

Impact of circuit vs. high intensity interval training on muscular strength and endurance Abilities of Padang State University Student Regiment

Abdul Latif¹, Ridho Bahtra², Hastria Effendi³, Ilham⁴, Devi Tirtawirya⁵, Ria Lumintuarso⁶

^{1,2,3,4}Department of Health and Recreation, Sports Science Faculty, Universitas Negeri Padang, Padang, Indonesia

^{5,6}Sports Coaching Department, Sports Science Faculty and Health, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia

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Abstract:

Objective. This research addresses the issue of insufficient endurance and strength abilities among the student regiment at Padang State University. **Methods.** It employs a quasi-experimental research approach with a two-group pre-test and post-test design. The study involves the entire student regiment, consisting of 25 individuals, with inclusion criteria for a sample size of 20 participants were recruited in this research. Endurance and strength tests (bleep test and kesemaptaan test) are the primary instruments for data collection, with data analysis conducted using the t-test at a significance level of $\alpha = 0.05$. **Results.** The study reveals that the average endurance pre-test and post-test results for the circuit training (CT) group were 34.9 ± 4.63 and 39.35 ± 4.73 , respectively, with an average improvement of 41.70 ± 7.07 . Additionally, the average strength pre-test and post-test results for the CT group were 53.00 ± 9.34 and 77.44 ± 11.99 , respectively, with an average improvement of 46.70 ± 4.69 . Conversely, the average endurance pre-test and post-test results for the High-Intensity Interval Training (HIIT) group were 35.03 ± 4.57 and 38.72 ± 5.49 , with an average improvement of 10.30 ± 3.23 . The average strength pre-test and post-test results for the HIIT group were 55.72 ± 9.39 and 78.50 ± 11.14 , with an average improvement of 13.50 ± 4.92 . These findings indicate that the average improvement in endurance and strength for the CT group was higher compared to the HIIT group. The independent sample test verified the significant effectiveness of CT and HIIT exercises on endurance and muscle strength outcomes for each group ($P < 0.05$). This study underscores the efficacy of both circuit training and High-Intensity Interval Training in enhancing the endurance and strength of Padang State University student regiments, particularly in both male and female participants. It was verified that the intervention group undergoing circuit training displayed superior endurance and strength performance compared to the High-Intensity Interval Training group.

Keywords: - Circuit Training, High Intensity Interval Training, Endurance, Muscle Strength

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Introduction

The Student Regiment is an organization comprising students and civilian personnel aimed at defending the nation, serving as a platform to cultivate and channel students' interests and talents in organizational skills (Berni, 2021). The Student Regiment serves as a venue to meet the needs of students for martial and national values. In this regard, values such as nationalism, patriotism, courage, discipline, loyalty, high dedication, perseverance, fairness, honesty, and a strong sense of esprit de corps are instilled among the students. Universitas Negeri Padang is one of the universities where a student organization, namely the Student Regiment with the name Battalion 102 Mahabhakti UNP, is established. In this context, the Student Regiment Battalion 102 Mahabhakti UNP (Menwa 102) functions as a stabilizer, dynamizer, and motivator for other students.

In the execution of its duties, the physical aspect assumes a predominant role, both within its educational framework and during the membership period. Additionally, the enhancement of physical condition through physical training is a realized aspect within the activities of Menwa 102, with the aim of optimizing physical fitness and achieving excellence in both academic and non-academic domains. The physical fitness development within Menwa 102 adheres to military standards, incorporating guidelines akin to exercises that enhance the basic biomotor components of physical fitness, including endurance, strength, speed, and flexibility (Balyi, Istvan; Way, Richard; Higgs, 2013; T. Bompa & Buzzichelli, 2015; T. O. Bompa & Carrera, 1999; Ilham & Dimiyati, 2021; Sumaryanti et al., 2019). In this context, each interrelation or combination of the respective biomotor components, when trained individually or in combination, contributes to the overall physical condition synergistically (Ria, 2013). For instance, strength and speed amalgamate into power, speed and flexibility form agility, and so forth

Endurance is the ability to sustain work over an extended period while facing fatigue (T. Bompa & Buzzichelli, 2015; T. O. Bompa & Carrera, 1999; Elnaggar et al., 2020). While the forms of endurance include aerobic endurance, anaerobic endurance, and specific endurance, aerobic capacity (aerobic endurance) stands as a highly valuable biomotor component in physical activities, indicating the duration one can engage in an activity or work without experiencing fatigue (Agus, 2012). The high or low level of an individual's aerobic capacity is influenced by their maximal oxygen consumption volume (Çapkın et al., 2019; Menon et al., 2020). Given that aerobic capacity relies significantly on sufficient oxygen intake for aerobic energy metabolism, an indication of increased aerobic capacity correlates with a higher VO₂Max (Burnett et al., 2013).

The Maximal Oxygen Volume (VO₂Max) serves as an indicator to determine the amount of oxygen that can be consumed or the maximum level of oxygen utilized by the body during physical activity (Dhara & Chatterjee, 2015). VO₂Max represents the optimal function of the heart-rate system and cells during both activity and rest, closely associated with an individual's body fitness level, often regarded as the prime indicator of aerobic endurance. Training to enhance endurance can be achieved through various methods, such as extensive interval, continuous run (CR), fartlek, and jog-stride. Additionally, methods to improve anaerobic endurance include intensive interval training (T. Bompa & Buzzichelli, 2015). Furthermore, specific endurance can be developed through training related to the chosen sport discipline (Fernandez et al., 2009; Ria, 2013). The principles of endurance training can be categorized based on the duration and an individual's capacity. Endurance training can be conducted using methods like duration, intervals, repetitions, and competitive exercises. Assessing an individual's endurance level involves cardiovascular endurance tests and muscle endurance assessments (Bafirman & Agus, 2008).

On the other hand, Strength denotes the muscle's ability or a group of muscles to generate force in overcoming resistance during physical activities (Letombe et al., 2010). Muscle capability is also observed in an individual's ability to pull, push, lift, or press an object and maintain the body in a hanging position (Agus, 2012). Engaging in strength training can prevent injuries by fortifying the various soft tissues around each joint (Agostinis-Sobrinho et al., 2018; Cannell et al., 2001). Every activity or sports engagement generally demands strength, necessitating strength-building exercises (T. Bompa & Buzzichelli, 2015). Strength serves as a fundamental asset with a significant influence on movement speed, thereby fostering muscular endurance for repeated contractions over a relatively extended period without fatigue.

Strength is the muscle's capability to endure or withstand a load during work, visible in one's ability to pull, push, lift, press an object, or maintain the body in a hanging position (Tsuji et al., 2019). It stands as a vital component in overall physical condition, serving as the driving force behind every physical activity (Rodriguez-Ayllon et al., 2020). Muscular endurance represents the muscle's capacity to sustain work over a prolonged period, a fusion of both strength and endurance.

The various fundamental forms of strength include maximum strength, strength endurance, speed strength, power endurance, and specific sports branch strength (T. O. Bompa & Carrera, 1999). Exercises aimed at enhancing strength can involve the use of medicine balls, core stabilization, circuit training (CT), partner exercises, and rubber bands. Among these, circuit training stands out as an exercise with a high effect size for improvement (Sidik & Rosdiana, 2023; Wu et al., 2017). This is because circuit training is conducted at moderate to high intensity, encompassing a series of aerobic exercises, bodyweight exercises, with rest intervals between positions. It serves as a training model involving diverse exercise variations to develop both aerobic endurance and strength across a range of movements interspersed with rest intervals.

Circuit training is an exercise modality that involves stations, where each station entails a different form of exercise activity (Putra et al., 2020). It operates as a sequence where, upon completing one station, individuals move to the next. The transition from one station to the next is sequential and interspersed with rest intervals. The circuit training method is systematically delivered, structured into a designed program that is measurable and organized in line with the training stages. Therefore, achieving an optimal physical condition occurs when the program is consistently and continuously performed in accordance with the principles and proper exercise norms and practices (Sidik & Rosdiana, 2023). Circuit training is an exercise regimen capable of simultaneously enhancing overall body fitness, including body endurance, power components, flexibility, and more (Mola & Bayisa, 2020; Relida et al., 2022). A circuit workout, comprising multiple exercise stations, offers distinct advantages for Menwa personnel. With varied stations and diverse movement activities, it diminishes training monotony, thereby positively impacting motivation and the willingness of personnel to engage in the training program.

Meanwhile, HIIT involves exercising at a high speed/intensity and offers a continuous moderate exercise alternative, referring to short intervals of intense activity interspersed with low-activity (rest) periods, resulting in a stronger cardiac response compared to continuous moderate exercise (Pymmer et al., 2020). This exercise is meant to enhance both strength and speed as well as muscular endurance and aerobic endurance. High-Intensity Interval Training (HIIT) can also be defined as brief bursts of maximum effort interspersed with several minutes of rest or active recovery (John et al., 2022). High-intensity training involves alternating between high and moderate intensities. This training method is not only impactful and beneficial but also enjoyable and time-efficient.

The cardiometabolic benefits of high-intensity training include lowering blood pressure, increasing insulin sensitivity, and improving body composition. Furthermore, in terms of cardiorespiratory fitness, HIIT enhances cardiorespiratory fitness (VO₂Max) better than moderate-intensity exercise (De Lorenzo et al., 2018; Martínez-Vizcaíno et al., 2019). High-intensity training encompasses all forms of physical activity that prompt all body parts to move actively, such as running, jogging, cycling, and brisk walking.

The observations gathered from the Commander of Menwa 102 highlight the significant role of aerobic capacity (endurance) in supporting the performance of Menwa 102 Maha Bhakti UNP members in carrying out their core tasks and functions. It also contributes to physical fitness in preparation for attending the Basic Education of the Maharuyung Student Regiment throughout West Sumatra. However, based on interviews with the Menwa 102 Commander, it is evident that besides aerobic capacity, the strength of Menwa 102 members remains relatively low, as seen in their performance in regional and national competitions. The current training structure lacks programming and relies only on specific event-based exercises. Consequently, the members' endurance and strength are not systematically measured. For instance, during mandatory education sequences that demand strength and endurance, a consistently directed training program allows the body to easily adapt and perform optimally, reducing fatigue during education and other activities.

Based on literature and field issues, the aim of this research is to compare circuit training and high-intensity training in enhancing the muscle strength and endurance required by the members of Menwa 102 in their education and operational duties, to be conducted at Menwa 102 Maha Bhakti UNP headquarters. This study is beneficial for improving the strength and endurance needs of Menwa members, offering a comparison of training forms to enhance muscle strength and aerobic capacity. As a result, the devised training program can be considered for comprehensive or separate physical training by fitness trainers.

Material & methods

Research design

This research employed a quasi-experimental method using the Two Group Pre-test and Post-test design (Montgomery, 2013). This design was conducted on two distinct groups receiving different training. To equalize or balance these two groups, subject matching was conducted through ordinal pairing. Subjects with similar or nearly identical initial test results were paired using the AB BA formula, resulting in two groups, A and B, with balanced levels of ability.

Participant

In the study, 10 male individuals and 20 female members of the student regiment was used, totaling 20 individuals who met the inclusion criteria.

Intervention Procedure

The first stage of this research involved obtaining research permission. The sample was drawn from the entire Menwa personnel, where 20 male and female individuals were subjected to the treatment. In this study, the treatment was administered 16 times, commencing with general preparation at the initial meetings. General preparation aimed to prevent muscle injury and condition the samples before undertaking the training program, which was of high intensity. Following the general preparation, an initial test was conducted to assess the samples' abilities, using the Bleep test for endurance and a fitness test to measure muscle strength. Subsequently, the participants were divided into groups and underwent the training treatment 16 times. Finally, a post-test was carried

out to determine the improvements in the samples after the training program. Thus, the total number of treatments administered was 19 times.

Measurement/Instruments

The measurement was conducted using pre-test and post-test, where the endurance test utilized the Bleep test and the strength was assessed using the *kesemaptaan* test. The initial test was administered after providing general preparation, while the final test was conducted after the completion of the training program.

Statistical analysis

The data obtained was analyzed using SPSS Version 25. Before hypothesis testing, prerequisites such as data normality were examined using the Kolmogorov-Smirnov and Shapiro-Wilk tests. The hypothesis testing, determining the acceptance or rejection of hypotheses, was conducted using an independent sample test, with a significance level of $\alpha = 0.05$.

Results and Discussion

Results

This research discovered average endurance results for the exercise groups with CT pre-test and post-test endurance at 34.9 ± 4.63 and 39.35 ± 4.73 , with an average increase of 41.70 ± 7.07 . Additionally, the average strength pre-test and post-test for the exercise groups with CT were 53.00 ± 9.34 and 77.44 ± 11.99 , with an average increase of 46.70 ± 4.69 . On the other hand, the average endurance for the exercise groups with HIIT pre-test and post-test was 35.03 ± 4.57 and 38.72 ± 5.49 , with an average increase of 10.30 ± 3.23 . Furthermore, the average strength pre-test and post-test for the exercise groups with HIIT were 55.72 ± 9.39 and 78.50 ± 11.14 , with an average increase of 13.50 ± 4.92 . These results indicate that the average increase in endurance and strength for the CT versus HIIT groups shows a higher improvement in the CT group compared to the HIIT group. For further details, refer to **Table 1** and **Figure 1**. Inferential statistical tests on the difference in the effects of endurance and strength between CT and HIIT exercises were verified as significant ($P < 0.05$) (see **Table 3**).

Table 1. Average endurance and strength results for each group.

Group	<i>n</i>	Min	Max	<i>M</i> ± <i>SD</i>
Pre_end_CT	10	26.20	42.70	34.77 ± 4.57
Post_end_CT	10	29.90	47.40	39.35 ± 4.73
Inc_end_CT	10	30.00	53.00	41.70 ± 7.07
Pre_str_CT	10	38.00	66.60	53.00 ± 9.34
Post_str_CT	10	58.00	93.20	77.44 ± 11.99
Inc_str_CT	10	40.00	54.00	46.70 ± 4.69
Pre_end_HIIT	10	27.60	41.40	35.03 ± 4.57
Post_end_HIIT	10	30.20	48.40	38.72 ± 5.49
Inc_end_HIIT	10	6.00	17.00	10.30 ± 3.23
Pre_str_HIIT	10	38.00	69.80	55.72 ± 9.39
Post_str_HIIT	10	58.00	92.20	78.50 ± 11.14
Inc_str_HIIT	10	7.00	25.00	13.50 ± 4.92

Information: Pre_end_CT: Pretest endurance in the CT group. Post_end_CT: Posttest endurance in the CT group. Inc_end_CT: Average increase in endurance in the CT group. Pre_str_CT: Pretest strength in the CT group. Post_str_CT: Posttest strength in the CT group. Inc_str_CT: Average increase in strength in the CT group. Pre_end_HIIT: Pretest endurance in the HIIT group. Post_end_HIIT: Posttest endurance in the HIIT group. Inc_end_HIIT: Average increase in endurance in the HIIT group. Pre_str_HIIT: Pretest strength in the HIIT group. Post_str_HIIT: Posttest strength in the HIIT group. Inc_str_HIIT: Average increase in strength in the HIIT group.

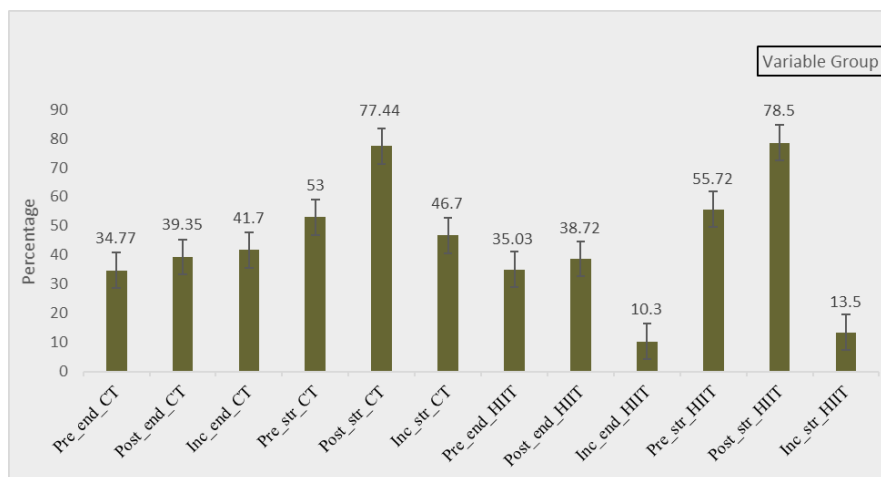


Figure 1. The average endurance and strength results of each group

Table 2. Normality test pada tiap kelompok

Source	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	P	Statistic	df	P
pre_end	.095	20	0.200*	.977	20	0.884
post_end	.090	20	0.200*	.976	20	0.874
pre_str	.129	20	0.200*	.954	20	0.433
post_str	.159	20	0.200*	.922	20	0.109

The results of the independent sample test to examine the effectiveness of CR and HIIT exercises on endurance and muscle strength yielded statistically significant findings, as indicated by the respective *P*-values for each group ($P < 0.05$).

Table 3. Independent Sampel Test: Homegenitas dan t-test results

		Independent Samples Test						
		Levene's Homogeneity Test			t-test for Equality of Means			
		F	P	t	df	P	MD	SE
Inc_end	CR	6.024	0.625	12.769	18	0.000	31.40	2.45
	CR			12.769	12.60	0.000	31.400	2.45
Inc_str	HIIT	0.084	0.775	15.431	18	0.000	33.20	2.15
	HIIT			15.431	17.957	0.000	33.20	2.15

Informasiton: Inc end: Increasing endurance ability. Inc_str: Increasing Strength.

Discussions

Based on theoretical studies and statistical calculations, as well as referring to the conclusions drawn from the analysis conducted, there is a significant improvement in both muscle strength and endurance. Efforts to enhance the strength and endurance of the Padang State University Student Regiment require appropriate exercise methods. Among these, CT and HIIT are considered. Both forms of exercise will be assessed to understand their impact and differences in enhancing the endurance and strength of the Padang State University Student Regiment. This research confirms previous studies concerning the impact of circuit training on muscle strength improvement (Relida et al., 2022; Sumaryanti et al., 2019; Yendrizar et al., 2023). The findings of this research shed light on the considerable impact of two distinct training methods, circuit training (CT) and HIIT, on the endurance and strength levels of Padang State University's student regiment. Notably, the results showcased distinct patterns in the improvements observed between the two training modalities.

The analysis of the endurance and strength pre-test and post-test outcomes unveiled significant disparities between the CT and HIIT groups. The CT group demonstrated substantial advancements in both endurance and strength, recording remarkable mean improvements in both parameters. In contrast, the HIIT group showcased comparatively lower improvements, signifying a more moderate effect on endurance and strength enhancement. These outcomes underscore the efficacy of CT and HIIT in affecting the physical capabilities of the participants. The substantial improvements observed in the CT group suggest its higher effectiveness in enhancing both endurance and strength, portraying it as a more favorable training method compared to HIIT within the context of this study. The comparative analysis revealed a statistically significant difference between the impact of CT and HIIT on the physical performance of the student regiment. The results of the independent sample tests ($P < 0.05$) further emphasized the substantial effectiveness of both CT and HIIT in fostering endurance and muscle strength.

However, the magnitude of enhancement observed in the CT group surpasses that of the HIIT group. Moreover, the findings reinforce the notion that gender is not a discriminating factor in the efficacy of these training modalities. Both male and female participants exhibited similar trends in the superiority of CT over HIIT in improving their endurance and strength levels (Porcari et al., 2015).

This study provides compelling evidence of the superiority of circuit training over High-Intensity Interval Training in augmenting the endurance and strength of Padang State University's student regiment. The results emphasize the critical role of tailored training approaches in addressing the identified inadequacies in endurance and strength among university students. Further research should explore the long-term implications and potential variations of these training methods to validate these findings comprehensively.

Conclusions

This study addresses the concern of inadequate levels of endurance and strength capabilities within the student regiment at Padang State University. This study emphasizes the effectiveness of both circuit training and High-Intensity Interval Training (HIIT) in improving the endurance and strength of student regiments at Padang State University, including both male and female participants. The results confirmed that the intervention group undergoing circuit training exhibited superior performance in both endurance and strength when compared to the High-Intensity Interval Training group. These findings emphasize the significant role of these training methodologies in augmenting the physical capabilities of the university's student regiments, establishing their efficacy in promoting physical fitness among both genders.

Conflicts of Interest

There is no conflict interest to declare.

Acknowledgment

There is no acknowledgment to declare.

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