THE EFFECTS OF VERTICAL VERSUS HORIZONTAL BASED STRENGTH TRAINING ON MUSCLE ACTIVATION, KINEMATICS AND KINETICS OUTPUT IN RELATION WITH THE METHOD OF INSTRUCTIONS GIVEN

ROSHDAN BIN AHMAD

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ROSHDAN BIN AHMAD

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

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23th August 2021

Date

Dr. Nur Ikhwan Bin Mohamad
Profesor Madya,
Fakulti Sains Sukan dan Kejurulatihan,
Universiti Pendidikan Sultan Idris,
35900 Tanjung Malim, Perak
Email : nur.ikhwan@fsskj.upsi.edu.my

Signature of the Supervisor

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APPRECIATION

Alhamdulillah, with ALLAH's permission this dissertation was successfully completed. In order to conduct research, data collection and processing and analysis of research data has received direct and indirect assistance from the following individuals; Associate Professor Dr. Nur Ihkwan Mohamad, Supervisor of the dissertation who provided a lot of guidance and advice, co-supervisor Dr Thariq Khan Bin Azizuddin Khan, fellow lecturers of the Faculty of Sports Science and Coaching who have provided direct and indirect assistance throughout the study process. Not forgetting the whole family, Bonda, wife and children who always give support, love and most importantly is the infinite spirit and encouragement to this self.

ABSTRACT

This study was conducted to investigate the effectiveness of vertical versus horizontal based training on muscle activation, kinematics and kinetics output in relation to instructional delivery methods. A total of 30 recreationally active male participants aged between 19-29 years old were recruited for the purpose of this study. All participants went through 8 weeks of vertical and horizontal training based on two instructional methods (verbal and video). Pre and post tests were conducted. Electromyography (EMG) was used to measure muscle activation, force platform was used to measure kinetics output, and high-speed motion analysis system was used to measure kinematics variables. MANOVA was used to determine significant differences in muscle activation, kinematic output and kinetic output for both groups of instruction, verbal and video methods in pre- and post-test, One way ANCOVA was used to compare the effectiveness of strength training using the vertical (lunges) and horizontal (squat) to the kinematic output, kinetic output and muscle activation between verbal and video instruction groups, with Pearson Product Moment was used to determine relationship between variables. The results of the study found that there were no significant difference for both groups in the pre-test and post-test, except for biceps femoris muscle activation and ankle kinematics during the lunge and squat. Based on percentage of differences, verbal mode of instruction was better than video mode of instruction. In conclusion, result of this study indicated that mode of instructions given in not much different between each other, as long as the instructions able to ensure accurate mechanical performance For future studies, it is suggested to look further on the focus of each of the instructions from mechanical point on participants from various skill's level background.

KESAN LATIHAN KEKUATAN BERTERASKAN VERTIKAL LAWAN HORIZONTAL TERHADAP AKTIVITI OTOT, PENGHASILAN KINEMATIK DAN KINETIK SERTA KAITANNYA DENGAN KAEDAH PEMBERIAN ARAHAN

ABSTRAK

Kajian ini dijalankan untuk mebgkaji keberkesanan latihan vertical berbanding horizontal dari segi aktiviti otot, penghasilan kinematik dan kinetik serta kaitannya dengan kaedah pemberian arahan. Seramai 30 orang peserta lelaki yang aktif secara rekreasi berusia antara 19-29 tahun telah direkrut bagi tujuan kajian ini. Semua peserta melalui 8 minggu latihan vertical dan horizontal berdasarkan dua kaedah pemberian arahan (verbal dan video). Ujian pra dan pasca telah dijalankan. Electromyography (EMG) telah digunakan untuk mengukur aktiviti otot, pelantar daya telah digunakan untuk mengukur penghasilan kinetik dan sistam analisa pergerakan berhalaju tinggi telah digunakan untuk mengukur pembolehubah kinematik. MANOVA telah digunakan untuk menentukan perbezaan signifikan di antara aktiviti otot, penghasilan kinematik dan kinetik serta untuk kedua-dua kumpulan kaedah pemberian arahan bagi pra dan pasca ujian. ANCOVA sehala telah digunakan untuk membandingkan keberkesanan latihan kekuatan menggunakan kaedah vertical (squat) dan horizontal (lunges) dengan *Pearson Product Moment* telah digunakan untuk menentukan perkaitan antara pembolehubah. Daatan kajian ini menunjukkan tiada perbezaan signifikan bagi kedua-dua kumpulan dalam pra dan pasca ujian, kecuali bagi aktiviti otot biceps femoris dan kinematik buku lali. Berdasarkan peratus perbezaan, kaedah pemberian arahan verbal lebih baik berbanding kaedah pemberian arahan menggunakan video. Kesimpulannya, dapatan kajian ini menunjukkan jenis kaedah pemberian arahan tidak banyak berbeza antara satu kaedah dengan kaedah yang lain, selagi mana arahan tersebut dapat memastikan penghasilan lakuan mekanikal yang tepat. Bagi kajian masa hadapan, adalah dicadangkan untuk melihat dengan lebih lanjut fokus setiap bentuk arahan dari sudut mekanikal pada peserta yang datang dari pelbagai latarbelakang tahap kemahiran.

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LIST OF ABBREVIATIONS

ANCOVA	Analysis of Covariance
BF	Biceps Femoris Muscle
EMG	Electromyography
GL	Gastrocnemius Lateralis Muscle
GM	Gastrocnemius Medialis Muscle
MANOVA	Multivariate Analysis of Variance
SPSS	Statistical Packages For The Social Science
VL	Vastus Lateralis Muscle
VM	Vastus Medialis Muscle

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Strength and conditioning training program relies on types of exercise given to produce the desired physiological (Kraemer, Fleck, & Evans, 1996) and biomechanical (Hakkinen et al., 1996) adaptations. The adaptations (neurological and/or morphological) on the other hands are dependable on the types of stimulus given during the training (Folland & Williams, 2007; Mohamad, Cronin, & Nosaka, 2012). The stimulus given are closely related to the manipulation of strength training variables used, mechanical characteristics of the exercise given and ability of the exercise to transfer the desired adaptation into specific movement, specific to the types of sports involved (Swinton, Stewart, Agouris, Keogh, & Lloyd, 2011; Wernbom, Augustsson, & Thomee, 2007). Based on these facts, choosing the right exercise for the right adaptations has become one of the utmost important task that need to be properly

addressed by strength and conditioning practitioners and sports scientist alike. While types of exercise seem to be the determining factor in specific movement adaptations, the way the technique of the exercise being given to the athletes has been said to also play a vital role.

Excellent communications typically being said as one of the indicators of a good sports coach. However, the way the communication being done seems more important when in involves technical instructions, such as exercise technique instructions. Due to this, proper methods of instruction might need to be addressing first prior delivering certain new exercise technique to the athletes. Demonstration and verbal instruction are two methods that can help to provide information to help individuals perform a motor movement effectively (Filipa, Byrnes, Paterno, Myer, & Hewett, 2010; Marchant, 2011). Verbal instruction is verbal communications to others on how to perform motor skills. Demonstrations give advantages in conveying information about how to perform a skill with similar act being shown to the receiver. Demonstration of a movement can use live model or model that are recorded and shown through a video, in which case, the model will show the proper technique to perform the movement. These two methods of instruction can either be used independently to each other or in combination of both. No matter what, both will have an effect on exercise technique performed by athletes (Porter, Ostrowski, Nolan, & Wu, 2010; Snyder & Fry, 2012). It is important to be noted that slight changes in exercise technique is known to also change the mechanical properties of the movement (Crewther, Cronin, & Keogh, 2008; Milner, Fairbrother, Srivatsan, & Zhang, 2012).

For the purpose of peak sports performance, most of the time the aim is on producing the peak output from each mechanical movement of the performer. Mechanical properties of movement which produce kinetics output is actually influenced by muscle architecture that produces the movement (Lichtwark, Bougoulias, & Wilson, 2007; Lichtwark & Wilson, 2008). Two types of muscle architecture properties that determine kinetics output are muscle fascicle length and muscle fascicle pennation angle (Cormie, McGuigan, & Newton, 2011; Earp et al., 2011; Lee & Piazza, 2009). Moreover, activation of the appropriate muscle in order to produce kinetics output for intended movement is determined by appropriate movement technique being executed (Garcia-Vaquero, Moreside, Brontons-Gil, Peco-Gonzalez, & Vera-Garcia, 2012; Gorsuch et al., 2013). Thus, the most accurate ways to determine proper movement execution is by assessing which muscles has been activated and how much (Vera-Garcia, Moreside, & McGill, 2011). Both muscle architecture and muscle activation rate will then determine kinetics output of the movement (Arnold, Hamner, Seth, Millard, & Delp, 2013; Chauhan, Hamzeh, & Cuesta-Vargas, 2013; Guilhem, Cornu, & Guavel, 2011).

1.2 Problem Statement

Moving further in-depth into specificity of training, the transfer of effect of training onto actual sports performance requires the movement of strength exercises to be quite similar to actual movement on field or on track (Buchheit, Mendez-Villanueva, Delhomel, Brughelli, & Ahmaidi, 2010; Lockie, Murphy, Schultz, Knight, & Janse de Jonge, 2012). Most sporting movement requires running and sprinting. Both involve

more on ability to generate horizontal forces (kinetic output) rather than vertical forces alone (Lockie, Murphy, Schultz, Jeffriess, & Callaghan, 2013; Morin, Edouard, & Samozino, 2011). Due to this the questions arise, whether typically used vertical based strength training exercises such as squat, deadlift, and counter movement jump (for example) will produce similar effect on muscle architecture, muscle activation and kinetics output to horizontal types of movement or not. Studies have shown that vertical based strength training do have positive correlations to sprinting ability (horizontal movement), however the study do not really compare vertical versus horizontal based strength training per se (Requena, Garcia, Requena, Saez-Saez de Villarreal, & Cronin, 2011). Instead, the comparison was actually just between two types of vertical exercises effect on horizontal performance.

Based on all information provided above, this study were focus in investigations on two most important facts. The first was assessing and exploring the most appropriate way exercise technique instructions should be given, and second to this (which is the key investigation) was to investigate the effect of vertical and horizontal based strength training on muscle activation, kinematic output and kinetics output.

1.3 Purpose of Study

a) To determine the effects of method of instruction given (verbal instruction vs video instruction) on muscle activation, kinematic output and kinetic output during vertical and horizontal based strength training.

b) To determine the relationship between kinematics output and muscles activation among the method of instruction given groups (verbal instruction vs video instruction) during vertical and horizontal based strength training.

c) To determine the relationship between kinematics output and kinetics output among the method of instruction given groups (verbal instruction vs video instruction) during vertical and horizontal based strength training.

d) To determine the effects of vertical and horizontal based strength training muscle activation, kinematic output and kinetic output.

e) To compare the effects between vertical and horizontal based strength training on muscle activation, kinematic output and kinetic output.

1.4 Research Question

The study addressed the following questions:

1.4.1 Are there any significant differences effects of vertical based strength training on muscle activation, kinematic output and kinetic output for verbal instruction groups during the pre-test and post-test.

1.4.2 Are there any significant differences effects of vertical based strength training on muscle activation, kinematic output and kinetic output for video instruction groups during the pre-test and post-test.

1.4.3 Are there any significant differences effects of horizontal based strength training on muscle activation, kinematic output and kinetic output for verbal instruction groups during the pre-test and post-test.

1.4.4 Are there any significant differences effects of horizontal based strength training on muscle activation, kinematic output and kinetic output for video instruction groups during the pre-test and post-test.

1.4.5 What are the significant differences between the two methods of instructions given (verbal instruction vs. video instruction) on muscle activation, kinematic output and kinetic output during vertical and horizontal based strength training?

1.4.6 What are the significant correlations between kinematics output and muscle activation among the two methods of instruction given (verbal instruction vs. video instruction) during vertical and horizontal based strength training?

1.4.7 What is the effect of vertical and horizontal based strength training on muscle activation, kinematic output and kinetic output?

1.4.8 What are the significant differences between vertical and horizontal based strength training effect on muscle activation, kinematic output and kinetic output?

1.4.9 What are the significant correlations between kinematics output and kinetics output among the two methods of instruction given (verbal instruction vs. video instruction) during vertical and horizontal based strength training?

1.5 Limitation of study

This study was limited by:

1.5.1 Limitations

Limitation of this study are related to the muscle groups that are focused during producing a vertical and horizontal movement of are biceps femoris, gastocnemius letaralis, gastrocnemius medialis, vastus letaralis and vastus medialis, the methods of instruction used verbal and video to motivated to perform training sessions and the test session. Finally the participants age are between 19 to 25 years old.

1.5.2 Delimitations

The delimitation of this study are related to the muscles activation recorded by EMG during vertical and horizontal based strength training, the kinematic output recorded by Vicon camera, the kinetic output result recorded by force platform during vertical and horizontal based strength training, finally the participants perform vertical and horizontal based strength training activities.

1.6 Operational Definitions

a) Kinetic output

Kinetic output refers to the force produced as a result of a motion. The kinetics data that were measured in this study was the ground reaction forces. It was referring to the highest force reading before the take-off after the participants performed the vertical and horizontal movement.

b) Kinematic output

Kinematic output refers to the quality of motion perform by person according the activities need to be performed. The kinematics data that were measured in this study were the time taken for the participants to complete the movement consists of the descent, ascent and full movement of lunges and squat and the joint angle of the ankle, knee and hip during the maximum descent phase.

c) Muscle activation

Muscle activation refers to electrical activity of a muscle or group of muscles as a result of motion. The muscle activation data that were measured in this study were the average muscle activity of; i) bicep femoris (BF), ii) gastrocnemius lateralis (GL), iii) gastrocnemius medialis (GM), iv) vastus lateralis (VL) and v) vastus medialis (VM).

d) Instructional method

Instruction refers to the form of communication used to perform a motion. For this study, the instructions are referring to the verbal instruction and video instruction.

e) Verbal instruction

Verbal instructions are the words or short phrase which directed a learner's attention to a particular aspect of skill performance or of environmental factors that influenced skill performance. Verbal instruction used in this study were in the form of instructions to perform squats and lunges movements in strength training.

f) Video instruction

Video instructions are the form of delivery using model to deliver information about the actions of a behavior. Demonstration form used in this study is to perform squats and lunges movements with correct technique in strength training.

1.7 Significance of Study

This study was conducted by exploring mainly two important areas in sports science disciplines; training methods and motor learning. Exploration of these two areas will provide information on how the two methods of strength training (vertical based and horizontal based) along with instruction methods used (verbal instructions and non-verbal-demonstration) will optimized the training effect and adaptation. Strength training regime for sports performance requires the adaptation or effect of training should be specific to the sports. Movement in sports occurs in many planes, in which exercise that being used also act similarly. Thus, the most logical thinking is that the prescribed exercise should always implement similar movement planes to the sports specific movement. Of course, in sports all planes typically occur during the play; however, the concern is on the main movement plane that being used. In running for

example, the movement occurs horizontally, and thus, horizontal force output seems more important.

From another point of view, effectiveness of exercise also influences by the ability of the performer to perform the exercise in a technically sound manner. Exercise technique mainly determined by the instructions received by the performer from the instructor. Due to this, investigating the most appropriate method of instructions given, in the opinion of the researcher, should be done first. Therefore, the significance of this study was to determine either vertical or horizontal based strength training will most influence the muscle architecture, muscle activation and kinetic output. In addition, this research finding will help coaches or trainers choose the proper strength training according to specific sports. Moreover, this finding also will determine the precision method of instructions given used in strength training to enhance muscle architecture, muscle activation and kinetic output.