COMPARISON OF SHORT TERM LINEAR AND NON-LINEAR STRENGTH TRAINING PROGRAMS ON MUSCLE PERFORMANCE AMONG MALE FOOTBALL PLAYERS

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ABSTRAK

Tujuan kajian ini adalah untuk mengkaji kesan program latihan kekuatan jangka pendek linear dan tidak linear terhadap prestasi otot di kalangan pemain bola sepak lelaki Universiti Teknologi Malaysia (UTM) Skudai. Reka bentuk kajian ini adalah quasi-experimental kerana kajian ini menekankan analisis perubahan min skor prestasi otot selepas empat minggu latihan linear dan tidak linear. Tiga puluh pemain bola sepak lelaki UTM Skudai yang berumur 18-23 tahun terlibat dalam kajian ini. Pembolehubah bebas dalam kajian ini adalah program linear (LST) dan tidak linear (NLST) dan pemboleh ubah bersandar adalah ujian kekuatan maksimum (1RM) bahagian atas badan, ujian kekuatan maksimum (1RM) bahagian bawah badan, 30 meter larian pecut, dan ukur lilit lengan dan peha. Kajian ini menggunakan ujian *Paired Sample T* untuk menganalisis ujian pra dan pasca untuk peserta di dalam kedua-dua kumpulan latihan dan *Multivariate Analysis of Variances* (MANOVA) untuk menganalisis perbezaan antara kumpulan selepas empat minggu latihan. Hasil kajian menunjukkan bahawa tidak terdapat perbezaan min yang ketara antara kumpulan linear dan tidak linear, F (5, 30) = 1.46, p = 0.239. Hasil kajian juga menunjukkan skor min kumpulan tidak linear adalah lebih tinggi daripada kumpulan linear untuk semua ujian yang dilakukan kecuali ukur lilit saiz peha. Secara statistik terdapat perbezaan prestasi otot yang signifikan untuk kedua-dua kumpulan dari pra ke pasca ujian dimana nilai p <0.05. Kedua-dua latihan boleh diaplikasikan sebagai latihan yang dapat meningkatkan prestasi otot dalam kalangan atlet.

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ABSTRACT

The purpose of this study is to investigate the effect of short term linear and non-linear strength training program on muscle performance among male football players at Universiti Teknologi Malaysia (UTM) Skudai. Thirty male football players from UTM Skudai ranging from 18-23 years old were involved in the study. The independent variables in this study are linear (LST) and non-linear (NLST) training program and the dependent variables are 1RM lower body, 1RM upper body, 30 meter sprint, and arm & thigh circumferences. The study used Paired Sample T-test to analyse pre-test and post-test mean score for the participants in both training groups and Multivariate Analysis of Variances (MANOVA) to analyse the mean difference between the groups after 4 weeks of training intervention. The results showed that there is no significant difference in the mean score between group of LST and NLST, F (5, 30) = 1.46, p = 0.239. The results also showed that mean score of NLST group is slightly higher than LST group for all tests implemented except thigh size circumference. There is a statistically significant difference of muscle performance for both groups from pre to post-test where $p < 0.05$. Both training methods can be recommended to improve muscle performance among athletes.

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LIST OF ABBREVIATIONS

ACSM	American College Of Sports Medicine
APRE	Auto-regulatory Progressive Resistance Exercise
DXA	Dual Energy X-Ray Absorptiometry
DNLP	Daily Non-Linear Periodization
FNLP	Flexible Non-Linear Periodization
GAS	General Adaptation Syndrome
LP	Linear Periodization
MANOVA	Multivariate Analysis Of Variance
MRI	Magnetic Resonance Imaging
NLP	Non-Linear Periodization
PAR-Q	Physical Activity Readiness Questionaire
RPE	Rate Perceived Exertion
RLP	Reverse Linear Periodization
SPSS	*Statistical Packages For The Social Science*
UTM	Universiti Teknologi Malaysia

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Football is categorized as an alternating sport modality in which bio-motor element movements are accomplished at a high intensity and short period of time, thus demanding optimum stages of muscular strength, velocity, and power. Considerations for this type of act are reliant on proficient anaerobic system for the recognition of explosive muscle actions (Lopes et al., 2015). Weight-training method is suggested which can increase muscle strength, muscle size, and bone density (Grgic et al., 2017). Greater mobility also can be increased through this type training (Yamamoto et al., 2016). Other than that, enhanced quality of life (Grgic et al., 2017), enhanced resting metabolic rate, and reduction of type-2 diabetes (Grøntved et al., 2012) can be achieved. There are studies examining populations in Australia

and the US which established that 18.6% and 31.7% of adults, respectively, took part in strength training to increase muscle strength (Bennie et al., 2016; Loustalot et al., 2013).

Hypertrophy is believed to be a vital aspect manipulating performance in many fields of sports, mainly in physique sports such as bodybuilding, men's physique and others. Weight training aims to enhance muscle mass and muscular strength so it is an essential aspect of athletes' training programs. Strength training has been used extensively to improve sport performance. According to Monteiro et al. (2009), it has been confirmed that strength training is among the best methods to increase maximum strength, muscular power, jumping movements, velocity of the tennis serve, and running speed or mechanics. According to Caldwell (2004), the system of planning phases or cycles of the training intensity, specificity, and volume alterations in a whole training program is referred to as periodization.

Among the many systems used to enhance sport performance, resistance training is perceived as a productive way to improve muscle performances and encourage increments in top athletes' performances through the competitive period (Chelly et al., 2010; Hermassi et al., 2011). Lopez et al. (2015) specified that the degree of adaptive reactions in an uninterrupted method of training relies on the alteration of acute variables containing intensity, volume, muscle action, choice and order of exercises, rest intervals between sets and exercises, movement velocity, and weekly frequency. Due to the high adaptive capability of the neuromuscular system, training programs need continuous variations in the training load to endorse a constant adaptive reaction. Periodization is a

method regularly led by groups from numerous modalities to achieve specific training objectives and top performance (Gramble, 2006).

Monteiro et al. (2009) also identified that periodic modification in a training load has been stated as a productive method to enhance physiological strain and therefore yield superior growth in muscle strength as compared to a continuous load training model. According to Souza et al. (2014), resistance training is known to persuade specific adaptive muscular and hormonal reactions. They also stated that the degree of neuromuscular adaptation was revealed to be connected to the training volume, relative load, type of exercise, and rest periods between contractions. Spineti et al. (2013) found that periodization of training means the alteration of variables of the physical training separated into reasonable stages. It also has the objectives to execute definite modifications for individual physical performance surge and avoid continuous trainings without recovery.

According to Souza et al. (2014), they specified that such scheduled adjustment of programmed variables is named periodization such as for linear or non-linear programs. Souza et al. (2014) also stated that linear periodization strength training surges progressively in intensity by a minor manipulation to every micro-cycle all two to four weeks. This periodization program is established to achieve ultimate strength in an exact period of time. According to Harries et al. (2015), non-linear periodization involves further regular, daily, weekly, bi-weekly variations of intensity and volume and it commonly exploits repetition of extreme regime to propose exercise intensity. Several

studies attempted to examine the outcome of linear and non-linear periodization on neuromuscular adaptation but the outcome appeared inconsistent.

There are some researchers who recommend linear models as more productive in increasing neuromuscular adaptation as compared to non-linear models, while some other researchers proposed that other models of periodization are more productive than linear ones. In addition, there are several factors that are still deficient in this field of training. The aim of the current study was to investigate the effects of short-term linear and non-linear programs on muscle performance among male football players.

1.2 Problem Statement

The aim of current study was to investigate the influence of short-term linear and non-linear programs on muscle performance among male football players in UTM Skudai. There are numerous studies which have been executed to verify which periodization model is more effective to enhance muscle performance. Some of them revealed that linear is better than non-linear programs. Researchers have found that the periodization of strength training models delivered a positive impact in enhancing neuromuscular adaptation among athletes. There are, however, several issues that are still deficient in this field of study.

Short-term duration interventions for both periodization models in enhancing athletes' performances is still lacking in this field. According to Souza et al. (2014), recognizing which training program produces better effects in muscle strength and size in a short-period intervention will be beneficial for those in the sports business. Forthcoming research would deliver extra evidence regarding the effects of pre-season short-term interventions of different periodization models toward neuromuscular adaptations (Lopes et al., 2015). According to Harries et al. (2014), previous studies investigated exclusively the 1-Repetition Maximum (1RM) of either the upper or lower body, and that there was no strong mark preferring any periodization method for the expansion of the lower or upper body strength.

Other than that, there was conflicting evidence between the periodization models in improving neuromuscular adaptation among athletes (Simao et al., 2012). A few studies indicated that linear periodization brought substantial enhancement in muscle performance while others stated the effects of the non-linear model were dominant. The present empirical evidence delivers visions about the frequency of training (Schoenfeld, Ogborn&Krieger, 2016), volume (Schoenfeld, Ogborn& Krieger, 2017), recovery intervals, and repetition series (Schoenfeld et al., 2016). Regardless of these evidence-based general suggestions for inventing a training program for muscle hypertrophy, there is a scarcity of evidence about different periodization approaches.

According to Mattocks et al. (2016), many resistance training protocols apply a few methods of periodization, but it is still unclear whether the efficiency of periodization

is primarily associated with the principle of specificity or more determined by the changing structure of the training protocols and the modifications in the volume of training (Grgic et al., 2017). Thus, the current study sought to investigate the effectiveness of short-term linear and non-linear programs on the muscle performance among male football players.

1.3 Purpose of the Study

The purpose of this study was to investigate the effects of short-term linear to non-linear strength training programs on muscle performance among male football players in UTM Skudai.

1.4 Research Objectives

i. To analyze the effectiveness of linear strength training programs on muscle performance.

ii. To analyze the effectiveness of non-linear strength training programs on muscle performance.

iii. To compare the effectiveness of linear to non-linear programs on muscle performance.

1.5 Hypotheses

i. H_a: There is significant improvement of linear strength training group from pre to post test.

ii. H_a: There is significant improvement of non-linear strength training group from pre to post test

iii. H_o: There are no significant differences between linear and non-linear strength training groups after 4 weeks intervention.

1.6 Significance of the Study

The current study was carried out to examine the influence of short-term linear and non-linear programs on the muscle performance of male football players. The outcome of the study would provide valuable information to coaches and athletes in order to enhance performance in many kinds of sports they participate in that include upper and lower body strength, agility, and speed. The information provided through this study can be used by the sport scientists to enhance sport performances among trained and untrained athletes. With the information, they can apply suitable programs to increase speed, maximal power, and maximal strength. Empirical findings on which type of program will boost athlete performance would be obtained. Furthermore, it will contribute to a lot of benefits for future researchers who are interested in exploring further the effectiveness of linear and non-linear periodization models.

1.7 Limitations of the Study

The current study highlights the most effective short-term strength training model in improving muscle performance among the population of male football players in UTM Skudai whose age ranged from 18-23 years old. Other than that, external features such as dietary intake and activity level might diminish the energy used during training and also affect the outcome of the study. Athletes might have been unable to join all of the training sessions conducted by the researcher due to other training sessions that had been planned by their coaches. A player might have been exposed to or involved in an injury during the training sessions. The training conducted by the researcher had to be executed outside of the required training session due to limitations to equipment or tools. The study used Paired Sample T-Test to evaluate the pre-test and post-test of the participants in both groups after four weeks of intervention. Meanwhile, MANOVA is used to compare the mean differences between both groups.

1.8 Delimitations of the Study

i. The participants of the study were 18-23 year old male football athletes from UTM Skudai.

ii. The training sessions were executed 4 times a week.

iii. The researcher used bench press 1RM for upper body strength and back squat 1RM for lower body strength, arm and thigh circumferences, and 30-meter sprint for speed in order to evaluate the performances of the athletes.

iv. The researcher did not execute the testing during bad weather condition.

v. Athletes who were experiencing chronic and bad injury were excluded from the study.

1.9 Operational Definitions

i. *Periodization*: It is the alteration of the methodological variables of the physical training divided into logical phases and has the aim to perform specific adjustments for physical performance increase and prevention of overtraining. The coaches used it in order to achieved peak performance at the right time (Spineti et al., 2013).

ii. *Non-linear periodization*: It is described as more frequent, either daily, weekly, or bi-weekly variation of intensity and volume and generally utilizes repetition of maximum zones to prescribe exercise intensity. Non-linear program can be used to the person or team who need more variety to comply with the training protocol (Harries et al., 2015).

iii. *Linear periodization*: It is done by gradually increasing the intensity with a slight alteration to each micro-cycle every 2 to 4 weeks. Linear training program provide a greater benefit to the individuals or teams who have a courtesy to track progress on a week to week or a month to month basis (Souza et al., 2010).

iv. *Football*: It is characterized as having an intermittent sport modality in which bio-motor determinant actions are performed at a high intensity and short duration requiring high levels of strength, velocity, and power (Lopes et al., 2015).

v. *Strength training:* Strength training is a form of physical conditioning that can increase force, muscular strength and power (Edwards, 2012). Strength training is applied by many team sports in order to enhance an athlete's ability to yield or pledge the strength (Ignjatovic et al., 2007).

vi. *Muscle performance***:** refer to the capability of muscle or group of muscles to create forces to yield, preserve, endure, and alter poses and movements that are essential to functional action (Simao et al., 2012). Weight-training method is suggested which can increase muscle strength, muscle size, and bone density (Grgic et al., 2017).

vii. *One repetition maximum:* defined as the maximum amount of load that can be lifted by a person for only one repetition. This type of test was used in order to measure lower and upper body maximum strength of an athlete. Taylor and Fletcher (2012).

1.10 Assumptions

There were five vital assumptions for the current study. First, the two groups of training will enhance neuromuscular adaptation of football players. Second, the non-linear

program is more effective in improving muscle performance as compared to the linear program. Third, the weight training session is more difficult to execute if there is limitation to the equipment. Fourth, athlete injury will have bad effects on the data analysis, so the researcher must eliminate injured participants from the study. Lastly, the participants will give full commitment and show enthusiasm in the intervention conducted by the researcher.