



**Faculty of Mechanical and Manufacturing Engineering
Technology**

**THE STUDY OF MUSCLE FATIGUE ON WRIST AND LOWER
BACK IN GYM ACTIVITIES USING ELECTROMYOGRAPHY (EMG)**

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Tajuk: THE STUDY OF MUSCLE FATIGUE ON WRIST AND LOWER BACK IN GYM ACTIVITIES USING ELECTROMYOGRAPHY (EMG)

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering Technology (Product Design) with Honours. The member of the supervisory is as follow:

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DEDICATION

This project dedicates to my beloved parents, Lin Kee Yong and See Nyet Yuen, who gave me unconditional love since and raise me to become the person I am today. They always encourage me mentally, physically, and spiritually to keep moving throughout the process and inspire me to break the border of true limitation and reach for my definite set of purpose. Through their guidance and support, I am confident with doing anything I put in my mind. Thank you for everything.

ABSTRACT

Surface Electromyography (sEMG) is a measure of the electrical potential caused by muscle contraction through the human skin. It also allows the study of dynamic muscle activity, which can apply to bio-mechanical motion analysis, muscle fatigue research, sport or exercise performance and application in work medicine and ergonomics. Nowadays, weight training is one of the most popular exercise in the gym. Weight training can be divided into three categories, which are free weight, body weight and machine weight. However, wrist pain and lower back pain are the common problem for the weight-related exercises. What types of weight training will cause more muscle fatigue on the wrist and lower back muscles? Does the BMI category and gender also affect muscle fatigue during weight lifting exercises? The objective of this study is to determine, analyze and compare the muscle fatigue on the wrist and lower back in the push-up, barbell bench press and Smith machine bench press exercises at the gym. The EMG signals were collected from the wrist (extensor carpi ulnaris muscles, ECU) and lower back (multifidus muscles). There are 9 resistance-trained males and 9 resistance-trained females are volunteer for this study. Every participant was required to perform the push-up, barbell bench press, and Smith machine bench press exercises orderly at the UTeM gym. Participants must be in the ready posture before the EMG signals began to record using DELSYS® Trigno & EMGworks equipment. Ten repetitions (10 RM) occurred for each exercise at the same rate. A minimum of 3 minutes of rest occurred between exercises for each participant. Next, the collected EMG signal will be analyzed using DELSYS® EMGworks software. The root mean square (RMS) is the time domain that used in feature extraction. The extracted feature will be displayed in the bar chart form at the end of the study. Furthermore, the comparisons among three different types of weightlifting exercise, genders and subject BMI category for both extensor carpi ulnaris (ECU) and multifidus muscles also will be discussed in this study. As overall results, the underweight and normal weight subjects have the highest risk of fatigue on ECU and multifidus muscles in the free-weight bench press exercise; the lowest risk of fatigue on ECU and multifidus muscles in the body-weight push-up exercise. While, the over weight subjects have the highest risk of fatigue on ECU and multifidus muscles in the body-weight push-up exercise; the lowest risk of fatigue on ECU and multifidus muscles in the Machined-weight bench press exercise.

ABSTRAK

Electromyography Surface (sEMG) adalah ukuran potensi elektrik yang disebabkan oleh penguncupan otot melalui kulit manusia. Ia juga membolehkan kajian aktiviti otot dinamik, yang boleh digunakan untuk analisis gerakan bio-mekanikal, penyelidikan keletihan otot, sukan atau prestasi senaman dan aplikasi dalam perubatan kerja dan ergonomik. Kini, latihan berat adalah salah satu latihan yang paling popular di gym. Latihan berat boleh dibahagikan kepada tiga kategori, iaitu berat badan, berat alatan dan berat mesin. Walau bagaimanapun, kesakitan pergelangan tangan dan kesakitan belakang adalah masalah biasa untuk latihan-latihan yang berkaitan dengan berat. Apakah jenis latihan berat badan yang akan menyebabkan lebih banyak keletihan otot pada pergelangan tangan dan belakang? Adakah kategori BMI dan jantina juga menjejaskan keletihan otot semasa latihan angkat berat? Objektif kajian ini adalah untuk menentukan, menganalisis dan membandingkan keletihan otot pada pergelangan tangan dan bahagian bawah belakang di *push-up*, tekan bangku barbell dan Smith mesin bangku di gym. Isyarat EMG dikumpulkan dari otot *extensor carpi ulnaris (ECU)* dan otot *multifidus* yang boleh menyebabkan kesakitan pergelangan tangan dan kesakitan belakang. Terdapat 9 lelaki dan 9 wanita yang dilatih rintangan adalah sukarela untuk kajian ini. Setiap peserta dikehendaki melakukan tekan tubi, tekan bangku barbell, dan Smith mesin bangku latihan secara teratur di gym UTeM. Para peserta mestilah menyiapkan dalam postur yang ditentukan sebelum isyarat EMG mula direkod dengan menggunakan peralatan *DELSYS® Trigno & EMGworks*. Sepuluh kali pengulangan (10 RM) berlaku untuk setiap latihan dengan kadar yang sama. Sekurang-kurangnya 3 minit untuk berehat antara latihan untuk setiap peserta. Seterusnya, isyarat EMG yang dikumpulkan akan dianalisis dengan menggunakan perisian *EMSworks DELSYS*. *Root mean square (RMS)* adalah domain waktu yang digunakan dalam pengekstrakan ciri. Ciri yang diekstrak akan dipaparkan dalam bentuk carta bar pada akhir kajian. Sebagai keputusan keseluruhan, subjek-subjek yang kurang berat dan normal berat mempunyai risiko keletihan tertinggi pada otot ECU dan multifidus dalam latihan berat alatan (tekan bangku barbell); risiko keletihan paling rendah pada otot ECU dan multifidus dalam latihan berat badan (*push-up*). Walaupun, subjek yang lebih berat mempunyai risiko keletihan tertinggi pada otot ECU dan multifidus dalam latihan berat badan (*push-up*); risiko paling rendah keletihan pada otot ECU dan multifidus dalam latihan berat machine (Smith mesin bangku).

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LIST OF SYMBOLS

s	-	Seconds
V	-	Volts

LIST OF ABBREVIATIONS

MSDs	Musculoskeletal Disorders
LBP	Lower Back Pain
EMG	Electromyography
sEMG	Surface Electromyography
RMS	Root Mean Square
ECU	Extensor Carpi Ulnaris muscle
BMI	Body Mass Index

CHAPTER 1

INTRODUCTION

1.1 Introduction

In this chapter, it will provide information about the research background, problem statement, and research objectives. The scope of the study is explained in this chapter. The expected results of this study are also described in the last of the chapter.

1.2 Background

A gym is a gymnasium, also known as health club and fitness centre. The gymnasium is a large room with equipment for exercising the body and increasing strength or staying healthy. Today, most of the people went to the gym for increasing their body strength through certain types of exercise, especially resistance exercise. Resistance training is an exercise that increases muscle strength and endurance. During resistance training exercises, limbs need to against the resistance provided by the body weight, gravity, weighted bar or dumbbell. Some exercise machines can also be used for resistance training. People who take this type of training can usually perform activities of daily living more easily because their muscle activity is more efficient.

Weight training can strengthen muscles and increase muscle mass by placing stress on the skeletal muscle that against external resistance sources. In most cases, the wrist is a common victim of weight-related stress. Every lifting requires two-handed gripping which will put pressure on the wrist. In order to avoid wrist pain during weight

lifting, it is necessary to recover from trauma and injuries, as well as to improve lifting technique and habits. Otherwise, apply a brace or splint may help to keep the wrist in neutral position but can limit physical activity.

Furthermore, lower back pain is also one of the most common problems that gymnasts deal with during weight training. Weightlifters always have sprained and strained back muscles issues after the training. This is because, some of them twist their spine while lifting, or use poor postures and sudden movements to lift a heavy object. This may indirectly create an excessive pressure on the lumbar and cause back injuries.

Currently, some of the researchers focus on the integration of biological components with electrical and mechanical. Biosignal is signal that generated by the human body which can produce useful information from living organisms. There are some types of bioelectrical signals that are widely used in medical applications, such as electroencephalography (EEG), electromyography (EMG), and electrocardiogram (ECG). Each of these bioelectric signals has different applications and purposes. Due to the development of biomedical and healthcare applications, there are several methods that can be used to monitor muscle status. One of them is through the use of electromyography (EMG). People today work harder to improve their performance in order to improve their life quality. However, they only pay attention on physical condition to assess their health status and ignore their muscle condition.

In the past two decades, many researchers have proposed many methods and investigations for the diagnosis of wrist and back pain in various sports activities through the EMG application, especially weight lifting related exercises. Moreover, several studies in these recent years have focused more on muscle activation of the upper body (pectoralis major and triceps brachii) during weight training such as push-up, bench press, barbell, and

dumbbell. But there have no any researchers compared or found out whether it is free weight training, body weight training or machine weight training can more affect wrist and lower back muscle fatigue. Will body weight cause more muscle fatigue or equipment weight during the training?

This study will pay more attention to weight training muscle fatigue index and determine which type of these weight training will more affect the wrist and lower back pain according to the genders and BMI categories. Additionally, the comparison of the muscle condition of the wrist and lower back between the free weight (barbell), body weight (push up) and machine weight (smith machine barbell) also will be performed by using electromyography (EMG).

1.3 Objective

- i. To determine the muscle fatigue of the wrist and lower back at three different types of weight training (Body Weight: push up; Free Weight: barbell bench press and Machine Weight: smith machine bench press) in the gym by using electromyography (EMG).
- ii. To analyse the muscle fatigue of wrist and lower back in these three different types of weight training for both genders according to BMI category.
- iii. To compare the level of muscle fatigue of wrist and lower back in these three different types of weight training for both genders according to BMI category.

1.4 Problem Statement

In fact, back pain after weight lifting is common to every weightlifter. Back pain is most often caused by poor posture or technique (Lucas et. al., 2016). The wrist pain