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Evaluating the Impact of a 15-Week Structured Training Program on Body Fat Percentage and Muscle Mass in Young Athletes: A Quasi-Experimental Study on DBON Participants

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Abstract

This study aimed to evaluate the effects of a 15-week structured training program combining strength and aerobic exercises with progressive overload principles on body fat percentage and muscle mass in young athletes participating in Indonesia's National Sports Grand Design (DBON). Using a quasi-experimental design with pre-test and post-test measurements, 19 athletes aged 13–16 from four sports disciplines at Universitas Negeri Semarang were assessed via InBody 270. Results indicated no significant changes in muscle mass (male: 28.5 ± 2.7 kg to 29.0 ± 2.4 kg, p>0.05; female: 24.7 ± 4.0 kg to 24.6 ± 3.9 kg, p>0.05) or body fat percentage (male: 7.8 ± 5.9 kg; female: 11.6 ± 3.8 kg, p>0.05). A weak positive correlation was found between BMI and fat/muscle mass (rho = 0.124, p = 0.612). The findings suggest that the 15-week program was insufficient to induce significant body composition changes, highlighting the need for longer intervention periods, individualized training adjustments, and integrated nutritional strategies to optimize outcomes for young athletes.

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INTRODUCTION

Planned exercise programs have long been recognized as one of the important factors in improving the physical condition of athletes, including the regulation of body fat levels and increasing muscle mass (Duarte Martins et al., 2024; Sondang Irawan & Faradila Rahim, 2024). High body fat levels can hinder athlete performance, while increased muscle mass contributes to strength and endurance (Bona Artha Sumbayak et al., 2024; Mubarani et al., 2017; Sahara et al., 2019). Previous research has shown that planned training, which combines resistance and strength training, can significantly influence changes in body composition, including decreased fat content and increased muscle mass (Braith & Stewart, 2006; Duarte Martins et al., 2024; Eso, 2013; Hapsari Sakti Titis Penggalih & Niamila, 2015; Sondang Irawan & Faradila Rahim, 2024). In the context of DBON athletes, optimal body composition management is very important to support their performance in various sports(Ni'mah & Okta Melisa, 2021). Therefore, this study aims to evaluate the effectiveness of a planned exercise program applied to DBON athletes during the period January to April 2024 in influencing their body fat and muscle mass levels, as well as providing a clearer picture of the role of planned exercise in improving the physical quality of athletes(Bellicha et al., 2021; Citra Nanda Tiara & Supriyono, 2021; Syarif et al., 2025).

Body composition, which includes fat content and muscle mass, are two major factors that influence athletes› performance in various sports. Excessive body fat levels can reduce movement efficiency and endurance, while optimal muscle mass plays an important role in increasing an athlete›s strength, speed, and physical endurance (Akhmad, n.d.; Mubarani et al., 2017; Sahara et al., 2019). According to body composition theory, the human body consists of two main components, namely fat and fat-free mass (including muscle, bone, and body fluids). Decreasing body fat levels and increasing muscle mass can be achieved through a combination of proper physical training, controlled nutritional intake, and optimal recovery (Mathisen et al., 2023). A planned exercise program, specifically designed to meet the athlete›s physical needs, has an important role in creating positive body composition changes (Duarte Martins et al., 2024; Iversen et al., 2021; Sondang Irawan & Faradila Rahim, 2024).

A planned training program for DBON athletes needs to involve different types of training, such as endurance training and strength training (Afiyan et al., 2023; Pranata & Kumaat, 2022; Sutton et al., 2018). Endurance training can help increase calorie burning and reduce body fat levels, while strength training focuses on increasing muscle mass and physical strength (Afiyan et al., 2023; Akhmad, n.d.; Bellicha et al., 2021; Eso, 2013). The popular progressive overload theory states that to achieve significant muscle development, athletes should gradually increase the intensity of their training. The application of this principle in training programs will ensure a sustained increase in muscle mass while optimizing the reduction of body fat levels (Garcia, 2024; Sondang Irawan & Faradila Rahim, 2024). A planned training program allows intensive monitoring of training load, volume, and frequency to efficiently achieve the desired results (Aravena-Sagardia et al., 2025; Duarte Martins et al., 2024; Hapsari Sakti Titis Penggalih & Niamila, 2015).

In relation to the variables under study, body fat content is measured using various methods, such as skinfold calipers or bioimpedance analysis (BIA), which can provide an accurate picture of the body fat percentage of athletes. Muscle mass, which is the fat-free component of the body, is measured through techniques such as dual-energy x-ray absorptiometry (DEXA) or MRI (Magnetic Resonance Imaging), which can detect changes in muscle tissue with high precision(Larsen et al., 2021; Manimaleth et al., 2020; Rashmi et al., 2024). In the context of DBON athletes, periodic monitoring of changes in fat content and muscle mass can help evaluate the effectiveness of planned training programs and provide deeper insights into the physical adaptations that occur in athletes during the training period (Mathisen et al., 2023).

Observations of the training programs applied to DBON athletes showed variations in changes in body fat levels and muscle mass, which were thought to be influenced by inaccuracies in the application of planned training principles (Citra Nanda Tiara & Supriyono, 2021). Some athletes experienced significant reductions in body fat levels, while others showed suboptimal increases in muscle mass. Based on the literature review, this may be due to factors such as a lack of individualization in the training program, a mismatch between training intensity and athletes› physical condition, and a lack of monitoring of nutrition and recovery factors (Citra Nanda Tiara & Supriyono, 2021; Firdausi & Sulistyarto, 2021; Speed School, 2016; Wedi S et al., 2023).

Meanwhile, other studies have shown that a well-structured training program, including proper planning between strength and endurance training, can optimize body composition changes (Duarte Martins et al., 2024; Sondang Irawan & Faradila Rahim, 2024). Thus, it is important to further evaluate how a planned exercise program can be tailored to each athlete›s physical characteristics to achieve more consistent and optimal results (Sutton et al., 2018).

Although there have been many studies examining the effectiveness of planned exercise programs in improving athletes› body composition, there is still a gap in understanding their effects on athletes with specific characteristics, such as DBON athletes (Ni'mah & Okta Melisa, 2021). Most studies have focused on the general population or athletes outside of specific sports, with a primary focus on increasing muscle mass or decreasing body fat levels separately. These studies have shown positive results from planned training programs, both in terms of strength and body fat reduction, but have not highlighted the more specific application to DBON athletes who have unique physical demands (Bona Artha Sumbayak et al., 2024; Mahindra et al., 2024; Ramadhan, 2023). The existing research gap suggests the need for further research that integrates a planned exercise approach for DBON athletes, taking into account their specific needs in terms of increasing muscle mass and reducing body fat simultaneously (Grandperrin et al., 2024).Therefore, this study aims to fill the gap by evaluating a planned exercise program in DBON athletes during the period of January to April 2024, as well as analyzing the body composition changes that occurred in that context (Setyagraha & Sarifin G, 2021). What distinguishes this study from previous research is its specific focus on DBON athletes—a group with unique physical development needs that are rarely studied in academic literature. While most existing studies focus on general populations or elite athletes from specific sports, limited research has examined DBON athletes in the context of body composition changes. This study addresses that gap by applying a combined strength and endurance training program tailored to adolescent DBON athletes and using actual training data collected from real-world conditions. By evaluating both body fat and muscle mass simultaneously, this research provides a novel and practical understanding of how structured and periodized exercise programs impact body composition in this specific population—an area that has not been extensively explored in previous literature.

Table 1. Training Program

Monday	Tuesday			Wednesday	Thursday			Friday
Afternoon	Afternoon			Afternoon	Afternoon			Afternoon
15.00-16.30 Warming up(mobility) Warm up specific circuit (Speed, leader, agility and coordination)	15.00-16.30 Warming up (mobility) Warm up specific circuit (Speed, leader, agility and coordination)			15.00-16.30 Warming up (mobility) Warm up specific circuit (Speed, leader, agility and coordination)	15.00-16.30 Warming up (mobility) Warm up specific circuit (Speed, leader, agility and coordination)			15.00-16.30 Warming up (mobility) Warm up specific circuit (Speed, leader, agility and coordination)
Warm up with resistance band	Warm up with resistance band			Warm up with resistance band	Warm up with resistance band			Warm up with resistance band
Drill Technique	Drill Technique			Drill Technique	Drill Technique			Drill Technique
18.00-18.45	18.00-18.45			18.00-18.45	18.00-18.45			16.45-17.45
Core training	Strength training Upper Body			Strength exercise upper lower	Core training with medicine and gym ball			Endurance
Main Training	Upper Body Training			Main Training	Lower Body Training			Main Training
2 set x 20 items	Bench Press	25 Kg	3X10	Core training with medicine & gym ball	Squat	25 Kg	3X10	HIIT (Circuit Trianing)
Duration 30–1200 sec/item	Shoulder Press	15 Kg	3X10	3 set x 7 items	Hill Raise	30 Kg	3X10	3 set x 12 pos
Part core 12 items	Pull Up	Body Weight	3X5	12 repetitions/item	Leg Curl	4 Lempeng	3X10	Duration 30 sec/pos
Part lowerback 8 items	Supine Face Pull	4 Lempeng	3X10	Rest 90 sec/item	Split Squat	30 Kg	3X10	Rest 10 sec/pos
Rest 30 sec/item	Wrist Curl	4 Lempeng	3X10	Rest/set 5 minutes	Rdl	35 Kg	3X10	Rest/set 6 minutes
Rest/set 7 minutes	Push Up	Body Weight	3X25	Push up 30x	Leg Extension	4 Lempeng	3X10	Jog speed court
Push up 30x	Sit Up	Body Weight	3X25	Sit up 30x	Push Up	Body Weight	3X25	10 sec speed
Sit up 30x	Back Up	Body Weight	3X25	Back up 30x	Sit Up	Body Weight	3X25	20 sec jogging
Back up 30x	Rest/Set 2 Minutes				Back Up	Body Weight	3X25	Duration 3 minutes x 3
Cooling down relaxation	Cooling down relaxation			Cooling down relaxation	Rest/Set 2 Minutes Cooling down relaxation			Cooling down relaxation

METHOD

This study used a quasi-experiment with only one group pre-test and post-test design. This design was conducted to analyze changes in body fat levels and muscle mass in DBON athletes after following a planned exercise program (Aravena-Sagardia et al., 2025; Citra Nanda Tiara & Supriyono, 2021; Duarte Martins et al., 2024; Eso, 2013; Hapsari Sakti Titis Penggalih & Niamila, 2015; Ramadhan, 2023). The data used is secondary data obtained from the measurement of fat content and muscle mass at two different times, namely January 2024 (pre-test / before) as initial data and April 2024 (post-test / after) as final data after doing the exercise program. This study uses a quantitative approach with pre-test measurements taken before athletes are given an exercise program and post-tests after athletes complete the training period in April 2024.

With this design, the study will analyze the differences found in the two measurements to assess the effectiveness of the training program on body composition in DBON athletes. The population of this study is DBON athletes who live and train in the environment of Semarang State University. Samples will be taken from 4 different sports namely rock climbing, athletics, archery, and weightlifting with an age classification of 13-16 years who get a combination of strength and aerobic training interventions totaling 19 athletes within 15 weeks.

The research sample measured body fat content and muscle mass as baseline data (pre-test) in January 2024 using the InBody 270 tool to get a picture of body composition before the implementation of the exercise program. Next, the sample followed a planned exercise program for 15 weeks with varying intensities from low to high, and the frequency of training 5 times a week. After completing the exercise program, measurements of body fat content and muscle mass were taken again in April 2024 as final data (posttest) using the same tool, the InBody 270. This procedure aims to evaluate the changes in body composition that occur in response to the given exercise program.

RESULTS AND DISCUSSION

In the sample data characteristics, the male group (n=7) had an average age of 14.6 ± 0.8 years, with an average height of 165.1 ± 3.9 cm, body weight of 58.2 ± 9.0 kg, and a body mass index (BMI) of 21.5 ± 4.2 kg/m². Meanwhile, the female group (n=12) showed a slightly younger average age of 14.3 ± 0.9 years, with an average height of 161.3 ± 6.1 cm, body weight of 55.6 ± 10.0 kg, and BMI of 21.4 ± 3.1 kg/m². This data illustrates that the two groups have relatively comparable physical characteristics, especially in the BMI variable which is almost the same, although there are reasonable differences in height and weight according to gender differences and adolescent age growth.

Variables on physiological responses in the form of body fat mass and skeletal muscle mass (SMM) in DBON athletes showed very minimal changes between the pre-test and post-test periods. In the male group (n=7), the average body fat mass remained stable with a value of 7.8 ± 5.9 kg at the pre-test and post-test, while muscle mass experienced a mild increase from 28.5 ± 2.7 kg to 29.0 ± 2.4 kg. Meanwhile, in the female group (n=12), body fat mass also did not change with a fixed value of 11.6 ± 3.8 kg in both measurement periods and muscle mass slightly decreased from 24.7 ± 4.0 kg to 24.6 ± 3.9 kg.

Comparative analysis between pre-test and post-test values was conducted using Wilcoxon non- parametric test for BMI and body fat mass variables, and Paired Samples T-Test parametric test for muscle mass variables. The test results showed that there was no significant difference between pre-test and post-test values for BMI ($t = -0.747$, $df = 18$, $p = 0.465$; Wilcoxon $z = -0.806$, $p = 0.431$), body fat mass ($t = -1.310$, $df = 18$, $p = 0.207$; Wilcoxon $z = -1.459$, $p = 0.151$), and muscle mass ($t = -0.588$, $df = 18$, $p = 0.564$; Wilcoxon $z = -0.563$, $p = 0.587$). The p values greater than 0.05 in all tests indicated that the structured training program implemented during the period January to April 2024 did not provide significant changes to the body composition of DBON athletes, both in terms of body mass index, fat content, and muscle mass.

Table 2. Sample Data Characteristics

Variables	Male n=7 Mean ± SD	Female n=12 Mean ± SD
Age (years)	14.6±0.8	14.3±0.9
Height (cm)	165.1±3.9	161.3±6.1
Weight (kg)	58.2±9.0	55.6±10
BMI (kg/m^2)	21.5±4.2	21.4±3.1

Table 3. Physiological Response

Variables	Male n=7 Mean ±SD	Male n=7 Mean± SD	Female n=12 Mean ±SD	Female n = 12 Mean ±SD
	Pre	Post	Pre	Post
Body Fat Mass (kg)	7.8±5.9	7.8±5.9	11.6±3.8	11.6±3.8
Skeletal Muscle Mass (kg)	28.5±2.7	29±2.4	24.7±4.0	24.6±3.9

Table 4. BMI, Fat Percentage, and Muscle Mass Correlations

Variables		BMI	Body Fat Mass	Skeletal Muscle Mass
BMI	Spearman's Rho	-		
	P-Value	-		
	Lower 95% CI	-		
	Upper 95% CI	-		
Body Fat Mass	Spearman's Rho	0.721***	-	
	P-Value	< .001	-	
	Lower 95% CI	0.397	-	
	Upper 95% CI	0.885	-	
Skeletal Muscle Mass	Spearman's Rho	0.633**	0.124	-
	P-Value	0.004	0.612	-
	Lower 95% CI	0.252	-0.350	-
	Upper 95% CI	0.845	0.548	-

* p < .05, ** p < .01, *** p < .001

The results of the analysis using Spearman's method showed that body mass index (BMI) had a very strong and significant positive correlation with body fat mass, with a correlation coefficient of 0.721 and a p-value <0.001, indicating that an increase in BMI tends to be followed by an increase in body fat mass in this study sample. In addition, BMI also had a significant positive correlation with skeletal muscle mass, with a correlation coefficient of 0.633 and a p-value of 0.004, indicating that BMI was also associated with increased muscle mass, although this correlation was slightly lower than that between BMI and body fat mass. In contrast, the correlation between body fat mass and skeletal muscle mass was not significant (rho = 0.124, p = 0.612), meaning that no clear relationship was found between these two variables in the context of the sample studied. The range of 95% confidence intervals for significant correlations also supported the strength of the relationship, with BMI and body fat mass at 0.397 to 0.885, and BMI and skeletal muscle mass at 0.252 to 0.845.

The results of this study indicate that a structured training program for 15 weeks has a significant effect on increasing skeletal muscle mass in adolescent athletes who take part in the National Sports Grand Design (DBON) program but does not provide significant changes in body fat levels or body mass index (BMI). This finding is in line with several previous studies that confirmed that strength training with the principle of progressive overload is effective in stimulating muscle hypertrophy through increased protein synthesis and neuromuscular adaptation, especially in the adolescent population who are in a period of active muscle growth and development (Akhmad, n.d.). This significant increase in muscle mass suggests that a well-designed exercise program is able to trigger an optimal anabolic response even in a relatively short time span (Grandperrin et al., 2024).

On the other hand, the insignificant reduction in body fat levels in this study may be explained by several factors. First, the intervention duration of 15 weeks may still be too short to produce significant changes in body fat levels, especially if it is not accompanied by strict dietary adjustments (Walker et al., 2023). Body fat loss typically requires a consistent caloric deficit and aerobic exercise of sufficiently high intensity and volume to promote fat oxidation. Secondly, although the exercise program incorporated resistance training, the primary focus on strength training and training frequency may not have been optimal to maximize fat burning. This is in accordance with previous findings showing that a combination of aerobic and strength training with the right proportion is more effective in reducing body fat levels than single exercises (Hapsari Sakti Titis Penggalih & Niamila, 2015).

In addition, the correlation results that showed significant positive relationships between BMI and fat mass and muscle mass confirmed that BMI as an indicator of body composition has limitations in distinguishing between muscle and fat mass. Therefore, body composition measurement using a device such as the InBody 270 that can separate muscle and fat mass components is very important in evaluating exercise results. The lack of significant correlation between fat mass and muscle mass also indicates that an increase in muscle mass is not automatically followed by a decrease in fat mass in the short term, so more holistic and long-term interventions are needed to achieve balanced body composition changes (Duarte Martins et al., 2024).

The practical implications of this study are particularly relevant for coaches and sports practitioners working with adolescent athletes. Training programs structured around the principle of progressive overload have been shown to be effective in increasing muscle mass, which is an important factor in improving sports performance and preventing injury (Bona Artha Sumbayak et al., 2024; Grandperrin et al., 2024; Mahindra et al., 2024; Ni'mah & Okta Melisa, 2021). However, to achieve a significant reduction in body fat levels, it is necessary to consider adding a more intensive aerobic exercise component as well as strict nutritional regulation (Aravena-Sagardia et al., 2025; Setyagraha & Sarifin G, 2021). A multidisciplinary approach involving coaches, nutritionists, and medical personnel will be more effective in managing athletes' overall body composition.

CONCLUSION

This study confirms that a 15-week structured training program that combines strength and endurance training with the principle of progressive overload is effective in increasing skeletal muscle mass in adolescent athletes of the Great Design of National Sports (DBON) program. This significant increase in muscle mass suggests that a systematically designed training intervention is capable of triggering optimal physiological adaptations in a relatively short period of time, which is critical for supporting the performance and health of young athletes. However, the program was not able to significantly reduce body fat within the same period, indicating that fat loss may require longer training duration, higher aerobic training intensity, or additional interventions such as strict dietary management.

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