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# Estimation and Analysis of Muscle Fatigue due to different Work Patterns—A Critical Review

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***Abstract***—Fatigue is the important cause for Vehicle accidents. Muscle Fatigue is the temporary reduction in the muscle strength. The need for muscle fatigue analysis is to estimate the the fatigue that accumulates in muscles during different analysis. There is a need to minimize the fatigue so that the injuries will also get minimized. In this paper we have reviewed the different work patterns causing muscle fatigue and their analysis using Electromyography.

**Keywords:** Muscle Fatigue, Electromyography. Different Work Patterns, Estimation, Analysis

## Introduction

A surface Electromyographic study of muscle fatigue analysis has been conducted for almost 25 years for different work patterns and has been debated. Different work patterns such as Motor cycle riding, assembly task, Hand grip task, static cases, dynamic lifting, overhead work, Desktop Computer work, occupational field task studies are considered for our review.

Hence understanding muscle movements during different work patterns are very important for the analysis of muscle fatigue. Also it helps the physiotherapists to train the subjects. Knowledge of muscle fatigue in the major muscles during different work leads to train the muscles better.

This paper provides a review on different work patterns, methodology to analyze the different types of fatigue, corresponding muscle group involvements and the electrodes used and the observations made as a result of analysis.

## Muscle Fatigue due to Motor cycle Riding

To determine Muscle Fatigue due to Motor Cycle Riding using Surface EMG, two Motor Cycles similar in all specifications except one had erect/Straight Posture and the other has leaning Forward Posture has been considered for study. Two Road Conditions - One involving High number of road shocks and the other with heavy traffic. The muscle groups involved are Four Muscle groups-Flexor Carpi Ulnaris, Trapizius, Erector Spine, Lattissimus Dorsi. The key findings from this paper shows that Erect/Straight Posture Motor Vehicle causes higher fatigue than leaning forward posture motor vehicle during road shocks. Higher level of discomfort in shoulder/neck, midback and low back muscle groups for erect/ straight Posture motor vehicle.

## Standing Postures

This study compares the efficiency of a dynamic standing posture and the stationary standing posture using SEMG and Psychophysical analysis (venkatesh et.al.,). Nine Healthy right Dexterous males were participated in the study. The muscle group involved are Gastrocnemius, trapizius, erector spine.

The proposed standing posture can reduce risk of lower extremity disorders than the stationary standing posture. From the SEMG study, it was found that the amount of fatigue affected in leg and lower back muscles were more higher in the dynamic standing posture.

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**Estimation of Fatigue Resistances**

A theoretical Maximum Endurance Time(MET) model is extended from a simple muscle fatigue model. The MET model was analyzed in comparison to 24 already existing empirical MET models. Using this Mathematical regression method, 21 models have intraclass correlations over 0.9, which means it replaces the existing models in a computationally efficient way.(Liang ma et.al.,).

**Estimation of Muscle Fatigue**

To estimate the relationship between the muscle fatigue and the rest period, Two Subject Groups, totally 11 male students were considered for Study. Subjects were advised to seated upright The chair was made so that the forearm and the upper arm formed an angle of 110º. (Yewguan Soo et.al.,).

**Measurement of Muscle Fatigue**

The measurement of Muscle fatigue is to determine the relationship between the cumulative fatigue of trunk muscles and the recovery time. Ten subjects were participated in the experiment. During a 9 min period of lifting and lowering, recovery times of 1 to 5 mins with an interval of 1 min were applied respectively. The lifting weight was set equal to 25% of the individual's maximum Voluntary Condition (MVC).

**Biomechanical Assessment of gloves**

The purpose of assessment of gloves is to measure muscle fatigue and muscle activation. Thirty Subjects performed a 60s static fatigue handgrip contraction for each experimental condition such as barehand, moderately stiff glove and very stiff glove. The muscle group involved are Flexor digittorum Superficialis, Flexor carpi radialis, Extensor carpi radialis longus, Extensor digitorum. Males produced a better handgrip force than females. The holding time for female is lower for the very stiff glove .(C.Lariviere et.al.,).

**Shoulder Muscle Fatigue**

Determining Shoulder girdle muscle fatigue for weight of hand tools, shoulder postures, arm up and down time. Ten young female subjects were participated in the experiment. The simulation consisted of four tasks each of 1 min job-cycle. Each cycle was repeated 50 times. The muscles involved are shoulder girdle muscles. An analysis of variance showed that all four variables were found ($p \leq 0.01$). Increase in Muscle fatigue and pain with an increase in the weights of the work piece and the hand tool. (Arun Garg et.al.,)

**Muscle Fatigue during Exercise**

The age, gender and task parameters on muscle fatigue during prolonged isokinetic torso exercises are assessed. 24 participants performed repetitive intermittent isokinetic torso extensions until exhaustion. Effort level were set to 30% to 40% of (MVC) and work rest cycles had duration of 30s and 60s of the 50% duty cycle. The muscle groups involved are Paraspinal muscles specifically to target longissimus thoracis and the multifidus muscles. Males had 38% higher MVC's than females. Rates of RPD (Ratings of Perceived discomfort) were significantly greater at the higher effort level. (Yassierli et.al.,),

In order to investigate the performance of the first autoregressive model coefficient (ARC) in quantification of fatigue of the trunk muscle, Ten males were participated in the study. EMG signals were collected for a period of 20s while subjects were isometrically extending their trunk at different force levels of each 15% MVC intervals. The muscle groups involved are right and left erector spinae muscles. 94.55% intervals of EMG signal recorded were stationary.

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### Muscle Fatigue at Work

In order to determine the relationship between posture and performance while working on a Computer Monitor, 21 female subjects performed a 20 min task, Each subject carried out 20 min choice rotation in four different conditions, 0º shoulder flexion in a quiet and noisy condition and 30º shoulder flexion in a quiet and noisy condition. The muscle groups involved are Right anterior Deltoid muscle. 30º shoulder flexion posture has poor performance than 0º shoulder flexion posture. 30º shoulder flexion posture has greater discomfort.

Fifty Normal young adults were performed a study. Subjects were asked to seat upright neutral posture in an axial rotation tester such that the rotations occur only in thoracho-lumbar region.

### Body vibration effects

To determine the acute effects of whole body vibration, twelve healthy males were participated The exclusion criteria were neurological disease, musculoskeletal problem, low back pain. To facilitate EMG measures, the body mass index of the subject exceeds 3kg/m2.

To investigate the muscular fatigue affection the human's perception of weights, 40 subjects were participated in this experiment. The containers weighed between 50 and 500g in increments of 50g resulting in ten variable weights. The RPE scale values coincided well with the test weight, when muscles were not fatigued. When muscles are fatigued, the RPE values were lower. Also the results showed that subjects perceived 17% less in weight.

### Conclusion of the Study

The most commonly used muscles for analyzing the fatigue for different work patterns in this review paper are Flexor Carpi Ulnaris, Gastrocnemius, Trapizius, Erector Spine, Lattissimus Dorsi Extensor carpi radialis longus, Flexor digittorum Superficialis, Flexor carpi radialis, Extensor carpi radialis longus, Extensor digitorum. During Motor cycle riding, erect / straight posture motor vehicle causes higher fatigue than leaning forward posture motor vehicle. Higher level of discomfort in shoulder/neck, midback and low back muscle groups for erect/ straight Posture motor vehicle. From the Surface Electromyographic study, Muscle fatigue in leg and lower back muscles were higher in the stationary standing posture. While undergoing biomechanical assessment of gloves, it was found that, Males produce higher grip force than females. The holding time for female is lower for the very stiff glove.

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