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THE EFFECT OF KETTLEBELL TRAINING ON FLEXIBILITY IN YOUTH BOXERS (17 – 18 YEARS)

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Abstract:
This study aims to analyze the effect of kettlebell training for six weeks on the flexibility of youth category boxing athletes. The design of this study was a pre-experimental two-group pretest-posttest. The sample of this study was 26 boxers (18 male and 8 female) divided into 13 boxers in the Kettlebell Group (KG) and 13 boxers in the Control Group (CG). Characteristics of boxers were as follow: aged 17.3±5.7; had 3.1±7.2 years training experience; height and weight of male boxers were 168.3±0.4 cm and 57.7±6.2 kg; height and weight of female boxers were 163.7±4.7 cm and 51.2±1.8 kg. Back flexibility test used sit and reach, and the shoulder and wrist flexibility test used static flexibility test-shoulder and wrist. This type of kettlebell exercises is Goblet Squat, Sumo Squat, Romanian Deadlift, Uneven Lunge, Bent Over Row, Over Head Press, Single Arm Chest, Tricep Diamond Press, Squat to Press. Then, the weight of the kettlebell is 4 kg, 6 kg, 8 kg; Intensity 60%-80%; while in CG the boxer only trains as usual. The results of the study using the t-test showed that there was an effect between back flexibility, shoulder flexibility and wrist flexibility in KG and CG ($p<0.05$). However, during the independent t-test, there was a difference in the results of KG and CG training on back flexibility of 0.027 or $p<0.05$; then there was a difference in the results of KG and CG training on shoulder and wrist flexibility of 0.009 or $p<0.05$. The results of this study can provide insight, especially for boxing trainers and athletes who practice kettlebell. However, it is necessary to pay attention in terms of volume and intensity so that the increase in training results using kettlebell can be significant.

Keywords: kettlebell training, boxing, flexibility

1. Introduction

Flexibility is the ability to move joints and muscles with a wide range without joint tension and muscle injury. Flexibility makes the body more flexible in practicing and

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avoids injuries from the movements carried out (Gök & Özen, 2023). Some of the factors that affect the flexibility of the athlete are determined by heredity or a number of environmental factors such as exercise, warm-up, and temperature (Hidayatullah *et al.*, 2022; Permatasari *et al.*, 2024). Every type of sport definitely requires a physical component of flexibility, including the type of combat sport (Devi *et al.*, 2022; Almas *et al.*, 2023; Alfredatama *et al.*, 2024). In the fighting category of martial arts, flexibility has the role of attacking consecutively, dodging and countering attacks from narrow spaces, to crying out for attacks. Therefore, flexibility training must always be exercised at all times to avoid joint and muscle stiffness when competing (Cid-Calfucura *et al.*, 2023). One type of fighting sport that requires a physical component of flexibility is boxing.

Boxing is a fighting art that involves two participants of the same weight (Adi Prabowo *et al.*, 2022). Boxers are required to hit without kicking, so without good flexibility, it cannot produce a large number of hits. In addition, without good flexibility, opponents will read joint movements in the shoulders and elbows because stiff movements will be easily read by opponents (Wangi *et al.*, 2023; Fadhila *et al.*, 2024; Aga *et al.*, 2023). In general, many theories that explain the ability of flexibility are limited by several factors, such as synergistic and antagonistic muscle coordination (Paredes-Gómez & Potosí-Moya, 2023, Feng, 2023). The synergistic muscle is the cooperation of the biceps muscle with the brachial muscle in the front upper arm in performing a movement, while the antagonistic muscle is the cooperation of a pair of opposing muscles in performing movements such as the work of the biceps muscle (front upper arm) with the triceps muscle (back upper arm) (Paredes-Gómez & Potosí-Moya, 2023; Feng, 2023). Then, the shape of the joints in the body has different functions and abilities.

The shoulder joint has functions and abilities beyond the knee, foot and hip joints because the shoulder joint is a bullet joint that can move in all directions widely (Ren, 2023). Furthermore, the elbow and knee joints can only perform flexion and extension movements due to the limited function and shape of the joints (Ren, 2023). Furthermore, the temperature in high muscles has a better elasticity than in low-temperature muscles, as well as the ability of tendons and ligaments (Guo, 2023; Duan *et al.*, 2023). Therefore, flexibility can function and develop properly when muscles, tendons and ligaments are heated first through warm-up activities. Both components of this active mobility device have high elasticity ability, so that, of course, it greatly affects the flexibility ability. Flexibility is also an element of physical condition that influences the quality of movement skills, so the function of flexibility is also determined by the ability of the central nervous system (Feng, 2023; Guo, 2023, Duan *et al.*, 2023).

Kettlebell training for five months can have a significant effect on the balance of dance athletes as well as blood pressure and heart rate compared to the control group (Grigoletto *et al.*, 2020). Furthermore, 16-kg kettlebell training with snatches movements can provide a stimulus to aerobic endurance so that it can improve cardiorespiratory fitness in active men in girevoy sport (Chan *et al.*, 2020). Kettlebell training for 12 weeks, with three meetings a week, can lose weight in 60 obese men, and there are other physical abilities such as flexibility, muscular endurance, muscle strength, and cardiovascular (Govindasamy *et al.*, 2022). In kabaddi, kettlebell training for six weeks with six meetings

a week can also significantly affect shoulder and leg strength (Rajasekaran & Mahaboobjan, 2022). In trained young adults, kettlebell swing training by increasing kettlebell load over body mass by 10%, 15%, and 20% led to greater strength gains in muscles and torso (Levine *et al.*, 2022). Thus, from the research evidence, kettlebell training can increase muscle flexibility in athletes, especially boxers.

Based on observations, the flexibility of boxing athletes in the youth category is still low through sit-and-reach test results. Then, the analysis from the trainer states that the flexibility of the boxer is still low because the hitting movement is less fast, it cannot be consecutive to more than five strokes, an easily predictable movement. Therefore, the purpose of this study is to analyze training methods to improve muscle flexibility in youth boxers. This training method uses kettlebells, although this training method has not yet been scientifically studied for specific flexibility for boxing or fighting sports. Based on the results of previous studies, kettlebell training has a good impact on flexibility even though it is not significant (Prontenko *et al.*, 2017; Prontenko *et al.*, 2020; Govindasamy *et al.*, 2022). However, the publication of the results of this study can provide a reference for boxing trainers and boxing academics to provide a variety of exercises for athletes, specifically to increase flexibility.

2. Methods

2.1 Research Design

The type of research is a pre-experimental with two groups pretest-posttest. The population of this study was boxers in South Kalimantan Province, Indonesia, with a total of seven boxing clubs. The sample of this study was boxers in the youth category or those aged 17-18 years. Sampling used the purposive sampling method, so that the sample must have a minimum qualification to be a champion at the city or district level. The boxers involved in this study were 26 boxers (18 male and 8 female), then the division of training groups, namely the kettlebell group of 13 boxers and the control group of 13 boxers. Characteristics of boxers were as follow: aged 17.3±5.7; had 3.1±7.2 years training experience; height and weight of male boxers were 168.3±0.4 cm and 57.7±6.2 kg; height and weight of female boxers were 163.7 ±4.7 cm and 51.2±1.8 kg.

2.2 Data Collection

The tests for the pretest and posttest were sit and reach to test the flexibility of the back and static flexibility test-shoulder and wrist. Boxers were given a chance to try three times; data was taken based on the highest score from each test. To obtain maximum results, the recovery time for each back and shoulder flexibility test is five minutes. The data collection time for the pretest and posttest was carried out one day before and after the training program.

2.3 Training Program

This training program (kettlebell group) was conducted for six weeks (three meetings per week). The exercise was conducted on Monday, Wednesday, and Friday at 4.00 PM. The

following is an exercise program (Table 1). Meanwhile, boxers in the control group continued to practice boxing without kettlebell training in accordance with the trainer's instructions.

The types of kettlebell exercises are Goblet Squat, Sumo Squat, Romanian Deadlift (right-left), Uneven Lunge (right-left), Bent Over Row (right-left), Over Head Press, Single Arm Chest (right-left), Tricep Diamond Press, Squat To Press.

The training dosage, in weeks 1-2 is 10 repetitions, 3 sets, 60% intensity, recovery between movements 30-40 seconds, recovery between sets 60 seconds, weight on the kettlebell 4 kg. In weeks 3-4 is 12 repetitions, 4 sets, 70% intensity, recovery between movements 30-40 seconds, recovery between sets 90 seconds, weight on the kettlebell 6 kg. In weeks 5-6 is 14 repetitions, 5 sets, 80% intensity, recovery between movements 30-40 seconds, recovery between sets 120 seconds, weight on the kettlebell 8 kg.

3. Results

3.1 Normality Test

Table 1: Normality Test Results

Normality Test					
Variable	**Group**	**Test**	**Shapiro-Wilk**		
			Statistic	**df**	**Sig.**
Back Flexibility	Kettlebell Group	Pretest	0.729	13	0.235
		Posttest	0.786	13	0.394
Shoulder and Wrist Flexibility		Pretest	0.472	13	0.200
		Posttest	0.329	13	0.159
Back Flexibility	Control Group	Pretest	0.829	13	0.197
		Posttest	0.621	13	0.113
Shoulder and Wrist Flexibility		Pretest	0.588	13	0.263
		Posttest	0.279	13	0.183

Based on Table 1, the normality test used Shapiro Wilk. In the kettlebell group, the back flexibility test showed a significance value at pretest 0.235 ($p>0.05$) and posttest 0.394 ($p>0.05$), the shoulder and wrist flexibility test showed a significance value of pretest 0.200 ($p>0.05$) and posttest 0.159 ($p>0.05$). It can be concluded that the kettlebell group is normally distributed.

Then, in the control group, the back flexibility test showed a significance value at pretest 0.197 ($p>0.05$) and posttest 0.113 ($p>0.05$), the shoulder and wrist flexibility test showed a significance value of pretest 0.263 ($p>0.05$) and posttest 0.183 ($p>0.05$). It can be concluded that the control group is normally distributed.

3.2 Homogeneity Test

Table 2: Homogeneity Test Results

Test of Homogeneity of Variances						
			Levene Statistic	**df1**	**df2**	**Sig.**
Back Flexibility	Pretest-posttest	Kettlebell Group	0.860	1	51	0.361
Shoulder and Wrist Flexibility	Pretest-posttest		0.532	2	49	0.248
Back Flexibility	Pretest-posttest	Control Group	0.760	1	51	0.338
Shoulder and Wrist Flexibility	Pretest-posttest		0.612	1	51	0.113

Based on Table 2, the results of the homogeneity test in the kettlebell group, namely the pretest and posttest of back flexibility, showed a significance value of 0.361 (p>0.05). The pretest and posttest on shoulder and wrist flexibility showed a significance value of 0.248 (p>0.05). Then, in the control group, the pretest and posttest of back flexibility showed a significance value of 0.338 (p>0.05). The pretest and posttest on shoulder and wrist flexibility showed a significance value of 0.113 (p>0.05).

3.4 Descriptive Statistics

Table 3: Descriptive Statistics Results of Youth Boxing Athletes

Descriptive Statistics							
Variable	**Test**	**Group**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Back Flexibility	Pretest	Kettlebell Group	13	268	311	282.31	26.523
	Posttest		13	337	407	393.25	20.802
Shoulder and Wrist Flexibility	Pretest		13	353	372	361.25	28.244
	Posttest		13	421	458	442.82	85.591
Back Flexibility	Pretest	Control Group	13	267	310	280.85	27.130
	Posttest		13	281	376	348.77	22.122
Shoulder and Wrist Flexibility	Pretest		13	354	372	362.87	26.042
	Posttest		13	397	406	398.62	45.893

Based on Table 3, in the kettlebell group, the back flexibility test using sit and reach showed a minimum pretest value of 26.8 cm, a maximum of 31.1 cm, and a mean of 28.2 cm. After being given treatment at the post-test value, it showed a minimum of 33.7 cm, a maximum of 40.7 cm, and a mean of 39.3 cm. The average increase was 11.1 cm. The shoulder and wrist flexibility test using the static flexibility test showed a minimum pretest value of 35.3 cm, a maximum of 37.2 cm, and a mean of 36.1 cm. After being given treatment, the posttest score was a minimum of 42.1 cm, a maximum of 45.8 cm, and a mean of 44.2 cm. The average increase was 11.1 cm.

Based on Table 3, in the kettlebell group, the back flexibility test using sit and reach showed a minimum pretest value of 26.8 cm, a maximum of 31.1 cm, and a mean of 28.2 cm. After being given treatment at the post-test value, it showed a minimum of 28.1 cm, a maximum of 37.6 cm, and a mean of 34.8 cm. The average increase was 11.1 cm. The shoulder and wrist flexibility test using the static flexibility test-shoulder and wrist showed a pretest value of a minimum of 35.4 cm, a maximum of 37.2 cm, and a mean of

36.2 cm. After being given treatment, the posttest score was a minimum of 39.7 cm, a maximum of 40.6 cm, and a mean of 39.8 cm. The average increase is 3.6 cm.

3.5 T-test

Table 4: Kettlebell Group T-test results

Paired Samples Test							
Variable	**Result**	**Paired Differences**			**t**	**df**	**Sig. (2-tailed)**
		Mean	**Std. Deviation**	**Std. Error Mean**			
Back Flexibility	Pretest – posttest	-110.938	16.599	4.150	-9.913	13	0.000
Shoulder and Wrist Flexibility	Pretest – posttest	-81.570	77.151	19288	-11.186	13	0.000

Table 5: Control Group T-test results

Paired Samples Test							
Variable	**Result**	**Paired Differences**			**T**	**df**	**Sig. (2-tailed)**
		Mean	**Std. Deviation**	**Std. Error Mean**			
Back Flexibility	Pretest - posttest	-67.955	9.327	6.740	-2.653	13	0.019
Shoulder and Wrist Flexibility	Pretest - posttest	-35.757	81.081	13.589	-2.281	13	0.042

Based on Tables 4 and 5, the effect of kettlebell training on the back flexibility of boxing athletes in the youth category showed a significance value of 0.000 < 0.05 (Kettlebell Group) and 0.019 < 0.05 (Control Group). So, there is an influence between kettlebell training and the control group on back flexibility.

Based on Tables 4 and 5, the effect of kettlebell training on the flexibility of the shoulders and wrists of boxing athletes in the youth category showed a significance value of 0.000 < 0.05 (Kettlebell group) and 0.042 < 0.05 (Control Group). So, there is an influence between kettlebell training and the control group on shoulder and wrist flexibility.

3.6 Independent Sample T-test

Table 6: Independent T-test on Back Flexibility

Independent Sample Test						
		t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**
Back flexibility	Equal variances assumed	-2.286	50	0.027	-4.352	1.376
	Equal variances not assumed	-2.286	9.047	0.027	-4.352	1.376

Table 7: Independent T-test on Shoulder and Wrist Flexibility

Independent Sample Test						
		t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**
Shoulder and wrist flexibility	Equal variances assumed	-2.728	50	0.009	-4.521	1.784
	Equal variances not assumed	-2.728	10.772	0.009	-4.521	1.784

Based on Tables 6 and 7, the results of the independent t-test on back muscle flexibility showed a significance value of 0.027 < 0.05, meaning that there was a difference in exercise in the kettlebell group and the control group. Then, the flexibility of the shoulder and wrist muscles showed a significance value of 0.009 < 0.05, meaning that there was a difference in the exercise in the kettlebell group and the control group.

4. Discussion

Based on research results, kettlebell training has an effect on increasing boxers' physical abilities. These results are in accordance with previous research that kettlebell training can affect athletes' physical abilities (Grigoletto *et al.*, 2020; Chan *et al.*, 2020; Govindasamy *et al.*, 2022; Rajasekaran & Mahaboobjan, 2022; Levine *et al.*, 2022). Factors that cause an increase in back flexibility, shoulder, and wrist flexibility also vary, such as training time, kettlebell weight, meeting duration, training volume and intensity (Stagi *et al.*, 2023). Based on the analysis of the training program provided for athletes, six weeks of kettlebell training was able to improve flexibility in boxing athletes in the youth category. Unlike previous studies, kettlebell training for ballet dancer athletes requires six weeks of training to improve lower extremity strength and body balance (Grigoletto *et al.*, 2020). However, the results of research on taekwondo athletes show that training for eight weeks can improve anaerobic power and muscle thickness (Kim & Jung, 2022). Still in combat sports, high-intensity interval training kettlebell workouts affect anaerobic endurance with training duration, namely three times a week for four weeks (Susilo, 2019). Thus, training time must also be considered when training using kettlebells. However, if the athlete is undergoing a competition periodization program, then six weeks of training is enough because the athlete must improve his physical ability through more strenuous training.

Then, the weight on the kettlebell must also be increased to support the flexibility of the boxer. Increasing the training load is also included in the principles of exercise. The weight of kettlebells in this study started from 4 kg, 6 kg, and 8 kg; there are no definite research reports on effective kettlebell weights to increase boxer flexibility. Previous studies have only described kettlebell weight, and there is no specific benchmark in determining kettlebell weight (Duncan *et al.*, 2015; Falatic *et al.*, 2015; Vuk & Pajtak, 2023). However, there are similar research study results in this research, namely that a 6 kg kettlebell weight can strengthen the shoulder and back muscles when doing overhead presses (Błażkiewicz & Hadamus, 2022). Dosing on volume and intensity is also

considered so that flexibility in boxers increases and does not cause overtraining or injury. Previous studies have explained that dosing in kettlebell training is done with the athlete's body weight (Prontenko *et al.*, 2020; Rajasekaran & Mahaboobjan, 2022). However, the situation of youth boxers have never done kettlebell training, so the selection of kettlebell weights is carried out from 4 kg and a maximum of 8 kg.

Training using kettlebells is indeed effective in increasing the flexibility of boxers, in addition to the possibility of improving other physical abilities. Research on martial sports that analyze kettlebell training is still sparsely done. However, from the previous explanation, kettlebell training is effective in increasing anaerobic power and muscle thickness in taekwondo athletes (Kim & Jung, 2022), and can increase anaerobic endurance abilities in pencak silat athletes (Susilo, 2019). The specific training program was not explained in detail, but the kettlebell weight, training time and training intensity were almost the same in this study. Thus, kettlebell training can be adopted by coaches or boxers who want to train with kettlebells.

Recommendations from the results of this study can be used by trainers and boxers, of course, to improve physical abilities at the general preparation stage. If you want to be given in the special preparation phase or competition phase, it would be better to take into account the other volumes and intensities. The limitation of this study is the lack of literacy on the effect of kettlebell training on flexibility. In addition, there is no exact formula on how to determine the weight of a kettlebell. However, the results of this study can form the basis of future research, especially on boxing.

5. Conclusion

Kettlebell training for six weeks affects the flexibility of the back, shoulder flexibility and wrist of youth boxing athletes. Then, there were differences in training results on back flexibility in the kettlebell group and the control group 0.027 or $p<0.05$. There were differences in training results on shoulder and wrist flexibility in the kettlebell group and the control group 0.009 or $p<0.05$. The results of this study can provide insight, especially for boxing trainers and athletes who practice kettlebells. However, it is necessary to pay attention in terms of volume and intensity so that the increase in training results using kettlebells can be significant. Recommendations from the results of this study can be used by trainers and boxers, of course, to improve physical abilities at the general preparation stage.

Conflict of Interest Statement

The author declares no conflicts of interest.

About the Author

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