A STUDY AND COMPARISON OF BIOIMPEDANCE PARAMETERS DURING FOOT MASSAGE REFLEXOLOGY USING AROMA OIL

SAEED AHMED

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ABSTRACT

Massage is one of the most common therapeutic techniques for muscle relaxation and pain reduction. It is used for maintaining the condition of the body and treating human diseases for thousands of years. Foot massage basically is a massage treatment around the calf muscle until underneath foot area where it initiates stimulation to anatomical organs. In this thesis, the bio impedance parameters (BI) of people undergoing reflexology therapy are analyzed. A comparison between bio impedance (BI) parameters of a subject using aroma oil is measured before and after the massage, to see improvement of the hydration level of cells. The measurement of bio impedance parameters is done by using Bodystat Quadscan 4000. The main purpose of this study is to investigate the effect of reflexology in terms of resistance (R); reactance (X); impedance (Z); Phase angle; and capacitance (C) of male and female subjects that can be measured as bio impedance (BI) parameters. All these parameters are analyzed by using statistical analysis program called SPSS. The result showed that there is significant difference between the mean of each bio impedance parameters of before and after massage therapy. This makes us conclude that conclude that reflexology massage treatment does have a significant effect in improving cell hydration levels.

ABSTRAK

Urut adalah salah satu teknik yang paling biasa terapeutik untuk relaksasi otot dan pengurangan kesakitan. Ia digunakan untuk mengekalkan keadaan badan dan merawat penyakit-penyakit manusia selama beribu-ribu tahun. Urut kaki pada asasnya adalah satu rawatan urut di sekitar otot betis sehingga mengalir di bawahnya beberapa kawasan kaki di mana ia memulakan rangsangan kepada organ-organ anatomi. Dalam tesis ini, parameter impedans bio (BI) orang yang menjalani terapi refleksologi dianalisis. Satu perbandingan antara bio galangan (BI) parameter subjek yang menggunakan minyak aroma diukur sebelum dan selepas urut, untuk melihat peningkatan tahap penghidratan sel-sel. Pengukuran parameter bio impedans dilakukan dengan menggunakan Bodystat Quadscan 4000. Tujuan utama kajian ini adalah untuk mengkaji kesan refleksologi dalam tempoh rintangan (R); regangan (X); galangan (Z); Fasa sudut; dan kapasitan (C) subjek lelaki dan perempuan yang boleh diukur sebagai bio parameter impedans (BI). Kesemua parameter ini dianalisis dengan menggunakan program analisis statistik yang dipanggil SPSS. Hasilnya menunjukkan bahawa terdapat perbezaan yang signifikan antara min setiap parameter impedans bio sebelum dan selepas terapi urut. Ini menjadikan kita membuat kesimpulan bahawa menyimpulkan bahawa rawatan urut refleksologi tidak mempunyai kesan penting dalam meningkatkan tahap penghidratan sel.

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Name of the candidate: **Saeed Ahmed** (I.C/Passport No. **Z1809310**)
Registration/Matric No: **KGL090013**

Name of the Degree: **Master of Engineering (Bio Medical Engineering)**

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To my revered father Naseem Ahmed and to my beloved mother Rabia Fatima who have made endless sacrifice throughout their life. Thank you very much. Not a day goes by without remembering their love and sacrifices. *Jazakumallah KhairaljazÉ'. RabÊ iqfirli wa li-walidayya wa irham humÉ kamÉ rabbayÉnÊ Îagira.*

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LIST OF ABBREVIATIONS

ANOVA	Analysis Of Variance
BI	Bio-Impedance
BIA	Bio-Impedance Analysis
BMI	Body Mass Index
DOF	Degrees of Freedom
FFM	Fat-Free Mass
PCM	Phase Changing Materials
TBW	Total Body Water

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

The word “massage” originates from the Arabic word “mass”, which means to touch or feel. Massage is basically a physical therapy treatment which can be categorized as rehabilitating medicines, which adapts all forms of mechanical, electrical, thermal, chemical and radioactive energy for therapeutic purposes (wikii 2008). Massage has been known since ancient times of Ayurvedic medicine and was well established by the Romans. Therapeutic practices were also mostly being used by the ancient Chinese, Japanese and Greeks. However only after the decline of the Roman Empire, its practice was introduced again to the Europeans as “Turkish massage” through the writings of de Chauliac in the 1300s and Pare’ in the 1500s (Scull CW 1945; Kamenetz HL 1985). The west showed much interest in massage in the early nineteenth century after the French missionary worked in China. Ling in Sweden, followed by Metzger in Holland, as well as Tissot and Georgii in France, spread the use of massage in Europe.

Furthermore, (Kamenetz HL 1985) presented the history of the therapeutic massage starting in the early civilizations of Babylon, Assyria, China, India, Ancient Greece and Rome and stated that in the 20th century massage has shown significant development in order to be studied and researched. However, (Kamenetz HL 1985) noted that massage had declined over the greater part of the 20th century and proposed three reasons for this decline:

1. The development of the pharmaceutical industry
2. New machines supplanted older forms of physical therapy
3. Dehumanization in the relationship between therapist and patient.

A researcher (Scu11 CW 1945) recommended massage in controlling significant features of diverse syndromes such as poliomyelitis, anemia, arthritis, cardiac edema and nervous conditions. However the physiological basis for these techniques was speculative. The application of physical therapy like rest, massage, heat and exercise became more machine related and required a person with more technical understanding of anatomical, physiological and pathological knowledge to administer these stimuli with use of new machines and instruments using X-rays and radium. Gradually the use of massage advocated by Scull disappeared from hospital physiotherapy departments; but has remained in the sporting industry for the conditioning of athletes (Kamenetz HL 1985).

1.2 RESEARCH PROBLEM AND PROBLEM STATEMENT

Over the past years, massage has been used solely as a method of relaxation, without much evidence of its scientific benefits. However, recently reflexology has found its importance in medicine, in particular healing therapy as a pain reliever therapy where the study aims to find bio impedance parameters during root massage reflexology using aroma oil. In this analysis muscle activity of a subject is monitored by a measuring device.

1.3 RESEARCH OBJECTIVES

To achieve the objectives, this research focuses to clearly set the following objectives:

1. To measure body composition data for before and after foot massage using aroma oil.
2. To analyze the result of body composition of the subject before and after massage, by using statistical tools.

3. To validate the results by comparing the bio impedance parameters before and after fool reflexology treatment.

1.4 HYPOTHESIS

It can be hypothesized that the foot reflexology therapy technology will bring in beneficial changes in the body composition of subject and increase clarity of the mind, rejuvenate and balance energy and emotions. Moreover attain effective measurement based on quantitative analysis.

1.5 SCOPE OF STUDY

The scope of this research covers a vast range of population or subjects being exposed to the foot reflexology therapy. This study is conducted based on the regularity of the subject's foot reflexology therapy, i.e. weekly basis or going for the therapy for the first time. Hence, this study is directed to measure the bio impedance of the subjects before and after the foot reflexology therapy.

1.6 SIGNIFICANCE OF THE STUDY

It is envisaged that the benefits for undertaking foot reflexology therapy will effectively relax and heal an individual. Previously foot reflexology therapy did not have much scientific findings of its impact. However this research aims to quantitatively measure the effects of foot massage on a person's health before and after the foot reflexology therapy and justify the claim that foot reflexology therapy technology will bring in beneficial changes in the body composition.

1.7 REPORT OUTLINE

This thesis is organized as follows. Chapter one is an introductory chapter, which begins with a brief introduction on history of massage. It then narrows the discussion down to problem statements for this study. The hypothesis is declared and the scope of study has been explained, followed by the significance of the study in this report for achieving research objectives of this study.

Chapter two reviews the relevant literature, providing the ground work for the methodology of this work to study the bio impedance parameters during therapy root massage reflexology using aroma oil.

Chapter three, “Methodology”, presents the details of the measurement techniques being carried out.

Chapter four, “Results, Analysis and Discussion”, analyses the results of the foot massage therapy. The measured result is then compared between the bioimpedance of the foot massage treatment before and after. There is a discussion of the acquired results.

Chapter five, “Conclusion and Recommendations”, concludes by summarizing what the research work in this thesis has achieved. It gives a precise account of the extent to which the objectives have been accomplished, and elaborates on further ideas that are suggested to be carried out as an extension of this work.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter begins with a general description on the different types of massage therapy techniques, followed by an explanation on the types of oil used in foot massage. It further extends its discussion to related research undertaken and reported in the context of massage reflexology. In this study foot massage therapy is being conducted because in most of the regions of Malaysia and South East Asia, there is an increasing number of foot massage parlors' springing-up, thus learning the authenticity of this kind of massage has brought interest in the study of foot massage techniques. Moreover, other massage techniques like the Traditional Thai massage and Medical massage have been studied previously including here at University of Malaya. However the most common oil used commercially with foot-massage reflexology is the aroma oil; thus in this study aroma oil is being used for the foot-massage therapy.

2.2 BACKGROUND

Massage can be defined as the soft tissues manipulations of the body performed by using hands for providing relief on the vascular, muscular and nervous systems of the body. Several techniques of massage have been introduced by massage therapist during the last few decades. Most of these massage techniques have been evolved through hereditary knowledge. The main purpose in the development of massage techniques is to provide beneficial healing properties to a human body. With growth in age muscles tend to create difficulties and pain to human body, hence massage therapy will help a great deal in relieving severe tension in the muscles and in re-energizing the body, mind and soul, eliminating physical and mental uneasiness (wikii 2012).

2.3 TYPES OF MASSAGE AND TECHNIQUES

There are several massage therapy techniques available at the present time, and these techniques are being practiced worldwide by specific group of people such as massage therapists, athletic trainers, physical therapists and alternative medicine practitioners. A few of the massage techniques including foot massage reflexology therapy are detailed as follows:

2.3.1 Breema Massage

Breema massage is commonly known as partner of yoga or Thai massage. This type of massage aims to bring the body and mind together without exerting a high level of force/pain or muscular contortions (Pendergrast 2002). The driving force behind this massage involves nine basic principles of harmony. The main teaching center for this massage is the Breema Center in Oakland, CA – USA, in which more than 300 exact Breema sequences are taught (Frey 2006).

2.3.2 Champissage Massage

An Indian head massage known as champissage massage. Champi comes from a Hindi word meaning practice or massage. The champissage treatment begins with massage of the upper back, shoulders, upper arms and neck to melt fatigue. This is followed by a scalp massage, which is a series of integrated techniques (Massage 2005). This technique is designed in order to stimulate the scalp to improve blood circulation.

2.3.3 Barefoot Deep Tissue Massage

Barefoot deep tissue massage is generally termed as barefoot sports massage. This technique of massage allows the therapist to use his feet to apply pressure via the heels, instead of his hand (wikii 2010).

2.3.4 Deep Tissue Massage

Deep tissue massage technique is usually recommended to athletes suffering from chronic pain in the back, neck, shoulders, or knees. This technique applies pressure on the muscles located below the surface of the top muscles and is designed to ease symptoms of chronic pain, increase functional range of motion, and improve posture (wikii 2010).

2.3.5 Swedish Massage

Swedish massage was developed by the Dutch practitioner Johan Georg Mezger. This massage uses several massaging techniques which includes; long strokes, kneading, friction, tapping, percussion, vibration, effleurage, and shaking motions. It is known to be quite helpful in reducing pain, joint stiffness, and improving function in patients with osteoarthritis of the knee, thus promoting health and well-being (wikii 2008).

2.3.6 Stone Massage

A massaging technique in which, the therapist uses smooth, heated stones, to apply pressure and provide heat to the body. Furthermore oil coated stones are also used sometimes by the therapist for delivering various massaging strokes. The hot stones used in stone massage are Basalt stones or lava rocks. These stones are very polished and smooth, and retain heat (wikii 2009).

2.3.7 Thai Massage

This massage is also known as "traditional massage" in Thailand. This massage was originally started by the Indians based on the principles of ayurveda and yoga. Thai massage therapy uses yoga-like positions. The northern style of Thai massage emphasizes on stretching whereas the southern style emphasizes on acupressure. Thai massage is usually done on a padded mat on the floor without the application of any oil (wikii 2008).

2.3.8 Chinese Massage

Chinese massage can be categorized into two major types, Tuina and ZhiYa. Tuina Chinese massage emphasizes mainly on pushing, stretching and kneading the muscle. Other applications like friction and vibration are also adapted in this massage. ZhiYa chines massage emphasizes on pinching and pressing at acupressure points. (wikii 2006).

2.3.9 Medical Massage

Medical massage is vague term used in the profession of massage. It is known to be a specific medical therapy used for lymphedema which can also be utilized in conjunction with breast cancer treatment (Lim SH January 1998).

2.3.10 Foot Massage

Foot massage is a familiar massage technique known among the other massage techniques. There are several types of foot massage, however in this work much focus is given to reflexology, as it has gained an intense popularity in many countries such including United States, United Kingdom, China, and Japan apart from the Asia region.

Reflexology is a kind of healing or aided physical care method which is performed by massaging or by stimulating predefined reflex regions on the feet where

they represent specific organs of the human body to improve general health of the individual (sees Figure 2.1 for reflex areas on the foot). Moreover foot reflexology is used as an a relaxation therapy without any side effects for patients suffering from effect of diabetics (Mars M Feb 2008), cancer (Quattrin R 2006 Mar; Stephenson NL Jan 2007), post-operative pains (Wang HL 2004 Jun), menopausal effects (Williamson J 2002 Sep), high blood pressure (Park HS Aug 2004), renal problems (Sudmeier l et al Jun 1999) and general aging (Lee YM 2006 Feb).

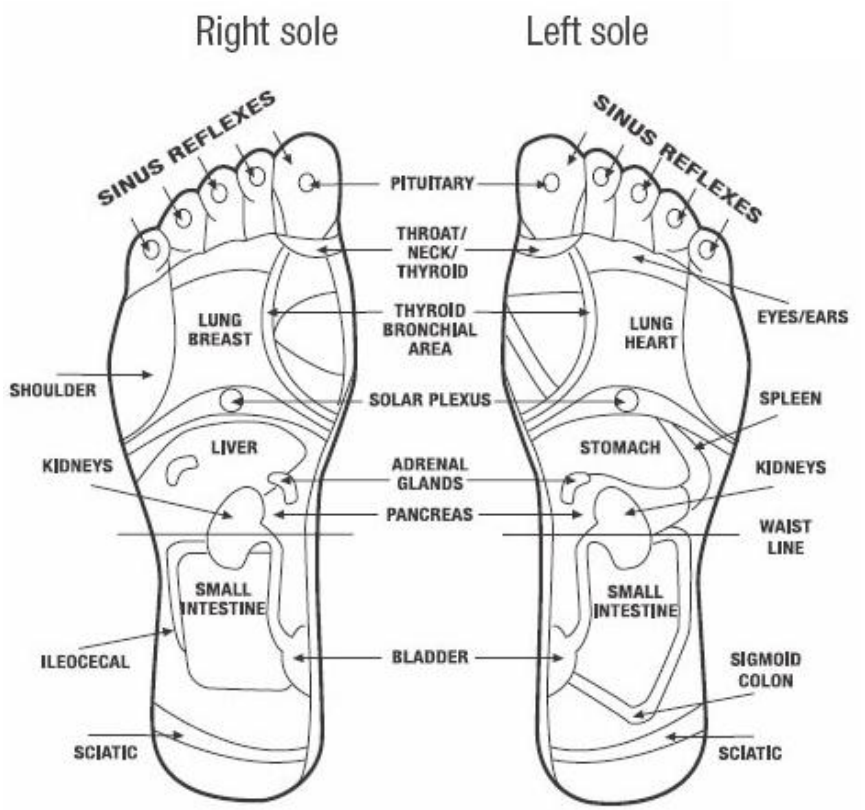

Figure 2.1: A basic reflexology foot chart indicating the reflex areas on the foot.

(Wikii 2008)

2.4 HEALTH BENEFITS OF MASSAGE THERAPY

(Solis 2009) detailed the benefits of massage, in his work, as he stated that the massage therapy is useful for the restoration of better health in various conditions like oral health problems. In another paper (Jingguo Wang; Yangmin Li* 2010) demonstrated his work of massaging human feet by using 7-DOF redundant manipulator with tactile sensor installed at the end-effector. A massaging therapy described (Jingguo Wang; Yangmin Li* 2010) focused on the massage of the torso and limbs for beneficial effects. Simulations and real experiments were carried out to confirm the effect of the massage provided by the 7-DOF, for reflexology in order to track the desired massaging trajectory. (Chang-Ren Chen 2002) illustrated an innovative approach of designing foot massage and analysing heat energy storage and release by using PCM. In his work the aim of the proposed approach was to develop a foot massaging technique which will be able to reduce the loss of heat energy from the water which was used in the massage therapy, thus reducing cost effectively.

An extensive study was undertaken (Ferrel-Torry & Glick 1993), which led to the understanding of vital benefits of patients receiving massage over the years. Table 2.1 below presents the physical comforts and benefits attained by massage therapy.

Table 2.1

Physical advantages gained by massage

Increased circulation of blood (Sudmeier I et al 1999)
Relief of pain and tension (Lee YM 2006)
Improved sleep (Lee YM 2006)
Healing of diabetic foot ulcers. It has been found that by using compressed air massage the time for its healing is decreased (Mars M 2008)
The patients after a surgery often have pains. The use of foot massage and hand massages to the patient after having undergone an operation has shown that there is reduction in pain scores, and beneficial restoration of heart rate and respiratory rate. (Stephenson NL 2007)
Patients suffering from cancer may experience discomfort in their bodies and minds. The use of massage reflexology has been used as complementary therapies with traditional medical treatments to cancer. Research on this topic has shown that use of massage in cancer patients decreases their anxiety, pain intensity, nausea, vomiting and fatigue. (Quattrin R 2006), (Stephenson NL 2007)
The main reason of Peripheral artery disease is hardening and narrowing of the arteries, which after some time result in decreased blood flow. The usage of Acupressure has shown to increase blood flow in such cases (Lim SH 1998)

Moreover, specific benefits of foot-massage reflexology have been detailed earlier in section (2.3.10).

2.5 TYPES OF OIL USED IN MASSAGE

One of the key features of massage is in the use of oils. The usage of the oil in most cases reduces anxiety or promotes relaxation to increase well-being of the patients. It may also act as a means of relieving depression, reducing stress, soothing, sedating or stimulating the body and mind, and restoring both physical and emotional well-being (Wilkinson S 1999). There are several types of oils for massage having different beneficial properties, such as fractionated coconut oil, grape seed oil, olive oil, almond oil, apricot kernel oil, jojoba oil sesame oil, cocoa butter, shea butter, commercial foot massage cream (aroma oil), and leech oil (wikii 2011). In this work much focus is given to Commercial Foot Massage Cream (Aroma Oil) which consists of aqua, paraffinum liquidum, petrolatum, cera alba, cetearyl alcohol, trethanolamine, stearic acid, perfume, tetraborates, methylparaben and propylparaben. This aroma oil is widely being used and claimed by reflexologists to be very relaxing and effective for foot massage treatment, hence this work will further study its quantitative effects.

2.6 BIOELECTRIC IMPEDANCE ANALYSIS

Bioelectric Impedance Analysis of simply Bioimpedance Analysis (BIA) is a technique related to impedance and body water content. BIA is used for the estimation of the body composition using the concept of dealing with the difference in conductivity in biological tissues. The main function of this device is to determine the electrical impedance of the body tissues through which total body water (TBW) can be estimated easily. (Kyle, Bosaeus et al. 2004) highlights the use of bioelectrical impedance analysis to measure electrical current flow in tissues which is initiated by the heart. This type of electricity is considered to be endogenic, that is generated by the tissue itself. Extensive study has been done by (Thomasset A 1962; Thomasset A 1963) for the measurement of electrical impedance as an index of total body water (TBW), using two subcutaneously

inserted needles. However (Boulier A 1990), stated that the surface electrodes has a disadvantage. It requires high current (800 mA) and high voltage to be applied for reducing the instability of injected current related to cutaneous impedance (10000 O/cm^2). However, furthermore BIA can work via wireless means, thus being portable and safe for recording bioimpedance measurements. Researchers have studied the reliability and accuracy of the BIA machine and identified that it is a useful and reliable tool in the measurement of body impedance parameters as long as a standardized protocol is established to reduce possible causes or error and variability (J.R. Dobratz 2007).

2.6.1 Principle of Bioimpedance Analysis

The principle of BIA is based upon the principle that the human body is assumed to be a homogeneous cylinder composed of arms, legs and trunk, thus allowing calculation of the total body water and mass of body fat. Figure 2.2 shows the cylindrical homogenous conductor, assumed to be a human body. By analysing this assumption into a formula that impedance of a cylindrical homogenous conductor is proportional to the length of conductor and inversely proportional to the square length and inversely proportional to impedance as shown in Equations 2.1 and 2.2 (Gang 2005).

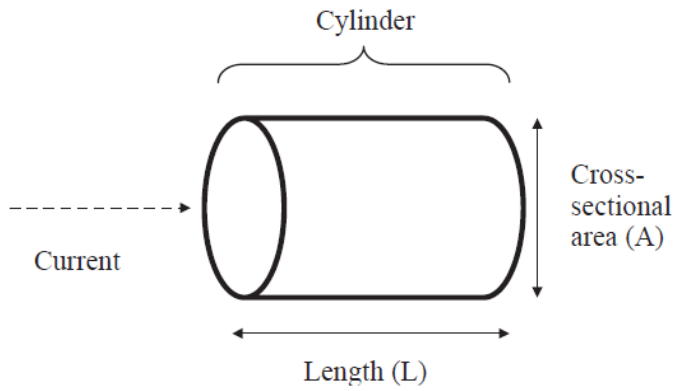

Figure 2.2: Cylindrical homogenous conductor (Kyle, Bosaeus et al. 2004)

$$Z = \rho \frac{L}{A} \tag{2.1}$$

$$Z = \rho X \frac{Length}{Area} X \frac{Length}{Length}$$

$$Z = \rho X \frac{Length^2}{Volume}$$

$$Volume = \rho \frac{Height^2}{Z} \tag{2.2}$$

Where

Z- is the impedance

L- is the length

A- is the cross-sectional area

ρ - is the specific resistivity

2.7 BIO IMPEDANCE PARAMETERS

Mainly there are five bioimpedance parameters which are being used in this study.

1. Impedance

According to Ohm's Law, the impedance (Z) is depended on frequency and opposes a conductor for the flow of alternating current. Impedance (Z) can be defined as the ratio of voltage to current, thus this can further be illustrated by Equation (2.3).

2. Resistance

All substances have resistance to the flow of an electric direct current (DC). According to Ohm's law the resistance of a substance is proportional to the voltage drop of an applied current as it passes through a resistive substance,

$$\text{Resistance}(\text{ohms}) = \frac{\text{appied voltage drop } (\text{volts})}{\text{current } (\text{amps})} \tag{2.3}$$

In the body, highly conductive lean tissues contain large amounts of water and conducting electrolytes, and represent a low resistance electrical pathway. Fat and bone, on the other hand, are poor conductors or a high resistance electrical pathway with low amounts of fluid and conducting electrolytes (Rudolph J. Liedtke 1997).

3. Reactance/ Capacitance

Reactance is the opposition to the instantaneous flow of electric current caused by capacitance. However reactance is also known as capacitive reactance when describing biological tissues.

$$\text{Reactance}(\text{ohms}) = \frac{1}{2 \times \pi \times \text{frequency} \times \text{capacitance}} \tag{2.4}$$

Where:

Reactance is expressed in Ohms

Frequency is expressed in Hertz

Capacitance is expressed in Farads

PI = 3.1428

Theoretically, reactance is a measure of the volume of cell membrane capacitance and an indirect measure of the intracellular volume or body cell mass. Whereas, body fat, total body water and extracellular water offer resistance to electrical current, only cell membranes offer capacitive reactance. Since fat tissue cells are not

surrounded by cell membranes, reactance is not affected by the quantity of body fat (Rudolph J. Liedtke 1997).

4. Phase angle

Phase angle is a linear method of measuring the relationship between resistance and reactance in series or parallel circuits. Phase angle can range from 0 to 90 degrees; 0 degrees if the circuit is only resistive (as in a system with no cell membranes) and 90 degrees if the circuit is only capacitive (all membranes with no fluid). A phase angle of 45 degrees would reflect a circuit (or body) with an equal amount of capacitive reactance and resistance (Rudolph J. Liedtke 1997).

5. Illness Marker

For simplicity, the Bodystat Quadscan machine uses an 'illness marker' using the index between Impedance values at frequencies 5 kHz and 200 kHz. This approach uses only factual raw data measurement and does require the use of the latest in multi-frequency electronic technology. As a rule of thumb for healthy people with good cellular nutritional status, this illness marker is around 0.75 and for very fit people, even lower. In the case of critically ill subjects, with poor and deteriorating cellular status, this "Illness Marker" may increase to around 0.86 and higher. As a subject approaches death, the ratio would therefore become even closer to 1.00 (wikki 2010).

2.8 BODY COMPOSITION ANALYSIS DEVICE

Quad Scan 4000 is a device used for measuring the body composition analysis based on measuring the current flow from body (impedance) when frequency is applied; it offers a quick, easy economical, portable and non-invasive means to record fluid assessment and hence perform body composition analysis. Figure 2.3 shows the picture of Quad Scan 4000.

Figure 2.3: Body composition analyser Quad Scan 4000 which is used in this study

CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

This chapter contains the methodology used for this study. Bio impedance analyzer is used to measure the bio impedance parameters before and after reflexology massage.

3.2 RESEARCH METHODOLOGY

The research is conducted through the following steps

1. Subjects were recruited amongst Kota Damansara and PJ Section 17.
2. Consent form was filled by the subjects.
3. The data base system was constructed i.e. using the bioimpedence machine to store the readings and then transferring them to the computer before the memory becomes full.
4. Subject particulars like age, height, weight, intensity of physical activity, frequency and reason for taking foot massage were noted before reflexology therapy.
5. Data measured before reflexology.
6. Subjects underwent the reflexology using aroma oil.
7. Data measured after the reflexology therapy.
8. Analyze the results obtained using statistical analysis.

The research methodology is further elaborated with a block diagram as show in Figure 3.1.

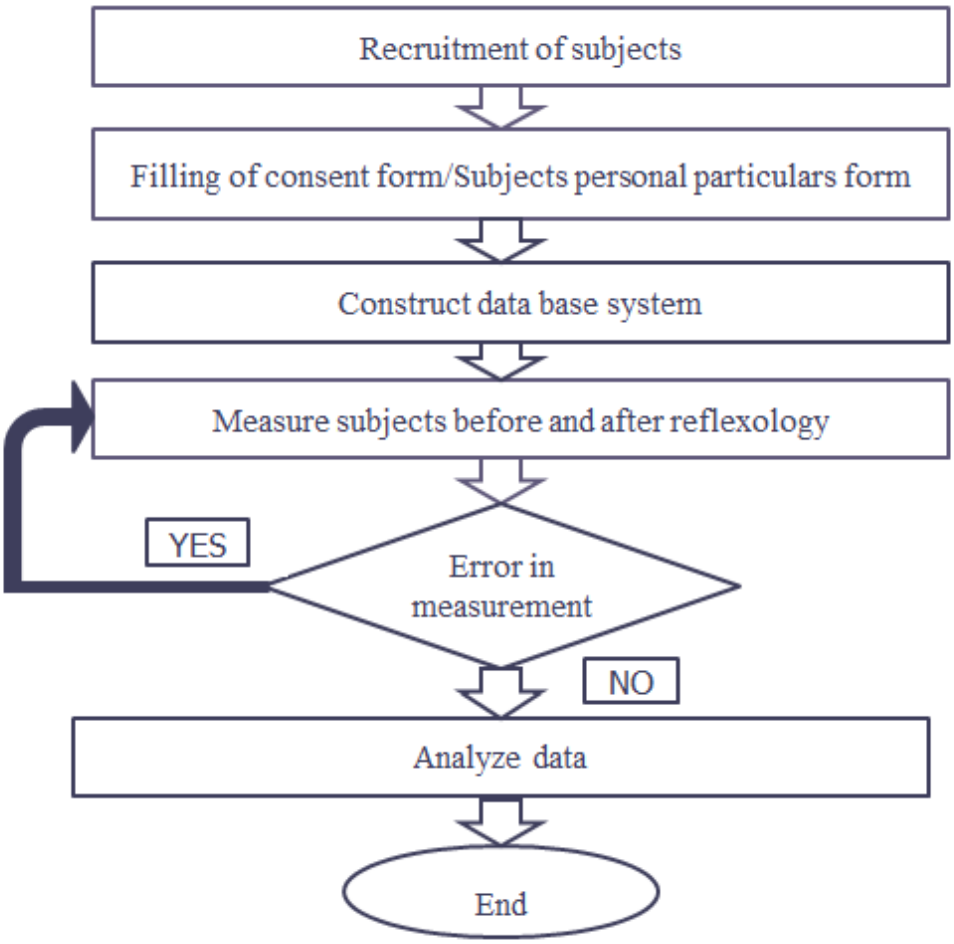

Figure 3.1: Research methodology flow chart

In this schematic, error in measurement is mentioned and this only occurs when sensors are not placed firmly to the body or when the electrodes are not attached properly to the sensors. This error is detected by the body composition analyzer equipment which displays an ‘error’ message or gives a very high value i.e. greater than 10 for the illness marker.

Even though there is no quantitative measurement of relaxation, subjects were asked if they felt relaxed, and all of them agreed that foot-massage made them feel relaxed. Some felt pain during the massage, but after the massage they felt relaxed.

3.3 SUBJECTS / PARTICIPANTS

A total number of 50 subjects participated in this study, from these 40 participants were male and 10 were female. The location selected for this study was a popular Reflexology Spa in Giant Mall of Kota Damansara and International House of University of Malaya. The participants were required to give their personal details as listed below. A sample of the personal particulars form is given in Appendix A.

- Age
- Weight
- Frequency & purpose of having refleogy
- Passport/ I.C
- Height
- Physical activity
- Sex

First the subjects filled their personal detail form. Height and weight was recorded before the measurement session began. Subjects were asked to remove their shoes when their height and weight were being recorded. This is to minimize errors during the calculation of BMI. Standing height and weight were used to calculate the BMI (kg/m^2) of the participants.

Out of these 50 subjects/participants, the first 25 used Leech oil on the right foot and Aroma oil on the left foot. For the remaining 25 subjects, the oils were interchanged on the legs i.e. Aroma oil on the right foot and Leech oil on the left foot. The subjects were categorized into three age groups. The age groups were between 21-30; 31-40 and 41-50. The races of the subjects were South East Asia, South Asian, Arab, Iranian, African and Caucasian; however the maximum number were South East Asian and South Asian. Each reflexology session required approximately 30 minutes, 15 minutes for each feet.

3.4 CONDUCTING BIA MEASUREMENT

The lean tissue present in the body mainly comprises of water and electrolytes, the electrolytes allows conductivity with the electric current, and the existing fat inside the human body acts as an insulator, making use of this understanding can assist in the measurement of impedance of the body. The relationship between impedance and fat free mass (FFM) is determined by regression equations.

3.4.1 Subject Test Position

Firstly the subject is made to sit in the foot massage position, with his / her back straight in a sitting position and legs stretched (fowler's position). Self-adhesive disposable electrodes shown in the Figure 3.2 are attached to the leg; one set on the knee (one above and one below the knee) and the other on the foot (one above toes and the other on top of the ankle) to measure the bioimpedance in the leg from knee to foot. The Body stat Quad Scan 4000 unit has two main lead wires colored red and black. The red lead is the power source or the injecting lead which sends signals through the body, whereas the black lead is the sensing or measuring lead. It does not matter which of the two sets of main leads are connected to the knee or foot, however, it is important to remember that, just above the knee and toe the red leads are connected, whereas the black leads are connected on the electrodes below the knee and on the ankle. If the leads are not properly connected to the body, the current cannot be transmitted effectively and the impedance measurement will be inaccurate (very high) or an error message will be displayed in the machine. For convenience sake, the metal tab on the electrode should point in the same direction as the length of the wires on each set of electrodes is not very long (see Figure 3.3 for electrode positioning).

Figure 3.2: Electrodes used with Quad Scan 4000

Figure 3.3: Electrode position on knee and foot

3.4.2 Data Measurement

Quad Scan 4000 Bio impedance analyzer is used to measure body composition parameter of the subjects. Before taking the readings of the subjects, their basic information (age, gender, height, weight, exercise activity) has to be keyed into the measuring device (Quad Scan 4000). The overall procedure is given below.

1. Patient lies down in the correct position (fowler's position with legs stretched straight). Care is taken to make sure that the patient's body parts do not touch each other.

2. The electrodes are then placed on to the patient's leg, while attaching the crocodile clips to the electrodes (clips to the metal tab strip of the electrodes back to foot and knee).

3. Quad Scan 4000 unit No. 56 is used for recording the measurements.

The stored results are then downloaded from the device via Bluetooth into the bodystat software. The data collected is then converted and saved in MS Excel format. Furthermore by using SPSS 19 software, Independent T-test, ANOVA and Pair T-test analysis is carried out on the data.

3.5 STATISTICAL ANALYSIS

The data obtained using Quad Scan 4000 is then further analyzed by statistical analysis, which is was carried out using the software SPSS version 19.0 for Windows (SPSS Inc., Chicago U.S.A) and Microsoft Office Excel version 2007. Microsoft Office Excel 2007 is a common application for Windows, can be easily used and provides several options for performing mathematical calculations and plotting graphs.

SPSS 19.0 for Windows is user-friendly and interactive software, specialized for statistical analysis, and we have used it for our data analysis.

3.5.1 Analysis of Demographic Variables

Before proceeding with the test and measurement, each patient were asked to fill up the patient information form (see Appendix A) for demographic analysis. The necessary particulars the patients had to fill were; IC/Passport number, age, gender, weight, height, profession, exercise activity level and the frequency and purpose of getting the foot reflexology therapy. Once participant data has been obtained, measurements can then be taken for further processing and data analysis.

3.5.2 Analysis of Bio-Impedance Parameters

The main objective of this research work is to investigate the foot massage effect in human body in terms of resistance (R); reactance (X); impedance (Z); Phase angle; and Illness marker of male and female subjects that can be measured as bio impedance (BI) parameters. The body composition parameters are automatically calculated based on specific formulae stored in the device using the measured bio impedance (BI) parameters. Table 3.1 highlights the main and secondary BI parameters.

Table 3.1

Main and Secondary Bio impedance Parameters

Bio impedance Parameters	**Frequency**
Impedance	5 kHz
Impedance	50 kHz
Impedance	100 kHz
Impedance	200 kHz
Resistance	50 kHz
Reactance	50 kHz
Phase Angle	50 kHz
Illness marker	-

3.5.3 Comparison Analysis

A comparison between bio impedance parameters before foot massage treatment and after the massage treatment is carried out. The overall comparison is further extended by carrying out the pair t-test, without considering the interaction with independent variables. Figure 3.4 shows a screen shot of the paired t-test analysis, whereas Figure 3.5 presents the screen shot for independent t-test analysis, which is used for the analyzing the effect of gender on the bio impedance parameters. Moreover for other independent variables, ANOVA is used with POST hoc tests for multiple variable comparisons, and a screen shot of its procedure is shown in Figure 3.6.

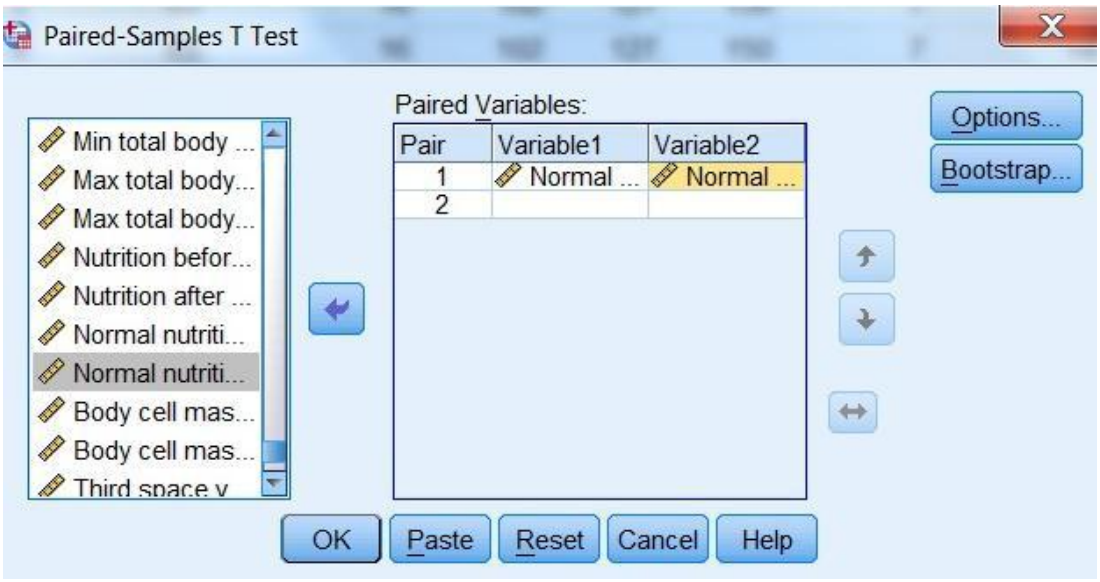

Figure 3.4: Windows pop up for Paired –Sampled T-Test analysis.

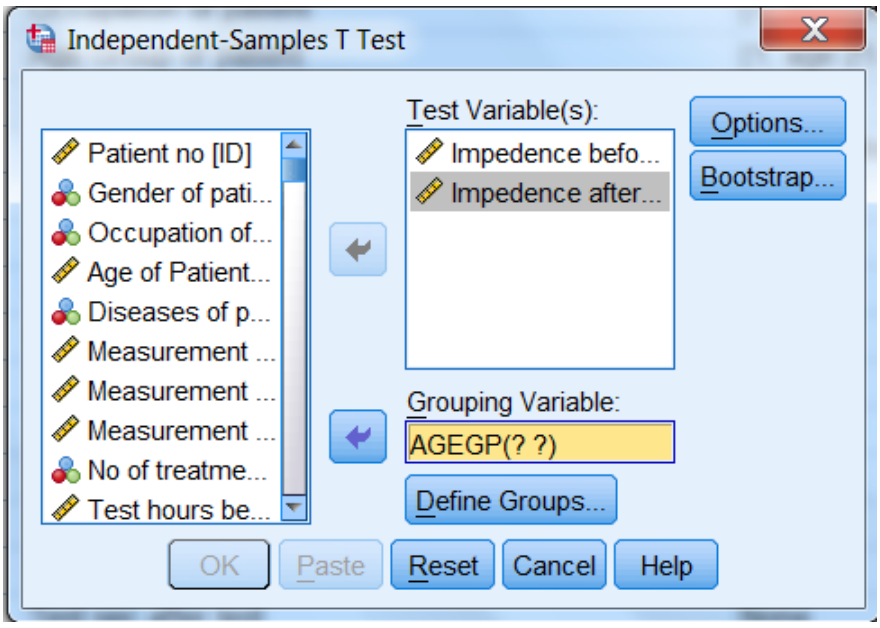

Figure 3.5: Windows pop up for Independent sampled T-Test.

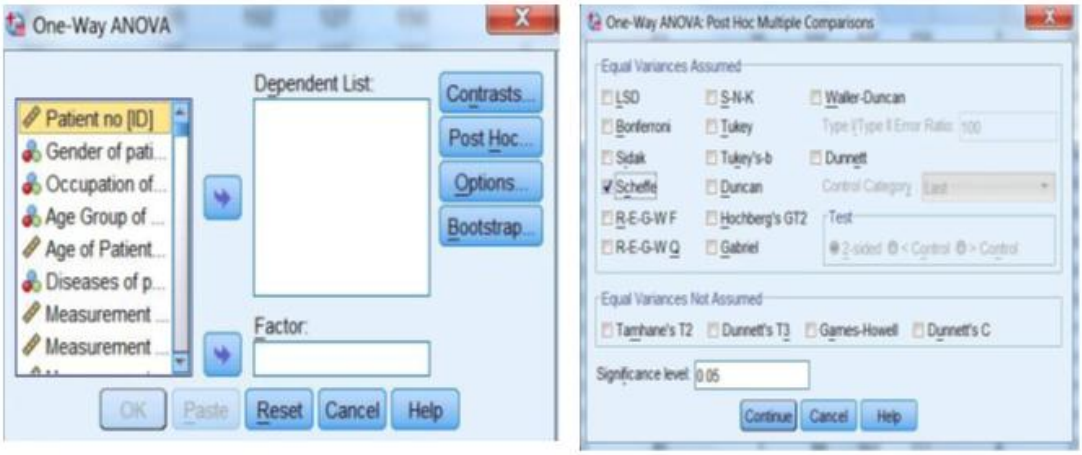

Figure 3.6: Windows pop up for One-Way ANOVA and POST hoc multiple comparisons

CHAPTER FOUR

RESULTS, ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

This chapter focuses on the results obtained from the data collected by carrying out real experiments and then analyzing these data. As mentioned earlier, SPSS software was used to analyze the results. As a brief summary, the initial data was taken from all participants using the questionnaire and was fed in the BIA machine, the Quad scan 4000 Impedance Analyzer. After this the data obtained was transferred to the Biostat software in the computer via Bluetooth technology, and was then exported to Microsoft excel, where data was sorted out and arranged, before being finally transferred to SPSS for data analysis. First demographic data was identified and analyzed and then for the final data analysis, paired t-test, independent t-test and one way ANOVA was performed on the BI parameters. The BI parameters recorded and studied where Resistance (R), Reactance (X), Impedance (Z), Phase Angle and the Illness marker.

4.2 DEMOGRAPHIC DATA

There were a total of 50 subjects who voluntarily participated in this study. In order to perform the analysis, the subjects were divided into different groups according to Age group, BMI and Exercise activity. These are independent variables in this study. Summary of these demographic variables are illustrated in Table 4.1.

Table 4.1

Demographic data for all subjects

Demographic Parameter		**Frequency (number of subjects)**	**Percent (%)**
Gender	Male Female	40 10	80.0 20.0
Age Group in years	21-30 (group 1) 31-40 (group 2) 41-50 (group 3)	41 4 5	82.0 8.0 10.0
BMI Group	under weight (group 1) normal weight (group 2) over weight (group 3) obese (group 4)	3 28 18 1	6.0 56.0 36.0 2.0
Exercise Activity	Very Low (group 1) Low/Medium (group 2) Medium (group 3)	20 20 10	40.0 40.0 20.0

For the age group, three age groups were categorized; group 1 consisted of ages 21-30, group 2 consisted of ages of 31-40 and group 3 consisted of ages 41-50. It was noted that 41 out of 50 subjects fell in the category of age group 1 and hence formed the majority (82%). 4 subjects fell into age group 2 (8%) and 5 subjects fell into age group 3 (10%).

Body Mass Index (BMI) was identified into 4 groups as per the universal BMI standard. Anything less than 18.5 was classified as underweight and categorized as group 1. BMI 18.5 – 24.9 is normal weight and is group 2, BMI 25 – 29.9 is classified as overweight and is our BMI group 3, and a BMI value of 30 and above was allocated to group 4 as obese. The majority of subjects i.e. 28 belonged to group 2 having a

normal weight (56%). 3 subjects were in the category of group 1 (6%), 18 subjects were overweight falling in the group 3 category (36%) and lastly 1 subject fell in group 4 (2%).

More groups were further identified based on the subject's physical activity. There were 3 groups for this. Group 1, for very less physical activity (low) i.e. people who didn't exercise in particular or did any kind of exercise for a maximum of 1 day per week, group 2 for low / medium physical activity, those involved in physical exercise for 2-3 days a week and group 3 with medium exercise activity level, for those people who exercised for 4 – 5 days in a week. It was observed that 20 subjects belonged to group 1 (40%), another 20 subjects belonged to group 2 (40%) and 10 subjects belonged to group 3 (20%).

4.2.1 Demographic Data for Male Subjects

From the 50 participants who took part in this study, there were 40 males participants who were further divided into smaller groups of independent variables, i.e. (Age, BMI and Exercise activity) these variables were used in the statistical analysis for male subjects. A summary of demographic data for each variable is given in Table 4.2.

Table 4.2

Demographic data for male subjects

Demographic Parameter		Frequency (number of subjects)	Percent (%)
Age Group in years	21-30 (group 1) 31-40 (group 2) 41-50 (group 3)	35 2 3	87.5 5.0 7.5
BMI Group	under weight (group 1) normal weight (group 2) over weight (group 3) obese (group 4)	3 19 17 1	7.5 47.5 42.5 2.5
Exercise Activity	Very Low (group 1) Low/Medium (group 2) Medium (group 3)	11 19 10	27.5 47.5 25.0

It can be seen that the majority of male subjects, 35 belonged to age group 1 (87.5%), 2 subjects belonged to age group 2 (5%) and 3 subjects belonged to age group 3 (7.5%). For BMI group, there were 3 male subjects in group 1 (7.5%), 19 male subjects in group 2 (47.5%), 17 male subjects in group 3 (42.5%) and 1 male subject in group 4 (2.5%). For exercise activity, there were 11 male subjects in group 1 (27.5%), 19 male subjects in group 2 (47.5%) and 10 male subjects in group 3 (25%).

4.2.2 Demographic Data for Female Subjects

The study carried out on female subject population was observed to be a smaller group. There were a total of 10 female subjects out of 50. Once again, the female subject group was identified in a similar manner as the male independent variables, i.e. (Age, BMI and

Exercise activity) thus these variables were used in the statistical analysis for female subjects. Table 4.3 presents a summary of demographic data for each variable.

Table 4.3

Demographic data for female subjects

Demographic Parameter		**Frequency (number of subjects)**	**Percent (%)**
Age Group in years	21-30 (group 1) 31-40 (group 2) 41-50 (group 3)	6 2 2	60.0 20.0 20.0
BMI Group	normal weight (group 2) over weight (group 3)	9 1	90.0 10.0
Exercise Activity	Very Low (group 1) Low/Medium (group 2)	9 1	90.0 10.0

The above Table 4.3 illustrates that 6 females subjects were placed in age group 1 (60%), 2 female subjects in groups 2 and 3 (20%) each. A total of 9 females subjects were observed to be in BMI group 2 (90%) and 1 in BMI group 3 (10%), with nil in BMI groups 1 and 4. For exercise activity category, it was noted that there were 9 female subjects in exercise activity group 1 (90%) and 1 female subject in exercise activity group 2 (10%).

4.3 STATISTICAL COMPARISON OF BIO IMPEDANCE PARAMETERS

In this section the statistical comparison of Bio impedance parameters is carried out for before and after treatment. For the after treatment procedure, aroma oil was used and analyzed. For the first 25 subjects, aroma oil has been used on the left leg and leech oil on the right, and for the remaining 25 subjects the leech oil had been used on the left leg, and aroma oil on the right leg. However leech oil is not the main concern of study in this work, but is also a part university of Malaya research project, performed by another student. Here the p value, for testing null hypothesis was analyzed for before and after treatment. There are no significant differences between them when $p>0.05$.

Table 4.4 shows the comparison of bio impedance parameters between leg 1 and leg 2 before (no oil) and after treatment (aroma oil). Two values for p were obtained in this analysis; one of them is equal variance assumed and second is equal variance not assumed. Since the value is same for most cases, we consider only p values with equal variance assumed. Independent t-test is used to analyze the data.

Table 4.4

Independent t-test result for the comparison of bio impedance parameters for no oil and Aroma oil of both legs

Bio Impedance Parameter	**No oil (p)**	**Aroma Oil (p)**
Impedance 5k	.087	.001
Impedance 50k	.165	.002
Impedance 100k	.925	.075
Impedance 200k	.089	.000
Resistance 50k	.072	.020
Reactance 50k	.017	.152
Phase Angle 50k	.043	.051
Illness marker	.380	.246

The result in Table 4.4 concludes that there is no significant difference ($p>0.05$) in no oil in all parameters except for Reactance at 50k and Phase angle 50k, while a significant difference is observed with Aroma oil in bio impedance parameters except Impedance at 100k, Reactance at 50k Phase angle 50k and Illness marker.

Table 4.5

Independent t-test results for the comparison of Bio impedance parameters of both legs between genders and using Aroma oil

Bio Impedance Parameter	**Leg 1 (p)**	**Leg 2 (p)**
Impedance 5k	.001	.326
Impedance 50k	.014	.281
Impedance 100k	.000	.361
Impedance 200k	.100	.334
Resistance 50k	.001	.304
Reactance 50k	.016	.001
Phase Angle 50k	.149	.002
Illness marker	.000	.617

Table 4.5 presents the comparison of Bio Impedance Parameters of leg 1 and leg 2 between genders. Independent t-test is used to analyze the data. For conducting the experiments no oil was applied before and aroma oil was applied for after treatment. As stated earlier, two values for p in the analysis were obtained; one of them is equal variance assumed and second is equal variance not assumed. Since the value is same for most cases, we consider only p values with equal variance assumed.

Table 4.6

Paired t-test for the comparison of Bio Impedance Parameters for Leg1 and Leg 2 using Aroma oil for before and after treatment

Bio Impedance Parameter	**Leg 1 (p)**	**Leg 2 (p)**
Impedance 5k	.000	.041
Impedance 50k	.000	.001
Impedance 100k	.000	.002
Impedance 200k	.000	.002
Resistance 50k	.000	.001
Reactance 50k	.000	.000
Phase Angle 50k	.142	.000
Illness marker	.196	.294

Table 4.6 shows the comparison of before and after parameters for leg 1 and leg 2 using aroma oil for the all the subjects present. It was seen that, there is a significant difference in the before and after reading for all except for Phase angle 50k and Illness marker for leg 1 and significant difference is observed between before and after readings in all except for the Illness marker for leg 2. Hence application of aroma oil changes the bio impedance parameter reading in most variables.

New analysis is further carried out based on male and female groups.

Table 4.7

Paired t-test of before and after Bio impedance Parameters of leg 1 and leg 2 with Aroma oil for male and female subjects

Bio impedance Parameter	**Male**		**Female**	
Variables	Leg 1 (p)	Leg 2 (p)	Leg 1 (p)	Leg 2 (p)
Impedance 5k	.000	.448	.556	.000
Impedance 50k	.000	.060	.085	.000
Impedance 100k	.000	.120	.228	.000
Impedance 200k	.000	.113	.724	.000
Resistance 50k	.000	.071	.011	.000
Reactance 50k	.000	.000	.197	.000
Phase Angle 50k	.019	.000	.006	.284
Illness marker	.223	.285	.000	.003

Table 4.7 shows that the comparison of before and after bio impedance parameters of leg 1 and leg 2 for males and female subjects. Paired t-test was used for this analysis. Here for leg 1 – male, there were significant differences observed in before and after values for all except the illness marker. For leg 2 – male, it was noted that there is a mixed trend with significant differences in just Reactance 50k and Phase angle 50k. In leg 1 female also it was observed a mixed trend with significant differences in between before and after values for Resistance 50K, Phase angle 50k and Illness marker. For leg 2 – female, a much more uniform trend was observed with significant differences between before and after reading for all except Phase angle 50k.

The subjects are further categorized into different groups of Exercise Activity, Age group and BMI group, to study before and after bio impedance parameters for leg 1 and for the mixed population. Paired t – test was used for this analysis.

Table 4.8

Paired t-test of before and after Bio impedance Parameters of leg 1 with Aroma oil for Activity group, Age group and BMI group for entire population

Bio Impedance Parameter	**Exercise Activity Group**			**Age Group**			**BMI Group**			
	1 (p)	2 (p)	3 (p)	1 (p)	2 (p)	3 (p)	1 (p)	2 (p)	3 (p)	4 (p)
Impedance 5k	.135	.000	.000	.000	-	.000	.000	.000	.061	-
Impedance 50k	.605	.000	.000	.000	-	.001	.000	.000	.054	-
Impedance 100k	.415	.000	.000	.000	-	.001	.000	.000	.160	-
Impedance 200k	.098	.000	.000	.000	-	.000	.000	.000	.046	-
Resistance 50k	.662	.000	.021	.000	-	.001	.000	.000	.950	-
Reactance 50k	.817	.000	.001	.000	-	.892	.003	.000	.227	-
Phase Angle 50k	.077	.769	.000	.033	-	.000	.014	.029	.169	-
Illness marker	.005	.859	.000	.082	-	.580	.867	.570	.000	-

The results obtained in Table 4.8 shows the readings obtained for Exercise Activity. There was significant difference in before and after readings for group 1 only. For group 2, there was significant difference in all except Phase angle and Illness marker, and for group 3, there was significant difference in all bio impedance parameters.

For Age group, it can be noted that there was significant difference in before and after readings for all bio impedance parameters in group 1 except Illness marker. For group 2, the data was not sufficient due to fewer subjects in the group, whereas in group

3, we see significant differences for all parameters except Reactance 50k and Illness marker.

For BMI groups, we see that in BMI group 1 there were significant differences in all except Illness marker. For group 2, there were significant differences in all parameters except Illness marker. For group 3, the results are more mixed with significant differences in Impedance 200k, and Illness marker. For BMI group 4, not sufficient data was available due to fewer subjects being in the group.

In Table 4.9 below, once again different groups of Exercise Activity, Age group and BMI group were analyze for before and after bio impedance parameters but for leg 2 and for the mixed population. Paired t – test was used for this analysis.

Table 4.9

Paired t-test of before and after Bio impedance Parameters of leg 2 with Aroma oil for Activity group, Age group and BMI group for entire population

Bio Impedance Parameter	**Exercise Activity Group**			**Age Group**			**BMI Group**			
	1 (p)	2 (p)	3 (p)	1 (p)	2 (p)	3 (p)	1 (p)	2 (p)	3 (p)	4 (p)
Impedance 5k	.000	.398	.811	.516	.000	.000	.000	.374	.286	.000
Impedance 50k	.001	.003	.856	.091	.000	.000	.000	.001	.858	.000
Impedance 100k	.002	.008	.858	.178	.000	.000	.000	.002	.961	.000
Impedance 200k	.002	.011	.980	.194	.000	.000	.000	.004	.902	.000
Resistance 50k	.001	.004	.863	.107	.000	.000	.000	.001	.879	.000
Reactance 50k	.000	.000	.842	.000	.001	.000	.002	.000	.029	.000
Phase Angle 50k	.048	.000	.588	.000	.586	.576	.003	.001	.001	.000
Illness marker	.000	.270	.096	.291	.979	.007	.001	.267	.000	.000

As shown by Table 4.9, for Exercise activity group 1, there were significant differences in the before and after bio impedance parameters for all except Phase angle 50k. For group 2, there were significant differences in all parameters except for Impedance 5K and Illness marker. Group 3 showed no significant differences for all parameters.

For Age group, we see group 1 showed significant differences in Reactance 50k and Phase angle 50k. Group 2 showed significant differences in all but Phase angle 50k and Illness marker and group 3 showed significant differences in all but Phase angle.

For BMI groups, we see that group 1 showed significant differences for all bio impedance parameters. Group 2 showed significant differences for all except Impedance 5k and Illness marker. Group 3 showed significant differences for Reactance 50k, Phase angle and Illness marker, and group 4 showed significant differences for all bio impedance parameters.

Further grouping was carried out for male and female subjects as a second level and paired t – test was analyzed for before and after bio impedance parameters.

Table 4.10 below shows the paired t-test results for comparison of bio impedance parameters of leg 1 with aroma oil for different groups for males only.

Table 4.10

Paired t test of before and after Bio impedance Parameters of leg 1 with Aroma oil for Activity group, Age group and BMI group for male subjects only

Bio Impedance Parameter	**Exercise Activity Group**			**Age Group**			**BMI Group**			
	1 (p)	2 (p)	3 (p)	1 (p)	2 (p)	3 (p)	1 (p)	2 (p)	3 (p)	4 (p)
Impedance 5k	.041	.000	.000	.000	-	.000	.000	.000	.011	-
Impedance 50k	.106	.000	.000	.000	-	.001	.000	.000	.007	-
Impedance 100k	.100	.000	.000	.000	-	.001	.000	.000	.029	-
Impedance 200k	.077	.000	.000	.000	-	.001	.000	.000	.005	-
Resistance 50k	.112	.000	.021	.000	-	.001	.000	.000	.626	-
Reactance 50k	.279	.000	.001	.000	-	.133	.003	.000	.091	-
Phase Angle 50k	.841	.769	.000	.111	-	.000	.014	.236	.099	-
Illness marker	.263	.859	.000	.288	-	.771	.867	.881	.001	-

Table 4.10 shows that for Exercise Activity groups; group 1 had significant differences between before and after treatment for Impedance at 5k. Group 2 showed significant differences for all bio impedance parameters except Phase angle and Illness marker, and group 3 showed significant differences for all parameters.

For Age groups, a significant difference for all parameters except for Phase angle 50k and Illness marker for group 1 was noted. Due to fewer subjects in group 2, the analysis was not performed by the software and for group 3; there were significant differences in all parameters except for Reactance 50k and Illness marker.

In BMI grouping, group 1 showed significant differences in all parameters except Illness marker. Group 2 had significant differences in all parameters except Phase angle and Illness marker. Group 3 had significant differences in all parameters except Resistance 50k; Reactance 50k and Phase angle 50k, whereas there was not enough data for the analysis in group 4.

Table 4.11 shows the same paired t-test analysis but for leg 1 and females.

Table 4.11

Paired t-test of before and after Bio impedance Parameters of leg 1 with Aroma oil for Activity group, Age group and BMI group for female subjects only

Bio Impedance Parameter	**Exercise Activity Group**			**Age Group**			**BMI Group**			
	1 (p)	2 (p)	3 (p)	1 (p)	2 (p)	3 (p)	1 (p)	2 (p)	3 (p)	4 (p)
Impedance 5k	.556	-	-	.349	-	.000	-	.010	.000	-
Impedance 50k	.085	-	-	.053	-	.001	-	.775	.000	-
Impedance 100k	.228	-	-	.171	-	.001	-	.110	.000	-
Impedance 200k	.724	-	-	.886	-	.001	-	.001	.000	-
Resistance 50k	.011	-	-	.007	-	.001	-	.153	.000	-
Reactance 50k	.197	-	-	.455	--	.004	-	.537	.000	-
Phase Angle 50k	.006	-	-	.026	-	.000	-	.000	.007	-
Illness marker	.000	-	-	.000	-	.125	-	.003	.002	-

Table 4.11 shows results for Exercise activity groups, there are significant differences in Resistance 50k, Phase angle 50k and Illness marker. Data was not sufficient for the analysis in groups 2 and 3.

In Age groups, for group 1, there were significant differences in parameters Resistance 50k, Phase angle 50k and the Illness marker. Sufficient data was not available for the analysis in group 2, and in group 3, significant differences were observed in all bio impedance parameters except the Illness marker.

For BMI groups, sufficient data was not available for the analysis in group 1. Significant differences in bio impedance parameters were observed for Impedance 5k, Impedance 200k, Phase angle 50k and Illness marker in group 2. Significant differences were observed for all parameters in group 3 and sufficient data was not available for BMI group 4.

Furthermore, comparison for before and after bio impedance parameters was performed for leg 2 – male subjects for aroma oil using paired t-test, the results of which are shown in Table 4.12.

Table 4.12

Paired t-test of before and after Bio impedance Parameters of leg 2 with Aroma oil for Activity group, Age group and BMI group for male subjects only

Bio Impedance Parameter	**Exercise Activity Group**			**Age Group**			**BMI Group**			
	1 (p)	2 (p)	3 (p)	1 (p)	2 (p)	3 (p)	1 (p)	2 (p)	3 (p)	4 (p)
Impedance 5k	.133	.735	.811	.934	.000	.000	.000	.495	.286	.000
Impedance 50k	.365	.023	.856	.317	.000	.000	.000	.272	.858	.000
Impedance 100k	.497	.051	.858	.502	.000	.000	.000	.449	.961	.000
Impedance 200k	.532	.065	.980	.490	.000	.000	.000	.519	.902	.000
Resistance 50k	.385	.028	.863	.356	.000	.000	.000	.312	.879	.000
Reactance 50k	.005	.000	.842	.000	.000	.005	.002	.001	.029	.000
Phase Angle 50k	.000	.000	.588	.000	.033	.573	.003	.002	.001	.000
Illness marker	.000	.268	.096	.284	.621	.354	.001	.259	.000	.000

It can be is observed from the results in Table 4.12, for Exercise Activity group 1, that a significant differences between before and after bio impedance parameters are observed for Reactance 50k, Phase angle 50k, and Illness marker. For group 2, significant differences are seen in Impedance 50k, Resistance 50k, Reactance 50k and Phase angle. In group 3, significant differences are observed in none of the parameters.

For Age Groups, in group 1, significant differences are observed for Reactance 50k and Phase angle 50k. In group 2, significant differences are observed in all

parameters except Illness marker and in group 3; significant differences are observed in all parameters except Phase angle 50k and Illness marker.

For BMI groups, significant differences are observed in all parameters for group 1. Significant differences are observed for Reactance 50k and Phase angle 50k in group 2. Significant differences are observed for parameters Reactance 50k; Phase angle 50k and Illness marker in group 3 and significant differences are observed for all parameters in group 4.

Similar paired t-test analysis was carried out for leg 2 – female to study the before and after affects in bio impedance parameters for different groups. Table 4.13 summarizes the results.

Table 4.13

Paired t-test of before and after Bio impedance Parameters of leg 2 with Aroma oil for Activity group, Age group and BMI group for female subjects only

Bio Impedance Parameter	**Exercise Activity Group**			**Age Group**			**BMI Group**			
	1 (p)	2 (p)	3 (p)	1 (p)	2 (p)	3 (p)	1 (p)	2 (p)	3 (p)	4 (p)
Impedance 5k	.000	.000	-	.000	.001	.000	-	.000	-	-
Impedance 50k	.000	.000	-	.001	.000	.000	-	.000	-	-
Impedance 100k	.000	.000	-	.001	.000	.000	-	.000	-	-
Impedance 200k	.000	.000	-	.003	.000	.000	-	.000	-	-
Resistance 50k	.000	.000	-	.001	.000	.000	-	.000	-	-
Reactance 50k	.000	.000	-	.000	.029	.002	-	.000	-	-
Phase Angle 50k	.728	.000	-	.185	.892	1.000	-	.284	-	-
Illness marker	.024	.000	-	.016	.894	.001	-	.003	-	-

Table 4.13 shows that in Exercise Activity group 1, significant differences in bio impedance parameters are seen for all, except Phase angle 50k. Significant differences are seen for all parameters in group 2 and there isn't sufficient data for the paired t-test analysis in group 3.

For Age group 1, significant differences are seen for all bio impedance parameters except for Phase angle 50k. Significant differences are seen in group 2 for all parameters except Phase angle 50k and Illness marker, and significant differences are also seen in all parameters of group 3 except for Phase angle 50k.

For BMI groups, sufficient data is not available for analysis for groups 1, 3 and 4. In group 2, significant differences are seen in all bio impedance parameters except in Phase angle 50k.

An analysis is then performed to compare the after treatment of Bio Impedance parameters between different groups. Statistical comparison of Bio Impedance parameters is done first for the complete mixed data between 3 Groups (Activity, Age and BMI) with different legs and Aroma oil. Each group has more than three two groups so, here one way Anova is used to analyze the data and Post HOC test is done to know which category of group has higher difference of p. The result of the Anova test of the analysis of bio impedance parameters is shown in Tables 4.14- Table 4.16. There are no significant difference when $p>0.05$.

Table 4.14 below shows the after treatment comparison of Bio Impedance Parameter between Activity groups, Age groups and BMI groups. One way Anova test is used to analyze the data. Table 4.14 shows the comparison between 3 Groups (Activity, Age and BMI) after treatment of aroma oil for leg1 and leg 2 for the entire population. If $p>0.05$ then no significant difference. Post HOC test also performed to know which category among individual groups has higher difference.

Table 4.14

One way Anova test for the comparison of after treatment Bio Impedance Parameters between groups for leg 1 and leg 2 for Aroma Oil for the entire population

Bio Impedance Parameter	Leg 1			Leg 2		
	Exercise Activity Group (p)	Age Group (p)	BMI Group (p)	Exercise Activity Group (p)	Age Group (p)	BMI Group (p)
Impedance 5k	.000	.788	.000	.377	.381	.114
Impedance 50k	.004	.248	.000	.031	.232	.000
Impedance 100k	.018	.027	.000	.026	.217	.000
Impedance 200k	.002	.004	.000	.018	.227	.000
Resistance 50k	.009	.498	.000	.032	.228	.000
Reactance 50k	.000	.007	.000	.091	.008	.003
Phase Angle 50k	.051	.000	.045	.005	.000	.005
Illness marker	.000	.000	.500	.424	.896	.754

Post Hoc tests for the above table given in Appendix B.

Table 4.14 presents the results of Bio Impedance Parameters between different Groups. For the group of exercise activity on leg 1, significant differences except in

Phase angle at 50k is noted. For leg 2 a significant difference except for Impedance at 5k, Reactance at 50k and Illness marker is noted as well. By comparing both legs in this group, it can be said that leg 1 BI parameters have more number of significant differences using aroma oil than leg 2. For Age group leg 1, there are significant differences except for Impedance at 5k and Reactance at 50k. Leg 2 has no significant differences except for Reactance and Phase angle at 50k. By comparing both legs in this group, it can be noted leg 1 has more number of significant differences using Aroma oil. Group of BMI of leg 1 has significant differences except for Illness marker and for leg 2, there are significant differences too except for Impedance at 5k and Illness marker. By comparing both legs in this group, it can be noted that leg 1 has more number of significant differences using aroma oil.

Table 4.15 below shows the after treatment comparison of Bio Impedance Parameters between Activity groups, Age groups and BMI groups for all male subjects. One way Anova test is used to analyze the data. The table shows the comparison between 3 Groups (Activity, Age and BMI) after treatment of aroma oil for leg1 and leg 2 for male subjects. If the $p>0.05$ then there exists no significant difference. Post HOC test also performed to know which category among individual groups has higher difference.

Table 4.15

One way Anova test for the comparison of after treatment Bio Impedance Parameters between groups for leg 1 and leg 2 for Aroma Oil for the all-male subjects

Bio Impedance Parameter	Leg 1			Leg 2		
	Exercise Activity Group (p)	Age Group (p)	BMI Group (p)	Exercise Activity Group (p)	Age Group (p)	BMI Group (p)
Impedance 5k	.035	.926	.000	.174	.975	.014
Impedance 50k	.066	.377	.000	.498	.846	.000
Impedance 100k	.581	.017	.000	.489	.803	.000
Impedance 200k	.009	.005	.001	.518	.746	.000
Resistance 50k	.298	.465	.000	.487	.850	.000
Reactance 50k	.004	.012	.000	.276	.038	.000
Phase Angle 50k	.189	.000	.098	.027	.000	.010
Illness marker	.004	.000	.141	.525	.945	.633

Post Hoc tests for the above table given in Appendix B.

Table 4.15 above shows the results of after treatment Bio Impedance Parameters between different Groups. For the group of exercise activity on leg 1 (male subjects), no

significant difference is seen except for Impedance at 5k, 200k and Reactance at 50k. For leg 2 male subjects, no significant difference was observed except for Phase angle 50k. By comparing both legs in this group, it can be noted that leg 1 has more number of significant differences using aroma oil. For Age group leg 1 (male subjects) we can note significant differences except for Impedance at 5k, 50k and Resistance at 50k. For leg 2, again no significant difference is noted except for Phase angle at 50k. By comparing both legs in this group, it can be noted that leg 1 has more number of significant differences using aroma oil. For the group of BMI of leg 1 (male subjects), it was observed that there was significant differences except for Phase angle and Illness marker, and for leg 2 once again a significant differences was observed except for Illness marker. By comparing both legs, it can be noted that leg 2 has more number of significant differences for male subjects using aroma oil.

Table 4.16 below shows the after treatment comparison of Bio Impedance Parameter between Activity groups, Age groups and BMI groups for all female subjects. One way Anova is used to analyze the data. The table shows the comparison between 3 Groups (Activity, Age and BMI) after treatment of aroma oil for leg1 and leg 2 for female subjects. If the $p>0.05$ then there exists no significant difference. Post HOC test also performed to know which category among individual groups has higher difference. However, due to fewer subjects, there is not sufficient data to get the analysis results for the Post HOC test.

Table 4.16

One way Anova test for the comparison of after treatment Bio Impedance Parameters between groups for leg 1 and leg 2 for Aroma Oil for the all-female subjects

Bio Impedance Parameter	Leg 1			Leg 2		
	Exercise Activity Group (p)	Age Group (p)	BMI Group (p)	Exercise Activity Group (p)	Age Group (p)	BMI Group (p)
Impedance 5k	-	.261	.000	.000	.093	-
Impedance 50k	-	.328	.000	.000	.065	-
Impedance 100k	-	.000	.000	.000	.062	-
Impedance 200k	-	.827	.002	.000	.054	-
Resistance 50k	-	.003	.000	.000	.065	-
Reactance 50k	-	.827	.000	.000	.444	-
Phase Angle 50k	-	.111	.000	.000	.001	-
Illness marker	-	.338	.461	.000	.000	-

Table 4.16 shows the results of Bio Impedance Parameters between different Groups. For the group of exercise activity on leg 2 (female subjects), there are significant differences in all parameters. For Age group on leg 1 (female subjects) there are significant differences for Impedance at 100k and Resistance at 50k. For leg 2, a

significant difference is seen for Phase angle at 50k and Illness marker. By comparing both legs in this group, it can be noted that both have equal number for significant differences using aroma oil. For the group of BMI for leg1 (female subjects), a significant differences was observed except for Illness marker. For leg 1 Exercise Activity and leg 2 BMI group, sufficient data was not available to complete one way Anova analysis due to less number of subjects.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

The statistical data shows significant results obtained. Before and after measurements significantly differ in most of the analysis, hence the hypothesis that Bio Impedance parameters significantly differ and bring about beneficial changes when comparing after with before aroma oil foot reflexology therapy stands true in most analysis.

5.1 LIMITATIONS

Some obstacles when conducting this study are recognized. It was hard to find a massage therapy center that gave permission to get the subjects in their premises, due to high volume of patrons. Therefore some participants were given therapy at the massage center when there were fewer customers at the center and for the remaining majority of participants, the foot reflexology therapy was done at home by the masseurs. In some cases the waiting time between completed massage and bio impedance readings was significantly large i.e. more than 15 minutes which may have affected our results. Also, most of the subjects were healthy, young males and were students, and this may not necessarily be representative of actual population in the real world. Some of the participants didn't give full commitment during the experiment as it took a long duration (one hour or more for the entire procedure). It was difficult to make sure all the participants were in a relaxed condition as some of them were restless and made movements when the measurements were being taken. All these mentioned limitations may have affected this study i.e. the data acquisition to some extent.

5.2 RECOMMENDATIONS

For future work, a broader variety of subjects could be recruited in terms of age, gender, occupation, physical activity and health conditions to broaden the scope of the study and to make it more representative of actual population. Also, foot massage therapy should be done in the proper settings, rather than at a crowded massage center with a pressure of time or a student house without a proper setting for the therapy.

The findings of this study are:

1. Comparison between before and after foot reflexology aroma oil therapy shows that this therapy can give a good effect to bio impedance and body composition parameters, and could be done more regularly for consistent better effects.
2. The following parameters were got after completing the measurements of subjects in this study:
    a. Impedance 5k - increase
    b. Impedance 50k - increase
    c. Impedance 100k - increase
    d. Impedance 200k - increase
    e. Resistance (Ω) – increase
    f. Reactance (Ω) – increase
    g. Phase angle 50k (°) – increase
    h. Illness Marker – decrease / increase in isolated cases
3. This topic should be researched more, with other participants and different oils to give solid recommendations of this therapy to others as a therapeutic activity.

5.3 CONCLUSION

The study concluded that bio impedance (BI) parameters of subjects before and after foot reflexology therapy using aroma oil are significantly different. It showed that most parameters gave a sign of improvement in the body health. Therefore foot reflexology massage therapy is proven in making a good state of health as most of the parameters have shown an increase in cellular health after the experiment. This kind of this study is useful for professional massage therapists in order to explain the beneficial effects of foot reflexology therapy. There were no complains and side-effects reported by the subjects after the therapy and usage of the BIA machine. Hence we can say that this method of BIA measurement is relatively safe and without any side-effects.

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APPENDIX A

SAMPLE OF THE PERSONAL PARTICULAR FORM

IC / Passport no:

Gender:

Age:

Height (cm)

Weight (kg)

Profession:

Physical Activity / Exercise:

Frequency of getting foot massage and purpose:

Disclaimer: I hereby agree on being a part of the study conducted by University of Malaya students on Bio Impedance parameters during foot massage. As compensation, I would receive RM 10 from the University.

Date: Signature:

APPENDIX B

POST HOC TESTS

Post Hoc test for the comparison of after treatment Bio Impedance Parameters between groups for leg 1 for Aroma oil and for the entire population

Analyzed Groups	Comparison pair	Impedance 5k	Impedance 50k	Impedance 100k	Impedance 200k	Resistance 50k	Reactance 50k	Phase Angle 50k	Illness marker
Activity	V.Low/Low Medium	.014	.121	.015	.436	.034	.012	.141	.003
	V.Low/Medium	.002	.011	.194	.006	.051	.001	.075	.000
	Low Medium/Medium	.464	.319	1.000	.055	.891	.559	999	.149
Age	21-30/30-40	.004	.000	.000	.000	.002	.000	.000	.313
	21-30/41-50	1.000	.945	.789	.943	.886	.178	.000	.000
	31-40/41-50	.708	.419	.006	.005	.379	.000	.000	.000
BMI	Underweight/Normal Weight	.003	.019	.018	.079	.013	.001	.769	.997
	Underweight/Over Weight	.000	.000	.000	.003	.000	.000	.932	.990
	Underweight/Obesity	-	-	-	-	-	-	-	-
	Normal Weight/Over weight	.000	.000	.000	010	.000	.000	.75	.524
	Normal weight/Obesity	-	-	-	-	-	-	-	-
	Over weight/Obesity	-	-	-	-	-	-	-	-

Post Hoc test for the comparison of after treatment Bio Impedance Parameters between groups for leg 2 for Aroma oil and for the entire population

Analyzed Groups	Comparison pair	Impedance 5k	Impedance 50k	Impedance 100k	Impedance 200k	Resistance 50k	Reactance 50k	Phase Angle 50k	Illness marker
Activity	V.Low/Low Medium	.570	.031	.027	.018	.033	.361	.368	.523
	V.Low/Medium	.177	.464	.520	.481	.487	.043	.133	.157
	Low Medium/Medium	.962	.421	.342	.286	.413	.591	.024	.473
Age	21-30/30-40	.800	.784	.741	.737	.771	.364	.020	.712
	21-30/41-50	.118	.163	.348	.469	.194	.000	.002	.738
	31-40/41-50	.305	.354	.398	.432	.362	.020	.585	.961
BMI	Underweight/Normal Weight	.341	.015	.045	.072	.017	.000	.000	.874
	Underweight/Over Weight	.029	.000	.000	.000	.000	.000	.000	.000
	Underweight/Obesity	.000	.000	.003	.000	.000	.000	.000	.000
	Normal Weight/Over weight	.038	.000	.000	.000	.000	.013	.663	.751
	Normal weight/Obesity	.999	.299	.191	.447	.312	.281	.000	.743
	Over weight/Obesity	.000	.000	.000	.000	.000	.000	.032	.998

Post Hoc test for the comparison of after treatment Bio Impedance Parameters between groups for leg 1 for Aroma oil and for all male subjects

Analyzed Groups	Comparison pair	Impedance 5k	Impedance 50k	Impedance 100k	Impedance 200k	Resistance 50k	Reactance 50k	Phase Angle 50k	Illness marker
Activity	V.Low/Low Medium	.334	.646	.710	.749	.657	.061	.363	.148
	V.Low/Medium	.053	.102	.847	.026	.438	.005	.275	.002
	Low Medium/Medium	.464	.319	1.000	.055	.891	.559	.999	.149
Age	21-30/30-40	.346	.000	.000	.000	.000	.000	.009	.011
	21-30/41-50	.999	.970	.943	.935	.967	.343	.000	.000
	31-40/41-50	965	.864	.057	.128	.536	.014	.000	.000
BMI	Underweight/Normal Weight	.021	.049	.084	.116	.052	.086	.590	.862
	Underweight/Over Weight	.000	.000	.000	.007	.000	.000	.991	.999
	Underweight/Obesity	-	-	-	-	-	-	-	-
	Normal Weight/Over weight	.000	.001	.000	.041	.000	.000	.133	.123
	Normal weight/Obesity	-	-	-	-	-	-	-	-
	Over weight/Obesity	-	-	-	-	-	-	-	-

Post Hoc test for the comparison of after treatment Bio Impedance Parameters between groups for leg 2 for Aroma oil and for all male subjects

Analyzed Groups	Comparison pair	Impedance 5k	Impedance 50k	Impedance 100k	Impedance 200k	Resistance 50k	Reactance 50k	Phase Angle 50k	Illness marker
Activity	V.Low/Low Medium	.140	.726	.762	.821	.720	.195	.163	.516
	V.Low/Medium	.692	.550	.553	.564	.545	.993	.751	.772
	Low Medium/Medium	.481	.975	.951	.951	.974	.501	.075	.494
Age	21-30/30-40	.895	.053	.037	.022	.059	.653	.443	.533
	21-30/41-50	.852	1.000	.730	.379	.999	.000	.000	.827
	31-40/41-50	.535	.000	.000	.000	.000	.000	.000	.000
BMI	Underweight/Normal Weight	.114	.000	.000	.000	.000	.000	.000	.861
	Underweight/Over Weight	.029	.000	.000	.000	.000	.000	.000	.000
	Underweight/Obesity	.000	.000	.003	.000	.000	.000	.000	.000
	Normal Weight/Over weight	.016	.000	.000	.000	.000	.000	1.000	.784
	Normal weight/Obesity	.979	.001	.001	.002	.001	.895	.017	.779
	Over weight/Obesity	.000	.000	.000	.000	.000	.000	.032	.998