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ORIGINAL

Effect of kettle bells and battle rope training on grip strength and body composition among university volleyball players

Efecto del entrenamiento con kettle bells y battle rope sobre la fuerza de agarre y la composición corporal en jugadores universitarios de voleibol

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ABSTRACT

The current research is to examine the possible impacts of High-Intensity Interval Training (HIIT) using battle ropes and kettlebells on body composition and grip strength. The aforementioned workout regimen's influence will be assessed by focusing on these two chosen variables, which are considered essential elements of interest. Existing research suggests that HIIT may have a beneficial effect on both body composition and grip strength, based on current hypotheses. The fundamental concept is that HIIT may induce favorable alterations in body composition, such as increases in lean muscle mass and reductions in body fat. This is due to its structure of brief intervals of very vigorous exercise followed by short periods of rest. HIIT has the ability to improve grip strength, which is an important measure of upper body strength and endurance. The experimental design facilitates the examination of many physical attributes by delivering pre- and post-tests to participants in both groups. The factors under investigation include grip strength (measured using handgrip dynamometers), and body composition (measured using skinfold callipers). The rationale behind our study involves the assessment of triceps strength as well as the strength of the left and right hand grips.

Keywords: Body Composition; Hand Grip Strength; HIIT; Significance; Kettlebells; Battle Ropes.

RESUMEN

El objetivo de la presente investigación es examinar los posibles efectos del entrenamiento en intervalos de alta intensidad (HIIT) con cuerdas de combate y kettlebells sobre la composición corporal y la fuerza de agarre. La influencia de dicho régimen de entrenamiento se evaluará centrándose en estas dos variables elegidas, que se consideran elementos esenciales de interés. La investigación existente sugiere que el HIIT puede tener un efecto beneficioso tanto en la composición corporal como en la fuerza de agarre, basándose en las hipótesis actuales. El concepto fundamental es que el HIIT puede inducir alteraciones favorables en la composición corporal, como aumentos de la masa muscular magra y reducciones de la grasa corporal. Esto se debe a su estructura de intervalos breves de ejercicio muy vigoroso seguidos de periodos cortos de descanso. El HIIT tiene la capacidad de mejorar la fuerza de agarre, que es una medida importante de la fuerza y la resistencia de la parte superior del cuerpo. El diseño experimental facilita el examen de muchos atributos físicos mediante la administración de pruebas previas y posteriores a los participantes de ambos grupos. Los factores que se investigan son la fuerza de agarre (medida con dinamómetros de agarre manual) y la composición corporal (medida con calibradores de pliegues cutáneos). Nuestro estudio se basa en la evaluación de la fuerza del tríceps y de la fuerza de agarre de las manos izquierda y derecha.

INTRODUCTION

High-Intensity Circuit Training (HIIT) is becoming more popular among health and wellness experts as well as rehabilitation patients. Prior research has shown that the approach being studied might lead to quick gains in strength, cardiovascular fitness, and body fat percentage. In HIIT, you move between short, intense bursts of activity and longer, less strenuous rest intervals. This training method has grown popularity due to its potential to improve cardiovascular fitness, increase calorie burn, and enhance overall athletic performance. During the intense bursts of exercise, individuals typically push themselves to their maximum capacity, engaging multiple muscle groups and elevating heart rate. The subsequent rest or low-intensity periods allow for recovery and replenishment of energy stores.[1,2,3,4] This sequence of high-intensity and recuperation phases is believed to generate several physiological changes, such as greater oxygen usage, higher muscular endurance, and enhanced metabolic efficiency. A HIIT session may include a wide range of physical activities, from running and cycling to workouts that just need the use of the body's natural muscles and fat stores, as well as a extensive array of confrontation and aerobic training equipment. Several studies that examined the aerobic advantages of HIIT found that the method might boost aerobic fitness and stamina in a number of muscle groups in as little as four weeks. Research has shown that this training method, even when combined with weight training, yields effects that are on par with those of lengthier aerobic workouts.[1]

The phenomenon of HIIT offers a multitude of advantages, one of which is the capacity to effectively expend a significant number of calories within a relatively short duration. Considerable attention has been devoted to elucidating the specific benefits of work-to-rest interval training in the past ten years. In order to optimize the advantages of HIIT, it is imperative to effectively manage and regulate the duration of your rest intervals. By carefully controlling the periods of rest between intense bursts of exercise, individuals can maximize the physiological adaptations and metabolic improvements associated with HIIT. By maintaining an elevated heart rate throughout the duration of the workout, HIIT has been shown to augment oxygen consumption in comparison to traditional exercise regimens. It has been observed that shorter rest times exhibit a positive correlation with elevated heart rates and increased oxygen consumption. This implies that the duration of rest intervals plays a critical role in determining the physiological response during intervals. Key elements of upper-extremity motor and skill-related fitness encompass grip strength, cardiovascular fitness, and appropriate nutritional intake. Handgrip strength is a crucial requirement for individuals across various professions due to its necessity in performing everyday tasks that are executed instinctively, without deliberate effort. Prior research has extensively investigated the phenomenon of handgrip strength and has consistently demonstrated that individuals with lower handgrip strength are more susceptible to experiencing disability, functional decline, premature mortality, and challenges in their later years.[2,5,6,7,8]

It has been established that grip strength is a dependable measure for assessing different dimensions of health and overall well-being. The factors under investigation encompass a range of variables, namely overall strength, fissures, falls, cognitive damage, sadness, insomnia, and nutritional status. The association between grip strength and various health outcomes has been extensively studied. Research has consistently shown that individuals with higher grip strength tend to exhibit better cognitive function, experience lower levels of depression, have a reduced likelihood of fractures, and face a decreased risk of mortality from any cause or disease. Furthermore, higher grip strength has been linked to improved functional outcomes in the future and a lower incidence of hospital complications. These verdicts highlight the potential significance of grip strength as a valuable indicator of overall health and well-being. It has been observed that individuals with poor grip strength may experience prolonged recovery periods following surgery or extended hospital stays. Recent studies have suggested that engaging in HIIT utilizing battle ropes and kettlebells may lead to a notable improvement in handgrip strength. This improvement in handgrip strength, in turn, has been associated with a potential decrease in the likelihood of experiencing future health problems. Therefore, incorporating HIIT exercises involving battle ropes and kettlebells into one's fitness routine may have promising implications for overall health and well-being. Consequently, it is advantageous to investigate the impact of HIIT employing kettle bells and battle ropes on the muscular strength and body composition of individuals enrolled in higher education institutions. The principal aim of this research endeavor is to examine the potential impacts of HIIT employing battle ropes and kettle bells on the physiological makeup of the human body, specifically focusing on body composition and grip strength among a cohort of young individuals.[3,9]

Exercise Post-Oxygen Consumption (EPOC) is a phenomenon in which the body's oxygen deficits caused by exercise are restored. During HIIT, there is an increase in oxygen consumption, leading to significant physiological

changes, including alterations in body fat composition. It is recommended to minimize rest intervals to 30 seconds or fewer between workouts in order to achieve the optimal metabolic effect. This approach has been found to be effective in enhancing metabolic activity and promoting efficient energy utilization during exercise. The activity-to-rest ratio, commonly employed in various research studies, typically involves alternating between 30 seconds of exercise and 30 seconds of rest. The present study seeks to assess the effects of a relatively understudied time interval, namely a 15:15 ratio, on body composition and handgrip strength. The HIIT phenomenon has garnered significant interest due to its potential efficacy in facilitating accelerated weight loss compared to traditional, continuous aerobic exercise. Previous studies have conducted research to compare the effects of low-intensity and high-intensity circuit training groups. These studies have specifically focused on examining the impact of using the same amounts and frequencies of exercise on body fat reduction. The findings from these studies have consistently demonstrated that the low-intensity circuit training group produces a more noticeable reduction in body fat compared to the high-intensity circuit training group.

METHODS

For the purpose of our study, a total of forty-five college-level volleyball players were recruited from the Avinashilingam Institute. The age distribution of the individuals in question spanned from eighteen to twenty-one years old. As part of a HIIT trial, participants willingly incorporated the utilization of battle ropes and kettlebells into their exercise regimen. The selected participants underwent a series of assessments to evaluate specific attributes, such as their grip strength and body composition.[7]

For this research, the individuals were split into three separate groups. We used a random assignment system with fifteen people in the CG and fifteen in the EG. Individuals placed in the EGs trained intensely over twelve weeks, using tools like kettlebells and battle ropes. The control group, on the other hand, did not exercise at all over the course of the research. Prior to and after the training session, both the experimental and control groups were given pre- and post-tests. One of the statistical methods used in this study was Analysis of Covariance (ANCOVA). ANCOVA is a popular statistical tool for investigating the interplay between independent factors and dependent variables. Additional factors that may affect the connection under study are called covariates, and this technique accounts for their effect. Analyzing the link between the dependent and independent variables is made more accurate using ANCOVA, which accounts for these confounders. In order to examine the possible impacts of the independent variables on the dependent variable and to account for the potential influence of covariates, this research used ANCOVA.

The body composition was assessed by employing skinfold measurements. The skinfold measurements were conducted utilizing the Holtain Skinfold Caliper, a widely recognized tool for this purpose, which applies a consistent tension during the measurement process. Additionally, various components of body composition were evaluated using well-established equations that have been previously validated. The study employed a dynamometer, specifically designed for the purpose of measuring the maximum voluntary muscular contraction, to assess the hand grip strength. The dynamometer used in this study was manufactured by Inco, a reputable company based in Ambala, India.[4,10,11,12]

RESULTS

Muscular strength (right hand)

Within the scope of this investigation, we have undertaken an ANCOVA (Analysis of Covariance) to scrutinize the disparities in pre-test, post-test, and adjusted post-test scores pertaining to muscular strength, specifically comparing the Control group (CG) with the experimental group (EG). In order to account for any initial differences between the groups, we took into account the pre-test scores as covariates. These covariates were included in our analysis to control for potential confounding factors. The details of this adjustment can be found in table 1.

Table 1. ANCOVA analysis of muscular strength (Right hand)								
Test		Control group (CG)	Exp Group (EG)	Sov	Sum of squares	df	Mean square	F Ratio
Pre test	Mean	7,88	10,23	B	27,61	1	138,33	
	S.D	1,30	1,93	W	49,15	18	2,73	10,11
Post test	Mean	7,69	12,95	B	138,33	1	138,33	
	S.D	1,09	2,65	W	74,37	18	4,13	33,48
Adjusted post test	Mean	8,44	11,50	B	29,85	1	29,85	11,33
				W	44,76	17	2,63	
Note: Significant at 0,05 level.								

At the 0,05 level of significance, the table value is 4,47 when looking at 1 and 18 degrees of freedom and -4,41

while looking at 1 and 17 degrees of freedom, respectively. On average, the EG scored 10,23 on the pre-test, compared to 7,88 for the control group. A statistical approach called one-way analysis of covariance (ANCOVA) was used to analyze the pre-test outcomes of both the control and EGs. The analysis showed a statistically significant difference in the pre-test averages ($F(1, 18) = 10,11$, $p < 0,05$) when done at a significance level of 0,05. According to the results, the two groups' physical strength levels were significantly different before the intervention.

The results demonstrate that the EG achieved a mean score of 12,95 on the post-test, in contrast to the control group's score of 7,69. The experimental and control groups showed a statistically significant variance in post-test results ($F(1, 18) = 33,48$, $p < 0,05$). When looking at the results from the post-test, comparing the two groups shows that the EG had significantly more muscular strength than the control group. That the experimental intervention had a considerable effect on the subjects' muscular strength is evident from these results. The CG achieved an average post-test score of 8,44 when all variables were considered. Nonetheless, the average score for the EG was 11,50. The difference between the control and EGs persisted even after controlling for pre-test scores. The following results were obtained from the statistical examination of the modified post-test scores: $F(1, 17) = 11,33$, $p < 0,05$. These findings demonstrate that the experimental intervention significantly affected muscle strength, even after accounting for any potential variations in pre-test scores.

The results of the analysis of covariance (ANCOVA) suggest that the experimental intervention had a significant positive effect on muscular strength. This effect was observed both immediately after the intervention (post-test) and after controlling for any initial differences between the groups (adjusted post-test). Specifically, the EG showed a significant improvement in muscular strength compared to the control group. The graphical representation of these averages can be observed in Figure 1. The determination was conducted using a significance threshold of 0,05. When considering the degrees of freedom, specifically 1 and 18, the calculated F values for the pre-test and post-test were found to be 4,41. However, for the corrected post-test, the computed F values were slightly higher at 4,47.

Upon accounting for initial disparities between groups, the analysis of covariance (ANCOVA) results indicate that the experimental intervention had a substantial impact on muscle strength compared to the CG during both the post-test and adjusted post-test periods. Figure 1 presents a visual representation illustrating the average values in question. At a significance level of 0,05, the estimated F-values for both the pre- and post-tests were found to be 4,41 each, while the adjusted post-test had a value of 4,47. These F-values exceeded the critical values for 1 and 18 degrees of freedom.
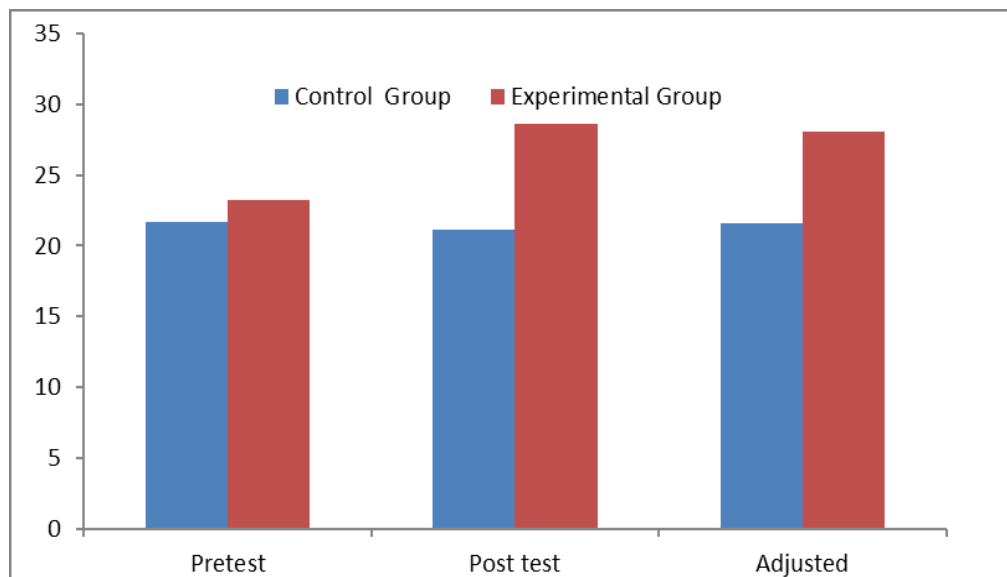

Figure 1. Mean values of muscular strength (RIGHT HAND)

At three separate time points—before, after, and adjusted after the test—this graph shows the control and EGs' mean levels of muscular strength (right hand). The main purpose of this graphic is to show how the two groups' physical strength ratings changed over time. This graph makes it easy to see how the intervention affected the results on the first and second tests, as well as how the results changed after controlling for baseline differences. Throughout the three time periods, the visual summary of the research data is provided by the easy observation of any trends, differences, or increases in muscular strength between the control and EGs.[5]

Grip strength (left hand) test

Here, we compared the control and EGs' grip strength for the left hand before and after the intervention using an Analysis of Covariance (ANCOVA). We also modified the post-test scores to see whether there were any significant changes. In order to account for any preliminary variations across groups, pre-test scores were taken into account as variables.

Test		Control group (CG)	Exp. Group EG)	Sov	Sum of squares	df	Mean square	F Ratio
Table 2. ANCOVA analysis of grip strength (left hand)								
Pre test	Mean	7,07	8,54	B	10,80	1	10,80	4,98
	S.D	1,17	1,71	W	39,02	18	2,16	
Post test	Mean	7,26	12,26	B	125,00	1	125,00	33,47
	S.D	1,18	2,46	W	67,20	18	3,73	
Adjusted post test	Mean	8,11	11,40	B	42,58	1	42,58	48,68
				W	14,87	17	,87	
Note: Significant at 0,05 level.								

The control group's pretest mean score was 7,07, whereas the EG's score was 8,54 (Table 2). An univariate analysis of covariance (ANCOVA) was conducted on the pre-test outcomes of the control and EGs. The analysis revealed a statistically significant difference in the pre-test averages ($F(1, 18) = 4,98$, $p < 0,05$) at the 0,05 level of confidence. This implies that there was a difference in the groups' physical strength before the intervention. The EG's mean post-test score was 12,26, whereas the control group's was 7,26, according to the results. The post-test findings also showed a significant difference ($F(1, 18) = 33,47$, $p < 0,05$) between the experimental and control groups. It seems that the experimental intervention greatly increased muscular strength since the EG's post-test scores were better than those of the control group. After modifications, the EG scored an average of 11,40 on the post-test, whereas the CG scored an average of 8,11. Even after accounting for pre-test scores as variables, the analysis of adjusted post-test scores revealed a significant difference between the control and EGs ($F(1, 17) = 48,68$, $p < 0,05$). This implies that even after adjusting for baseline variations in pre-test scores, the experimental intervention had a substantial impact on muscular strength. This shows that the experimental intervention significantly and persistently affected left -hand grip strength, even after controlling for baseline differences in test scores.

The ANCOVA findings show that the experimental intervention considerably increased left-hand grip strength in comparison to the control group. Immediate post-intervention (post-test) and adjusted post-intervention (adjusted post-test) assessments both showed this impact. Figure 2 shows a visual depiction of these average values. With a significance level of 0,05, the computed F-values for both the pre- and post-test periods (4,41 for 1& 18 degrees of freedom) and the adjusted post-test period (4,47 for 1& 17 degrees of freedom) exceeded the critical F-values.
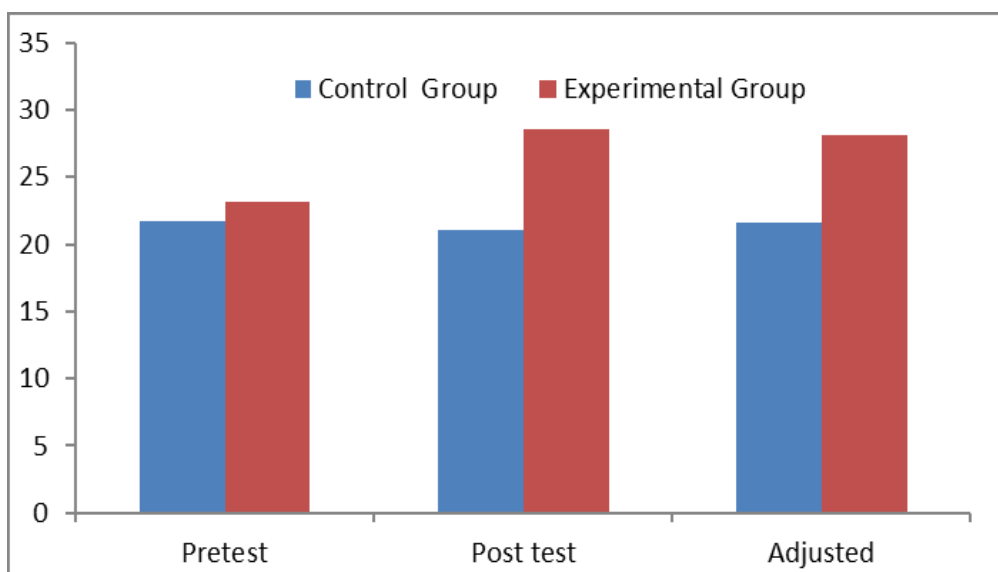

Figure 2. Mean values of muscular strength (LEFT HAND)

The left-hand muscular strength mean values for the control and EGs are shown graphically in figure 2 at three separate time points: pre-test, post-test, and adjusted post-test. This graph's main purpose is to graphically represent the time-dependent and group-specific changes in muscular strength scores. You can see how the intervention affected scores right away in the post-test graph, and how the results changed after adjusting for any variations in the original pre-test scores. During these three time periods, it is easy to notice and understand any trends, differences, or gains in left hand muscle strength between the control and EGs. The visual representation improves comprehension of the study's results and allows for a rapid evaluation of the intervention's impact on muscle strength throughout the research.[6,8]

Body composition (triceps)

This study compared the control and EGs' body composition scores (pre-, post-, and adjusted post-test) with respect to the triceps area. The researchers used an Analysis of Covariance (ANCOVA) to get their conclusions. To account for any initial differences between the groups, the effect of pre-test scores was taken into consideration as a covariate.

Table 3. ANACOVA of body composition (TRICEPS)								
Test		**Control group (CG)**	**Exp. Group (EG)**	**Sov**	**Sum of squares**	**Df**	**Mean square**	**F Ratio**
Pre test	Mean	1,95	1,56	B	0,76	1	0,76	2,21
	S.D	0,45	0,69	W	6,18	18	0,34	
Post test	Mean	2,00	1,39	B	1,86	1	1,86	5,84
	S.D	0,48	0,63	W	5,72	18	,31	
Adjusted post test	Mean	1,81	1,57	B	0,25	1	0,25	32,99
				W	0,13	17	0,008	
Note: Significant at 0,05 level.								

The significance at the 0,05 level table 3 values for 1 and 18 degrees of freedom are -4,41, and for 1 and 17 degrees of freedom, they are 4,47. The EG had an average pre-test score of 1,56, whereas the CG received an average score of 1,95. An univariate analysis of covariance (ANCOVA) was conducted on the pre-test outcomes of the control and EGs. At a 0,05 level of confidence, the findings demonstrated a significant difference in the pre-test averages ($F(1, 18) = 2,21$, $p < 0,05$). This implies that there was a difference in the groups' physical strength before the intervention. The EG received an average score of 1,39 on the post-test, whereas the CG received an average of 2,00. Furthermore, a significant difference was seen between the experimental and control groups in the post-test score analysis ($F(1, 18) = 5,84$, $p < 0,05$). It seems that the experimental intervention greatly increased muscular strength since the EG's post-test scores were better than those of the control group. The control group's mean after post-test findings were taken into account was 1,81, whereas the EG's mean was 1,57. Even after accounting for pre-test scores as variables, the analysis of adjusted post-test scores revealed a significant difference between the control and EGs ($F(1, 17) = 32,99$, $p < 0,05$).

Analyzing adjusted post-test scores allows one to determine whether there are any significant variations in body composition (triceps) between the control and EGs after controlling for pre-test scores as variables. This study clarifies the long-term impacts of the intervention by taking into consideration early differences. We can find out whether the experimental intervention significantly affected body composition (triceps) in comparison to the CG by using this ANCOVA analysis. We assess this effect at three distinct times in time: before the test, after the test, and adjusted post-test, which accounts for any disparities at the start. The following figures provide a visual depiction of these average values and the importance of them. Critical F values were determined for each analysis with a significance threshold of 0,05.Top of Form

Figure 3 is a graphical depiction of the control and EGs' mean values of body composition at three separate assessment points: pre-test, post-test, and adjusted post-test. The emphasis is on the triceps region. This graph's principal use is to graphically display the two groups' and the overall trend of the participants' body composition scores over time. The results after taking into consideration any initial differences in the adjusted post-test scores, the immediate effect of the intervention as seen in the post-test scores, and the original pre-test scores may all be easily compared using this graphical depiction. At each of these three checkpoints, you may see the control and EGs' triceps and draw conclusions on any changes, trends, or differences. In addition to improving comprehension of the study's results, the visual display makes it easy to quickly evaluate the intervention's impact on participants' body composition throughout the trial.
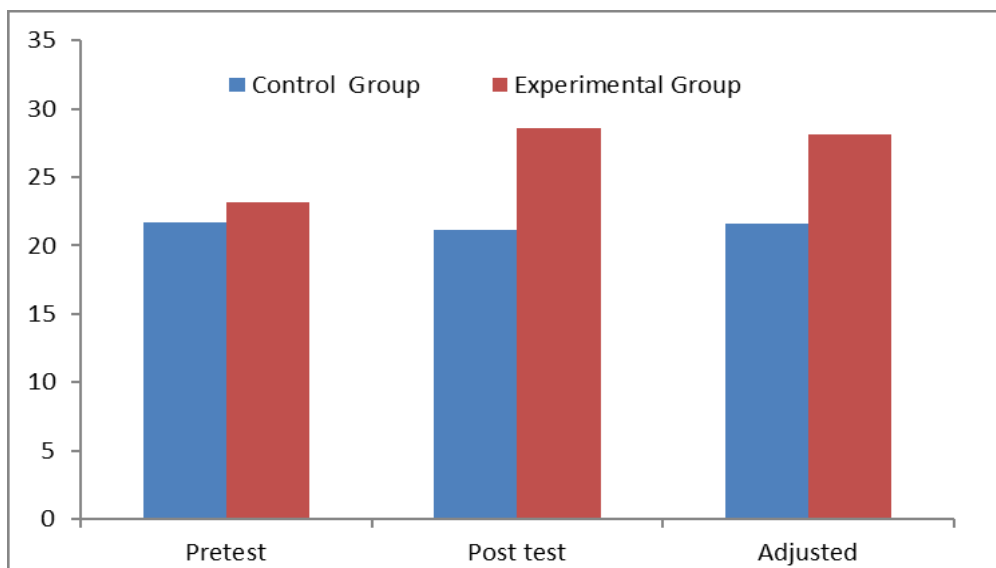
Figure 3. Mean values of body composition (TRICEPS)

Body composition (calf)

Test		Control group (CG)	Exp. Group (EG)	Sov	Sum of squares	Df	Mean square	F Ratio
					Table 4. ANACOVA of body composition (CALF)			
Pre test	Mean	2,20	1,92	B	,39	1	,39	1,89
	S.D	,56	,31	W	3,76	18	,20	
Post test	Mean	2,25	1,79	B	1,07	1	1,07	4,94
	S.D	,57	,32	W	3,90	18	,21	
Adjusted post test	Mean	2,11	1,93	B	,14	1	,14	54,48
				W	,04	17	,003	
Note: Significant at 0,05 level.								

With 1 and 18 degrees of freedom, the table value for significance at the 0,05 level is -4,41, and with 1 and 17 degrees of freedom, it is 4,47. The EG had pre-test scores of 1,92 ± 0,31 on the skin fold calf test, whereas the CG had values of 2,20 ± 0,56 (Table 4). Since the computed F value (1,89), being smaller than the crucial F value at 1 and 18 degrees of freedom (i.e., 4,41), suggests that there is no statistically significant difference between the pre-test averages at the 0,05 level of confidence. The EG had skin fold calf test scores of 1,79 ± 0,32 after the test, whereas the CG had values of 2,25 ± 0,57. Since the computed F value (4,94) is higher than the crucial F value at 1 and 18 degrees of freedom (i.e., 4,41), we may conclude that there is a statistically significant difference between the control and EGs' post-test averages at the 0,05 level of confidence. This yields a F ratio of 4,94. Skin fold calf measures in the CG were 1,93 and in the EG they were 2,11. Because the computed F value (54,48) significantly surpasses the crucial F value at 1 and 17 degrees of freedom (i.e., 4,47), a F ratio of 54,48 suggests that, at the 0,05 level of confidence, there is a very significant difference between the control and EGs' adjusted post-test averages. Figure 1 provides a graphical representation of these findings by showing the average skin fold calf test scores at each of the three time periods of evaluation for the two groups.

Graphically shown in figure 4 are the control and EGs' mean values of body composition, with an emphasis on the calf region, at three separate assessment points: pre-test, post-test, and adjusted post-test. The main objective of this graph is to clearly show the two groups' differences and the changes in body composition scores over time. With the help of this graph, we can easily see how the intervention affected the results on the first test, how the results changed after the intervention, and how the results changed after we accounted for any changes on the second test. At these three periods in time, it is easy to see and understand any changes, trends, or disparities in the calf body composition between the experimental and control groups. In addition to improving comprehension of the study's results, the visual display makes it easy to quickly evaluate the intervention's impact on participants' body composition throughout the trial.[12]
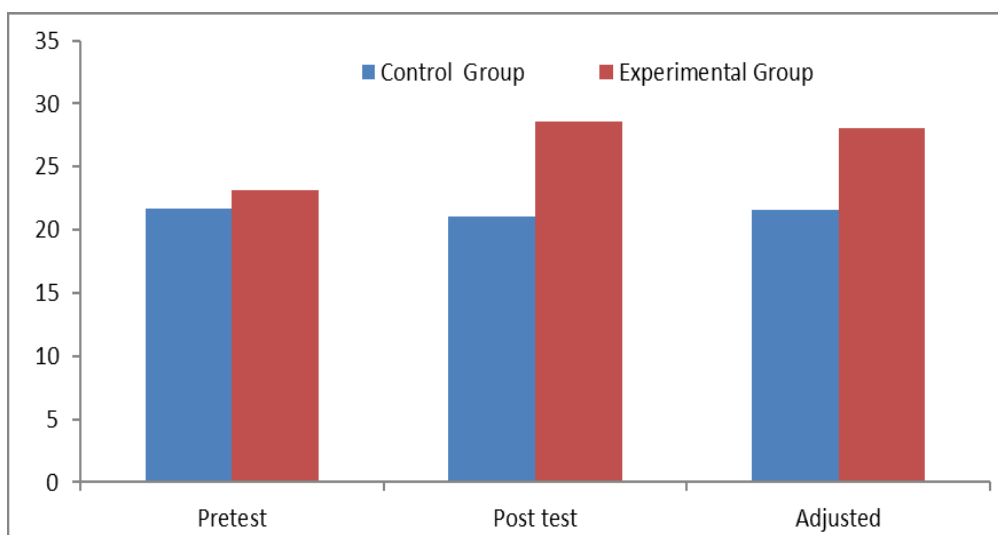
Figure 4. Mean values of body composition (Calf) for control and EGs

CONCLUSION

According to our current understanding, this study aimed to examine and compare the impact of HIIT utilizing battle ropes and kettle bells on the body composition and handgrip strength of the participants, who were students. The analysis of the data revealed a significant discovery: the group that participated in Kettlebell and battle rope training exhibited noteworthy enhancements in grip strength and body composition in comparison to the control group.

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Writing - revision and editing: A.H. Radhika, T. Shanmugavalli.