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Oce WIRIAWAN***

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

Purpose: The objective of this study is 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 quantitative method with quasi-experimental design techniques was used in the study. **Results:** The results showed that: 1) in the 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 the descending group, arm muscle strength had the highest score for 36% compared to other variables while the leg muscle power had the lowest score for 16%; 3) in the constant load group, arm muscle strength increased for 15%, leg muscle strength for 14%, arm muscle power for 12%, leg muscle power and stability for 8%, and body balance for 35%. **Conclusion:** There was significant effectiveness among the ascending, descending, and constant

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load groups in terms of increasing strength, power, and stability. The descending and constant load group had a greater or more effective impact on increasing arm muscle strength than the ascending group.

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

Streszczenie

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:** 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.

Introduction

Sport achievement is an observable and measurable thing which is assisted by scientific approach started from the early stage of athlete identification process until the success level. As has been explained by Suharto in [5], “[...] in order to achieve it (achievement), some efforts must be made together by a club. The club should do the structural training based on knowledge and sport technology necessary to make their athlete a champion, whether at the regional, national (PON), Sea Games, Asean Games, or Olympic level”. These efforts have been done along with the social demand on Indonesian sports achievements within the International scope. Setijono claimed, “There is the need for continuity in skill and performance training of an athlete starting from the early phase of training the athlete who showed his talent in sport” [16]. It showed that there are four determinants of sports achievement: physical, technical, mental and emotional. Besides, the availability of material and system are needed to support the training. The physical capacity has become the most important part that needs to be understood by both, a coach and an athlete, necessary to decrease the possibility of failure while achieving the goal. Thus, the researchers tried to study whether the combination of exercise using total body resistance has a good effect on the enhancement of physical condition components – strength, power and stability. Hopefully, the result of the study can give empirical and accurate information on the level of total body resistance exercise in increasing strength, power and stability.

1. Review of Literature

Generally, the function of exercise is 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 response of a body and its self-adaptation. The response is known to be a direct physical reaction to exercise procedure within a couple of times. Whereas adaptation is the reaction of a body to the exercise volume happening for a long period and relatively stable. As Nagarajan, Damodharanand Praven stated, exercise is a simple way for an athlete to plan through structured methodology until the limit of period duration based on the field [14]. Exercise is one of the structured methodologies which is done several times with volume that increases each day [14]. This means that exercise should be done in a structured and organized way based on a certain pattern, technique, method and continuity from easy to hard level. Whereas exercise means that the activity must be done in a frequent way in order to make the hard part become easy. Marsini and Sukmaningtyas also stated that the effectiveness of sports exercise depends on management of some exercise variables, including volume (time duration, space, and repetition), intensity (weight and velocity) and density [13].

1.1. 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 a more detailed way by using a rope as the media. TRX is based on the concept of 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 a base camp [17]. It is the easiest sport alternative done by sport fans, such as non-expert people and elite athletes. Its movements follow the anatomy or body joints movement of humans. TRX can be done by anyone in any place [17].

1.2. Exercise Model

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

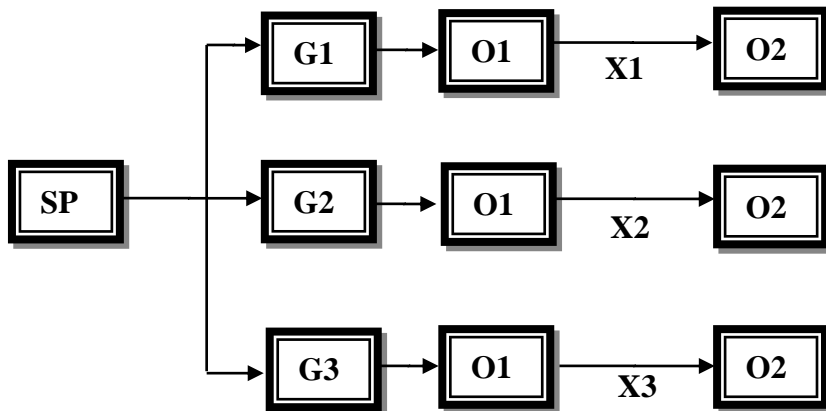
2. Methodology

2.1. Research Type

Quantitative methodology was used in this study as the research design with quasi experiment approach. Three sample groups were given similar treatment using a circuit of six post TRX exercise models, 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 into three different exercise models; group 1 using the ascending exercise model, group 2 using the descending model and group 3 using the constant load model. The objective of this study was to analyze the effect of ascending, descending and constant load on the enhancement of strength, power and stability of the arm and leg muscles, as well as to find out the level of effectiveness of the three groups of exercise models on the enhancement of strength, power and stability.

2.2. 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 on figure 1;



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

Figure 1. The Matching Only Design.

2.3. Research Variable

Two types of variables were distinguished; a free and a bound variable. The free variable consisted of total body resistance exercise and its models (ascending, descending, and constant load). Whereas the bound variable was strength, power and stability.

2.4. Research Population and Sample

The population used were 30, 18 to 20 year-old, male students, categorized as active university students of the Sport Coaching Education Department, at the State University of Surabayawith,. Since this study was a population research, the sample was the same as the total population that mentioned before. The sample was divided into three groups, and each groups consisted of 10 people. The group division was done using ordinal pairing based on the pretest result data in the form of the ability test taken from the leg muscle strength, that is push up.

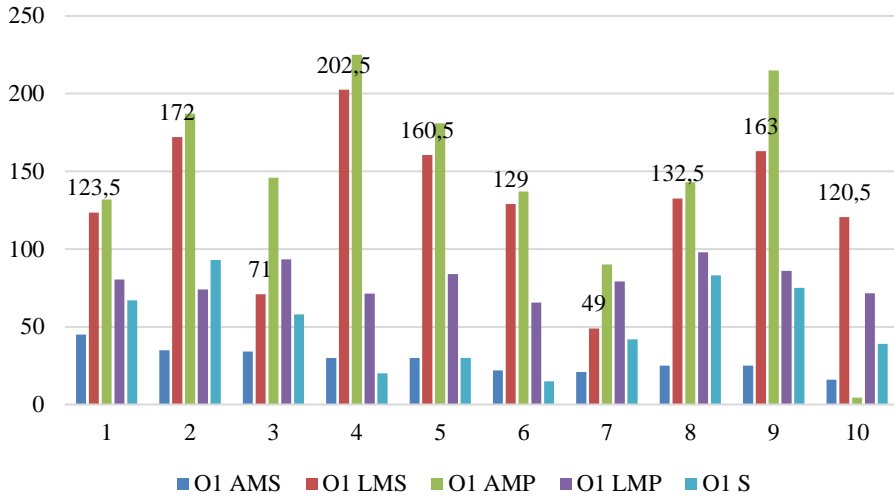
2.5. Research Instruments

Four kinds of tests along with the Standard Operational Procedure (SOP) were used in this study. They were; (a) Force plate or accu power test the purpose of which is 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 are used to measure the arm muscle power, (d) Push up test was used to measure the arm muscle strength, and (e) Balance beam test was used to measure the stability [12].

3. Results

3.1. Ascending Group

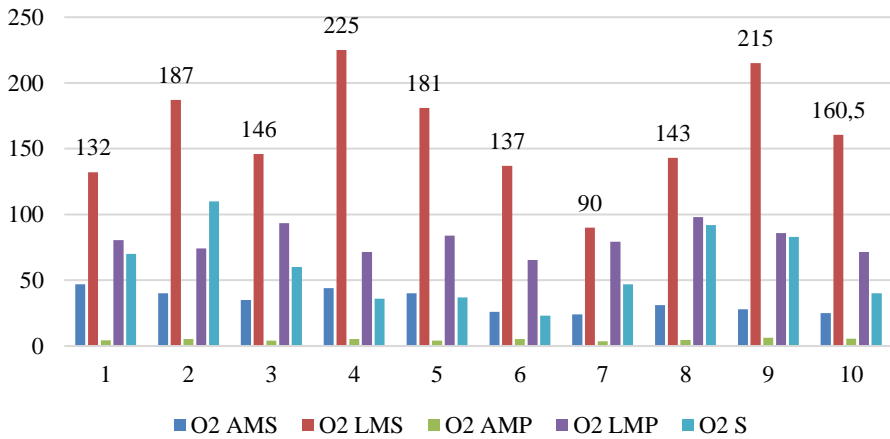
The data from the ascending group variable; arm muscle strength (AMS), leg muscle strength (LMS), arm muscle power (AMP), leg muscle power (LMP), and stability (S), were obtained from the results of pre and post treatment. During a six-week treatment, a transformation of all the variables was observed. The leg muscle strength had a higher improvement for 22% than the other variables. It was proved by 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 of 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 2 and 3.



Notes:

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

Figure 2. Pretest 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

Figure 3. Posttest Result – Ascending Group

3.2. Descending Group

In the descending group, effective transformation was found in every variable after the six weeks treatment. It showed that the arm muscle strength had a rather higher enhancement than the other variables 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, as shown in Figures 4 and 5.

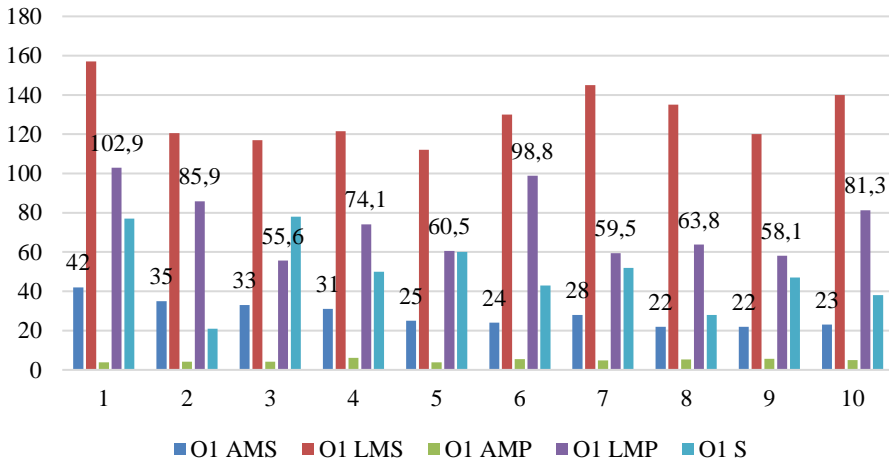


Figure 4. Pretest Result – Descending Group

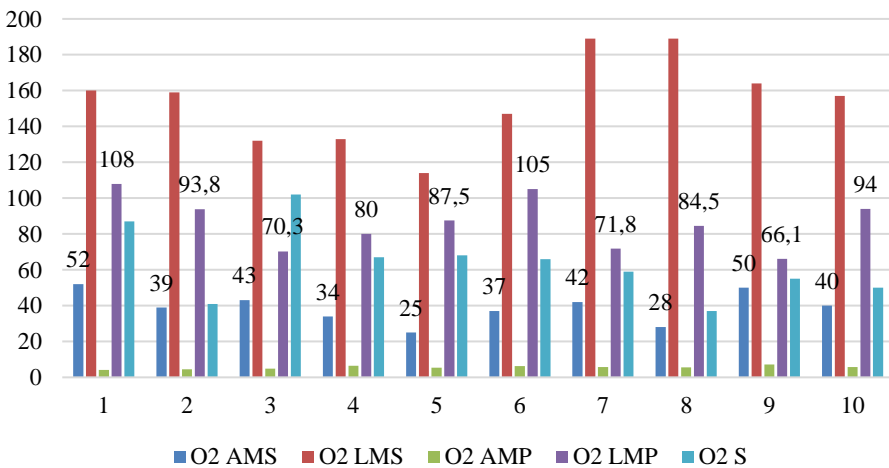


Figure 5. Posttest Result – Descending Group

3.3. Constant Load Group

In constant load group, each variable showed its enhancement before and after the treatment. The arm muscle strength improved 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 of the stability variable was higher than the other four variables. Moreover, the mean result of pre and posttest values are shown in Figures 6 and 7.

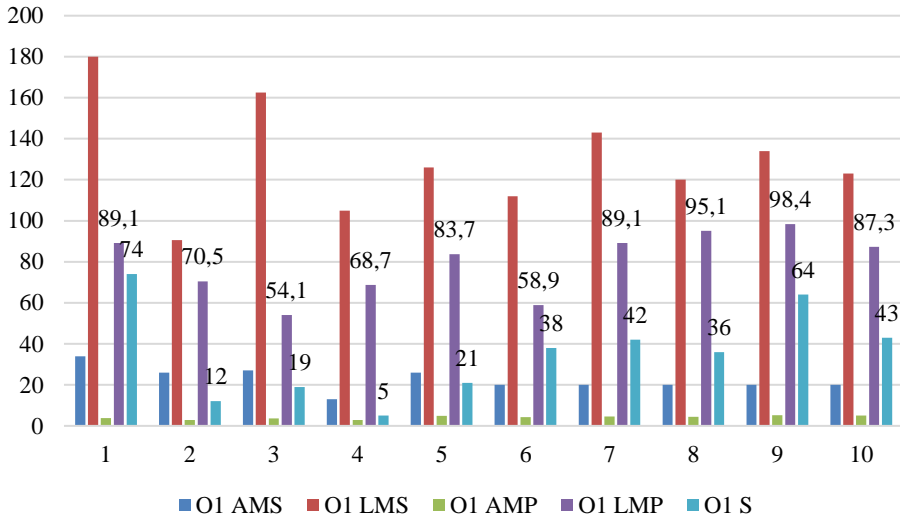


Figure 6. Pretest Result – Constant Load

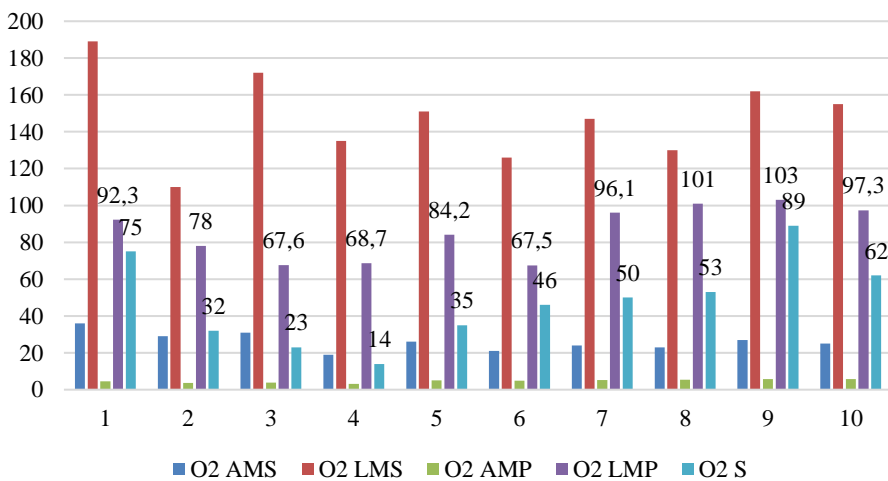


Figure 7. Posttest Result – Constant Load

Hypothesis Test Requirement

There were two requirements that had to be done before doing the hypothesis test; (1) the analysis result should be normally distributed, (2) the analysis result should be homogenous. After meeting these requirements, the normality and homogeneity test could be continued.

1. Normality Test

To make sure that the data have normal distribution, the Shapiro-Wilk test was done. This test can 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 higher than 0.05, then the data is regarded as normally distributed.

Table 1. Analysis Result of the 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, 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 were distributed as normal.

2. Homogeneity Test

Homogeneity test was aimed to prove 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 to be homogenous.

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, the all the variables had significant value for > 0.05 ($p > 0.05$) which meant that the data were homogenous. Therefore, the hypothesis test can be continued.

Hypothesis Test

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

a. Paired Sample T-Test

The paired sample t-test was done to know the differentiation on the paired subject. As can be seen from tables 3, 4 and 5, there was effective influence among the groups which seen on $t < 0.05$.

Table 3. Paired Sample T-Test of the Ascending Group

<i>Factor</i>	<i>Pair</i>	<i>t_{count}</i>	<i>Sig. 2-tailed</i>	<i>Note</i>
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 the Descending Group

<i>Factor</i>	<i>Pair</i>	<i>t_{count}</i>	<i>Sig. 2-tailed</i>	<i>Note</i>
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 the 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

Tables 3–5 showed that the significant standard for each variable was $p > 0.05$. Thus, it can be concluded that there is influence after the treatment has been done.

b. Variable Analysis Test

Variable analysis test was done in order to determine the modification caused by the experiments, so that the influence on each factors could be seen.

Table 6. Variable Analysis Test

Factor	f_{count}	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

Table 6 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 determine the result on significant differences among three groups of exercise model toward the variables, the post hoc test was done. However, since a large number of variables was used in this study, the table below only shows 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 can be seen on table 7, 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 summed up that there was different enhancement among the models.

4. Discussion

This study is focused on the comparison of 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 towards the arm muscle strength, leg muscle strength, arm muscle power, leg muscle power and stability, which is described below.

a. The Relation on Strength, Power and Stability

Physical condition is divided into two; physical fitness and physical performance [15]. 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. According to Bompa and Haff, there is correlation between physical conditions and the components of physical condition, or in other words, all the components of physical condition are related to one another in direct and indirect way [3]. Bompa also maintained that strength and speed are the main components in building power. The higher the strength and speed possessed by someone, the higher the power that will be released [1]. The correlations between strength and power are no longer doubtful, since power is the strength that combined with velocity can produce bigger force within a very limited time [18]. The combination between force and velocity was another evidence that strength and velocity cannot be separated from the aspect of power [7]. 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 nerves, such as the proprioceptive nerve, vestibular organ and signals from visual nerve. Factors that influence stability or body balance are the center of gravity (COG), the line of gravity (LOG) and the base of support (BOS). Moreover, muscles are also considered to be the main factor which influence the stability [11].

b. Suspension Training

Suspension training is mostly known as TRX (total body resistance exercise), a functional training concept using trainee's own body weight and body slope angle. The TRX exercise had many advantages either for body performance or health. According to Hetrick, TRX is one of the physical trainings that can keep and enhance strength, muscle durability, body balance or stability and nerve muscle coordination [8]. The intensity of the TRX exercises was defined by three principals, namely; stability principle, vector resistance principle and pendulum principle [4]. The stability principle is focused on the size and support position of the body. It focused on the body contact with the ground to adjust the stability. The vector principle put forward the body angle to ad-

just the resistance. Whereas, the pendulum principle pointed to the principle of gravity center in horizontal body while using and anchor point. Previous studies proved that the TRX exercises could increase the balance and stability. Balance controlled the bodyweight in dynamic and static condition [10]. Whereas stability defined the balance condition toward inside and outside pressure force and the pressure on muscle tissue and joints [9]. The result of this study showed that all exercise models had significant impact on stability. Like Gaedtke and Morat who stated that suspension training had influence on the body balance and stability [6].

For an athlete who aims to increase strength, suspension training could be used as an alternative exercise, such as doing squat, dead-lift 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 the process of recovery since TRX could decrease the stress on muscle joints without reducing the amplitude activity on muscle. Thus, the strength would be kept and decrease 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 Delorme technique as a basic exercise in which the load would increase in every set. Whereas the descending load adapted the Oxford model with load pattern as load degradation for every set [2]. Therefore, the result showed that ascending group had no significant differences caused by the TRX exercise with ascending model in arm muscle strength, leg muscle strength and leg muscle power. 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 there was significant differentiation caused by the TRX exercise with the descending model. In the descending model, the contraction would be lighter because the load would keep decreasing in every set. Even though the muscle entered the fatigue period, but the aspect of MVMA would continue to be maintained due to the occurrence of fatigue and recovery.

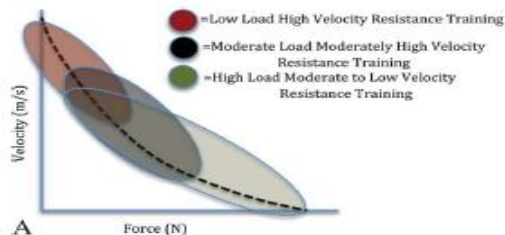


Figure 8. The relationship between muscle force and velocity [7].

Therefore, the body can maintain the MVMA 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. Whereas no significant enhancement on arm muscle strength and leg muscle power was observed. 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 the 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.

Conclusion

In conclusion, there was an effect on the enhancement of strength, power and stability through the total body resistance exercise. TRX was also very effective on the enhancement of arm muscle rather than on the other variables. Furthermore, TRX has become the medium that is simple and easy to do when using one's hands and feet as the support, while the load used was the bodyweight itself.

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