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The Effect of Total Body Resistance Exercise on Strength, Power and Stability Enhancement

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Wpływ ćwiczenia całkowitego oporu ciała na siłę, moc i wzmocnienie stabilności

Abstract

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Purpose: The objectives of this study are to analyze and compare the effectiveness of the total body resistance exercise – ascending, descending and constant load, in increasing strength, power, and stability. **Methodology:** The study is using quantitative with quasi-experimental techniques design as the methodology. **Results:** The results showed that: 1) in ascending group, leg muscle strength had the highest percentage compared to other variables for 22%, while leg muscle power had the lowest score for 12%; 2) in descending group, arm muscle strength had the highest score for 36% than the other variables and the leg muscle power had the lowest score for 16%; 3) in constant load group, arm muscle strength had an increase for 15%, leg muscle strength for 14%, 12% for arm muscle power, 8% for leg muscle power and stability or body balance for 35%. **Conclusion:** Hence, there were significant effectiveness between the ascending, descending, and constant load groups on increasing strength, power, and stability. The descending and constant load group had a greater or more effective effect than the ascending group on increasing arm muscle strength.

Keywords: total body resistance exercise, strength, power, stability.

Abstrakcyjny

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Cel: Celem tego badania jest przeanalizowanie i porównanie skuteczności ćwiczenia całkowitego oporu ciała - wznoszenia, opadania i stałego obciążenia, w zwiększaniu siły, mocy i stabilności. **Metodologia:** W badaniu wykorzystano metodę ilościową z quasi-eksperymentalnymi technikami projektowania. **Wyniki:** Wyniki pokazały, że: 1) w rosnącej grupie siła mięśni nóg miała najwyższy odsetek w porównaniu z innymi zmiennymi dla 22%, podczas gdy siła mięśni nóg miała najniższy wynik dla 12%; 2) w grupie malejącej siła mięśni ramienia miała najwyższy wynik dla 36% niż inne zmienne, a siła mięśni nogi miała najniższy wynik dla 16%; 3) w grupie o stałym obciążeniu siła mięśni ramienia wzrosła o 15%, siła mięśni nóg o 14%, 12% dla siły mięśni ramion, 8% dla siły i stabilności mięśni nóg lub równowagi ciała o 35%. **Wniosek:** Dlatego między grupami obciążeń wstępujących, opadających i stałych występowała znacząca skuteczność pod względem zwiększania siły,

mocy i stabilności. Grupa opadająca i o stałym obciążeniu miała większy lub bardziej skuteczny wpływ na zwiększenie siły mięśni ramienia niż grupa rosnąca.

Słowa kluczowe: całkowite ćwiczenia oporu ciała, siła, moc, stabilność.

1. Introduction

Sport achievement is an observable and measurable thing which done by scientific approach started from the early stage of athlete identification process until the success level. As what has been explained by Suharto as cited in (Dinas Pendidikan Nasional, 2000), "... in order to achieve it (achievement), some efforts must be done together by a club. The club should do the structural training based on knowledge and sport technology due to have their athlete as a champion, whether in the level of regional, national (PON), Sea Games, Asean Games, or Olympiad". These efforts have been done along with the social demand on Indonesian sport's achievement within the International scope. Setijono claimed, "it is needed a continuity on skill and performance training for athlete started from the early phase of athlete showed his talent in sport" (Setijono, 2005). It showed that there are four things as a determinant in sport achievement, including physic, technic, mental and emotional. Besides, the availability of material and system are needed to support the training. The physical capacity is becoming the important part that needed to be understood by both coach and athlete due to decrease the failure while achieving the goal. Thus, the researcher tried to know whether the combination on exercise using total body resistance have good effect on the enhancement of physical condition components – strength, power and stability. It is hoped that the result of the study could give empiric and accurate information on the level of total body resistance exercise in increasing strength, power and stability.

2. Literature Review

Generally, exercise has function to enhance the physical quality, physical movement and psychiatric quality of a trainee. Exercise is the volume replenishment (excitatory motion) within the body that shows a respond on body and self-adaption. Respond known as a direct physical reaction of exercise procedure within a couple of times. While adaption is the body reaction against the exercise volume happen in a long period and relatively stable. As what was stated by Nagarajan, Damodharan and Praven (2013), exercise is the simple way of athlete planning through structured methodology until the limit of period duration based on the field. Exercise is one of the structured methodologies which done in several times with volume that increase each day (Nagarajan, Damodharan, & Praven, 2013). This means that exercise should

be done in structured and organized way based on a certain pattern, technique, method and continuity from easy to hard level. While several times in exercise means the activity must be done in a frequent way due to make the hard part becomes easy. Marsini and Sukmaningtyas also stated that sport exercise effectiveness depends on the manipulation of some exercise variables, including volume (time duration, space, and repetition), intensity (weight and velocity) and density (Marsini & Sukmaningtyas, 2010).

2.1 Total Body Resistance Exercise (TRX)

Total body resistance exercise or TRX is an exercise program that is unique, innovative and easy to do for everyone. Looking at its uniqueness, an innovation is created by modifying the exercise in more detailed way by using rope as the media. TRX has concept in using the trainee's own body weight as the weight itself. TRX has become one of the solutions of body weight exercise that can be done inside and outside the room or in base camp (STC TRX, 2012). It is the easiest sport alternative done by sport fans, such as non-expert people and elite athlete. Its movements follow the anatomy or body joints movement of human. TRX can be done by everyone in every place and every chance (STC TRX, 2012).

2.2 Exercise Model

There are three exercise models examined in this study, those are; (a) Ascending. Ascending is a type of exercise model that has replenishment on the total amount of load and degradation on the repetition in each set, (b) Descending. Descending defined as degradation on the total amount of load and replenishment on the repetition for each set, (c) Constant Load. Constant load is a type of exercise that has no replenishment and degradation on the total amount of load for each set, but it is done in a stable way and continuity on the total of the repetition from the first set until the next set.

3. Methodology

3.1 Research Type

This study used quantitative methodology as the research design with quasi experiment approach. Three groups of sample were given similar treatment using circuit of six post TRX exercise model, including; TRX Rows, TRX Chest Press, TRX Balance Lunges, TRX Squat Jump, TRX Total Abdominal, and TRX Atomic Push-up. While each groups was divided in three different exercise models; group 1 using ascending exercise model, group 2 using descending model and group 3 using constant load model. This study aimed to analyze the effect from ascending, descending and constant load toward the enhancement on strength,

power and stability on arm and leg muscle. Also to know the effectiveness level among the three groups of exercise models on the enhancement of strength, power and stability.

3.2 Research Design

The matching only design was used as the research design in this study by dividing the groups based on the ordinal pairing result. The matching only design could be seen below;

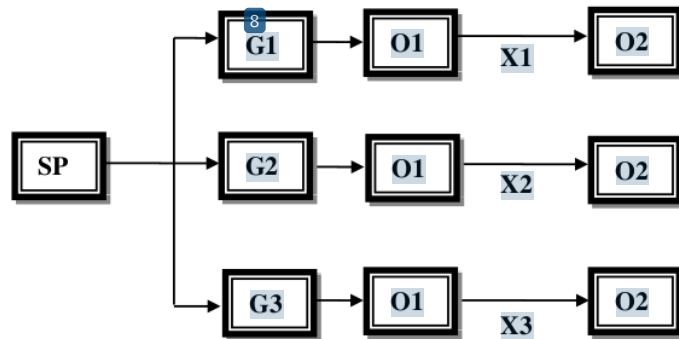


Figure 1. *The Matching Only Design.*

Notes:

- SP : Research Subject
- G1 : Group 1 (Ascending Model)
- G2 : Group 2 (Descending Model)
- G3 : Group 3 (Constant Load Model)
- O1 : Pretest
- O2 : Post test
- X : Treatment

3.3 Research Variable

The variable distinguished in two; free and bound variable. Free variable consisted of ¹total body resistance exercise and its models (ascending, descending, and constant load). Whereas bound variable was strength, power and stability.

3.4 Research Population and Sample

The population used was 30 ³male students of Sport Coaching Education Department, State University of Surabaya with age ranged from 18 to 20 years old and categorized as an active student in university. Since this study was population research, thus the sample was the total population that mentioned before. The sample was divided into three groups, which each groups contained of 10 people. The group division was done using ordinal pairing based on the

pretest result data in the form of ability test taken from one of the leg muscle strength, that is push up.

3.5 Research Instrument

For research instrument, this study used four kind of tests along with the Standard Operational Procedure (SOP), those are; (a) Force plate or accu power test which has purpose on measuring the leg muscle explosive power, (b) Leg dynamometer to measure the leg muscle strength, (c) Medicine ball throw or arm muscle power test, which aims to measure the arm muscle power, (d) Push up test to measure the arm muscle strength, and (e) Balance beam test, to measure the stability (Mackenzie, 2005).

4. Results

4.1 Ascending Group

The data from the ascending group variable; arm muscle strength (AMS), leg muscle strength (LMS), arm muscle power (AMP), leg muscle power (LMP), and stability (S), obtained from the result of pre and post treatment. During six weeks treatment, a transformation on the whole variables were seen. The leg muscle strength had higher improvement for 22% than the other variables, proved from its mean pretest value for 132.4 and post test result for 161.7. Meanwhile, the mean score for leg muscle power had the lowest enhancement than the other variables for 12%. It was proved by its mean pretest value for 71.4 and posttest value for 80.4. Thus, it can be concluded that in six weeks, the ascending group showed the enhancement with pattern as LMS>AMS>AMP>S>LMP as shown in figure 1 and 2 below;

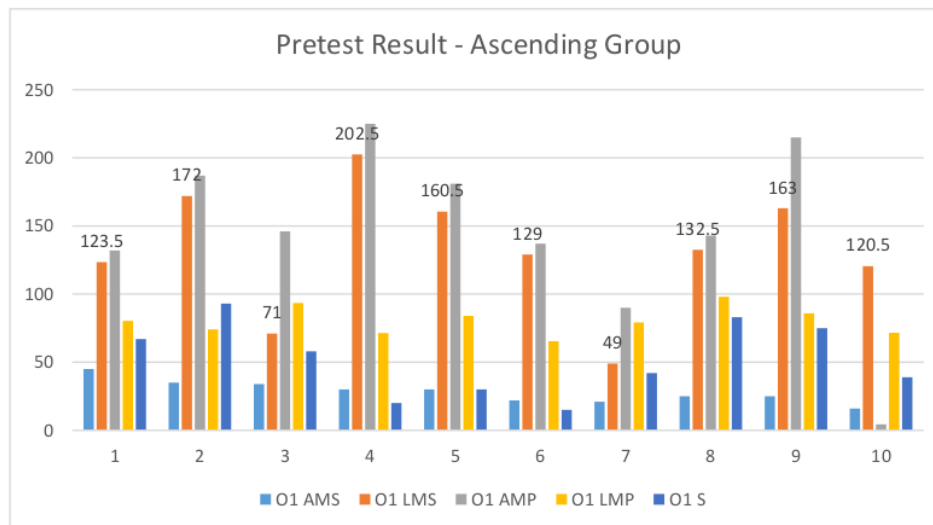


Figure 1. Pretest Result – Ascending Group

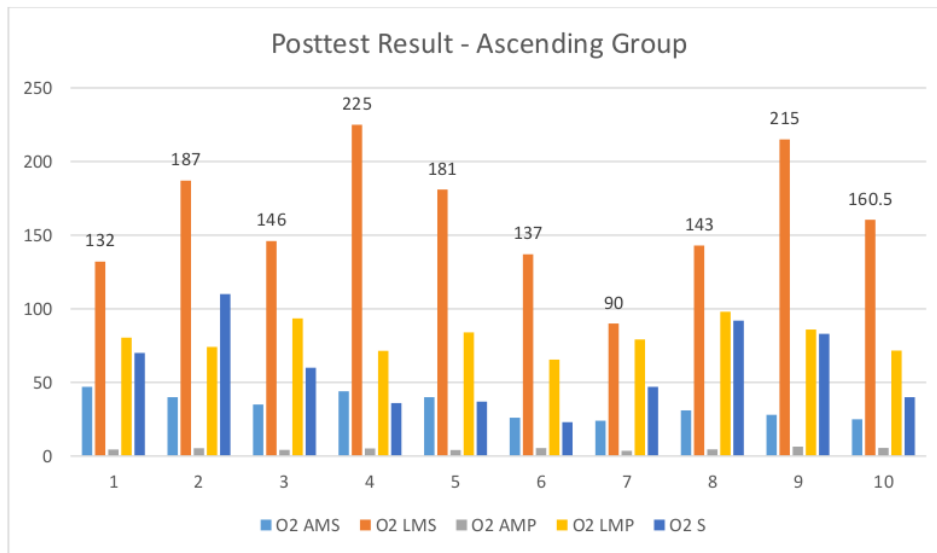


Figure 2. Posttest Result – Ascending Group

Notes:

AMS : Arm Muscle Strength	S : Stability
LMS : Leg Muscle Strength	O1 : Pretest
AMP : Arm Muscle Power	O2 : Posttest
LMP : Leg Muscle Power	

4.2 Descending Group

In descending group, it was found effective transformation in every variables after the six weeks treatment. It showed that the arm muscle strength had the highest enhancement rather than the other variable for about 36%. This result was proved in its mean pretest value for 28.5 and posttest value for 39.0. While the leg muscle power had the lowest enhancement for 16% which showed on its mean pretest value for 74.1 and posttest value for 86.1. Thus the pattern was AMS>S>LMS>AMP>LMP, which shown in the figure 3 and 4 below;

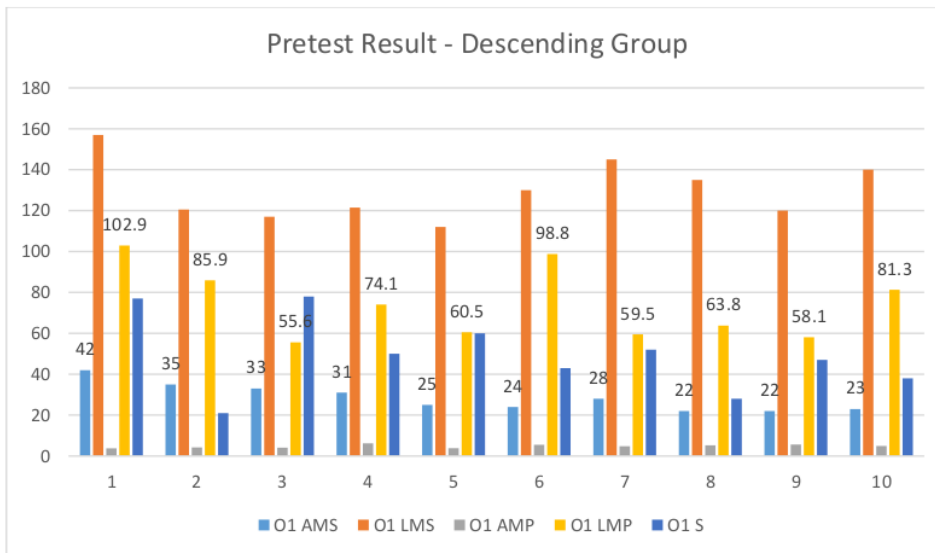


Figure 3. Pretest Result – Descending Group

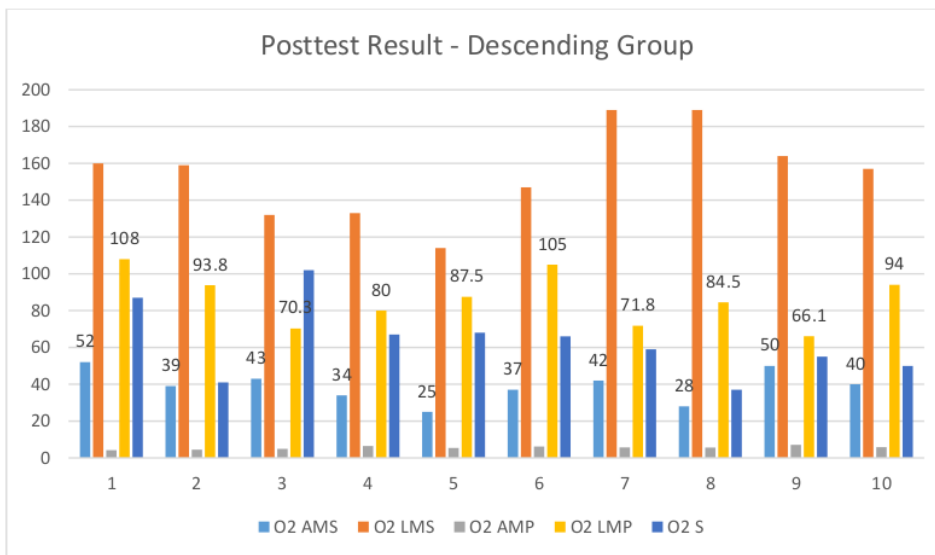


Figure 4. Posttest Result – Descending Group

4.3 Constant Load Group

In constant load group, each variables showed its enhancement before and after the treatment. The arm muscle strength had improvement for about 15%, leg muscle strength for 14%, arm muscle power for 12%, leg muscle power for 8% and 35% for stability. Therefore the

enhancement on stability variable was the highest enhancement than the other four variables. Moreover, the mean result of pre and posttest value were shown in figure 5 and 6 below;

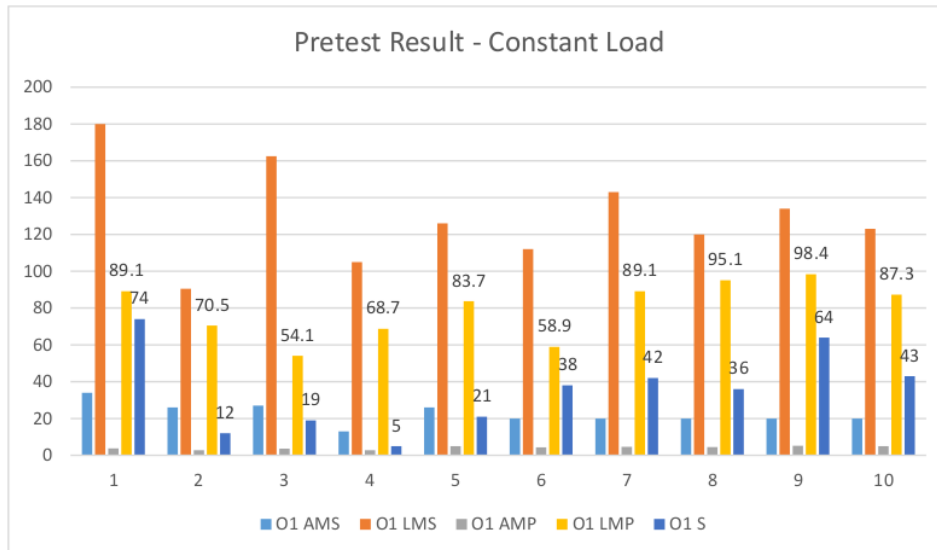


Figure 5. Pretest Result – Constant Load

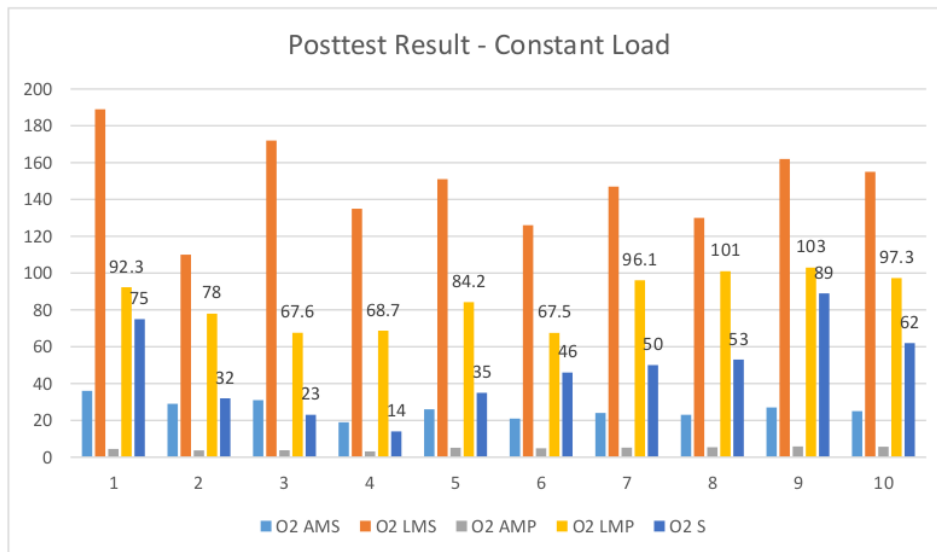


Figure 6. Posttest Result – Constant Load

Hypothesis Test Requirement

There were two requirements that must be done before doing the hypothesis test; (1) the analysis result should be distributed normal, (2) the analysis result should be homogeny. After completing the requirements, hence it continued with normality and homogeneity test.

1. Normality Test

To know the data have normal distribution, shapiro-wilk test was done. This test could define whether the data is normal or not by comparing the significant result of the data with the significant standard for 5% or 0.05. However, if the significant standard within the statistic test is bigger than 0.05, then the data is claimed as normal distribution.

Table 1. Analysis Result of Normality Test

Variable	Test	AC	DC	CL	P	Status
		Sig.	Sig.	Sig.		
AMS	O1	.850	.188	.211	> 0.05	Normal
	O2	.337	.869	.928	> 0.05	Normal
LMS	O1	.693	.511	.860	> 0.05	Normal
	O2	.848	.626	.998	> 0.05	Normal
AMP	O1	.563	.548	.234	> 0.05	Normal
	O2	.791	.976	.480	> 0.05	Normal
LMP	O1	.680	.145	.309	> 0.05	Normal
	O2	.860	.698	.118	> 0.05	Normal
S	O1	.712	.727	.705	> 0.05	Normal
	O2	.594	.637	.970	> 0.05	Normal

From the table 1 above, it can be seen that three groups were distributed normal with and without the treatment. It showed the significant value for > 0.05 ($p > 0.05$). Hence it can be concluded that the whole data on AMS, LMS, AMP, LMP, and S was distributed normal.

2. Homogeneity Test

Homogeneity test was aimed to prove the similarity of the whole data. In this study, there were 5 variables that should be tested for its homogeneity. If the statistic value was bigger than 0.05 then it can be said as homogeneity.

Table 2. Analysis Result of Homogeneity Test

Factor	Sig.	P	Note
AMS	.124	> 0.05	Similar
LMS	.134	> 0.05	Similar
AMP	.164	> 0.05	Similar

LMP	.366	> 0.05	Similar
S	.218	> 0.05	Similar

Based on the table 2 above, the whole variables had significant value for > 0.05 ($p > 0.05$) which meant that the data were homogeny. Therefore it can be continued to the hypothesis test.

Hypothesis Test

The criteria for hypothesis rejection was using the significant standard for 5% ($p < 0.05$). It meant that if the chance of hypothesis rejection was less than 5%, then the hypothesis is accepted.

a. Paired Sample T-Test

The paired sample t-test was done to know the differentiation on the paired subject. As what written on table 3, 4 and 5 below that there was effective influence among the groups which seen on $t < 0.05$.

Table 3. Paired Sample T-Test of Ascending Group

Factor	Pair	t_{count}	Sig. 2-tailed	Note
AMS	O1_AMS – O2_AMS	-4.385	0.002	Different
LMS	O1_LMS – O2_LMS	-4.180	0.002	Different
AMP	O1_AMP – O2_AMP	-4.171	0.002	Different
LMP	O1_LMP – O2_LMP	-4.147	0.002	Different
S	O1_S – O2_S	-4.434	0.002	Different

Table 4. Paired Sample T-Test of Descending Group

Factor	Pair	t_{count}	Sig. 2-tailed	Note
AMS	O1_AMS – O2_AMS	-4.079	0.003	Different
LMS	O1_LMS – O2_LMS	-4.147	0.002	Different
AMP	O1_AMP – O2_AMP	-5.223	0.001	Different
LMP	O1_LMP – O2_LMP	-5.331	0.000	Different
S	O1_S – O2_S	-6.616	0.000	Different

Table 5. Paired Sample T-Test of Constant load Group

<i>Factor</i>	<i>Pair</i>	<i>t_{count}</i>	<i>Sig. 2-tailed</i>	<i>Note</i>
AMS	O1_AMS – O2_AMS	-5.093	0.001	Different
LMS	O1_LMS – O2_LMS	-5.660	0.000	Different
AMP	O1_AMP – O2_AMP	-6.456	0.000	Different
LMP	O1_LMP – O2_LMP	-4.585	0.001	Different
S	O1_S – O2_S	-5.129	0.001	Different

Those three tables above showed that the significant standard for each variables was $p > 0.05$. Thus, it can be concluded that there is influence after the treatment was done.

b. Variable Analysis Test

Variable analysis test was done due to know the modification caused by the experiments, therefore the influence on each factors can be seen.

Table 6. Variable Analysis Test

Factor	<i>f_{count}</i>	Sig.	P	Note
AMS	4.37	.023	< 0.05	Ho rejected
LMS	1.00	.380	> 0.05	Ho accepted
AMP	.66	.524	> 0.05	Ho accepted
LMP	2.32	.117	> 0.05	Ho accepted
S	2.42	.108	> 0.05	Ho accepted

The table above showed that AMS had significant difference among the other four variables with f value for 4.37 and sig. 0.023, which meant $p < 0.05$. Hence, it can be concluded that there was significant differentiation after the treatment was given using three models of exercise. Furthermore, in other variables – LMS, AMP, LMP and S, had f value bigger than 0.05, which meant that these four variables were accepting the Ho.

c. Post Hoc Test

To know the result on significant differences among three groups of exercise model toward the variables, then post hoc test was done. However, since the huge amount of variables was used in this study, hence the table below only showed the test result of arm muscle strength.

Table 7. Analysis Result of Post Hoc Test

		Arm Muscle Strength			
		(I)	(J)	Mean Difference (I-J)	Sig.
Delta	LSD	AC	DC	-4.80000	.136
			CL	2.20000	.640
		DC	AC	4.80000	.136
			CL	-7.00000*	.020
	LC	CL	AC	-2.20000	.640
			DC	7.00000*	.020

As what it is seen on table 7 above, the model group that had effective influence with sig. value for < 0.05 can be observed through the (*) mark on mean differences column. Therefore it can be sum up that there was different enhancement among the models.

5 Discussion

This study focused on the comparison on total body resistance exercise with the structured loading model, including ascending, descending and constant load. The result of this study showed the effectiveness of total body resistance exercise with structured loading model toward the arm muscle strength, leg muscle strength, arm muscle power, leg muscle power and stability, which described below;

a. The Relation on Strength, Power and Stability

Physical condition is divided into two; physical fitness and physical performance (Ratamess, 2011). The physical fitness is derived from the basic motoric abilities, such as strength, flexibility, body resistance and body balance or stability. While the physical performance condition has strong connection with special movements and through exercise or training process, such as power and agility. As what Bompa and Haff said that there is correlation between physical conditions with the component of physical condition, or in other words, the whole physical condition is related to each other in direct and indirect way (Bompa & Haff, 2009). Bompa also said that, strength and speed are the main component in building power. The higher strength and speed owned by someone, then the higher power that he will be released (Adhi, Sugiharto, & Soeyonto, 2017). The correlation between strength and power are no longer doubtful, since power is the strength that combined with velocity that produce bigger force within a very

limited time (Stone et al., 2003). The combination between force and velocity was the other evidence that strength and velocity cannot be separated from the aspect of power (Haff et al., 2005). Stability is also one of the important aspects within physical condition and daily activities. In its definition, stability can be interpreted as a body condition in which the structure of central nervous system can control human body posture based on the input from nerve, such as proprioceptive nerve, vestibular organ and signals from visual nerve. Factors that influence stability or body balance are center of gravity (COG), line of gravity (LOG) and base of support (BOS). Moreover, muscle also considered as the main factor which influence the stability (Lee, Han, Cheon, Park, & Yong, 2015).

b. Suspension Training

Suspension training or mostly known as TRX (total body resistance exercise) had functional training concept using trainee's own body weight and body slope angle. TRX exercise had many advantages either for body performance or health. As what Hetrick said that TRX is one of the physical training that can keep and enhance strength, muscle durability, body balance or stability and nerve muscle coordination (Hetrick, 2007). The intensity of TRX exercise was defined by three principals, namely; stability principle, vector resistance principle and pendulum principle (Cugliari & Boccia, 2017). Stability principle focused on the size and support position of the body. It pointed on the body contact with the ground to adjust the stability. Vector principle put forward the body angle to adjust the resistance. While, pendulum principle pointed on the principle of gravity center in horizontal body using anchor point. Previous studies proved that TRX exercise could increase the balance and stability. Balance controlled the bodyweight in dynamic and static condition (Latash & Lestienne, 2006). Whereas stability defined as the balance condition toward inside and outside pressure force and the pressure on muscle tissue and joints (Hodges, Richardson, & Hides, 2004). The result of this study showed that all exercise models had significant impact on stability. This was similar Gaedtke and Morat who stated that suspension training had influence on the body balance and stability (Gaedtke & Morat, 2015).

For athlete who aimed to increase strength, suspension training could be used as an alternative exercise, such as doing squat, deadlift or power clean. TRX also could be used as additional training, a training with enhancing the volume and reducing the intensity can be put into one training period, especially in recovery process since TRX

could decrease the stress on muscle joints without reducing the amplitude activity on muscle. Thus, the strength would be kept and had degradation on the risk of injury.

c. Ascending and Descending Loading

The load pattern between the sets could be designed in ascending, descending and constant load. The ascending load followed the technique from Delorme as a basic in which the load would increase in every set. While the descending load adapted the Oxford model with load pattern as load degradation for every set (Alvarez, Salas, & Garofano, 2004). Therefore, the result showed that ascending group in arm muscle strength, leg muscle strength and leg muscle power had no significant differences caused by TRX exercise with ascending model. Meanwhile, the opposite result occurred in arm muscle power and stability variables which had significant differences. For descending group, the arm muscle power, leg muscle power and stability had no significant differentiation due to the training, then in arm muscle strength and leg muscle strength had significant differentiation caused by TRX exercise with descending model. In descending model, the contraction would be lighter because the load would keep decrease in every set. Even though the muscle entered the fatigue period, but the aspect of MVMA's would continue to be maintained due to the occurrence of fatigue and recovery.

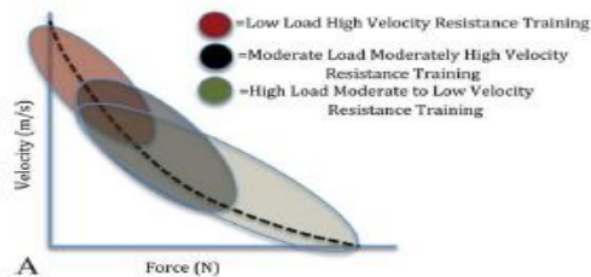


Figure 4. The relationship of muscle force and velocity (Haff et al., 2005)

Therefore, the body can maintain the MVMA's phase optimally and the enhancement on strength can be achieved. This happened since TRX had no limitation on movement (isolated movement) at the contraction of a certain muscle parts.

d. Constant Load Loading

In constant load loading training with same total repetition within each training set had significant result on the enhancement of leg muscle strength, arm muscle power and stability. While on arm muscle strength and leg muscle power found no significant

enhancement. However the continuity of post hoc test result showed that there was no differentiation between the constant load loading group and the other groups toward the variables. It meant that all variables had same enhancement with ascending, descending and constant load loading model. The different result only showed on the arm muscle strength within the descending and constant load loading model.

6 Conclusion

In conclusion, there was an effect on the enhancement of strength, power and stability through the total body resistance exercise. TRX also very effective on the enhancement of arm muscle rather than the other variables. Furthermore, TRX became the media that simple and easy to do by using hand and feet as the support, while the load used was the bodyweight itself.

7 Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article

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