MULTIMODAL ASSESSMENTS OF ACUPRESSURE IN MUSCLE FATIGUE OF FOREARM

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DEDICATION

This thesis is dedicated to late my father
Hj Mangon bin Kasan
Late my mother
Hjh Mentalsieh binti Hj Palil
My wife
Nooraini binti Ali
My Sons
Mohd Hafizd, Mohamad Hafizi, Ahmad Ismail, Yusof
My Daughter
Nurhafizatul Ain, Nurfarizatul Ainun
My Supervisor
Dr Muhamad Amir bin Ass'ari, Prof Dr Abdul Hafiz bin Hj Omar
My friend and everyone that gave internal and external support during completing this thesis.

My success is present for all
Thank you

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ABSTRACT

Acupressure is an alternative traditional Chinese medicinal practice believed to restore blocked internal energy or qi by applying manual pressure to specific points on the body and acts as an intervention strategy to improve muscle performance. Previous studies found that acupressure is an effective alternative medicinal practice in treating certain diseases, but the physiological reaction of the muscle is still unclear. Thus, this study aimed to conduct multimodal assessments that include the effectiveness of stimulation on acupressure in muscle fatigue of the forearm. Thirty subjects were randomly divided into two groups. The first group (n=15) received acupressure intervention, while the second group received kneading massage and act as a control group (n=15). During the acupressure intervention, the subjects received acupoints located at LI 4 (Hegu) and LI 11 (Guchi), and the acupoints were performed for 15– 30 seconds per attempt for 2–3 minutes on the brachioradialis muscle of the forearm. On the other hand, the control group received the kneading massage technique for 2– 3 minutes on the forearm after completing the 2 sets of 5 squeezed hand grip exercises within 15 – 30 seconds by using an adjustable hand grip exerciser. The results of the intervention group showed that there were significant differences in the levels of calcium, sodium, and potassium ions from about 0.01 mmol/l to 0.08 mmol/l. As for the lactic acid results, there was a change between 0.02 mmol/l and 0.08 mmol/l and the mean p-value is 0.05. Meanwhile, the mean value on the Fatigue Assessment Scale (FAS) was between 2.67 before acupressure and 2.99 after acupressure. The decreases in FAS after acupressure indicate that the level of fatigue in the forearm is mild. In addition, the electromyography (EMG) analysis before and after acupressure to the intervention group shows that the mean of descriptive analysis is 0.56 and 0.58, which indicates that the median frequency of nerve conduction velocity values between 0.064 mV and 0.901 mV of muscle contraction during muscle fatigue is quicker after acupressure has been applied. In conclusion, acupressure is effective to treat muscle fatigue by indicating the increased levels of calcium, sodium, and potassium ions as well as lactic acid. On the other hand, the Fatigue Assessment Scale supported that there was significance in measuring the level of muscle fatigue. Furthermore, EMG is proven to be able to measure the physiological reaction of nerve conduction velocity of the muscle on acupressure. Therefore, acupressure shows potential for further research regarding the effectiveness, implications and applications of acupressure toward the mechanism of muscle fatigue.

ABSTRAK

Akupresur adalah amalan perubatan alternatif tradisional Cina yang dipercayai boleh memulihkan tenaga dalaman atau qi dengan menggunakan tekanan manual dititik tertentu pada badan dan bertindak sebagai strategi intervensi untuk meningkatkan prestasi otot. Kajian terdahulu mendapati bahawa akupresur adalah amalan perubatan alternatif yang berkesan dalam merawat penyakit tertentu, tetapi tindak balas pada fisiologi otot masih tidak dapat dijelaskan. Justeru, kajian ini bertujuan untuk menjalankan penilaian multimodal yang merangkumi keberkesanan rangsangan akupresur pada otot lengan bawah tangan yang mengalami keletihan. Tiga puluh subjek telah dibahagikan secara rawak kepada dua kumpulan. Kumpulan pertama (n=15) menerima kaedah akupresur intervensi, manakala kumpulan kedua menerima kaedah urutan menguli dan bertindak sebagai kumpulan kawalan (n=15). Semasa akupresur intervensi, subjek menerima tekanan acupoint yang terletak di LI 4 (Hegu) dan LI 11 (Guchi), tekanan acutitik dilakukan selama 15 - 30 saat bagi setiap percubaan selama 2–3 minit pada otot brachioradialis dilengan bawah tangan. Sebaliknya, kumpulan kawalan pula menerima teknik urutan menguli selama 2– 3 minit pada lengan bawah tangan selepas melengkapkan 2 set 5 gengaman tangan dalam masa 15 – 30 saat dengan menggunakan senaman cengkaman tangan boleh laras. Keputusan kumpulan intervensi menunjukkan bahawa terdapat perbezaan ketara dalam tahap kalsium, natrium, dan ion kalium daripada 0.01 mmol/l hingga 0.08 mmol/l. Bagi keputusan asid laktik, terdapat perubahan antara 0.02 mmol/l dan 0.08 mmol/l dan min nilai p ialah 0.05. Manakala, nilai min pada Skala Penilaian Keletihan (FAS) adalah antara 2.67 sebelum akupresur dan 2.99 selepas akupresur. Penurunan dalam FAS selepas akupresur menunjukkan bahawa tahap keletihan didalam lengan bawah tangan adalah rendah. Selain itu, analisis elektromiografi (EMG) sebelum dan selepas akupresur kepada kumpulan intervensi menunjukkan bahawa min analisis deskriptif ialah 0.56 dan 0.58, yang menunjukkan bahawa kekerapan median nilai halaju pengaliran saraf diantara 0.064 mV dan 0.901 mV terhadap pengecutan otot semasa keletihan otot adalah lebih cepat selepas akupresur digunakan. Oleh itu, EMG terbukti boleh mengukur tindak balas fisiologi halaju pengaliran saraf otot pada akupresur. Kesimpulannya, akupresur berkesan untuk merawat keletihan otot dengan mengukur tahap peningkatan ion kalsium, natrium, dan kalium serta asid laktik didalam otot. Selain itu, Skala Penilaian Keletihan (FAS) juga menyokong bahawa terdapat kepentingan dalam mengukur tahap otot keletihan. Tambahan pula, EMG dapat membuktikan tindak balas fisiologi halaju pengaliran saraf otot pada akupresur. Oleh itu, kajian akupresur menunjukan penyelidikan lanjut mengenai keberkesanan, implikasi dan aplikasi akupresur terhadap mekanisme keletihan otot.

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LIST OF ABBREVIATIONS

ADP	-	Adenosine Diphosphate
ATP	-	Adenosine Triphosphate
Ca2+		Calcium
EMG	-	Electromyography
K+	-	Universiti Teknologi Malaysia
Na2+	-	Sodium
NCS	-	Nerve Conduction Velocity
UTM	-	Universiti Teknologi Malaysia

LIST OF SYMBOLS

mHtz	-	milihertz
mV	-	milivolts
mmol/l	-	Milimol/liter
mEq/l	-	Miliequivalance

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Fatigue is a common non-specific symptom that many individuals feel, and it has been connected to a number of health issues (Kim M., 2021). Fatigue is a term that refers to a difficulty in performing voluntary actions due to an overpowering sense of tiredness, lack of energy, and exhaustion (Gruet M., 2013). If exhaustion is not handled, it can progress to overwork, chronic fatigue syndrome (CFS), overtraining syndrome, and even endocrine abnormalities, immunological dysfunction, organic disorders, and a threat to human life. Another cause of fatigue is a lack of energy, which necessitates more rest than usual and makes typical activities exhausting (Lewis, T.R., Kundinger, S.R., Pavlovich, A.L., Bostrom, J.R., Link, B.A., Besharse, J.C., 2007).

In clinical practice, muscle fatigue is defined as a decline in the ability to produce force caused by exercise in humans (Jing-jing Wan, 2017). Muscle exhaustion is a long-term treatment that has a significant physical and mental impact on patients (Wang and Chen, 2012). In this condition, muscle tiredness is a typical occurrence that hampers athletic performance as well as other strenuous or long-term activities. It also enhances and decreases everyday activities in a range of pathological conditions, including neurological, muscular, and cardiovascular issues, as well as ageing and frailty.

There are numerous approaches for classifying fatigue. Fatigue can be classified as acute or chronic depending on how long it lasts (Norheim KB, 2013). Rest or lifestyle adjustments can immediately relieve acute exhaustion, however, chronic fatigue is defined as persistent tiredness lasting four months that is not cured by rest (Silverman MN, 2010). There are two sorts of exhaustion: mental fatigue, which

relates to the cognitive or perceptual components of weariness, and physical fatigue, which pertains to the operation of the motor system (Gandevia SC et al, 2001).

Muscle fatigue can be caused by a variety of factors, including psychological, physiological, and biochemical factors (Allen & Westerblad, 2001). Psychological disorders (Hilbert et al., 2003) are an extremely common comorbidity in the general population. Depression and anxiety were the most commonly reported psychological issues, both of which are independent risk factors for suicide behaviour and are closely linked to low quality of life (Feroze et al., 2012; Chen et al., 2010; Wang and Chen, 2012). Psychological diseases should be treated with both pharmacologic and non-pharmacologic interventions, such as social support networks, behavioural therapy, and participation in an exercise programme (Wang and Chen, 2012).

On the other hand, the serum electrolytes such as sodium, potassium, calcium, chloride, bicarbonate, urea, creatinine, and magnesium in our body system (Allen & Westerblad, 2001), to be caused by the effects of metabolic changes on either the contractile machinery or the activation processes (Del Rossi et al., 2014) (D. G. Allen and H. Westerblad, 2001). It will alter the biochemical reaction and be able to develop the symptoms and resulting in muscular fatigue. Serum electrolytes comprise positively and negatively charged molecules known as ions found in the body's cells and intracellular fluid, such as blood plasma (Henry et al., 2001). Cations are positive charges electrolytes, while anions are negative charges electrolytes (Gan et.al.2016). Serum plasma electrolytes are the electrolytes that are most impacted during exercise.

Besides that, because sodium is extracellular, sodium and chloride ions normally flow in the same direction inside the cell (Philip, 2005). This means that during extreme heat stress (Wallace et al., 2016), water replenishment may be more necessary than sodium replacement. Many athletes participating in long-duration endurance exercises have been identified with hypernatremia, which also is defined as a low sodium level in the blood plasma, and they have been recommended to drink as much water as possible during exercise to prevent dehydration (Speedy et al., 1997). Cramping and muscle tiredness (Vøllestad, 1997) are two of the side effects. Hypernatremia is a condition in which the body's sodium levels are too high, causing

water retention in the tissues (Convertino et al., 1996). The complication is someone can get oedema, hypertension, and a higher heart rate.

Potassium, a major electrolyte contained in the body's intracellular fluid and stored in muscle fibres alongside glycogen, plays an important function in glucose transport into muscle cells (Barstow C, 2017). Potassium also interacts with sodium and chloride to regulate fluid and electrolyte balances, as well as contribute to the transmission of nerve impulses. When glycogen is broken down to provide energy for activity, potassium is decreased in muscle cells (Wallace et al., 2016). Hyperkalaemia (R. M. Enoka & Stuart, 1992) can induce electrical impulse disturbances and perhaps death, it is critical to replenish potassium following the loss during exercise (Barstow C, 2017).

According to research conducted by Priscilla Le Mone and Burke in 2008, blood calcium plays a role in the process of muscle reaction during excitability and accessibility. Muscle cramps will develop from a calcium deficiency. This is because the ion calcium acts as a mediator between muscular contraction and excitement (Edward R., 2001). Calcium is also involved in the production of bones and teeth (Ross & Willson, 2002). In the force-generating condition, the process is a reduction of simultaneously attached cross-bridges. For force production, two processes are required: first, calcium ions (Ca^{2+}) discharge from the sarcoplasmic reticulum (Allen & Westerblad, 2001) to the sarcoplasm and calcium ions (Ca^{2+}) binding by the troponin molecule, and second, the turnover of myosin-actin cross-bridges (Edward R., 2001).

Reduced calcium ions' (Ca^{2+}) availability for release from the sarcoplasmic reticulum (SR) may contribute to a steady drop in force-generating capacity throughout all forms of exercise (Volstead et. al., 1988). The works by Takayuki et al. (2010) aimed at developing methods that may effectively train or improve the muscle's work efficiency. The feature of muscular exhaustion (Barry BK and Enoka RM, 2008) and the muscle recovery process are used to prevent muscle tension. As a result, we can objectively monitor muscle fatigue, optimise work efficiency, and prevent muscle strain (Katzberg, H.D., 2015).

Lactic acid (Rusdiawan et al., 2020), on the other hand, is one of the causes of muscle fatigue in the body, according to Sahlin K (1986). Lactic acid is generated and stored in the muscle when there has been a high energy demand, rapid impact on energy demand (Gang et al., 2021), and an insufficient supply of oxygen. Muscle pH falls to around 6.4-6.6 with severe exertion that continues till exhaustion. The concentration of lactate in the blood (Allen & Westerblad, 2001) is another important indicator of exercise intensity and fatigability. According to Kim et al. (1997), fast lactate removal aids fatigue recovery and enhances exercise performance. Cortisol levels were raised before the competitive phase (Enoka RM, Duchateau J. 2008), 2012).

On the other hand, our bodies require muscular fatigue recovery precisely since we are all dealing with this situation. Massage (Hilbert et al., 2003), acupuncture (Tan et al., 2015), or acupressure (Serçe et al., 2018) are examples of interventions, and acupressure was selected as the main focussed of this study. Acupressure is a common supplementary therapy that is said to help with mental and physical wellness (Liu, Y. W. et.al, 2021). Acupressure is a practice being used in traditional Chinese medicine to stimulate 'acupoints' or 'acupuncture points' by putting pressure on them through the hand, fingers, or thumb (Tsay, 2004). Acupoint is suggested to enhance blood flow, alleviate blood congestion, and vitalize organs by generating and smoothing the flow of energy (Qi) (Freeman and Lawlis, 2001). Manual acupressure site stimulation has been proven to increase serotonin and endorphin production, as well as enhance serum cortisol management (Lane, 2009). Changes in these hormones may lower anxiety, induce relaxation, and have a major effect on the pathophysiological mechanism that leads to depression (Gang et al., 2021).

Acupressure is an ancient therapeutic method that uses the fingers to progressively press key healing areas, stimulating the body's innate self-curative capacities (Atchison, J. W.et.al, 2021). Acupressure is an ancient therapeutic technique that entails gently pressing key healing points with the fingertips to assist the body's natural healing processes (Tan et al., 2015), Atchison, J. W.et.al, 2021). Acupressure

has been utilised as a medical treatment in most cultures since antiquity, and it has a long history of application in sports (Brian et.al. 2000). The muscle biochemical response (Allen & Westerblad, 2001) method is expected to promote muscular compliance, resulting in increased range of joint motion and decreased active and passive muscle stiffness by using the strength and sensitivity of the hand (Jonathan Devies, 2003).

Furthermore the effect of acupressure on serum electrolytes is more pronounced when the exercise is prolonged (Maimoun L., 2004). Despite due to training sessions and competitions being scheduled to close together, athletes and coaches (Del Rossi et al., 2014) always implement intervention strategies (French et. al., 2008) such as stretching, exercise, compression garments, and massage. So, it can help to avoid effects in delayed muscle fatigue (Cheung, Hume and Maxwell, 2003). Besides that, another issue is that once the strategies for intervention lacking, then the condition of muscle injuries like muscle strain, sprain, spasms, and cramps will become worse (Özgünen et al., 2010).

In sport, acupressure is believed will be a benefit to athletes and coaches (Gaetano et.al. R., 2015) recently a key part of rehabilitation from sports injuries (Mohd Nor Mohad Anizu, 2001). Based on observations and experiences, many coaches, athletes, and sports medical personnel believe that massage (Khoo, S., 2011) can bring various benefits to the body, including enhanced blood flow. It will also have a psychological benefit by reducing muscle tension and neuronal excitability (Hart Land, 2008), as well as an elevated sense of well-being. Based on observations and experiences, many coaches, players, and sports medical experts believe that massage (Khoo, S., 2011) can bring various advantages to the body, including enhanced blood flow. Besides that, it will reduce muscle tension and neurological excitability (Hart Land, 2008) psychologically effect and increase the sense of well-being.

Therefore, to help muscle performance and recovery time, it needs to compete not only massage but use other interventions to aid like acupressure in the recovery from any soft tissue injuries. Hence, greater research will be carried out on the effect of acupressure massage on enhancing muscle performance. Besides that, the efficacy

of acupressure as an alternative treatment for rehabilitation and prevention also will be focused on in the problem statement in the next section.

1.2 Problem Statement

Although some studies have suggested that acupressure may be effective in treating muscle fatigue (Xun, P. et.al., 2022), nausea and vomiting, insomnia, low back pain, migraines, and constipation, among other things, such studies have been found to be biased. There is no solid proof that acupressure is beneficial. On the other hand, the basic philosophy behind this technique is to restore energy flow or Qi (Mehta, P et.al. 2017). Is it Qi is responsible for maintaining the vital life energy that is necessary for the body to grow and develop properly? Therefore, as a consequence, the study aims to conduct investigations on biochemical reactions such as calcium, potassium, and sodium ions, lactic acid, as well as analyse muscle fatigue using the Fatigue assessment scale and validate muscular contraction velocity using electromyography.

Muscle fatigue is a symptom in non-clinical and clinical conditions. Besides that, it is always synonyms related to any activities involving muscle physiology (Xun, P. et.al (2022). Muscle fatigue may be even more important in society because it can prohibit individuals from participating in routine physical activity. Several factors can cause muscle fatigue such as physiological factors, psychology, biochemistry, and neurology. It can also occur when a person suffers from diseases such as diabetes, neurological disorders, and many more. However, they cannot determine the true cause of muscle fatigue. Sometimes when this condition lasts so long that it interferes with his daily life and affects their work performance can also decline (Lambay, A. et.al, 2022).

As mentioned above, biochemical reactions such as calcium, sodium, potassium may one of the causes of muscle fatigue (Nowak, B. 1996). The abnormalities of one of the serum electrolytes components will be disturbed the process of muscle contraction and nerve conduction velocity. The muscular contraction cycle is activated, for example, when the ion calcium binds to the protein

complex troponin, exposing the active-binding sites on actin. ATP (Adenosine Triphosphate) can then bind to myosin, resuming the cross-bridge cycle and allowing more muscle contraction to occur (Nowak, B. 1996). Calcium ions attach to troponin, altering its shape and allowing tropomyosin to move away from actin's myosin-binding sites. When tropomyosin is eliminated, a cross-bridge between actin and myosin can develop, influencing contraction. Therefore, if the present decreased level of calcium ions (Ca^{2+}) is called hypocalcaemia, it will be affected to muscle contraction and velocity with resulting the muscle weakness, soreness, lethargy, and fatigue (Vollestad, N.K. & Sejerted ,O.M. 1988)..

Extracellular and intracellular potassium (K+) concentrations in skeletal muscle berapa (Vollestad, N.K. & Sejerted, O.M. 1988) on the other hand, alter muscle cell activity and are significant drivers of cardiovascular and respiratory performance. Exercise causes K+ ions to be released from contracting muscles, resulting in a drop in intracellular K+ concentrations and an increase in plasma K+ concentrations (Vollestad, N.K. & Sejerted ,O.M. 1988). Hypokalaemia occurs when the potassium level in the blood is too low. The impact is frequently caused by vomiting, diarrhoea, adrenal gland dysfunction, or the use of diuretics. A low potassium level can cause muscles to become weak, cramp, twitch, or even paralysed, as well as irregular heart rhythms known as arrhythmia. Therefore, recovery of intracellular K+ concentrations in previously contracting muscle and plasma K+ concentrations must be returned to the normal values.

Furthermore, the influence of low sodium consumption (hypernatremia) on blood pressure, cardiovascular disease and possible side effects such as changes in blood lipids, catecholamine levels, and renal function. Because of their relevance in neuronal function, sodium and potassium play critical roles in muscle contraction (Kratz, A et.el. 2002). Simply because the ions sodium and potassium assist nerve cells in sending electrical impulses known as action potentials, which instruct the muscles to contract. Then, the level of sodium and potassium is diminished, which will resulting muscle twitching, spasm and can be bad with epilepsy (Vollestad, N.K. & Sejerted ,O.M. 1988). Therefore, a biochemical reaction of calcium, sodium, and potassium as explained becomes the influencing factors on the muscle and body

physiology. This, together with dehydration, causes the gaps between the cells of the muscles to tighten, increasing pressure on the nerve terminals and resulting in muscular tiredness and pain feelings.

On the other hand, the other factor on biochemical reaction are lactic acid (Westerblad, H., Allen, D. G., & Lannergren, J. 2002). The most common cause of skeletal muscle tiredness is intracellular acidosis, which is caused mostly by lactic acid buildup. Muscle fatigue is a sign of any continuous or repetitive physical activity. ATP (Adenosine triphosphate) is energy stored in muscle and will be used in seconds. If ATP generated from creatinine will be used in the muscle contraction in 15 seconds. (Vollestad, N.K. & Sejerted ,O.M. 1988). On the side, glucose molecules and pyruvate acid can be used in aerobic respiration and converted to lactic acid. So that, when oxygen insufficiency or decreased, the muscle contraction will have less power to work caused by the conversion of lactic acid. It will affect pH (potential hydrogen) (Hilbert et al., 2003) resulting in acidosis to the muscle. Therefore, this condition will be lead to muscle fatigue.

Besides that, the other problem that will take consideration in this study, is fatigue measurable? So that, the level of Fatigue Assessment Scale (FAS) (Vøllestad, 1997) before and after acupressure needs to be accessed. This is important psychologically (Hilbert et al., 2003) to investigate the level of muscle fatigue which is caused by processes occurring at various effects in the brain and spinal cord. In this issue, acupressure can be used to enhance muscle performance before and after training and competition, although its effectiveness is debatable. As a result, the goal of this research is to figure out how to treat muscle fatigue, which includes sprains, spasms, and cramps in sports. So that, to access the muscle activities in normal condition, using Fatigue Assessment Scale (FAS) is needful to analyses the level of muscle fatigue.

Furthermore, several research on the use of Electromyography has been conducted (EMG). Electromyography (EMG) (Ryait et al., 2011) was used as one of the tools in this trial to confirm the effectiveness of acupressure in postponing muscle weariness. However, there is little empirical proof that EMG is an effective instrument,

particularly for measuring acupressure after a muscle condition has been resolved. As a result, the purpose of this study is to validate the efficacy of acupressure by employing Electromyography (EMG).

Finally, the most important aspect is gaining and competitiveness. To date, the investigations had been conducted by a prior researcher who continues to oppose the use of proper machine tools or scientific medical technologies to address these concerns. So that, the biochemical reaction on calcium, sodium, potassium, and lactic acid will be explored, as well as the efficiency of acupressure as measured by the fatigue assessment scale (FAS) and confirmed by the electromyography (EMG). As a result of this research, acupressure will be promoted as one of the prophylactic methods for everyone, including athletes, during muscle tiredness to improve muscular performance. Indeed, the major problem will be investigated in-depth to build the research's main purpose will be explored in the theoretical framework of the study.

1.3 Theoretical Framework

The theoretical framework is a description of a study problem's theory that is generated by a review of previously tested knowledge of the variables involved. It identifies a strategy for investigating and interpreting the findings. The theoretical framework includes a well-supported reasoning and is arranged in such a way that the reader can comprehend and evaluate the study viewpoint. The goal is to show that the correlations are objective and established from facts acquired from prior research writers.

Many muscle properties change during fatigue (Rusdiawan et al., 2020). It may cause by physiological, psychological, neurological, and biochemical reactions (Allen & Westerblad, 2001). Hence, in this study, the biochemical reaction factors will be focused on calcium ions (Ca^{2+}) during muscle contraction and excitability. Besides that, the function of ion sodium (N +) and potassium (K +) (Wallace et al., 2016) is to look at the reaction of the nerve's conduction of the action potential. An action potential is a rapid depolarization and repolarization of the small portion of the

membrane. The membrane depolarizes when the sodium channel opens and sodium ions diffuse into the axon. It quickly repolarizes when the potassium channel open and potassium exit to the axon (Volstead et.al. 1988).

On the other hand, the calcium ions (Ca^{2+}) is part of the mediator during muscle contraction and excitability. Besides that, the function of ion sodium (N+) and potassium (K+) is to look at the reaction of the nerve's conduction of the action potential. An action potential is a rapid depolarization and repolarization (Allen & Westerblad, 2001) of the small portion of the membrane. The membrane depolarizes when the sodium channel opens and sodium ions diffuse into the axon. It quickly repolarizes when the potassium channel open and potassium exit to the axon. Besides that, a biochemical reaction to lactic acid will also be investigated. On the other hand, acupressure (Michael R.G, 2014) will be applied for intervention in delaying muscle fatigue. At the same time, it is to validate the effectiveness of acupressure by Surface electromyography signals (SEMG). SEMG will be used as a tool to measure the nerve conduction velocity of the muscle (Ryait et al., 2011). Figure 1 depicts the study's theoretical framework.

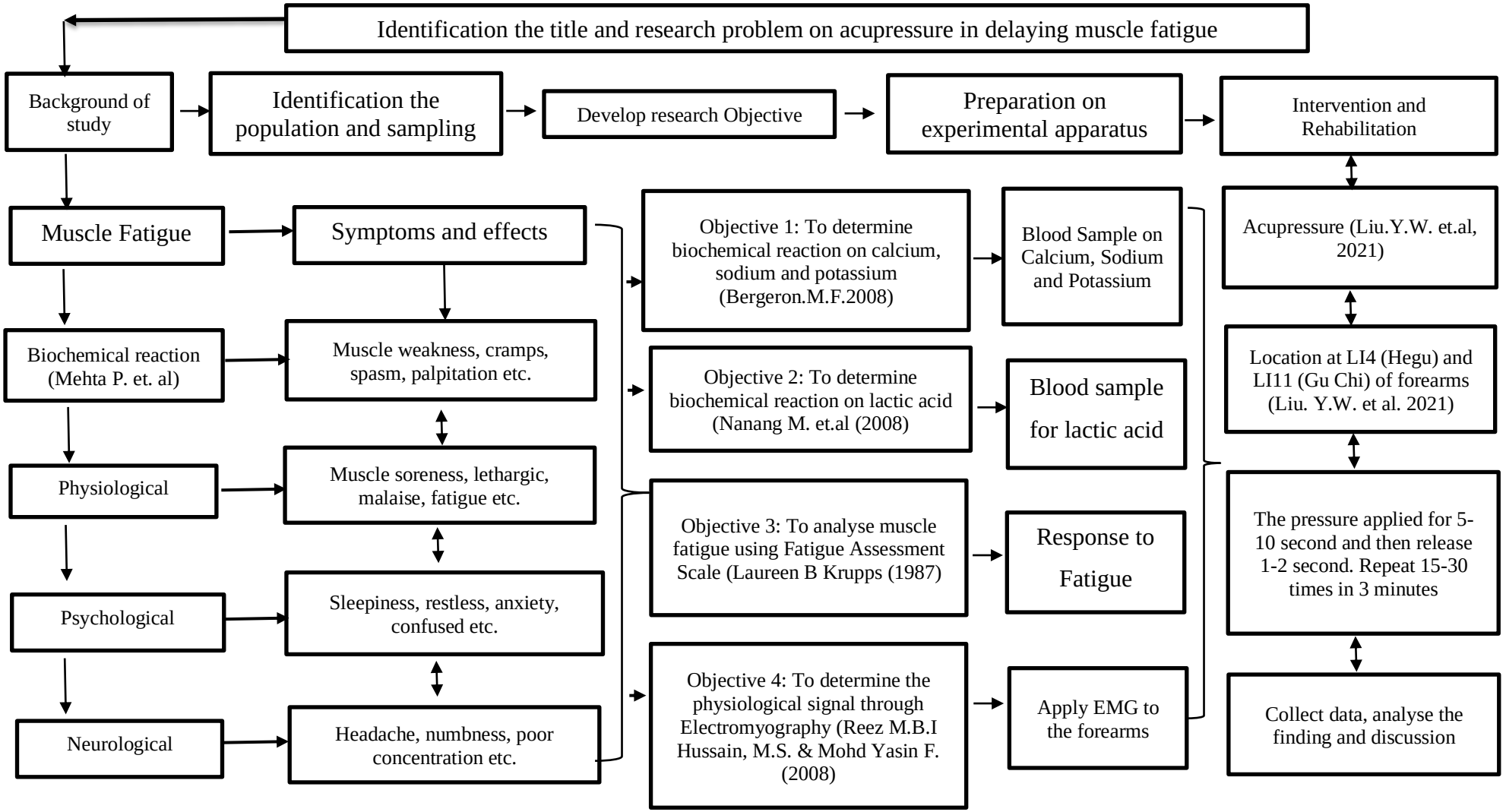

Figure 0.1 Theoretical Framework of Study

The major gap in this study is to investigate the effectiveness of acupressure in delaying muscle fatigue (Hilbert et al., 2003) and the relationship with ions calcium, sodium, potassium, and lactic acid. This alternative hopefully will be considered by clinicians to design as intervention strategies for muscle fatigue among athletes.

Therefore, this study will be investigating the correlation and influence of the biochemical factors on muscle fatigue in delaying muscle fatigue once apply acupressure. Finally, acupressure can be applied as one of the alternative treatments for intervention and rehabilitation on delaying muscle fatigue. Thus, greater research has to be carried out to the main objectives of the study based on the biochemical reaction of calcium, sodium, potassium, and lactic acid on acupressure in delaying muscle fatigue.

1.4 Research Objective

The objectives of this study are:

i. To determine the biochemical reaction of sodium, calcium, potassium in delaying muscle fatigue before and after acupressure.

ii. To determine the biochemical reaction of lactic acid in delaying muscle fatigue before and after acupressure.

iii. To analyse the level of Fatigue Assessment Scale (FAS) before and after acupressure.

iv. To determine the physiological signal reaction through Electromyography (EMG) before and after acupressure.

1.5 Research Question

i. How to determine the biochemical reaction such as sodium, calcium, and potassium in delaying muscle fatigue before and after acupressure?

ii. How to determine the biochemical reaction of lactic acid in delaying muscle fatigue before and after acupressure?

iii. How to analyse the level of Fatigue Assessment Scale (FAS) before and after acupressure on muscle fatigue before and after acupressure?

iv. Is it can determine the physiological signal reaction through Electromyography (EMG) before and after acupressure?

1.6 Hypothesis of the Study

Ho: There are no significant changes in biochemical reactions such as sodium, calcium, potassium, and lactic acid during muscle fatigue before and after acupressure.

H1: There is significant the level Fatigue Assessment Scale (FAS) before and after acupressure on muscle fatigue before and after acupressure.

H2: There is determine the physiological signal reaction through Electromyography (EMG) before and after acupressure.

1.7 Rationale of the Study

The gap of the study was to determine how biochemical reactions such as calcium, sodium, and potassium ions, as well as lactic acid, influenced the physiology of muscle contraction and relaxation. On the other hand, the Fatigue Assessment Scale can measure the level of fatigue in the brachioradialis muscle of the forearm. Besides that, in this study, the muscle physiological reaction was also analysed using electromyography, based on the research objective.

Normally, the common problem of muscle fatigue is more relevant to muscle sprain, strain, spasms, and cramps (Weerapong et.al 2005) that needs therapeutic rehabilitation. Muscle fatigue can be defined as the weakening of muscle performance due to strenuous activity. This can happen for a variety of things. Starting from activities that are done repeatedly or continuously, due to lack of sleep. Knowing the causes and how to deal with muscle fatigue is important to do. Because by knowing these two things, you become aware of what steps to take when muscle fatigue is experienced.

Muscle fatigue can be affected by mental health disorders, such as stress depression, and excessive anxiety. There are various causes of stress, such as office work, housework, relationships with a partner, or as a result of suffering from certain diseases. Causes of work fatigue are generally related to the nature of work that is less varied, work intensity, high mental and physical work endurance, work environment conditions, nutritional status, health status, and workload. During exercise, the body lacks oxygen so that the production of lactic acid increases. As a result, increased levels of lactic acid in the body cause muscle pain

Therefore, many practitioners and researchers believed that acupressure is an effective intervention for therapeutic rehabilitation to the patients also for athletes. Hence, this study needs to investigate scientifically to ensure its effectivenesss. It is hoped that the final finding of the studies will be published and proposed to the rehabilitation science industries such as in the sport sciences. Other than that, the technical modalities of acupressure will be proposed as a training module to the practitioner massage, reflexology, and healthcare providers or caregivers.

In conclusion, this study will aid some techniques to promote the clinicians create an idea or alternative on rehabilitation using acupressure. Finally, it is beneficial for those who need the intervention to avoid prolonged experience in muscle fatigue as well as help them to recover faster.

1.8 Limitation of the Study

The following are some factors of research restrictions in a normal dissertation:

1.8.1 Purposive Selection of the Research Title

Acupressure is the therapeutic Chinese ancient treatment for intervention and rehabilitation. Acupressure will promote Chi (Qi) as bioenergy once applying the acupoint to a certain place. According to reliable sources, there are 361 points, most of which are grouped in 'meridians' and may be seen on charts (The Academy of Traditional Chinese Medicine 1975). The four seams may be found on the inside of each of the four main joints of the index, middle, ring, and little fingers.

The Twelve Major Meridians are also the key meridians via which qi flows. The 12 standard meridians, also known as Principal Meridians, are separated into two groups: Yin and Yang. The Lung, Heart, and Pericardium are the Yin meridians of the arm. They have yin-yang qualities, are found in each arm and leg, and are linked to a distinct Zang-fu organ. In the inner regions of the arms, legs, chest, and torso, there are six yin meridians.

However in this study, only focused on pressure point Large Intestine 4 (LI4) called Hegu, which is found between the base of your thumb and list finger Pressure Point LI4 (Shambhavi and Dinan Lobo,2021). It is also known as acupressure point which is located on the lower arm at LI 4 (Union Valley) in the webbing where the index finger. On the other hand, Large Intestine 11 (LI 11) is known as (Qu Chi) at Crooked Pond) which are at the top of the elbow crease on the edge of the point (Li, W., & Ahn, A., 2016). The previous study has been shown that acupressure using this acupoint is mostly effective as an intervention to the muscle soreness, muscle fatigue, muscle stiffness of the arms, shoulders, and backache. Proponents of acupressure believe that these points can help treat digestive problems also. Therefore, this selection acupressure acupoint will be explained in-depth in the next section.

1.8.2 Formulation of Research Aims and Objectives

The research goals and objectives are far too broad. As a result, the research aims and objectives are set up, which narrows the formulation of research aims and objectives so that the focus of the study is on the target area. The major reasons for muscle are physiological, psychological, biochemical, and neurological, all of which are reflexes to the muscle, neuron, blood vessel, and respiration, all of which are connected to the oxygen supply to the tissue in the body system. There are five ions present in the metabolic process of serum electrolytes: sodium, calcium, potassium, chloride, phosphate, and magnesium. As a result, the focus of this research will be on the metabolic reactions of the ions calcium, sodium, and potassium, as well as lactic acid.

1.8.3 Implementation of the Data Collection Method

This is experimental study, and because the researcher lacks experience with primary data collecting, there is a strong chance that the nature of the data collection method's execution is flawed. After completing the analysis of the study findings, it may be discovered that the methods used to collect data or the methods used to measure variables limit the capacity to undertake a thorough analysis of the results. During the data collection, the process is a trial and error procedure. Future research must be equipped with an improved data collection method.

1.8.4 Sample Size. The Sample of the Size is Determine by the Nature of Research Topic

The sample size in this study was calculated using Krejcie & Morgan (1970) to determine the number of data points. Statistical tests would not be able to find significant associations within the data set since the sample size is too small. The sample data is a huge difficulty for the Movement Control Order (MCO) because the Covid 19 cases are growing at that period. As a result, the sample size was affected. When it comes to quantitative research, the sample size is more important than qualitative research. A larger sample size is frequently required for statistical tests to

ensure that the sample is representative of the population and that the statistical conclusion can be applied to a larger group.

1.8.5 Lack of Previous Studies in the Research Area

A literature review is an essential component of any study since it helps to determine the breadth of prior work on the subject area. The findings of the literature review serve as a foundation for the researcher to build upon in order to achieve the study objectives. Citing and referencing previous research studies is the foundation for this study's literature review, and these past studies give the theoretical underpinnings for the subject field.

1.8.6 Scope of Discussions

Regardless of the research field chosen, this aspect serves as a constraint of the study. Although the researcher has a lack of experience carrying out the research and generating academic papers of this scale, the scope and depth of the discussions in this article are limited in many ways when compared to the works of other experienced researchers. Therefore, the discussion will be based on the finding of this study and supported by literature from the previous researcher.

1.8.7 Time Constraints

Academic researchers may be required to fulfil deadlines for presenting a paper to a journal or face other time constraints related to their research, much as students and faculty must meet deadlines for turning in class assignments (e.g., participants are only available during a certain period; funding runs out; collaborators move to a new institution, family responsibilities). As a result, practical constraints may restrict the length of time available to investigate a research question and follow changes over time. In this circumstance, it will impose limits that will have a detrimental influence on the study in some way, and it will recognise this impact by emphasising the need for a future study.

1.8.8 Conflicts Arising from Cultural Bias and Other Personal Issues

This study's findings may be skewed owing to the researchers' cultural backgrounds or attitudes on particular events, which might jeopardise the study's credibility. While conducting this research, massage and reflexology practitioners aim to prevent any contradictions of ideas. Guanine was used to conduct the experiments and analyse the results to ensure that they were realistic and valid for this investigation. Thus, it is hoped that this study will have benefit others and be useful in the future.

1.9 Operational Definitions

1.9.1 Acupressure

Acupressure is a complementary and alternative practice that is frequently used with acupuncture. It is based on the concept of life energy flowing via the body's "meridians" (Ryait et al., 2011). Physical pressure is used at acupuncture sites or trigger points to alleviate blockages in these meridians during treatment. Pressure can be applied with the hand, the elbow, or a variety of tools (Tan et al., 2015).

1.9.2 Muscle Fatigue

Muscle fatigue is defined as a reduction in the ability to produce force exercise-induced muscle in humans (Roger M. Enoka & Duchateau, 2008). Because of overexertion or activities, the muscle becomes fatigued and exhausted (Edward R, 1975).

1.9.3 The Calcium, Sodium, and Potassium Ions

Aside from that, do look at the reaction of the neuron's conduction of the action potential for sodium (N +) and potassium (K +) ions (Vøllestad, 1997) (Kwon & Lee,

2018). A fast depolarization and repolarization of a tiny region of the membrane constitute an action potential (Vollestad, N.K. & Sejersted, O.M., 1988).

1.9.4 Adenosine Triphosphates (ATP)

When a muscle is no longer activated, ATP (Gang et al., 2021) is released to allow the skeletal muscle to stop contracting. When skeletal muscle is induced to contract, calcium binds to the globular protein troponin, causing tropomyosin (the threadlike protein that wraps itself around the actin filament) to pull away, allowing actin to connect to myosin. ATP may be replenished by three mechanisms: creatine phosphate metabolism, anaerobic glycolysis, fermentation, and aerobic respiration (Ross & Wilson, 2012).

1.9.5 Lactic Acid

Lactic acid is created by muscle tissue and red blood cells, which are responsible for transporting oxygen from the lungs to the rest of the body (Rusdiawan et al., 2020). Usually, lactic acid levels in the blood are low. Lactic acid levels rise when oxygen levels fall. The strenuous activity might result in low oxygen levels. An unstressed patient's blood lactate levels should be between 0.5 and 1.00 mmol/L. Lactate values of less than 2.00 mmol/L are considered normal in patients with severe illnesses. (2017, Komesu. et.al.).

1.9.6 Surface Electromyography (SEMG)

The FAS is a 10-item general fatigue questionnaire that is used to assess fatigue. Five questions address physical weariness, while five scales address mental fatigue (questions 3 and 6-9). In addition to standard functional testing such as lung function tests, it is also useful for physicians and other health care professionals in the follow-up of their patients (A. Shahid et al., 2012).

1.9.7 Fatigue Stress Scale (FAS)

Surface electromyography signals (SEMG) (Ryait et al., 2011) is a methodology central to the study of human movement. This is the most common form of non-invasive- measurement of muscle activities. It is invaluable for several purposes including monitoring the timing of contraction of muscles based upon the initiation and end of the SEMG signal during a movement. On the other hand, providing an indication of the force of contraction of the muscle and monitoring the change in the frequency spectrum of the SEMG signal acts as an indicator of fatigue (Hardeep S. Ryait, A.S. Arora, Ravinder Agarwal, 2011).

1.10 Conclusion

In conclusion, the background study related to acupressure, biochemical factors based on calcium ions (Ca^{2+}) sodium (N+), potassium (K+) ions, and also non-lactic acid was explained in this chapter. Therefore, the greater investigation and discussion will be continued in Chapter 2.

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