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Relationship between Leg Dynamometer with Squat and Deadlift 1RM Score among University Athletes

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Abstract. This study aimed to investigate the relationship between Leg Dynamometer (LD) with squat and deadlift one repetition maximum (1RM) test scores. Participant of this study involved 50 male university athletes who were recreationally active (aged between 21-25 years old). Participants performed LD and one repetition maximum for squat and deadlift test. The score of LD were tested for relationship with the 1RM squat and deadlift. Pearson correlation were conducted to test the relationship. Results showed that there was a significant correlation at high level ($r = 0.88$, $p = 0.000$, $p < 0.001$) between the LD test score and the squat while a very high correlation was obtained between the LD test score and the deadlift ($r = 0.98$, $p = 0.000$, $p < 0.001$). As the conclusion, LD test that is simple and easy to be conducted produce similar result as the squat and deadlift 1RM test and can be used as a simple assessment of muscular strength among university athletes.

1. Introduction

Muscle strength and endurance are two important components of any physical training program [1-4]. Muscle strength assessment is often carried out in physical fitness testing to determine an individual's force generating ability before any intervention is taken to improve muscle strength and endurance [5, 6]. In measuring muscle strength, the factor of convenience in conducting the test needs to be taken into account [7, 8]. Further steps are needed to compare muscle strength at both the individual and population levels, to assess muscle loss due to disease and to evaluate the benefits of appropriate intervention programs [9]. There have been numerous studies conducted over the past few years on effective physical training to improve muscle strength and endurance [10-12].

Generally, there are two types of commonly used strength testing, one-repetition maximum (1RM) and dynamometry. 1RM refers to the maximal load that can be lifted in one repetition. 1RM usually used as level of effort indicator during a training or exercise [1, 2, 13]. On the other hand, dynamometry requires either isometric or isokinetic contraction [9]. 1RM has been widely used to measure muscular strength [14]. Among the exercises that often been used in muscle strength test and training are squat and deadlift.



Muscle strength assessment is often used in physical assessment to determine if there is a possibility of physical deterioration or in an experimental situation to examine the effects of the intervention. Therefore, it is important to have simple, valid and reliable instruments in order to measure muscle strength [15].

Among athlete, one of the seen problem that bother them when we want to test their muscular strength is the anxiety to perform 1RM test. 1RM is undoubtedly a very demanding task, because it can cause fatigue to the neuromuscular system. Besides that, 1RM test also can take a lot of time to be finished. Thus, an alternative test that is easier and faster should be thought among coaches so that the tests will not bother the athletes' mind and time that will then might affect their training session. Dynamometry tools such as leg dynamometer (LD) are examples of tools that can be used as an alternative tests for testing lower limb muscular strength. LD is a device that can measure the isometric force produced by the muscles of the legs, back and arms. Dynamometry tools are efficient for research and clinical purposes and are often used to validate other strength assessment techniques [15].

However, until now, to the authors' knowledge, published literature on the use of the LD tool as alternative test to squat and deadlift 1RM was scarce. The question right now is that, if the athletes able to perform well in squat and deadlift 1RM, will they also able to perform it during LD strength test? As squat and deadlift movement is thought to be among specific test for physical abilities among athletes, it is the aim of this study to find the relationship between the LD score with squat and deadlift 1RM.

2. Methodology

2.1 Participants

The participant of this study consisted of 50 university male athletes involved in various types of sports (N = 50). The study sample selection was random and all of them had no injuries in the previous one year. Prior to the commencement of the study, informed consent was obtained from all participants. The researchers also reminded the participants that they were allowed to withdraw from the study at any time without giving any specific reason.

2.2 Data Collection

Leg dynamometer (Takei 5402 – Back D, Japan), barbell (Ivanko, USA), weight plates (Ivanko, USA) and bench (Body Solid, USA) were used in the data collection. Strength measurement is performed in a well-equipped physical conditioning laboratory. Prior to the data collection, consent forms were obtained from the participants during a familiarization session. During this session, participants were briefed on the research procedures and also to determine whether they can perform all the exercises with correct technique. Inability to perform the exercises with correct technique will cause the participants to be dropped from the participant list.

Twenty four hours after familiarization session, participants involved in LD test. The LD test was conducted first as this is a simple and less injury-risked test to the participants. To perform the test, the length of the iron chain on this tool will be adjusted according to the height of the participant. The tool holder is placed between the intra-articular spaces of the knee. At the start of the measurement test, participants should stand on the site of the tool with the knees and hips slightly flexed while the back of the body is maintained with appropriate lordotic curves. Then, participants were asked to lift the handle vertically by performing continuous isometric contraction from the lower back of the body, knees and hips. Participants are reminded to gradually increase their effort by gradually reaching the maximum force in three seconds while maintaining the contraction for two seconds. The maximum score of three trials was used for analysis.



Figure 1: Position of Performing LD Test

24 hours after LD test, the participants were tested on their squat and deadlift 1RM. The participants warmed up and stretched well before started the test. In both tests, the researcher used the 1RM test protocol[13], which is the maximum load that can be lifted once with the correct technique. During squat 1RM test, participants had to stand upright with a barbell above the body in the high-bar position. Then the body needs to be slowly lowered until the thighs become paralleled to the floor. Then, the body needs to be raised back to the starting position.

Next, one hour after squat test, participants completed the deadlift 1RM test. Participants started from a half position behind the barbell on the floor with a neutral back. The toes were facing forward and need to have some space (shoulder width) between the legs. Then, the participants held the barbell and need to lift the barbell with their hands stay closed to their body. The ascend phase end when participant has straightened their knees (without lock). Then, the participants reversed their movement for the descend phase until the weight plates touched the floor.

2.3 Statistical Analysis

Descriptive statistics were performed to determine the mean and standard deviation of physical characteristics and test scores. Relationship between LD and 1RM were analysed using Pearson Correlation. All statistical analyses were conducted using Statistical Package for Social Science (SPSS) version 23 (IBM, USA).

3. Results

Table 1 shows the mean and standard deviation of participants' physical characteristics (age, body mass, height) and strength test scores (LD, squat 1RM and deadlift 1RM).

Table 1: Mean and SD of Test

Variables	Mean	SD
Age (years old)	21.38	1.83
Body Mass (kg)	72.35	4.41
Height (cm)	170.82	5.83
Leg Dynamometer (kg)	64.61	8.64
Squat (kg)	99.35	13.74
Deadlift (kg)	110.83	11.94

Table 2 shows the correlation analysis of LD and squat and deadlift 1RM score. The analysis in Table 2 shows a positive correlation ($r = 0.88$) and a significant correlation between LD and squat test score ($p = 0.000$, $p < 0.001$). This means that the LD test score has a strong positive correlation with the squat test score. This result demonstrate that a person who perform well in LD tools will also have high scores in squat 1RM. For the deadlift, the correlation analysis showed that there was a significant relationship between LD and deadlift test score where very high and significant correlation coefficients were obtained ($r = 0.98$, $p = 0.000$, $p < 0.001$). As in squat, this result demonstrates that a person who performs well in LD tools will also have high scores in deadlift 1RM.

Table 2: Correlation Analysis of LD and Deadlift 1RM Score

		SQUAT	Deadlift
LD	Pearson correlation	.877**	.984**
	Sig. (2-tailed)	.000	.000
	N	50	50

** Significant at 0.01 (two-tailed)

4. Discussion

The aim of this study was to determine the relationship between LD and the squat and deadlift 1RM scores as a way to see whether LD tools can be used as an alternative for measuring lower body strength among university athletes. All the movements performed were closely monitored to ensure the results were not affected by other factors especially the techniques on performing the movement. Results of this study showed that LD score was highly correlated with squat and deadlift 1RM.

The high correlation could be contributed by the similar movement position between the tests. Although LD test involved participants performing isometric movement, while 1RM involved isotonic movement, the similar movement position during the start of ascends lifting phase is thought to be the main points to affect the results. Despite lack of studies previously has been done on the effectiveness of LD, the findings of this study were in line with what were found in several studies that showed the effectiveness of hand dynamometer to predict the total body strength [16, 17].

One more contributing factor can be related to the easiness of performing the test. For individuals that already familiar to perform squat and deadlift movement, performing LD test should not be a demanding task. As the movement position during the critical point are the same (starting of ascend lifting phase), the neuromuscular system should already be coordinated in producing the force needed to perform the tasks.

5. Conclusion

As a way to measure lower body strength, as an alternative to the squat and deadlift 1RM test that were demanding and neuromuscular challenging, LD tool can be used due to it been a simple test, and can be conducted in a quick time. Besides, the lightweight of the dynamometer will make it easier to be brought anywhere, whether to be used in a lab or field.

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