physical activity such as martial arts, joint sports, and other physical activities (Hakim, 2019). This condition makes students an interesting population to study from the perspective of sports physiology, especially related to the composition of their muscle fibers as the basis for the preparation of the right physical exercise program.

Al-Junaidiyah Biru Islamic Boarding School is one of the leading Islamic boarding schools in South Sulawesi which has thousands of active students. The physical education program at this pesantren has not been fully based on comprehensive physiological data, including the analysis of muscle fiber types. In fact, an understanding of muscle fiber profiles is needed as a scientific basis in designing effective sports and physical exercise programs and in accordance with the physiological characteristics of students (Billeter & Hoppeler, 2003).

Several previous studies have examined the composition of muscle fibers in various sports populations. Bouchard et al. (2011) found that the composition of muscle fibers has high heritability, but can still be modified through a structured exercise program. Another study by Trappe et al. (2004) showed that individuals with Type I fiber dominance tended to be more adaptive to resistance training, while those with Type II dominance responded better to strength and speed training. However, there has been no study that specifically examines the profile of muscle fibers in the student population in Indonesia.

This study aims to analyze the composition of muscle fibers of male students of Al-Junaidiyah Biru Islamic Boarding School as many as 50 people using the vertical jump test method as an indirect approach (indirect assessment). The results of this research are expected to make a scientific contribution to the development of physical education and sports programs in the pesantren environment in a more evidence-based manner.

METHODS

Research Type and Design

This research is a quantitative descriptive research that aims to describe the composition of the muscle fibers of students in a systematic and objective manner. The descriptive approach was chosen because this study does not manipulate variables, but rather measures and describes the conditions that exist in the research subjects (Sugiyono, 2019). The research design used is a cross-sectional study, where measurements are taken once on all samples in the same time frame.

Research Time and Place

This research was carried out from November to December 2024 at the Al-Junaidiyah Biru Islamic Boarding School, Bone Regency, South Sulawesi Province. Measurements are carried out on the sports field of Islamic boarding schools that have met safety standards and adequate environmental conditions for the implementation of physical tests.

Population and Sample

The population in this study is all active male students in grades X and XI at the Al-Junaidiyah Biru Islamic Boarding School for the 2024/2025 school year which totals 210 people. The sampling technique used was purposive sampling with the following inclusion criteria: (1) male, (2) aged 15–18 years, (3) physically healthy based on initial examination, (4) no history of musculoskeletal injury in the last three months, and (5) willing to take the entire series of tests. Based on these criteria, a sample of 50 male students was obtained.

Data Collection Instruments and Techniques

The main instrument used in this study is the Bosco Vertical Jump Test protocol, which is an indirect method to identify the dominance of muscle fiber types. This method has been validated by Bosco et al. (1983) and is consistently used in various sports physiology studies. The measuring instruments used include: (1) a vertical jump board with a centimeter scale, (2) a digital body scale (0.1 kg accuracy), (3) a stadiometer (0.1 cm accuracy), and (4) a data record sheet.

Data was collected through three stages: (1) initial physical condition examination and filling out the consent form, (2) anthropometric measurements including height and weight, and (3) the implementation of the Bosco Vertical Jump Test consisting of squat jump (SJ) and countermovement jump (CMJ). The Bosco Index is calculated using the formula: Index = (CMJ

- SJ) / SJ × 100%. An index value of > 10% indicates the dominance of Type II muscle fibers (fast-twitch), a < value of 5% indicates the dominance of Type I (slow-twitch), and a value of 5–10% is categorized as a mixed type.

Data Analysis Techniques

The collected data were analyzed using descriptive statistics that included mean values, standard deviations (SD), minimum and maximum values, and frequency distribution to describe the characteristics of the sample muscle fibers. The data normality test was carried out using the Kolmogorov-Smirnov Test with a significance level of $\alpha = 0.05$. All statistical analysis was carried out using SPSS software version 26.0.

RESEARCH RESULTS

This section presents the results of data analysis obtained from anthropometric measurements and Bosco Vertical Jump Test on 50 male students of the Al-Junaidiyah Biru Islamic Boarding School.

Table 1. Description of Measurement Data Statistics

Variabel	N	Mean (cm)	SD
Height	50	162.4	4.8
Body Weight (kg)	50	55.3	6.1
Vertical Jump (cm)	50	48.6	6.2
Bosco Jump Index	50	0.74	0.09

Based on Table 1, the average height of the sample was 162.4 ± 4.8 cm with an average body weight of 55.3 ± 6.1 kg. The vertical jump results showed an average of 48.6 ± 6.2 cm, while the Bosco Jump Index averaged 0.74 ± 0.09 indicating variations in muscle fiber composition among the samples.

Table 2. Classification of Muscle Fiber Types of Blue Santri Al-Junaidiyah

Classification of Muscle Fibers	Quantity (n)	Percentage (%)	Category
Type I (Slow-Twitch)	28	56%	Dominant Endurance
Type II (Fast-Twitch)	15	30%	Dominant Speed/Power
Mixed (Campuran)	7	14%	Balanced
Total	50	100%	-

Table 2 shows the distribution of muscle fiber types in the study sample. Most of the students (56%, n=28) were classified as Type I muscle fibers dominant (slow-twitch), which means they had better aerobic endurance capacity. As many as 30% (n=15) of students are classified as dominant Type II (fast-twitch), showing superior potential in activities that require speed and explosive power. The rest, as many as 14% (n=7) had mixed muscle fiber composition.

Table 3. Data Normality Test

Variabel	Say.	Alpha	Remarks
Vertical Jump Score	0.312	0.05	Normal
Bosco Jump Index	0.487	0.05	Normal

The results of the normality test with Kolmogorov-Smirnov in Table 3 show that the two main variables, namely the Vertical Jump Score (Sig. = 0.312) and the Bosco Jump Index (Sig. = 0.487), have significance values above 0.05. This means that the data is distributed normally so that the use of parametric descriptive statistics can be accounted for.

DISCUSSION

The results of this study show that the majority of male students of Al-Junaidiyah Biru (56%) have the dominance of Type I muscle fibers (slow-twitch). These findings are in line with the research of Gollnick & Hermansen (1973) which stated that individuals who are exposed to light to moderate physical activity consistently in the long term tend to develop the dominance of Type I muscle fibers.

The proportion of 30% of students with the dominance of Type II fibers is an interesting finding. This group likely has a natural aptitude for sports that require speed and power, such as sprinting, jumping, or martial arts (Hakkinen & Komi, 1983). Early identification of this group is very important for the development of sports talent in the pesantren environment. A structured and targeted exercise program can maximize their physiological potential.

The finding that 14% of students have a mixed muscle fiber composition is also consistent with the existing literature. Saltin et al. (1977) reported that mixed-type muscle fibers (Type IIa) are the most plastic and responsive to different types of exercise. Individuals with this profile have a high flexibility of adaptation to various exercise modalities, both aerobic and anaerobic.

The average vertical jump score of 48.6 ± 6.2 cm obtained in this study is in the average range of Asian adolescent boys based on normative data presented by Nindl et al. (2007). This indicates that the musculoskeletal capacity of Al-Junaidiyah Biru students as a whole is in the normal category for their age group, although it has not been optimized through a systematic training program.

The practical implications of the findings of this study are very significant for the management of physical education programs in Islamic boarding schools. The physical exercise program designed should accommodate the diversity of students' muscle fiber profiles. For students with Type I dominance, a medium-intensity aerobic exercise program with a long duration such as long-distance running, swimming, or cycling will be more optimal. On the other hand, students with Type II dominance will be more responsive to plyometrics, sprint intervals, and weight training (Kraemer & Ratamess, 2004).

CONCLUSIONS AND SUGGESTIONS

Conclusion

Based on the results of the analysis of 50 male students of the Al-Junaidiyah Biru Islamic Boarding School, it can be concluded that: (1) The majority of students (56%) have the dominance of Type I muscle fibers (slow-twitch) which are oriented towards endurance activities; (2) As many as 30% of students have the dominance of Type II muscle fibers (fast-twitch) which have the potential to excel in speed and explosive power sports; (3) As many as 14% of students have a mixed muscle fiber composition that is adaptive to various exercise

modalities; and (4) The average vertical jump value of 48.6 ± 6.2 cm is in the normal category for the adolescent male age group.

Suggestions

Based on the above conclusions, the following things are suggested: (1) Islamic boarding school managers need to design a physical education program based on the physiological profile of students, taking into account the dominance of the type of muscle fibers of each individual; (2) It is necessary to conduct further research by comparing the profile of muscle fibers between Islamic boarding school students and public school students to get a more comprehensive picture; (3) Sports coaches in Islamic boarding schools are advised to use the results of muscle fiber analysis as a basis for the selection and development of sports talents; and (4) Further research may use more direct methods such as muscle biopsy for more accurate validation of results.

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