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Tennis Ball Exersice: Variation to Increase Arm Muscle Strength in Martial Athletes at Sriwijaya State Sports School

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Abstract Strength is one of the biomotor components as the foundation to support technical ability in martial arts. To prove the effectiveness of arm muscle strength training using tennis in martial arts athletes at the Sriwijaya State Sports School was the purpose of this study. The experimental method with a pretest-posttest control group design was used. The experimental group (E G) performed arm muscle strength training using tennis balls with a frequency of 6 times a week for 1 month. The control group (C G) did arm muscle strength training by means of push-up only without using variations of movement or (conventional) equipment with the same frequency as the experimental group. The subjects in this study were 50 martial arts athletes aged 14-17 years which consisted of 10 pencak silat athletes, 7 judo athletes, 9 taekwondo athletes, 7 karate athletes, 10 wrestling athletes and 7 wushu athletes, separated into 2 groups, E G (n=25) and C G (n=25).The instruments used in the study were: 1 minute *push-up* assisted by the Fikri Muscle Strength Test application. Data analysis in this study used the statistical method paired sample t-test and independent sample t-test using SPSS 21 to see the effectiveness of arm muscle strength training using a tennis ball. The results of data analysis showed that there was a higher increase in the E G than the C G with the mean difference in push-up data of 3.84. The findings of this study are that the exercise variation developed is more effective than conventional exercise and the developed test instrument can help to calculate the results of the push-up test.

Keywords Exercises, Strength, Arm Muscle, Push Up

1. Introduction

Achievements in sports must have a tiered and sustainable plan involving science and technology as the supporting tools. One level of achievement sports coaching is started from educational units including the Special

Sports School (SKO) and the Student Sports Training Center (PPLP). From here the potential of athletes are produced to the National and International levels. In South Sumatra Province, there is the Sriwijaya State Sports School which fosters martial arts sports: pencak silat, judo, taekwondo, karate, wrestling and wushu. One of the supporting factors to achieve achievement is physical condition. Physical has 2 competencies which are divided into two dimensions, (performance dimensions: strength and speed, while (health dimensions: endurance and body composition) [1]. Physical condition supports technique, tactics, and mentality [2]. To increase the biomotor component of strength, there are many types and methods of exercise, depending on what muscle strength you want to increase. The treatment given is definitely different for the muscles you want to improve. Periodization is only understood as the systematic planning of long-term and short-term training programs that have traditionally focused on the training aspects of athletic preparation, while ignoring the integration of other elements (such as nutrition, biomechanics, or psychology) that can affect an athlete's readiness to achieve peak performance in competition [3]. "Exercise is a basic process in preparation for developing motor and psychological abilities in an effort to improve one's abilities" [4]. In the training unit, variations are needed as the training program undertaken by athletes is not repetitive. "Variations in training and the choice of training forms will keep athletes adapting and becoming their own motivation" [5]. Strength training is a very important component of all physical activity and is highly recommended during adolescence. Apart from the load and intensity of the exercise, the effect of the equipment used can provide maximum muscle capacity, but future research should also investigate the effectiveness of equipment-free or minimal-equipment methods for maintaining strength adaptations [6]. The benefits of strength training when it is properly designed and competently supervised, a strength training program for teens can offer health and fitness benefits such as increased: bone mineral density, power, muscle endurance, improved body composition, motor skill performance (jumping, balance throwing, and sprinting) and increase resistance to sports-related injuries [7]. Strength is a biomotor ability that determines the effectiveness of sports, increasing muscle strength provides a significant advantage for athletes in almost all sports [8]. Strength can be defined as the ability of the body's muscles to contract or perform maximum tension in accepting loads while carrying out activities [9]. In almost all sports, providing increased muscle strength is a very significant advantage for athletes. The results of scientific research on increasing muscle strength resulting from training methods have been developed. Strength has been shown to greatly support the performance of an athlete. Strength has also been shown to be associated with various components such as agility, speed, acceleration, and aerobic endurance [10]. Strength training programs are performed 3 to 5 sets with repetitions of 6-12 for each exercise at 60-80% of 1RM. Rest time varies between 3 and 4 minutes between sets and exercises [11]. Furthermore, [12] explains "Strength is the ability of the physical condition of humans to improve learning achievement in motion; this component is the basis for developing other components". Strength training is an important modality for promoting fitness behaviours, helping fight obesity, and most importantly for preventing injury in young athletes by "training to play" [13]. "Strength training forms the basis of training programs, including muscular endurance training [14]". "The benefits of strength training carried out by adolescents include increased strength and power, bone health and increased movement competence [15]". However, it should be noted that in strength training there is the most important thing to note, namely "safety in strength training is very important for young athletes, because often injuries are caused by errors in training techniques, use of inappropriate equipment, use of inappropriate training loads and lack of supervision [16]".

The type of strength training to increase muscle strength in the limbs is definitely different. If you want to train the muscle strength of the upper limbs, it will certainly be different from strength training for the lower limbs. This study focuses on arm muscle strength. "Arm muscle strength is a movement that is carried out explosively to increase the muscles in the arm that are deployed to the maximum" [17]. A form of exercise to train arm strength is push-ups, this exercise can improve the ability of the arm muscles [18]. One of the exercises that can be used to increase arm muscle strength is *push up*. However, often the *push up* performed by athletes do not vary, even though *push up* can be done in various ways, as explained by [19], "push up is widely used in training methods to increase arm muscle strength, and upper limbs, because there are many variants of exercises that can be performed simply by changing body position." and reinforced by the statement [20] "having some variation in the training program will be preferred by adolescent athletes". The type of arm muscle strength training in this study is a type of exercise developed by researchers using a tennis ball adopted from the push up movement. The aim of the researcher is to prove the effectiveness of the exercise using the tennis ball on martial athletes at the Sriwijaya State Sports School.

2. Method

The experimental method with a pretest-posttest control group design was used. The experimental group (E G) performed arm muscle strength training using tennis balls with a frequency of 6 times a week for 1 month. The control group (C G) did arm muscle strength training by means of *push-up* only without using variations of movement or (conventional) equipment with the same

frequency as the experimental group. The subjects in this study were 50 martial arts athletes aged 14-17 years which consisted of 10 pencak silat athletes, 7 judo athletes, 9 taekwondo athletes, 7 karate athletes, 10 wrestling athletes and 7 wushu athletes, separated into 2 groups. E G (n=25) and C G (n=25). Training unit for the control group (C G) and the experimental group (E G) was the same, because this study compared whether the variation of exercise given to the experimental group was better than conventional exercise. It's just that the experimental group did exercise with tennis balls, while the control group did not use tennis balls (conventional push-ups), with the following details: first week: 2 sets, 14 repetitions, 3 minutes recovery; second week: 3 sets, 15 reps, 3 minutes recovery; third week: 4 sets of 16 reps and the fourth week 5 sets, 17 reps. Tests and measurements of arm muscle strength were carried out before the exercise treatment was given and after the exercise treatment was given for 1 month. The test and measurement instrument used to measure arm muscle strength is *push up* [21]. The procedure for carrying out the test, lying face down, legs straight and placing both palms on the floor shoulder width apart, the testee bends his arms, then lowers the body until his chest can touch the floor, and pushes back to the starting position, before 1 minute the testee may rest a maximum of 3 seconds Among the frequency of *push up*, the value given is based on the number of repetitions performed correctly (*Evaluation of the Indonesian PPLP Physical Test*, 2016).

The test and measurements are assisted by using the "fikri muscle strength test" application. This instrument is a development of the push up test by the researcher. The work function of "fikri muscle strength test": 1. Can easily detect and calculate correct and incorrect movements from push up, sit up and back up tests, 2. Makes different sounds to signal the correct motion and wrong motion, 3. There is a timer that runs backwards as the time limit for carrying out the test, 4. The movement and calculation of push-ups, sit up and back up can be monitored directly on the PC/Laptop (realtime), 5. The results are automatically sent to the user application "fikri muscle strength test" after the timer has run out. The test results are stored in their account and can be downloaded as a pdf.

Tool work system: 1. This tool consists of a user application "fikri muscle strength test" for test participants and for admins (test officers), Kinect cameras and operator applications as a connection between the Kinect camera and the user application, 2. Participant downloads the user application "fikri muscle strength test" by filling in the biodata in the application. (this can be done anytime and anywhere before the test), 3. At the time of the test, the test officer calls the test taker by confirming from the biodata that has been filled in the user application. This is done to connect the user application and operator application by using the test taker's mobile number that they have filled in the user application, 4. When the user application and operator application are connected, the test officer directs the test taker to carry out the test. The implementation of this test is still guided by the test officer. But for the calculation, it is automatically calculated by the Kinect camera which has been developed into operator applications. The test results are directly sent to the user application "fikri muscle strength test", 5. This test must be carried out indoors, so that the Kinect camera is more accurate in capturing movement, 6. The implementation of this test must use the internet and electricity. The internet serves to connect the user application "fikri muscle strength test" with the operator application and automatically transfer the test results from the operator application to the user application, while the flow of electricity is to turn on the kinect camera. This explanation can be shown in **Figure 1** which describes the implementation of the test.

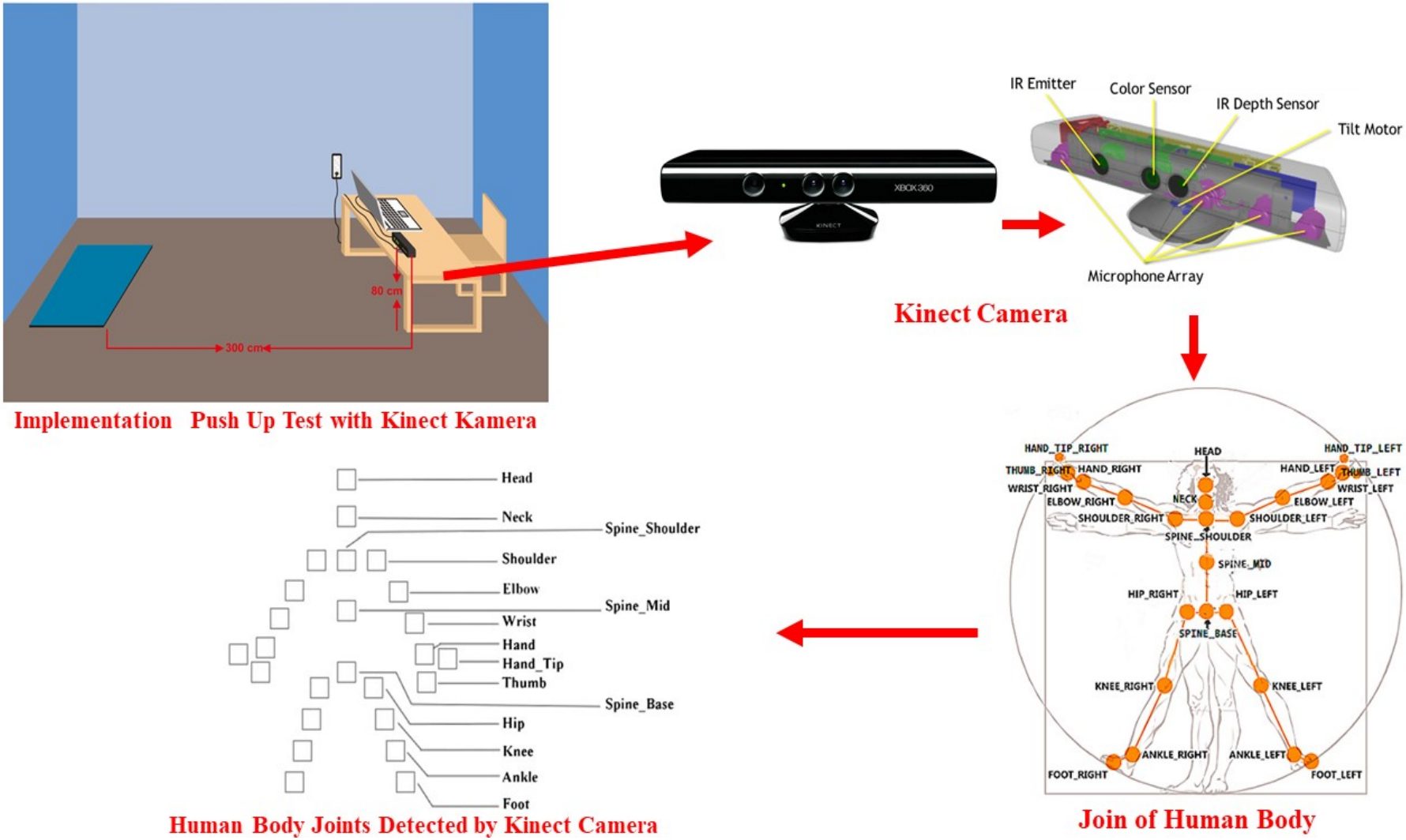

Figure 1. Test Design and Measurement of arm muscles using "Fikri Muscle Strength Test"

Data analysis used t test to analyze the difference between the (EG) and (CG) with a significance level of 0.05. The following are the types of strength training used in this study and are shown in **Figure 2**, **Figure 3**, **Figure 4**, **Figure 5** and **Figure 6**:

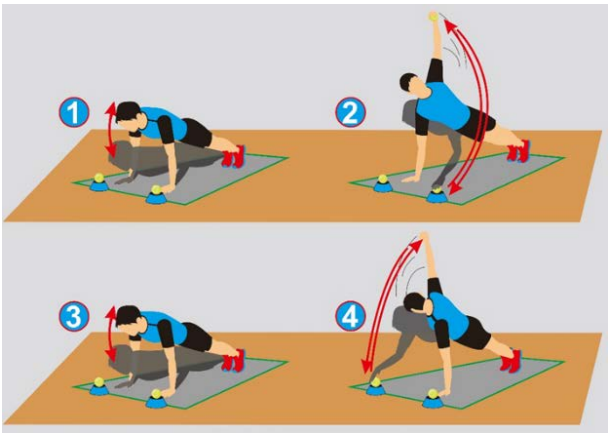

Figure 2. T *push up* exercise with tennis ball

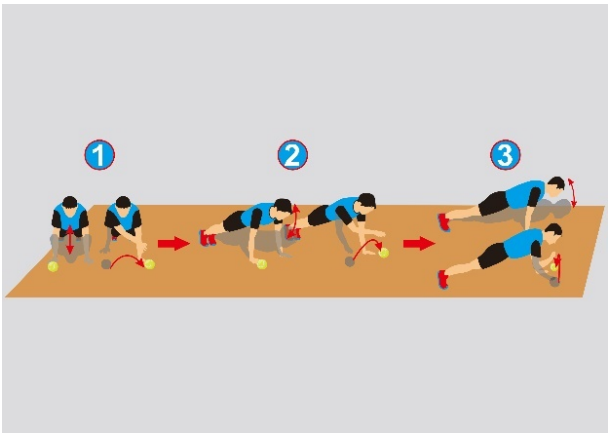

Figure 3. *Push up exercise* 90° right rotation by moving the tennis ball

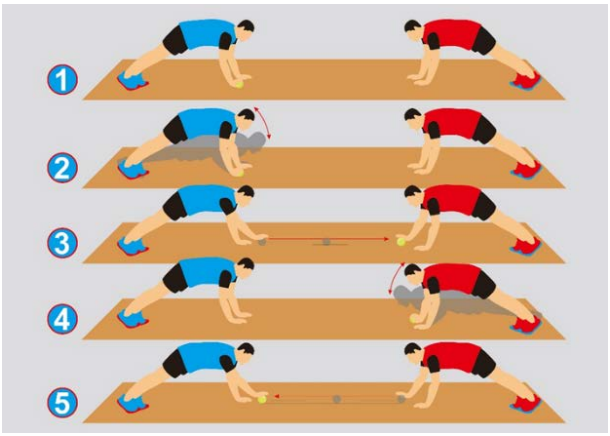

Figure 4. Paired *push up* by rolling the tennis ball forward

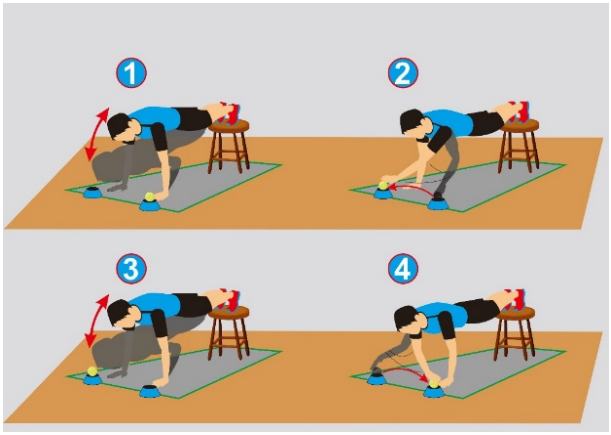

Figure 5. *Push up decline* exercise by moving the tennis ball

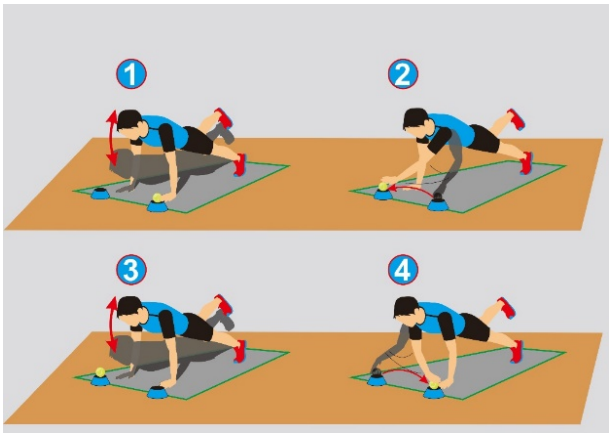

Figure 6. One leg *push up* exercise by moving the tennis ball

3. Result

The results obtained from the research are in the form of data which is a general description of the variable arm muscle strength. The following are data for the Sriwijaya State Sports School's martial arts athletes and are shown in **Table 1**:

Table 1. Normality Test Pretest and Posttest Experiment Group

	Kolmogorov-Smirnov[a]			**Shapiro-Wilk**		
	Statistic	Df	Sig.	Statistic	df	Sig.
pretest push up	.143	25	.198	.945	25	.193
posttest push up	.104	25	.200*	.956	25	.334

The test results are seen the Shapiro-Wilk column **Table 1** where the result is a variable arm muscle strength > (0.05), which means that the experimental group's research data is normally distributed.

Table 2. Experimental Group Homogeneity Test

	Levene Statistic	df1	df2	Sig.
test push up	.687	1	48	.411

Based on the analysis on the homogeneity test **Table 2** for the experimental group, the sig value of the *push up* data was 0.411. It was known that the sig value > 0.05 or H0 was accepted. Thus the *pretest* and *posttest* data in the experimental group are homogeneously distributed.

Table 3. Experimental Group Hypothesis Test

	Mean	N	Std. Deviation	Std. Error Mean
posttest push up	33.4400	25	4.56508	.91302
pretest push up	29.6000	25	5.09084	1.01817

The push-up pretest data has a mean of 29.6 and a standard deviation of 5.09. After being given the treatment of arm muscle strength training using a tennis ball, the post test results obtained an average of 33.44, and a standard deviation of 4.56. The results are shown in **Table 3**, descriptively the difference in the average results of push up data before and before the treatment was given.

Push-up data the average difference is 3.84, which means the difference in the push-up data scores, t count = 17,982, with df = 24 and sig or p-value = 0.000 > 0.05 or H0 is rejected. Thus it can be said that what is shown in **Table 4** is a difference in the push up data between the pretest and posttest in the experimental group.

The test results are seen in the Shapiro-Wilk column **Table 5** where the result is a variable arm muscle strength > (0.05), which means that the control group's research data is normally distributed.

Based on the analysis on the homogeneity test **Table 6** for the control group, the sig data push up value is 0.594 and the sig value is > 0.05 (H0 is accepted). Thus the pretest and posttest data in the control group are homogeneous.

The data from the push-up pretest mean 31.28 and standard deviation 4.58. After being treated with conventional arm muscle strength training, the posttest results had a mean of 31.28, and a standard deviation of 4.12. The results are shown in **Table 7,** descriptive of the difference in the average difference.

Table 4. Paired Samples Test Experimental Group

Paired Differences								
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
posttest push up-pretest push up	3.84000	1.06771	.21354	3.39927	4.28073	17.982	24	.000

Table 5. Normality Test Pre Test and Post Test Control Group

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
pretest push up	.111	25	.200*	.970	25	.650
posttest push up	.135	25	.200*	.969	25	.610

Table 6. Control Group Homogeneity Test

	Levene Statistic	df1	df2	Sig.
test push up	.287	1	48	.594

Table 7. Control Group Hypothesis Test

	Mean	N	Std. Deviation	Std. Error Mean
posttest push up	32.6400	25	4.12189	.82438
pretest push up	31.2800	25	4.58730	.91746

In push-up data, the average difference is 1.36, which means the difference in push-up test scores, t count = 17.982, with df = 24 and sig or p-value = 0.000 > 0.05 or H0 is rejected. Thus it can be said that what is shown in **Table 8** is a difference in the results of the push up test between the pre test and post test in the control group.

Table 9 explains, there was an increase in the average pre-test and post-test results in the control group and the experimental group with a sample of 25 people. The explanation is as follows: the control group has a mean of 1.36 and a standard deviation of 0.81035. However, the experimental group had a mean of 3.84 and a standard deviation of 1.06771. These results are descriptively there are differences in the average increase in arm muscle strength variables in the two research groups, with the experimental group's results being better. This is evidenced by hypothesis testing using the t-test shown in the **Table 10**.

The value of column F = 0.349 with sig value or p-value = 0.557 > 0.05 (homogeneous). t count = -9.2517, df = 48. If compared, the value of t count > t table and sig (2 tailed) or p-value = 0.000 < 0.05 or H0 is rejected. Thus, the proposed hypothesis has been tested with data so that it can be said that the experimental group's push-up test results are higher than the control group.

Table 8. Paired Samples Test Control Group

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
post test push up - pre test push up	1.36000	.81035	.16207	1.02550	1.69450	8.391	24	.000

Table 9. Independent Test

Group	N	Mean	Std. Deviation	Std. Error Mean
Control	25	1.3600	.81035	.16207
Experiment	25	3.8400	1.06771	.21354

Table 10. Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	.349	.557	-9.251	48	.000	-2.48000	.26808	-3.01901	-1.94099
Equal variances not assumed			-9.251	44.761	.000	-2.48000	.26808	-3.02002	-1.93998

4. Discussion

Physical component exercises may use free weights such as [23] implementing *body weight* training in improving the physical components of tae kwon do athletes. The main finding of this study is that the model of arm muscle strength training using a tennis ball is more effective than conventional arm muscle strength training. The tennis ball used during arm muscle strength training is an exercise medium whose function is to distract athletes who are focused on the push-up movement. So subconsciously, they do the movement with pleasure. "The pleasure factor will affect the quality of exercise, where pleasure in training is associated with increased exercise time and boredom is associated with shorter exercise duration [24]". This also makes them not bored in doing arm muscle strength training. “Boredom is an emotional state characterized by dissatisfaction with unstimulating situations and low arousal.”[25]. "Boredom plays an important role in the context of sports, if in general the sport that is done is fun it can actually eliminate boredom, but if it is seen specifically in carrying out an exercise program that makes athletes bored, it will affect the quality of the exercise" [26]. “Pleasure and boredom are psychological factors in exercise.”[27]. Previous research provides exercise with elastic rubber, proven to increase leg muscle strength [28]. This tennis ball has succeeded in becoming simple and inexpensive equipment to obtain as an exercise medium to increase arm muscle strength, which has been using equipment such as *dumbbells* and *machine gyms*.

5. Conclusions

According to the results and data analysis, it was concluded that there was a significant effect of arm muscle strength training using a tennis ball; this exercise was more effective than conventional arm muscle strength training. Therefore, this method is very suitable to be used for self-defense athletes to increase the biomotor component of arm muscle strength due to new breakthroughs that have been training media used for strength training using equipment such as dumbbells and machine gyms. In this study, the limitations of the study include only the biomotor component of arm muscle strength and the sample size is not too large so that the results of the study cannot be generalized. While the recommendation for further researchers is that it needs to be developed for the biomotor component of strength in the muscles of other parts of the body.

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