THE EFFECTS OF VERTICAL VERSUS HORIZONTAL BASED STRENGTH TRAINING ON MUSCLE ACTIVATION, KINEMATIC OUTPUT AND KINETIC OUTPUT AND THE RELATIONSHIPS WITH THE METHOD OF INSTRUCTIONS GIVEN

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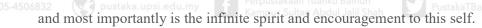## SULTAN IDRIS EDUCATION UNIVERSITY
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APPRECIATION

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 training on muscle activation, output kinematics and output kinetics and their relationship to instructional delivery methods. Therefore, a total of 30 recreationally active male participants aged between 19-29 years old were recruited for the purpose of this study. In the first week all participants underwent pre-test as base line, then study participants were divided into verbal instruction group and video instruction group. All participants went through the phase of vertical and horizontal training based on training training based on the instruction method that has been set for 8 weeks. After that, a post-test was conducted. Mega Electronics Wireless Bioamplifier 16 channel EMG System by DELSYS TRIGNO has been used to measure muscle activation, 6 Axis force platform Model AMTI BP400600HF to measure output kinetics, and Vicon T10s are used to measure output kinematics. 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, and Correlation analysis method used in this study was Pearson product moment to look at the relationship between variables on lunges and squat activity for verbal instruction groups and video instruction group. An alpha level of 0.05 was used for statistical significance in all normally distributed data. The results of the study found that there was no significant difference for both groups in the pre-test and post-test. Comparison between groups; for muscle activation only BF during lunges activity showed significant differences, kinematic output only ankle angle for lunges and squat, while kinetic output can be significant differences. As for the percentage of change, for the verbal activation of the verbal group is better than the video group, the kinematics of the output, both groups show significant permeability. In conclusion, the findings of this study indicate the role of instructional methods on muscle activation, output kinematics and output kinetics even with significantly less clarity. This is due to the possibility that the almost identical level of physical ability of the study participants produced such findings. For further study, manipulating the body mechanical among the participants, less focus on the smooth muscle among the participants, and the study of how muscle activation during the learning of a particular skill or movement.

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ABSTRAK

Kajian ini dijalankan untuk menyiasat keberkesanan vertical versus horizontal based strenght training ke atas aktivasi otot, kinematik output dan kinetik output dan hubungan dengan kaedah penyampain arahan. Untuk itu, seramai 30 peserta lelaki yang aktif berumur antara 19-29 tahun telah dipilih untuk tujuan kajian ini. Pada minggu pertama semua peserta telah menjalani ujian pra sebagai base line, kemudian peserta kajian telah dibahagikan kepada kumpulan arahan verbal dan kumpulan arahan video. Semua peserta melalui fasa intervensi latihan vertical dan horizontal based strenght training berdasarkan kaedah arahan yang telah ditetapkan selama 8 minggu. Setelah itu, ujian pasca dijalankan. *Mega Electronics Wireless Bioamplifier 16 channel EMG System by DELSYS TRIGNO* telah digunakan untuk mengukur aktivasi otot, *6 Axis force platform Model AMTI BP400600HF* untuk mengukur kinetik output, dan *Vicon T10s* digunakan untuk mengukur kinematik output. MANOVA telah digunakan untuk menentukan perbezaaan yang signifikan dalam aktivasi otot, ouput kinematik dan ouput kinetik kepada kedua-dua kumpulan kaedah arahan, verbal and video dalam ujian pra dan ujian pasca, ANCOVA sehala digunkan untuk membanding compare keberkesanan latihan kekuatan secara vertikal (*lunges*) dan horizontal (*squat*) kepada output kinematik dan output kinetik di anata kumplan arahan verbal dan video, dan analisis korelasi yang diaguanakan dalam kajian ini ialah Pearson product moment untuk melihat hubungan di antara pembolehubah aktiviti *lunges* dan *squat* bagi kumpulan arahan verbal dan video. Nilai alpha 0.05 digunakan bagi tahap signifikan. Keputusan kajian mendapati, tiada perbezaan yang signifikan bagi kedua-dua kumpulan dalam ujian pra dan ujian pasca. Perbandingan antara kumpulan; bagi aktivasi otot hanya Biceps Femoris (BF) semasa aktiviti lunges sahaja yang menunjukkan perbezaan yang signifikan, kinematik output hanya ankle angle bagi lunges dan squat, sementara kinetik output tiasa perbezaan signifikan. Bagi peratus perubahan, bagi aktivasi otot kumpulan verbal lebih baikberbanding kumpulan video, kinemaik output, kedua-dua kumpulan menunjukkan peruhana yang signifikan. kesimpulannya, dapatan kajian ini menunjukkan peranan kaedah arahan ke atas aktivasi otot, output kinematik dan output kinetik walaupun dengan signifikan yang kurang jelas. Ini berlaku kerana kemungkinan tahap keupayaan fizikal peserta kajian yang hampir serupa menghasilkan dapatan yang sebegitu rupa. Untuk kajian seterusnya, memanipulasi body mechaninal dalam kalangan peserta, kurang fokus kepada otot yang sepesik dalam kalangan peserta, dan kajian tentang bagaimana aktivasi otot semasa pembelajaran sesuatu kemahiran atau pergerakan fizikal.

CONTENT

instruction given (verbal instruction vs. video instruction) during vertical & horizontal based strength training?

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LIST OF ABBREVIATIONS

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

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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.