The Effects of Electrical Muscle Stimulation (EMS) towards Male Skeletal Muscle Mass

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Abstract**—**Electrical Muscle Stimulation (EMS) has been introduced and globally gained increasing attention on its usefulness. Continuous application of EMS may lead to the increment of muscle mass and indirectly will increase the strength. This study can be used as an alternative to help people especially those living a sedentary lifestyle to improve their muscle activity without having to go through a heavy workout session. Therefore, this study intended to investigate the effectiveness of EMS training program in 5 weeks interventions towards male body composition. It was a quasi-experimental design, held at the Impulse Studio Bangsar, which examined the effects of EMS training towards skeletal muscle mass among the subjects. Fifteen subjects (n = 15) were selected to assist in this study. The demographic data showed that, the average age of the subjects was 43.07 years old ± 9.90, height (173.4 cm ± 9.09) and weight was (85.79 kg ± 18.07). Results showed that there was a significant difference on the skeletal muscle mass ($p = 0.01 < 0.05$), upper body ($p = 0.01 < 0.05$) and lower body ($p = 0.00 < 0.05$). Therefore, the null hypothesis has been rejected in this study. As a conclusion, the application of EMS towards body composition can increase the muscle size and strength. This method has been proven to be able to improve athlete strength and thus, may be implemented in the sports science area of knowledge.

Keywords**—**Body composition, EMS, skeletal muscle mass, strength.

I. Introduction

A. Background of the Study

ELECTRICAL MUSCLE STIMULATION (EMS) can be known as the application of electrical current transcutaneously to muscles through electrodes to induce involuntary contractions [2] had been evoke contractile activity by applying an electric current to the neuromuscular system has been known since at least the 18th century [25]. Regularly, the human sensory system is sending electrical stimulation from the brain to the nerves to control our muscle activity. EMS utilizes this characteristic rule and has the capacity to heighten this procedure to reach more profound muscle layer, which was difficult to actuate through normal gym routines. People do not realize that EMS has existed in the previous generations long before. In those days EMS, preparing was predominantly utilized as a part of treatment for treating and recovery of muscle decay or loss of motion. In addition, counteract loss of muscle excitability and muscle atrophy result from disuse [1].

Reference [26] stated that EMS training is a good method to increase skeletal muscle and is equal to or even better than conventional strength training. Muscle mass is a component of function and improvements in the cross sectional area of a muscle have been shown to be associated with the increased strength and force in health and disease [8]. EMS training has the capacity to reach to the deeper muscle layers, which was difficult to enact through a conventional gym workout. According to [26] the higher the intensity resulted in greater improvement however the more intense the training also can deepen the muscle soreness. Muscles were also fortified through the electrodes while doing low intensity of the training. This combination of both EMS and training can prompt an extra increment of tension creating effectives results. Fitness coach can control every muscle gathered by altering the intensity according to the objectives. In a recent systematic review, EMS implementation in most of the selected controlled clinical trials produced significant improvements in muscle strength, exercise capacity, and disease-specific health status [20].

The EMS machine, which contains 20 pads all around the vest or training suit has the capacity to empower all big muscles around your body. For the upper body, it may include sleeves for covering the wearer's arms. A plurality of electrodes are distributed throughout the garment at locations where each electrode makes electrical contact with one or more muscles of a wearer, an electrical power source for providing an electrical current to the plurality of electrodes and a control device for controlling the amount of electrical current provided to the wearers muscles. It also includes a material that provides a spring force on the plurality of electrodes such that electrical conductivity between the electrodes and the skin of the wearer is maintained while the garment is worn [3]. People that train with impulse current had the decrement of problem around their girth area which is waist, hip and thigh and also the body composition at muscle mass, fat percentage and segmental lean analysis.

Supporting by [11], conventional weight training is not feasible and an alternative (using electrical muscle stimulation had been approached) is needed when a person is restricted to bed rest or during space flight. Therefore, the primary objective of this study was to investigate the effectiveness of EMS training in 5 weeks interventions program towards male body composition. Body composition that are to be tested includes skeletal muscle mass, upper body skeletal muscle mass, lower body skeletal muscle mass, dominant hand skeletal muscle mass, non-dominant hand skeletal muscle mass, dominant leg skeletal muscle mass and non-dominant leg skeletal muscle mass.

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B. Statements of the Problem

According to [15], low muscle mass has been assumed to be associated with disability that can lead to injuries, people who were very skinny or fat usually would had a low skeletal muscle mass which can lead to high body fat percentage. According to [22], people who have high level fats in their body composition would stand a higher chance for health problems. This is as a result of lack of health knowledge and their personal unwillingness to sign up for training programs or exercise routines. According to [18], [28], high body fat percentage conditions associated with insulin resistance such as type 2 diabetes, certain types of cancers, especially the hormonally related and large-bowel cancers and gallbladder disease.

Based on [10], loss of muscle mass was associated with the decline in strength. This strength decrement was much more rapid than the loss of skeletal muscle mass, suggested a decline in muscle quality. Therefore, people need to increase or maintain their skeletal muscle mass in order to keep their upper and lower body strong. Reference [10] stated that men tend to lose more skeletal muscle mass twice as much as women in upper body and lower body lean muscle. More studies on the effects of EMS training on body composition should be performed, especially when the training become trend in most commercialized gymnasium in Malaysia. EMS training was able to improve male body composition. Some of them maybe never heard about the EMS training or they may be afraid when they heard about this training which it may contains electricity shocks or maybe can be harmful to themselves. Therefore, the main purpose was to find the effectiveness of 5 weeks EMS training program towards male body composition. This study was also intended to find the difference between pre and posttest results of muscle mass, body fat percentage, segmental lean muscle, and the effectiveness of EMS towards muscle at dominant and dominant hand and legs of male body. This study also used a lot better version of EMS machine that was not similar from the previous studies.

C. Objective of the Study

The objectives of this study were:

- To identify the pre-test result of subject skeletal muscle mass, upper body muscle mass, lower body muscle mass, dominant hand muscle mass, dominant leg muscle mass, non-dominant hand muscle mass and non-dominant leg muscle mass before using EMS.
- To study the post-test result of subject skeletal muscle mass, upper body muscle mass, lower body muscle mass, dominant hand muscle mass, dominant leg muscle mass, non-dominant hand muscle mass and non-dominant leg muscle mass after using EMS.
- To examine the differences between pre and posttest result effects on skeletal muscle mass, upper body muscle mass, lower body muscle mass, dominant hand muscle mass, dominant leg muscle mass, non-dominant hand muscle mass and non-dominant leg muscle mass using EMS with body weight training.
- To measure the increment of skeletal muscle mass, upper body muscle mass, lower body muscle mass, dominant hand muscle mass, dominant leg muscle mass, non-dominant hand muscle mass and non-dominant leg muscle mass of the subject before and after the intervention.

D. Hypothesis

Based on this study, the following hypotheses were formulated:

- $H_0$1: There is no significant difference of 5 weeks EMS training program on skeletal muscle mass.
- $H_0$2: There is no significant difference of 5 weeks EMS training program on upper body muscle mass.
- $H_0$3: There is no significant difference of 5 weeks EMS training program on lower body muscle mass.
- $H_0$4: There is no significant difference of 5 weeks EMS training program on dominant hand muscle mass.
- $H_0$5: There is no significant difference of 5 weeks EMS training program on dominant leg muscle mass.
- $H_0$6: There is no significant difference of 5 weeks EMS training program on non-dominant hand muscle mass.
- $H_0$7: There is no significant difference of 5 weeks EMS training program on non-dominant leg muscle mass.

E. Significance of the Study

The result of this experiment is useful for:

- People to know the most effectives way to increase skeletal muscle by using this EMS machine.
- Help people that want to improve their strength without lifting weight.
- Promote the training using EMS machine to all coaches and fitness instructor to be used for their athlete or clients.

F. Limitations

The limitations of this research were as follows:

1. Commitment

Subject's commitment was important as it going to give effect to the result. Subjects should give their best performance during the test because it would affect the result. It was compulsory for the subjects to give their full commitment throughout the study.

2. Health

If subject had sickness issues, then they need to inform their current condition. Subjects have to be in good health during this study. Performing the test in bad health condition would effects the result of this study.

3. Daily Routines

Subject was being advised not to change their daily activities, sleeping pattern and also their dietary intakes. Tiredness or over eating would eventually affect the findings.

G. Delimitations

The delimitations of this study were as follows:

1. Equipment

The training program was conducted totally in indoor

environment which was held inside the Impulse Studio, Bangsar. The training must be done using EMS machine, vest and arm pad.

2. Subject

This study requires a subject to perform the five weeks training program. The subject's discipline and commitment plays a vital role in order to get the most accurate result from this study.

H. Definition of Terms

1. EMS Training

Machine gave muscle contraction by electrical stimulation. These were utilized as a part of standard non-intrusive treatment to diminish muscle soreness, keep the advancement of blood clotting after surgery, and counteract neglect decay of muscle. People that using EMS as a part of their routines to increase muscle size. Training with EMS can also help to improve body composition. There were 3 sections of training with EMS in this research, 2 minutes for warm-up, 13 different types of strength training and 5 minutes cardio.

2. Body Composition

Body composition alludes to the fat mass and fat free mass in the body. Those with a higher extent of fat free mass to a lower extent of muscle to fat ratios have a solid body piece. It's a measurement to know which part of the body need to improve and to make sure that the training programs have effects toward their body.

3. Muscular Size

Muscle hypertrophy includes an increment in size of skeletal muscle through a development in size of its segment cells. A scope of boosts can expand the volume of muscle cells. These progressions happen as a versatile reaction that serves to expand the capacity to produce drive weariness in anaerobic conditions. In this study, the muscular size of the subjects was measured in their skeletal muscle mass, upper body muscle mass, lower body muscle mass, dominant hand muscle mass, dominant leg muscle mass, non-dominant hand muscle mass and non-dominant leg muscle mass.

II. Literature Review

A. Body Composition

Body composition was one of the components in health related fitness, which body composition were used to be the measurement to know human fat percentage and muscle mass percentage, there were many ways to measure or to check body composition such as girth measurement and skinfold measurement, both can used as tools to measured our fat percentage. Now days, there were machines that can measures body composition.

According to [21], body composition can vary widely at any given BMI, as highlighted recently by the debate concerning the appropriateness of BMI definitions of obesity in different ethnic groups. In addition, it was the key part of wellbeing in a person. It was the body's relative measure of fats and muscles. In the other word, the body was carrying more fat than muscle mass which was not good. The higher the body fat, the higher chances ones to get health risk. Body composition were important for every person because it can avoid any critical health issues like heart diseases, stroke, diabetes, high blood pressure and high cholesterol level. People with normal body composition tends to have more stamina to do every day routine, they have good quality of sleep and enough rest and also have good blood circulation therefore reduce the risk of heart compilations [4].

The obesity had been diagnosed by using body mass index (BMI), percentages of body fat, waist, and hip ratios [28]. BMI was utilized estimated obesity levels of an individual. The distribution of BMI is shifting upwards in many populations. Recent studies have shown that people who were undernourished in early life and then become obese in adulthood, tend to develop conditions such as high blood pressure, heart disease, and diabetes at an earlier age and in more severe form than those who were never undernourished. [14] Therefore, body composition was important to guide to a better lifestyles. This was because from body composition itself we can measure if an individual were healthy or not. There were many ways to measure body composition. This can be done either in the laboratory test or in field tests.

B. Electric Muscle Stimulation (EMS)

In 21st century, sports science researcher came out with new technology that called EMS, this new technology can replace the conventional gym that people use to go to do exercise to be healthy or to build muscle. According to [16], EMS has proven to be more attractive for many people to who do not have time or motivation to engage in traditional exercise programed. Using EMS, people can get results with minimum time compare to the conventional gym. EMS only takes 20 minutes that was equivalent to four to six hours working out in conventional gym. EMS also promotes in reducing cellulites problem that often happened to overweight people.

Specifically, after performing a 45-minute session of EMS on the lower extremities, an improvement in the microcirculation of the thenar muscle as assessed by near infrared spectroscopy technique was observed [20]. Training and exercising using EMS can also prevent people from injuries especially people who was tend to get injured at lower back, knee, shoulders and also muscle injury. It's a very gentle on joints because people were going to train without using weight, therefore it reduced injury risk factors. According to [13] EMS can help increase strength without getting any injuries compared to conventional gym that tend to give people injuries because they need to lift high load in to order to achieve maximal strength.

C. EMS and Skeletal Muscle Mass

According to [16], EMS was more effective than exercise alone in strengthening skeletal muscle. This is because during the penetration of impulses to the muscle, the Central Nervous System (CNS) activates the smallest motor neurons and with increasing level of intensity, larger motor neurons were

activated. During EMS training, 90% of the muscles was activated simultaneously giving contraction to muscle and the muscle contractions was stronger and more intense than a voluntary exertion can do alone. Compared to conventional weight training, deeper muscle groups was activated which lead to better intra and inter muscular coordination. Previous researcher by [16] stated that, the intensity of each impulse current delivered to specific muscle groups in the body. Therefore, the electrically induced contraction must be in the range of 60-80% of maximal voluntary contraction (MVC) or master intensity which was being used in this experiment using Xbody machine, making it possible to target the problem areas, body sculpt and increase strength in areas that people choose to focus on.

The mechanism of action of EMS was the electrical stimulation does not specifically empower skeletal muscle. Electrical stimulation really energizes the nerve going to muscle and not muscle itself. According to [15], high frequency stimulation which was more than 70 Hz was going to give neuromuscular intersection failure and muscles that easy to get fatigue. The motor nerve most powerful to stimulate at the point it branches to enter the muscle, called the motor point. In this way, the closer the electrodes were to the motor point, the less impulse it takes to fortify the muscle through its nerve. During training session, by moving impedance over the muscle, the point where the motor point enters the muscle can be effortlessly found.

E. Summary

As a summary, this study found that EMS training can increase muscle mass. Even this type of training may be new for some regions; it still can be commercialized in gymnasium around the globe. Hence, this study would help the people to realize on how the benefits EMS training can help them in having a great body figure and become healthier. Hopefully, this study will convince future researcher to search more details about the benefits of the EMS training as a new alternative for new fitness globalization world.

III. Methodology

A. Introduction

This chapter shows the details how the study was carried out so that the research question should be answered and the hypotheses would be observed. Under this chapter divided into five sections which was explains about the research design. Then, explained about the sampling. Explains about the instrumentation used for this study and also explains about the data collection procedure. The last but not least were the section explaining about the data analysis. The definition for true experimental design was to prove or not to prove the hypothesis of the study with statistical analysis whether to accept or to reject null hypothesis.

B. Research Design

This study investigates the effects of electrical muscle stimulation (EMS) on body composition towards men skeletal muscle mass. The design of the study was quasi-experimental design with pre-test intervention and post-test intervention which was the sampling was not randomly chosen, there were only one intervention group and lack of one element that that was control group to compare for [5]. Results of this study were measured by pre and post-test results.

C. Sampling Procedures

This study was using convenient sampling technique, which was the subjects was chooses because of the availability of the subjects towards the study and the area of the study. The subjects included a total of 15 men that trained at Impulse Studio Bangsar aged between 24 to 60 years old. Participant need to fill up client's assessment form in order to make sure that the participant was not on any training and free from physical injuries or any diseases.

D. Instrumentation

The instruments that were used to collect data for this study are the In Body scale version 570 to measure subject's weight and body composition analysis. Measuring tape to measure subject's height. This study used X Body EMS machine manufactured from Hungary and the technology from Germany. In this study, subjects need to wear vest or training suit that was full body armor and consists of 20 paddings that attached to 20 major muscles around the body. In this study, subjects also required to wear attire which was made from a special material and fabrics that can help the pulses from the vest to skin without harming the skin. The intensity of the training was based from the subject's capability.

E. Data Collection Procedures

In order to measure the effects of EMS training, the subjects undergo a 5-week intervention training program. The procedures were pre-test measurement, intervention EMS training program and post-test measurement. The data collection procedures were as follows. Subjects were randomly chose into the intervention group (EMS, n=15). After fill the informed consent form, the researcher was the one who set the date to conduct the study. Instruction and information about the objective of the study was given verbally to all of the subjects by the researcher. Measurement of each of the subjects was taken before they undergo the training program. The measurements of body composition analysis using In Body machine version 570 that consists of muscle mass, body fat, weight, height and lean muscle segmental. After that, subjects underwent the five week intervention training program which was two times per week with 20 minutes training session. Lastly, after the end of five week, the post-test were measured once again which was the measurements of body composition analysis using In Body machine version 570 that consists of muscle mass, body fat, weight, height and lean muscle segmental. All of the information and data that have been collected before, during and after the study conducted was private and confidential.

F. Data Analysis

In this study, the mean and the standard deviation was calculated. The Statistical Package for the Social Science

(SPSS version 20.0) was used as the main method to analyze and interpret the data. Descriptive data includes means and standard deviations from dependent and independent variables were calculated for all variables. The pre-test and post-test results were compared. Paired sample t-test was used to determine the significant difference and hypotheses testing respectively.

IV. Results

A. Introduction

In this chapter, show all the details regarding the result from the pre and post-test conducted for the study of effectiveness of EMS training towards male body composition. Then data were analyzed using the SPSS (version 20 for Windows, SPSS Inc., Chicago, IL, US). This study was using Paired sample t-tests in effectiveness of EMS training towards male body composition. All of the data collected from the testing were converted into correlation statistics.

B. Descriptive Statistics

Data from 15 subjects (n=15) of EMS training were collected for these studies. Table I shows the height, age and weight of the subjects.

Table I showed the height of subjects involved in this study. The highest height of the subject was 189 cm and the lowest was 164 cm. The mean height of the subjects was 173.4 cm (M = ±171.75 and SD = ±9.09). Table I also showed the age of subjects involved in this study. The oldest subject was 57 years old and the lightest was 24 years old. The mean age of the subject was 43.07 years old (M = ±43.07 and SD = ±9.90). Table I also showed the weight of subjects involved in this study. The heaviest subject was 136 kg and the lightest was 68 kg. The mean weight of the subject was 85.79 years old (M= ±85.79 and SD = ±18.07).

C. Normality

Data from 15 subjects (n=15) for pre-test of EMS training were collected for these studies. Table II shows the normality body composition results of pre-test, based on Kolmogorov-Smirnov.

Table II shows that the data that had been collected from this study was normal, this was because the significance value for Kolmogorov-Smirnov for pre-test was $p = 0.2 > 0.05$. There was no violation of data and the data for the pre-test were normally distributed. All of the variables show normal distribution of data in this study. Data from 15 subjects (n=15) for post-test of EMS training were collected for these studies. Table II shows the normality body composition results of post-test, based on Kolmogorov-Smirnov.

Table III shows that the data that had been collected from this study was normal, this was because the significance value for Kolmogorov-Smirnov for post-test was $p = 0.2 > 0.05$. There was no violation of data and the data for the post-test was normally distributed. All of the variables show normal distribution of data in this study.

From the results of the normality test, this study can be assumed as normal because the result of this study for pre-test shows that majority of all four graphs for each variables of the normality test was a normal reading. The majority of the result shows a normal reading so the data can be assume as normal and well distributed. From the results of the normality test for the post-test, this study can be assumed as normal because the result of this study for post-test shows that majority of all four graphs for each variables of the normality test was a normal reading. The majority of the result shows a normal reading so the data can be assume as normal and well distributed. Therefore, the results of this study towards the normality test for pre-test and post-test were normal and had no violation in results.

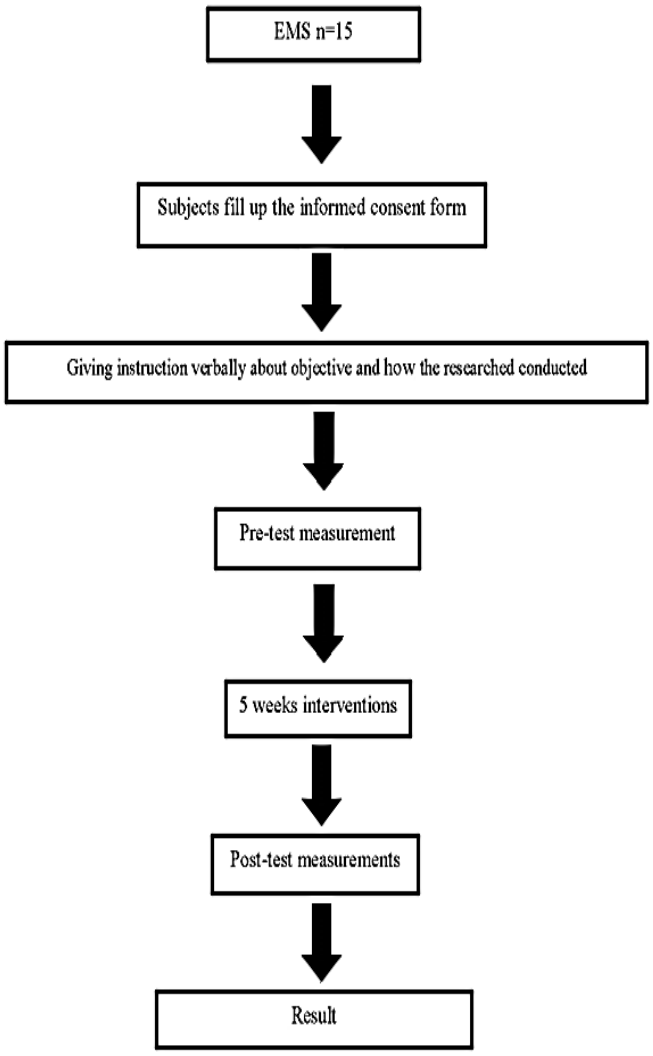

Fig. 1 Data Collection Procedures for EMS training group

TABLE I
DEMOGRAPHIC DATA

	Values	
N = 15	**M ± SD**	**Range**
Height (cm)	173.4 ± 9.09	164 - 189
Age	43.07 ± 9.90	24 - 57
Weight (kg)	85.79 ± 18.07	68 - 136

Mean (M) ± Standard Deviation (SD)

TABLE II
TEST OF NORMALITY FOR PRE-TEST

Statistic		df	Sig.
Skeletal Muscle Mass	.127	15	.200*
Upper Body Muscle Mass	.167	15	.200*
Lower Body Muscle Mass	.153	15	.200*
Dominant Hand Muscle Mass	.115	15	.200*
Non-Dominant Hand Muscle Mass	.097	15	.200*
Dominant Leg Muscle Mass	.143	15	.200*
Non-Dominant Leg Muscle Mass	.121	15	.200*

TABLE III
TEST OF NORMALITY FOR POST-TEST

Statistic		df	Sig.
Skeletal Muscle Mass	.133	15	.200*
Upper Body Muscle Mass	.138	15	.200*
Lower Body Muscle Mass	.153	15	.200*
Dominant Hand Muscle Mass	.112	15	.200*
Non-Dominant Hand Muscle Mass	.122	15	.200*
Dominant Leg Muscle Mass	.124	15	.200*
Non-Dominant Leg Muscle Mass	.120	15	.200*

D. Summary for Normality

TABLE IV
NORMALITY RESULT FOR PRE-TEST

Pre-Test	Values	Results
Skeletal Muscle Mass	$p = 0.2 > 0.05$	Normal
Upper Body Skeletal Muscle Mass	$p = 0.2 > 0.05$	Normal
Lower Body Skeletal Muscle Mass	$p = 0.2 > 0.05$	Normal
Dominant Hand Skeletal Muscle Mass	$p = 0.2 > 0.05$	Normal
Non-Dominant Hand Skeletal Muscle Mass	$p = 0.2 > 0.05$	Normal
Dominant Leg Skeletal Muscle Mass	$p = 0.2 > 0.05$	Normal
Non-Dominant Leg Skeletal Muscle Mass	$p = 0.2 > 0.05$	Normal

E. Paired Sample T-test

TABLE V
SKELETAL MUSCLE MASS

		Mean	Std. Deviation	t	df	Sig.(2-tailed)
Pair1	Pre - Post	-1.81	0.45	-4.06	14	0.01

Hypothesis 1: There is no significant difference of 5 weeks EMS training program on skeletal muscle mass. As shown in Table V, there was a significant difference in five weeks EMS training towards skeletal muscle mass when $p = 0.01 < 0.05$. Based on the findings, this study confirms reject null hypothesis 1. This showed that people who were using EMS have significant difference in skeletal muscle.

TABLE VI
UPPER BODY MUSCLE MASS

		Mean	Std. Deviation	t	df	Sig. (2-tailed)
Pair2	Pre - Post	-15.31	21.23	-2.79	14	0.01

Hypothesis 2: There is no significant difference of 5 weeks EMS training program on upper body muscle mass. As shown in Table VI, there was a significant difference in five weeks EMS training towards skeletal muscle mass when $p = 0.01 < 0.05$. Based on the findings, this study confirms reject null hypothesis 2. This showed that people who were using EMS have significant difference in upper body muscle mass.

TABLE VII
LOWER BODY MUSCLE MASS

		Mean	Std. Deviation	t	df	Sig. (2-tailed)
Pair3	Pre - Post	-3.11	1.34	-9.01	14	0.00

Hypothesis 3: There is no significant difference of 5 weeks EMS training program on lower body muscle mass. As shown in Table VII, there was a significant difference in five weeks EMS training towards skeletal muscle mass when $p = 0.00 < 0.05$. Based on the findings, this study confirms reject null hypothesis 3. This showed that people who had used EMS training have significant difference in lower body muscle mass.

TABLE VIII
DOMINANT HAND MUSCLE MASS

		Mean	Std. Deviation	t	df	Sig.(2-tailed)
Pair4	Pre - Post	-2.90	2.22	-5.05	14	0.00

Hypothesis 4: There is no significant difference of 5 weeks EMS training program on dominant hand muscle mass. As shown in Table VIII, there was a significant difference in five weeks EMS training towards skeletal muscle mass when $p = 0.00 < 0.05$. Based on the findings, this study confirms reject null hypothesis 5. This showed that people who were using EMS have significant difference in dominant hand muscle mass.

TABLE IX
NON-DOMINANT HAND MUSCLE MASS

		Mean	Std. Deviation	t	df	Sig. (2-tailed)
Pair5	Pre - Post	-2.84	2.00	-5.50	14	0.00

Hypothesis 5: There is no significant difference of 5 weeks EMS training program on non-dominant hand muscle mass. As shown in Table IX, there was a significant difference in five weeks EMS training towards skeletal muscle mass when $p = 0.00 < 0.05$. Based on the findings, this study confirms reject null hypothesis 5. This showed that people who were using EMS have significant difference in non-dominant hand muscle mass.

TABLE X
DOMINANT LEG MUSCLE MASS

		Mean	Std. Deviation	t	df	Sig. (2-tailed)
Pair6	Pre - Post	-1.38	0.85	-6.29	14	0.00

Hypothesis 6: There is no significant difference of 5 weeks EMS training program on dominant legs muscle mass. As shown in Table X, there was a significant difference in five weeks EMS training towards dominant leg skeletal muscle mass when $p = 0.00 < 0.05$. Based on the findings, this study confirms reject null hypothesis 6. This showed that people who were using EMS have significant difference in dominant legs muscle mass.

TABLE XI
NON-DOMINANT LEG MUSCLE MASS

		Mean	Std. Deviation	t	df	Sig. (2-tailed)
Pair7	Pre - Post	-1.73	0.75	-8.97	14	0.00

Hypothesis 7: There is no significant difference of 5 weeks EMS training program on non- dominant legs muscle mass. As shown in Table XI, there was a significant difference in five weeks EMS training towards non-dominant leg skeletal muscle mass when $p = 0.00 < 0.05$. Based on the findings, this study confirms reject null hypothesis 7. This showed that people who were using EMS have significant difference in non-dominant legs muscle mass.

F. Summary for Paired Sample T-test

This study used Paired Sample t-test to analyze the data. It suits the study, as Paired Sample T-test was the appropriate method to analyze the data of which involves the pre and post-test. Hypothesis testing was concluded by using the Paired Sample t-test. All the results show that the significant value towards the study has shown on Table XII.

TABLE XII
HYPOTHESIS RESULTS

Hypothesis	Value	Results
$H_0$1	$p = 0.01 < 0.05$	Reject null hypothesis
$H_0$2	$p = 0.01 < 0.05$	Reject null hypothesis
$H_0$3	$p = 0.00 < 0.05$	Reject null hypothesis
$H_0$4	$p = 0.00 < 0.05$	Reject null hypothesis
$H_0$5	$p = 0.00 < 0.05$	Reject null hypothesis
$H_0$6	$p = 0.00 < 0.05$	Reject null hypothesis
$H_0$7	$p = 0.00 < 0.05$	Reject null hypothesis

V. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

A. Introduction

This chapter shows the details on the discussions of the results towards the study, all the data that had been interpreted was discussed in this chapter to and to make conclusion towards the study and give recommendations towards the study if any areas of the study need to be improve or need to be forbid during the study.

B. Discussion

The findings of this study showed that there was a significant difference in 5 weeks intervention towards ($H_0$1) skeletal muscle mass, ($H_0$2) upper body of skeletal muscle mass, ($H_0$3) lower body of skeletal muscle mass, ($H_0$4) dominant hand of skeletal muscle mass, ($H_0$5) non-dominant of hand skeletal muscle mass, ($H_0$6) dominant leg of skeletal muscle mass and ($H_0$7) non-dominant leg of skeletal muscle mass. The results of this study shows the effectiveness of training using EMS, according to [9] suggested that EMS was more effective than exercise alone in strengthening skeletal muscle mass.

There were several factors that contribute to this study. EMS training should be done in high frequency in master intensity so that the pulses giving maximum contraction towards the muscle. According to [8], lower frequencies cause an unfused muscle contraction and [12] stated that the higher the intensity resulted in greater improvement however the more intense the training also can deepen the muscle soreness. Muscles were also fortified through the electrodes while doing low intensity of the training. This combination of both EMS and training can prompts an extra increment of tension creating effectives results. According to [9] stated that the electrically induced contraction must be in the range of 60-80% of maximal voluntary contraction (MVC) or master intensity. The lower the intensity the less effective it was towards the skeletal muscle.

In 21st century, people always wanted something that were less time consumed, so that they can spare a lot of time doing their work and their life and people also want something attractive to do. EMS training can give that to people who always in a hurry and want some attractive and high in technology. According to [11], training using the electrical muscle stimulation can gives an obvious and substantial progress in a brief time. According to [9], EMS has proven to be more attractive for many people to who do not have time or motivation to engage in traditional exercise programed.

Hypothesis 1: The findings of this study showed that there was a significant difference in 5 weeks EMS training towards skeletal muscle mass. It has showed that using EMS in training can increase skeletal muscle mass without lifting weight. It was also a time saving for people who want results in minimum time. In the training that had been conducted in this studies, the researcher use the frequencies that was suitable to increase skeletal muscle mass that was based and followed by the passed research. According to [15] stated that the electrically induced contraction must be in the range of 60-80% of maximal voluntary contraction (MVC) or master intensity. There were several factors that contribute to this study. EMS training should be done in high frequency in master intensity so that the pulses giving maximum contraction towards the muscle. According to [26], the higher the intensity resulted in greater improvement however the more intense the training also can deepen the muscle soreness. Previous study had supported the findings of this study by [26] stated that, EMS training was a good method to reduce widespread back pain yet also increases the body strength (relate with the muscle mass increment) and was equal to or better than results from conventional strength training.

Hypothesis 2: From the studies that had been conducted showed that there were increasing of upper body skeletal muscle mass towards the subjects. This was because due to the movement and exercise being focused on the upper body. This was assisted by the contraction of the pulses that made the upper body muscle contracted simultaneously during the training session. According to [24], training using the electrical muscle stimulation can gives an obvious and substantial progress in a brief time. According to [16] suggested that EMS was more effective than exercise alone in strengthening skeletal muscle mass. Previous study had supported the finding of this study by [13] EMS can help increase strength without getting any injuries compared to conventional gym that tend to give people injuries because

they need to lift high load in to order to achieve maximal strength. Another study by [11] that had been done toward chronic obstructive pulmonary disease (COPD) patients, it showed that EMS give some improvement towards muscle strength and exercise capacity during exercise.

Hypothesis 3: From the results of this study towards lower body skeletal muscle mass had shown us that EMS training can increase lower body skeletal muscle mass. It has proved that not only conventional strength training can improve skeletal muscle mass but also EMS training can increased skeletal muscle mass on lower body with more attractive and less time consumed. Reference [17] proved that EMS can be effective and become safe therapy to revert lower body (leg muscle wasting, enhance leg muscle strength) and improve activities of daily living and quality of life in patients with severe heart failure. Reference [27] found that, the intervention group had a trend towards an increase in quadriceps muscle strength with significant improvements in functional performance following by EMS prehabilitation. Previous study [16] stated that the electrically induced contraction must be in the range of 60-80% for making it possible to target the problem areas, body sculpt and increase strength in areas that people choose to focus on.

Hypothesis 4: Human beings make use of their hands in almost all of their daily activities. Every single person would have their own dominant side of the hands and this dominant hand side would have more strength as compared to the other. Understandably, people who are used to their dominant hand tend to have more skeletal muscle mass in their dominant hand, for example, right handed people having more muscle mass in their hands as a result of the increasing of strength on their right hand. In this regard, the EMS with its specific features used in the present study can be proposed as an efficient, non-exhausting alternative to enhance muscle strength and cardiorespiratory fitness [6]. Reference [23] founded that, in patients with COPD positive, statistically significant effects in muscle strength, exercise capacity, and health status were also noted after EMS application. Reference [19] found that a clinically significant improvement in strength of biceps associated with EMS treatment in septic patients.

Hypothesis 5: Using muscle less because of damage and muscle mass decreasing because of aging probably affect their grip strength. Based on the hypothesis testing, there was a significant difference towards non-dominant hand in 5 weeks intervention, this proved that EMS can increase skeletal muscle mass towards people dominant and non-dominant hand. Therefore, the strength is increasing because of increasing in skeletal muscle mass in dominant and non-dominant hand. Study [8] showed that EMS has been shown to have beneficial effects in terms of aerobic exercise capacity, muscle strength and quality of life for critical illness polyneuromyopathy (CIPNM) patients. Previous study had supported the findings of this study by [16] stated that the electrically induced contraction must be in the range of 60-80% of MVC which was being used in this experiment using Xbody machine, making it possible to target the problem areas, body sculpt and increase strength in areas that people choose to focus on.

Hypothesis 6: Leg muscle imbalance can caused human being injury, in this study the result of dominant and non-dominant leg muscle mass was significant, this proved that using EMS can increase and balance leg skeletal muscle. People tend to get injured in lower body extremities because of lack of muscle strength in leg areas. According to [7], muscular imbalances have been suggested to increase the risk of lower extremity injury. However, side-to-side strength imbalances in the range of 10% to 15% in other muscle groups have been associated with increased injury rates. Using EMS can increase skeletal muscle and balance it up because 90% of our muscle going to contract simultaneously during the exercise with EMS. Previous study from [13] states that EMS can help increase strength without getting any injuries compared to conventional gymnasium that tend to give people injuries because they need to lift high load in to order to achieve maximal strength. Reference [16] suggested that EMS was more effective than exercise alone in strengthening skeletal muscle. This was because during the penetration of impulses to the muscle, the CNS activates the smallest motor neurons and with increasing level of intensity, larger motor neurons are activated.

Hypothesis 7: According to [7], muscular imbalances have been suggested to increase the risk of lower extremity injury. However, side-to-side strength imbalances in the range of 10% to 15% in other muscle groups have been associated with increased injury rates. Human being tends to use their dominant leg rather than their non-dominant leg. That was why the non-dominant leg skeletal muscle mass usually would be lesser compares to dominant leg skeletal muscle mass. Using EMS as a tool for training can help increase and balance leg skeletal muscle mass whether it was dominant and non-dominant, because the contraction was equal in each muscle. Previous study by [13], states that EMS can help increase strength without getting any injuries compared to conventional gym that tend to give people injuries because they need to lift high load in to order to achieve maximal strength. Reference [14] stated that, the intended use of EMS in this review can be operationally defined as its impact upon quadriceps strength, functional performance, and self-reported function. Reference [19] found that a clinically significant improvement in strength of quadriceps associated with EMS treatment in septic patients.

C. Conclusion

The study objective was to identify if EMS training affect the skeletal muscle mass of subjects that attends the training at Impulse Studio Bangsar. There were seven variables that being tested (pre and post-tests) to collect the data. Paired sample t-test was used as the method to analyze data for pre and post-test for the hypotheses testing. In this study, EMS training did give effect to the increment of strength that directly cause by the increment of muscle size. Previous study had mentioned before by [10], loss of muscle mass was associated with the decline in strength and in contrast muscle

mass increment lead to the increment of strength. Therefore, this study assume that improvement of the skeletal muscle mass, upper body skeletal muscle mass, lower body skeletal muscle mass, dominant, and non-dominant hand skeletal muscle mass and also dominant and non-dominant leg skeletal muscle mass can be in line with past study. However, to prove that the results did not come by chance, more research should be performed to determine that this significant effect were consistent. Based on this study all the result we significant towards all the variables. This findings as a beneficial to all human beings that in searched for healthy life style and also good for athletes. Academician can also share the information from this research with the students or athletes.

D. Recommendations

More research on EMS training should be performed in the future, in order to search for new alternatives and to prove on the effectiveness of EMS training especially on athletes. The following were the possibilities for future research based on the findings of this study:

i. Variations of training programs may give an opportunity for EMS training to show greater results.
ii. The study should be performs towards athletes for example national athletes.
iii. This study should also be performed in order to check if there were any different towards body fat percentage.
iv. This study should also be performed in longer period, so that we can study the effectiveness of EMS training in long period of time, for example 8-12 weeks of interventions.
v. The intensity of the training should be increase, for example 80–100% of MVC.
vi. This study should also being test with different type of EMS machine.
vii. This study should also being performed towards female subjects in order to see the different in effectiveness with the male subjects.
viii. This study should also being tested and combined with resistance training to see the effectiveness of combination EMS training and resistance training.

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