CHAPTER ONE

INTRODUCTION

1.1   Introduction

Leeching or bloodletting has been long introduced since the ancient time as one of method to cure several diseases believing that it could exonerate noxious substances produced by these diseases. However it soon diminished around 20th century in Europe as antibacterial therapy takes place and soon becomes an unpopular until now. The revived of leech therapy in modern medicine happens in 1970's with limited application in the usage of relieving venous congestion in microsurgeries. Up until now scientist and medicine practitioner still making discoveries of this amazing ability of leech for many more functions especially in therapeutic areas.

In Malaysia, Leech therapy is considered as alternative medication that believed can cure or relieved some of the ailment that has been practiced since long time ago. Therefore, the effect of body composition is one of the methods of assessment to evaluate whether the therapy that has been practiced since their ancestor time is a worthwhile tool for therapy in healing some said illness. Using impedance method for body composition measurement can determine the constituent of body changes which model as 2 important compartment that divides the body into fat mass and fat-free mass (FFM). This measurement is normally used by nutritionist as this invasive method is very suitable to determine the health of a person which directly affected by the composition of the fat in the body that can be further subdivide into water, mineral and protein constituents. The result could be used to measure the effectiveness of the leech therapy treatment as the readings and changes are taken into consideration before and after the treatment.

1.2. Research Problem and Problem Statement

1) The effectiveness of leech therapy used as medicinal treatment is not quantitatively proven and thus need to be highlighted as the growing interest towards the ability of leeching is widely explored.

2) Leech therapy need to be measure quantitatively using an engineering tool as method of assessment of the effectiveness of the therapy.

1.3 Objectives

1) Measure and represent the data of the body composition of patient that undergo leech therapy treatment

2) Analyse the result of body composition of the leech therapy patient using statistical tool

1.4 Hypothesis

1) Leech therapy treatment will have some changes on body composition

2) Effectiveness of leech therapy treatment can be represented quantitatively.

1.5 Scope of the Study

Scope of this study is restricted to Malaysian patient that undergo the leech therapy treatment and only immediate response of the treatment is measured.

1.6 Significance of the Study

Mere believe in the alternative medicine needs to be proven quantitatively so that people can be convinced and not deceived by unsupported claims. As leech therapy exist since long time ago, accreditation is necessary to assess the effectiveness of this method.

CHAPTER TWO

LITERATURE REVIEW

2.0   Modern Medicine vs. Complementary and Alternative Medicine (CAM)

Modern medicine is view as a mainstream and conventional ways based on scientific evidence while alternative medicine has been define in many terms like holistic, traditional and mostly categorized as complementary and alternative medicine (CAM). Treatment of diseases has been developed and modernized with a lot of new tools, surgery and pills for either preventing or curing purposes. However, alternative medicines is still being practice and recently have gain a lot of attention from all over the world. It can be divided into diets and supplements, botanicals products, unconventional agents, traditional medicine and energy healing (Cassieth *et al.,* 2001). If to compare both of these methods, modern medicine is still considered the main method used for healing as the governments also in support of this kind of treatment as it is based on scientific value and proven to save many life every day. However, CAM is a minority but gaining its popularity day by day and it could be revive and used as conventional medicine if scientific research can support the effectiveness of these methods. Therefore, research such as changes in body composition to check the effectiveness of the traditional medicine like leeching can contribute to the scientific evidence CAM as a whole so that it could be accepted by the world community.

2.1. Modern medicine

2.1.1 Surgery

Surgery has been a mean of doctors in getting rid of or fixing out affected area that has been diagnosed 'ill'. From cosmetic surgery, teeth and transplantation or removing any tumours has been common nowadays. This procedure has saved many lives especially when it involves a vital organ like heart that has many possibilities for getting weak or failed like due to multivessel disease suffered from the diabetic patients (King, 2005). Bypass surgery or known as coronary artery bypass graft is normally performed to reduce the risk of death from coronary artery diseases. At the same time, injections and surgeries are inseparable combo a surgeon used as a tool in the operation. Injections not only used as pain reliever it could also be used to inject certain serum or protection agent to human body.

2.1.2 Pill/ tablets/ capsules

Pills, tablets or capsules that contain drugs to prevent or cure diseases are most necessary thing that a doctor will prescribed to its patient. Thus, a lot of research on drugs that can act on certain functions of our body has been actively pursued to treat various different of illness. The modern practitioner believed that drug must be assesses in the patient level. A report by WHO stated that drug utilization needs to have answer to some assessment questions like why, who the prescriber and person been prescribed also whether the patient medicine intake is in order and what are benefits and risk of the drugs being used (WHO, 2003). In addition, these are all important since a strict qualification by the food and drug administration always ensure that the drug used comply with some basic rule for it to be used in public.

2.1.3 Medicine tools

Modern medicine is also in another level with the engineered equipment and tools to assist the physician/ therapist and doctors in handling and diagnosing diseases. Application of ultrasound, nuclear magnetic resonance or x-ray in imaging system brings a great advancement to the modern medicine as a whole. These tools continue to flourish along with the modern medicine as a lot of potential been put aside for the scope of imaging in medicine. Besides that, tools like lasers not just benefit the physicist but give advantage in medicine world with the new ways of making surgery with lasers. Three basic laser principles that have been used in developing tools for medicinal purpose are photochemical effects, absorption which converted into heat and non-linear effect that can remove material fragment without heating the surrounding tissue (Senz and Muller, 1989). These are already applied in recanalization of arterial blood vessel, fragmentation of kidneys, bladder, lasik surgery and many more.

2.2 CAM

2.2.1 Diets and supplements

Some of the dangerous illness like cancer can actually be cure not just by the means of conventional medicine. Therefore, there are some theories in healing the cancer by using diet and eating supplements that is considered a natural way to fight cancer. This is because some foods contain a lot of nutrients that can boost the immune system. By eating the correct foods with a strict diet a person is believed to be able to fight the non-rapid cancer tissue by slowing the progression of cancer and strengthen the patient's body (Miller *et al*., 2000). Moerman diet therapy is popular in Netherlands with 2 important parts where the main diet involves a lot of organic product and also the supplement foods. There are eight key nutrients in this diets namely Vitamin A, B complex, C, E, citric acid, iodine, iron and sulphur (Kehr, 2011). This non-toxic method

receives a lot of attention as it can also be applied to healthy person to keep fit and prevent cancer in a better way. Other types of diets available are Houtsmuller diet, Macrobiotic diet, Gerson diet and a lot more.

2.2.2 Botanicals products

Besides diet and supplements, botanical products like herbs have been practice since long time before especially Chinese herbal medicine products. Sometimes, old generation will take the herbal medicine as a daily dose as raw or processed herbs with variety mixture of ingredients that believed can bring good health and youth to them. Malay herbs like kacip Fatimah, tongkat ali and hempedu bumi has even revolutionized as a commercial product so that it can be find easily (Aziz *et al*., 2005). Chinese traditional herbs also has been popular not in Asia but in western country and a lot of research on natural products from these herbs is made for cancer therapy treatment. Molecular target for the treatment are mostly signal transduction protein like kinases which able to control the malignant processes in cancer cells (Efferth *et al*., 2005).

2.2.3 Unconventional agents

Some of the alternative medicine falls under the category of unconventional agents such as shark cartilage, Ozone therapy, Hasumi vaccine, Di Bella therapy and more of new method that is unconventional. Shark cartilage has been an interest since research of glycoproteins that can extend the life in leukemic mice where extracted from the hammerhead sharks (Petit G.R. and Ode R.H., 1977). Moreover, there is also study done that shows that intraocular implantation of shark cartilage pallets can repressed tumour (Gawler I., 1984). Besides that, ozone therapy is more popular in Malaysia where the treatment could be used to cure external wound and even in dentistry. Since ozone has various effects such as antimicrobial, analgesic, immune stimulating and a lot

more benefits, this treatment has a variety of way to be used as cure (Seidler *et al.*, 2008). However, some precautious actions need to be taken so that any complications should be avoided.

2.2.4 Traditional medicine

Traditional medicine is one of the famous methods in CAM as it has been practiced since ancient time and still has a demand from one generation to another. Some of the famous traditional medicines used are Acupuncture, Hirudotherapy, Ayurveda, Qi gong and others. Acupuncture works through the theory of healing the "energy" called "Qi" inside the body via a network of pathways called "Meridian". The 365 acupuncture points are assessed through the 14 primary meridians which correspond to 12 different organ systems in our body. The mechanism is vague but some explaining that placing needles in the acupuncture points will stimulates a signal in the connective tissue. This signal will activate a biomechanical or biochemical reaction that helps in healing of body (Povolny, 2008). Besides that, hirudotherapy or leeching is a famous method in bloodletting and will be elaborate more in the next topic. Hirudotherapy is one of the ways in balancing back the biological humour according to the Ayurveda treatment in which there are three humours in the Indian traditional medicine referred as vata, pitta and kapha.

2.2.5 Energy healing

The energy healing is another types of alternative medicine that could cure illness. Some of the examples are homeopathy, bioresonance therapy, teletherapy, urine therapy a much more methods. Homeopathy for example has been introduced since 200 years ago by a German physician by using the "Principle of Similar". The principle works by giving out medicine with matching drug symptom to the symptom in the

patient in the minimum dosage (Jonas *et al.*, 2003). Bioresonance therapy is another types of therapy that has been invented in Germany using an electromagnetic concept. This therapy is believed to be able to stimulate a change of bioresonance in cell so that the cells could be healthy again after affected by changes carried by the disease. Therefore, the good energy is once restored and this claim is used for other types of energy healing agent too.

2.3   Leeching/ hirudotherapy in ancient time

Leeching has been an old remedy since 1500 BC where it is found in the painting in an Egyptian painting displaying the usage of leech as medicine. During the Roman Era, leech has been promoted because they believed that bloodletting will clear their bodies from the harmful substances produce by diseases. This faith of them is performed so that they can restore the four humour of human body namely blood, phlegm, yellow bile and black bile for proper balance (Munshi *et al.*, 2008). Then, it becomes extremely popular during the 18th and 19th century where indication of leeching is used in acute laryngitis, nephritis, subacute ovaritis, epitaxis, ophathalmia and brain congestion (Adams, 1988). Some prefer using leech than cupping as they can be used in the delicate areas like eyes, gums, breast and testicles. Later it becomes less popular as new modern medicine emerge until late 19th and early 20th century where some scientific research has found some usefulness of leech. For example, Haycraft in 1880 discovered the antithrombotic properties of leech saliva and Jacoby in 1904 has found the potential anticoagulant factor named *Hirudin* (Fields, 1991). This is expanded to the usage of leech as hirudotherapy in plastic, reconstructive and trauma surgery. Furthermore, nowadays leech is still on research to be used in many medicinal applications as it has high potential in helping to cure variety of diseases.

2.3.1 Leeches

For about 650 species of leeches, only some are used in the therapies like *Hirudinaria medicinalis, Hirudinaria asiatica* and *Hirudinaria manellensis.* Leech normally can be found on the fresh water and feed on decaying plant material. Leech is one of the animals under the category of hermaphroditic which has 2 reproduction organs both male and female. However, leech requires another leech to reproduce and lay egg in cocoons (Mory *et al*., 2000).

The leech can be categorized as annelids which looks like rings or segmented body same as the ringworms or earthworms. The medicinal leech or scientifically called as *Hirudo medicinalis* is quite special in which it can cause the deepest bite and eruption of blood after treatment for a longer time than others (Irish *et al*., 2000). Being a *Hirudo medicinalis*, this type of leech can expand themselves three times more than its resting length. There are about five segments for each of the 102 annuli in this leech which has a posterior sucker triradiate with three jaws to bite and smaller anterior sucker for feeding (Valauri, 1991).
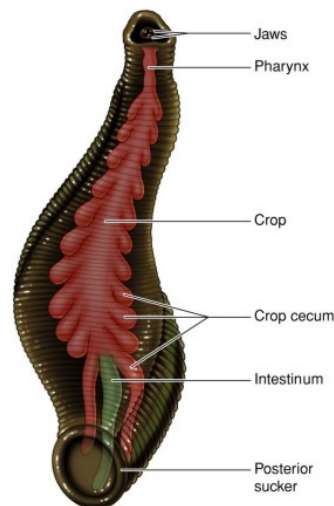

Figure 2.1: Leech
(Source: http://www.digitalmediatree.com/library/image/88/leech.jpg)
[Viewed : 12 September 2011]

Based on the picture, leech will use the jaw to bite and these jaws are connected to the pharynx, esophagus and crop. Crop is where it is literally said as the leech stomach that can be expanded during the feeding. The blood is store inside the crop and can be maintain in fluid state inside their bodies. The crop is connected to gizzard that finally connected to the intestenum and ends at the posterior sucker. The medicinal leech is used for therapy as the therapeutic effect can be obtained from the continued bleeding after the leech is removed. The amount of blood from the bloodletting process is approximately 5-12 ml and the bleeding from patient shows a good sign where this happen due to anticoagulant properties from the leech salivary gland secretion (Engemann and Hegner, 1981). Some animals are actively synthesizing the salivary anticoagulant to secure their nutritional requirements of the body which includes leeches (Ribeiro and Garcia, 1981). Ribeiro, 1981 also state that the salivary active compound could prevent blood finding or blood feeding in some animals.

The way the leech feeds is mostly stimulated by mammalian range temperature and the content of sodium and arginine in blood (Lent, 1986). In general leeches do not just feed on human blood. Some are actually able to consume small invertebrates and some will suck blood using their strong attaching sucker to the host. They have some preferential in blood from certain species and considered particular in feeding pattern. Since not all leeches have jaws, some can secrete enzymes that help them attach to an opening through the skin. In most of the cases, the host would not be able to realize the leech attack until the end because the leech can produce natural anesthetic substance emanate from the saliva of leech. The host will have bleeding for a period of time after the process since the saliva also contains anticoagulants known as hirudin that catalysed conversion of fibrinogen to fibrin and thus prevent blood clotting (Mory *et al.*, 2000). Blood remains in fluid state as the crop of leech is colonized by an endosymbiotic

bacteria like *Aeromonas spp* to help leech digest the blood that they feed (Eroglu *et al.*, 2001). Table 2.1 summarized the major enzymes that are important in leech:

Table 2.1: Major enzymes important in leech

Enzyme	Function
Hirudin	Act as anticoagulant
Bdellin	Protease inhibitor thus act as anti- inflammatory
Apyrase	Powerful platelet anti-aggregate to make blood flow more fluid
Eglin	Inflammation inhibitor and antioxidants
Destabilase	Powerful platelet anti-aggregate to dissolve blood clot
Hyaluronidase	For diffusion and antibiotic
Lipase and Esterases	For hyperlipidemia
Anti-Elastase	Degrade cutainous elastin particularly at the level of skin
Vasodilatory	Similar to histamine (act as neurotransmitter)
Catacholamines	Act on the nerve terminator (specifically at skin)

2.3.2   Mechanism of Hirudotherapy

The mode of action of hirudotherapy depends more on the secretion of enzymes from the salivary glands of leech. The salivary glands produce a lot of active substance that act as anticoagulant, anti-inflammatory, bacteriostatic and analgesic action. Therefore, the effect of these could eliminate hypoxia, increase immunity, restore any damaged vascular and reduce the blood pressure. In addition, the medicinal leech can directly act upon cellular and plasma factors associated with blood clotting as it blocks the attachment of thrombocytes and conversion of fibrinogen to fibrin.

2.3.2.1: Application in Soft Tissue Hematomas

Hematoma can be called as the phenomenon where collection of blood localized outside the blood vessels. This could happen in any part of body including the oral system in which macroglossia could happen due to seizure- related activity. The extensive lingual swelling could also come from penetrating injuries from the lower face or bleeding from the fracture site (Grossman and Karlovitz, 1998). To prevent acute airway emergency, treatment should be done earlier to avoid worsening swelling due to congestion in venous and lymphatic system. Thus, hirudotherapy has been reported as one of successful method in handling post-traumatic lingual swelling. Heckmann *et al.*, reported that there is significant improvement over the subsequent 24 hours after the treatment of using 13 leeches sucking out about 145 ml blood (Heckmann *et al.*, 2005).

2.3.2.2: Application in Tissue Flap Reconstructions

Tissue flap reconstruction is one of the most popular applications of hirudotherapy as it is effective in removing stagnant blood from a skin flap during reattachment of limbs. The stagnant blood is necessary to be put out of the area affected as pooling of blood will lead to the increases of venous pressure. If this is prolonging, the wound will not be provided with oxygen and nutrients thus the injury will not heal. So, in this case hirudotherapy come in handy because the leeches can absorb all the stagnant blood and after 3-7 days the damaged veins will resume the normal colour and pressure so that blood can flow to the affected area continuing the wound healing process (Amrit, 2010). Figure 2.2 depicts the process of application, attachment and satiation of leech in a facial flap reconstruction.

Figure 2.2: Application of hirudotherapy to tissue flap reconstruction
(Source: Porshinsky *et al.*, 2011)

2.3.2.3: Application in the Setting of Severe Soft Tissue Injury and Surgical

    Replantation

The venous disorder study has been made from 1995 to evaluate effectiveness using hirudotherapy for patients that have difficulties due to venous obstruction after head and neck tissue transfer (Chepeha D.B., 2002). All the flaps from the 8 patients could not be saved using conventional surgical or thrombolytic therapy. Therefore, after 6.6 days for inosculation and duration in intensive care unit for 9.6 days, it bring successful result where the flap is save by using about 215 leeches per patient.

In most of the reconstruction cases, the severe soft tissue injury are due to venous congestion where this is detect from a few symptom like development of tissue edema, purple discoloration and warmth of the reconstructed or replanted tissue (Hullet *et al.*, 2007). Applying leech to the affected area will reduce the swelling and discoloration and thus venous congestion will decrease at the same time.

Yet, another procedure that has been using hirudotherapy which is suitable for sensitive area is penile amputation. This has been a good alternative since penile replantation requires adequate postoperative venous outflow (Mineo *et al*., 2004). During the surgical procedure careful approximation of urethra and corporal bodies of the dorsal vein plays an important role. Therefore, for non-microsurgical replantation procedure, application of leech is one of the factors for the success of the replantation

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(Mineo *et al*., 2004). Some of the common effects from this non microsurgery procedure are skin loss, urethral strictures and fistulae, loss of glans penis also sensory deficits (Bhanganada *et al*., 1983). So, hirudotherapy play important steps that take place after the operation. In figure 3 the replantation is a success after using the leech where from a to b the leeches are held until the attachment and c shows that leech already attach and start to increase in size until it satiate from d to e.
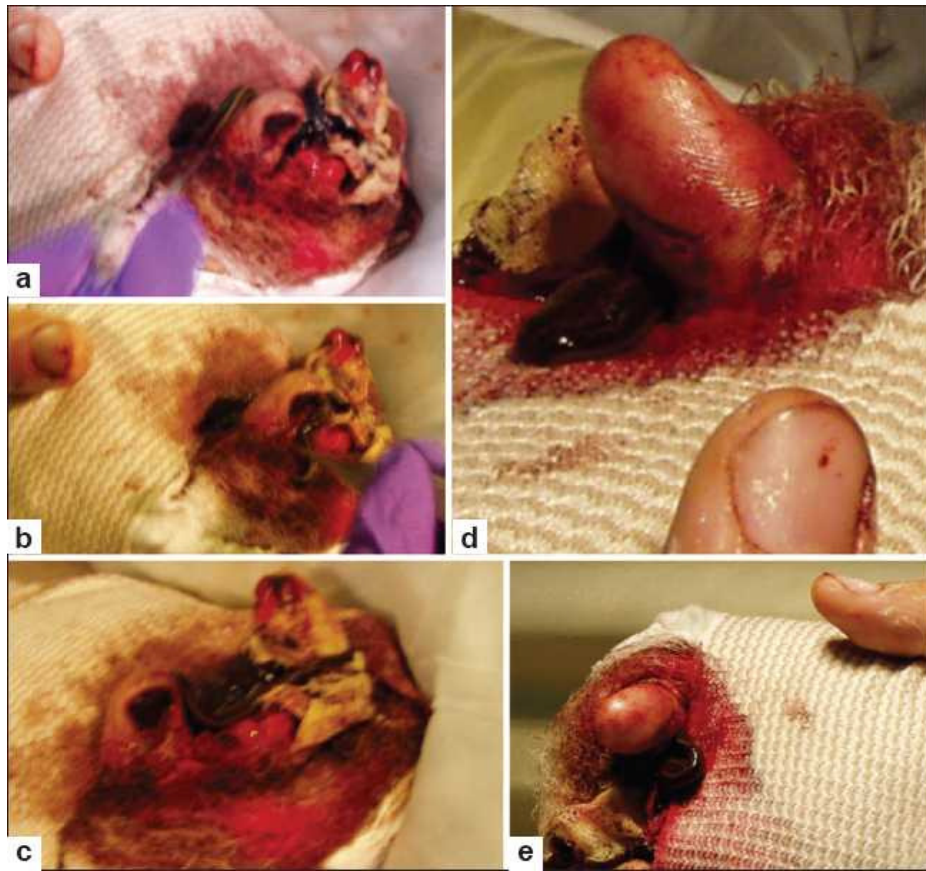
Figure 2.3: Application of hirudotherapy in a case of digital replantation
(Source: Porshinsky *et al.*, 2011)

2.4 Body composition

A body composition is the measures to describe compartments of our body that consists of fat and non-fat component (water, protein, minerals). This measurement is important as it can gives information on the components of human body due to nutrition, diet, exercise, disease and even therapy activities. Some of the basic definitions that must be known in body composition are:

1) **Body density (Db)** : total body mass expressed relative to total body volume

2) **Body mass (BM)** : Measure of the size of the body

3) **Fat mass (FM)** : All extractable lipids from adipose and other tissue in the body

4) **Fat free mass (FFM):** all residual lipid-free chemicals and tissues including water, muscle, bone, connective tissue and internal organs.

5) **Lean body mass (LBM)** : Fat free mass plus essential lipids

6) **Relative body fat (%BF)** : Fat mass expressed as a percentage of total body weight

7) **Total body bone mineral (TBBM)** : A measure of the osseous mineral content of the body

8) **Total body mineral (TBM)** : A measure of the osseous and non-osseous mineral content of the body

9) **Total body water (TBW)** : A measure of the intracellular and extracellular fluid compartments of the body

In order to measure the body composition of human body, measurement should be invasive and convenient where estimation can be done indirectly. Thus, early studies have been developed to model the body composition that divide the weight into two or more components. There are several applications of body composition:

1) To identify health risk due to extremely high or low level of total body fat

2) To monitor diseases by changes in body composition

3) To assess effect of nutritional intake, dietary, therapy and exercises to body composition

4) To keep track of healthy body weight for athletes

5) To monitor children development from changes in body composition

Therefore, body composition is one of the methods that is convenient and used frequently by many practitioner to see changes in body composition.

2.4.1 Body composition models

There are a few models that have been proposed since early studies in which they are:

1) Two component model (2-C)

2) Three component model (3-C)

3) Four component model(4-C)

4) Six component model(6-C)

Out of these four models, the 2-C model has been generally used. However, by using isotope dilution, dual energy x-ray and neutron activation analysis it is possible to derive the other models which can quantify and accurately measures body composition that divide fat free mass (FFM) into water, mineral and protein (Boileau, 1977).

2.4.1.1 Two component model

This model has been developed by Brozek and Siri where the model divides the compartment of human body into FM and FFM. They find and formulate a relationship to calculate the %BF. However, some assumptions are taken into account where:

1) Densities of FM and FFM are additive as well as constant for all people.

2) The content of FFM proportion is constant within and between all people.

3) Each different people only vary in term of fat and obesity tissue.

2.4.1.2 Three component model

This is enhanced from the two component model where body weight is the summation of fat, water and solids which consists of mineral and protein. The model developed is considering the hydration factor that is different from one individual to the other. However, Lohman also proposing the three components model where body weight is made of fat, mineral and protein with water. These two models are representing the body composition on molecular level while there's another three component model which is on tissue/cellular level. This is done by using the dual-energy X-ray absorptiometry that divides the body weight equation equal to summation of bone, bone free lean tissue and FM. The model which develops by Ellis separates the equation into two 2-C model. One is for bone and soft tissue mass and the other is lean and fat tissue.

2.4.1.3 Four component model

The four component model is based on the composition of body weight is made of fat, water, bone, mineral and protein. This has been developed by several researches like Friedl, Selinger, Heymsfield and Baumgartner. This model can portray estimation of fat more accurate than 2-C model but requires more measurement on different variable.

2.4.1.4 Six component model

The six component model is more detailed than the other types of model as the body composition is assess in atomic level. According to this model, body weight consists of TBW, TBN (total body nitrogen), TBCa (total body calcium), TBK (total body potassium), TBNa (total body sodium) and TBCl (total body chloride). This kind

of measurement need direct analysis of chemical composition in vivo. The atomic major elements of body are measured using neutron activation analysis.

2.4.2 Body composition measurement

There are a few types of assessment where we measures body composition by using the method of Hydrodensitometry, Anthropometry, Bioelectrical impedance analysis, Air displacement Plethysmography, hydrometry, Dual energy X-ray absorptiometry (DXA), Neutron activation analysis, Whole body counting of potassium, Computed tomography, and magnetic resonance imaging. These methods are developed to identify and estimate the body composition in molecular or atomic level.

2.4.2.1 Hydrodensitometry

Hydrodensitometry is also known as hydrostatic weighing or underwater weighing in which it is used to measure the body volume. It works by the principle of Archimedes where the estimation of total body volume is equal to the water displaced by the body when it is fully submerged. However, it is not practical to collect the amount of displace water thus measurement is done by determining the underwater weight (UWW) of an individual. This is normally difficult to conduct for excessively obese, pregnant, elderly or disabled subjects (Brodie and Slade, 1990). This method requires a sensitive and continuous measurement through the level of exhalation that will give the value of readings. The readings are the estimation of UWW which is directly proportional to the volume and weight of the water displaced by body volume.

2.4.2.2. Anthropometry

This method has been used to predict the body density that can be change to percentage of body fat. It involves skinfold technique where the thickness of skin fold is measure at different part of body, including bone dimension and limb circumferences. This technique is very common in the lab and anthropometric field for assessing the body fat in body composition and nutritional evaluation (Sloan, 1967). The skinfold method is use as it can estimates the general fatness and the distribution of subcutaneous adipose tissue which assume to represent the total body fat. Normally, the potential sources of error come from the caliper selection and tester reliability in which it fails to estimate simultaneously all possible sources of measurement error (Brodie, 1998). The error can also result in different degree of error variance for different conditions (Sloan and Shapiro, 1972; Lohman *et al*., 1984).

2.4.2.3 Bioelectrical Impedance

Bioelectrical impedance analysis (BIA) method is used since 1980's and now famous for practitioner to make different diagnosis and make a long term approach to treatment. Using the tools for measurement, BIA will give the result in impedance value of body tissues. The impedance then can be calculated to estimate the total body water (TBW) which also estimate the FFM and adiposity. In addition, BIA can also be used in approximating the body cell mass and TBW in different kind of clinical condition (Kyle *et al*., 2004).

2.4.2.4 Air displacement Plethysmography (ADP)

This method is an alternative to hydrodensitometry as it much more convenient and requires only minimal technician skill to conduct. The ADP is using a Bod Pod system where the derivation of BV and Db is based on the inverse relationship between pressure and volume (Boyle's law): $\dfrac{P_1}{P_2} = \dfrac{V_2}{V_1}$
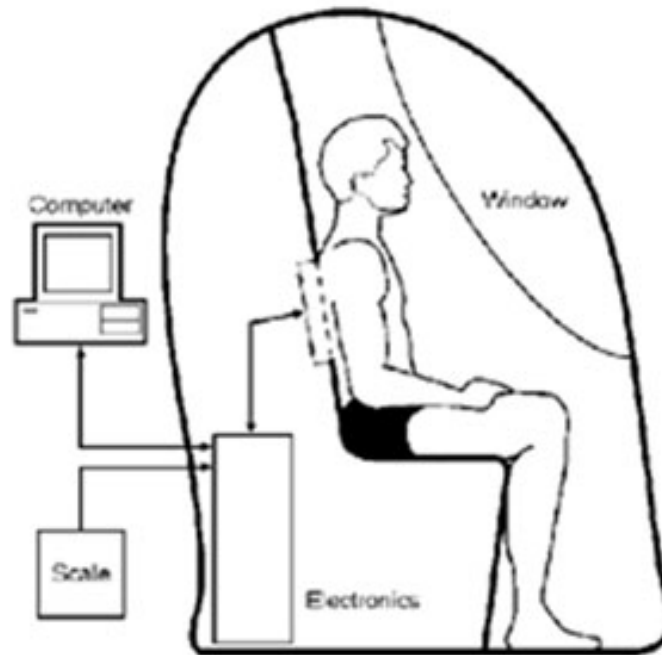
Figure. 2.4: Two chamber bod pod system
(Source: http://www.iub.edu/~k536/measure.html)
[Viewed: October 14, 2011]

Figure 4 show the Bod Pod system which consists of front chamber and rear chamber that separated by a wall made of molded fiberglass. An oscillating diaphragm is attach to create changes in volume where the measurement is taken twice and pressure and volume is calculated before and after the patient is inside.

2.4.2.5 Hydrometry

Hydrometry is the measurement of body water that is the most abundant components in the body. This technique is based on the dilution techniques where a tracer will be diluted in one of the water components. Hydrometry requires two fluid samples which is normally blood, saliva or urine. The first sample is for baseline measure where the second one measures the concentration of the tracer. Then, the TBW is calculated from the estimation of the water components that already equilibrate with the tracer like tritium oxide, deuterium oxide and oxygen-18 (Heyward and Stolarczyk, 1996).

2.4.2.6 Dual energy X-ray absorptiometry (DXA)

DXA provide a measurement of total body bone mineral and bone mineral density. In addition, it also able to measures FFM, %BF and soft tissue mass where it is equal to the summation of lean tissue mass (LTM) and FM. The bone mineral content that is captured by the DXA is given in grams and projected area of the measured site is in centimeter (Adams, 2003). Then bone mineral density is calculated by dividing the bone mineral content by the bone area (Blake *et al*., 1999). The principle is based on the measurement of attenuation of x-ray with high and low photon energies. Since the X-ray is absorbed by the body, the attenuation of the energy varies depending on the densities and chemical composition of the tissue.

2.4.2.7 Neutron activation analysis (NAA)

This method can give details composition of body in atomic level where suitable for 6-C model. During the assessment, a beam of neutrons will be projected to the patient thus creating an isotope that emits gamma rays. Then components like calcium,

sodium, chlorine, phosphorous, nitrogen, hydrogen, oxygen and carbon can be determined through the measurement of the emission of the gamma rays.

2.4.2.8 Whole body counting of potassium

This method is able to give the value of body cell mass by the measurement of total body potassium. Potassium is an element that can be found in the intracellular with different types namely ^{39}K, ^{40}K and ^{41}K. Only ^{40}K can be detected by the gamma rays making use of it as counter to determine the whole lean mass of the body. Finally, the fat percentage in the body can be determined from the lean mass and total body weight.

2.4.2.9 Computed tomography

Computed tomography (CT) is also based on the difference of X-ray attenuation where it allows identification of bone, adipose tissue and lean tissue. It is a powerful radiographic tool where fatness can be measures by combining a specific part with the whole body. In addition, due to the properties of CT that is more sensitive to small changes in attenuation result in the ability of CT in producing image of soft tissue in great clarity compared to standard radiography (Brooks and DiChiro, 1975; McCullough *et al*., 1976).
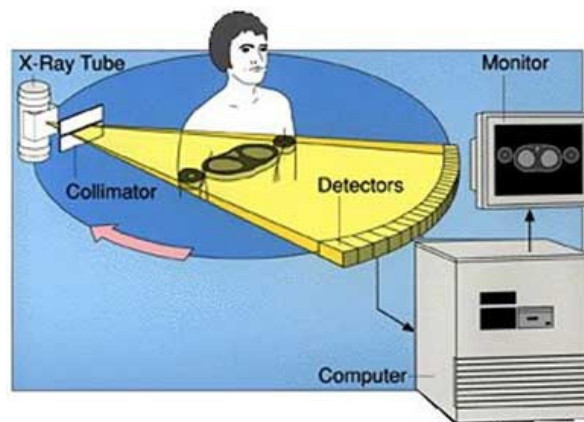
Figure 2.5: CT scan
(Source: http://www.iub.edu/~k536/measure.html)
[Viewed: October 14, 2011]

The figure depicts the concept of CT scan where the x-ray tube is placed opposite poles of a large ring that rotate around the patient. Then the computer will generate the 3-D image of organs and tissues slices by slices using the lead shutter in front of the X-ray tube and X-ray detector after complete rotation of 360°.

2.4.2.10 Magnetic resonance imaging (MRI)

MRI similarly can produce an image and simultaneously detect subcutaneous and visceral fat. It gives an unbiased measurement of fat content, internal and subcutaneous for a large range of body shapes and sizes (Thomas *et al*., 1998). Using MRI, the patient will be placed in a magnetic field that aligns together hydrogen nuclei when radio pulsed frequency is applied. When the radio frequency is turned off, the hydrogen nuclei will emit the radio signal that they absorbed creating an image at tissue level.

2.5   Bioelectrical impedance analysis (BIA)

BIA is method that uses an alternating current (AC) to measure the opposition of body tissue. Normally, the impedance value that captured will be varying according to the frequency of the current used. There are a few ways of using BIA where sometimes, single frequency or multi frequency is used in the analysis.

2.5.1   BIA principles

BIA works on the principles that relate the conductor volume, length, resistivity and impedance value. The conductor principle can be compare to the human body where conductor itself is the human body which has volume (V), height (L), specific resistivity for components like FM and FFM (ρ), and body impedance (Z).

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2.5.1.1 Body impedance (Z)

Impedance value is a resistive property of alternating current (AC) that is a frequency dependant. It consists of two components which are resistive (R) and reactive capacitive (X_c). The relationship can be put into an equation of:

$$Z^2 = X_c^{\,2} + R^2$$

The value of X_c refers to the value of body capacitance that present in the body when AC is in contact with the cell membrane. Therefore, X_c can be related to the body cell mass (BCM) that contains active components of the body like muscle, blood and immune cells. Resistive value, R, is the indicator of the extracellular mass and intracellular mass in which R is assume proportional to FM or FFM. The value of R is a resistive value when a current flow through the body and can indicate that high reading of R shows that FFM content is low in human body and vice versa. The effect of X_c sometimes is negligible due to comparatively small value but becomes significant as the frequency increases.

2.5.1.2 Volume and body composition

The volume of a conductor can be interpreted by the equation: $V = L \times A$. Since Length can be related to the height of human then area is derived from the relationship of resistance for a conductor: $R = \dfrac{\rho L}{A}$. Since R is proportional to impedance, rearranging the equation result in $A = \dfrac{\rho L}{Z}$. Thus, deriving again the equation of volume will result in:

$$V = \frac{\rho L^2}{Z} \quad \text{-------------------------------------- (1)}$$

This volume can be interpreted as the volume of the FFM or TBW that directly proportional to square of height and inversely proportional to value of impedance of body. However, this equation holds an assumption that the conductor is a perfect cylinder with a uniform cross sectional area. This is not true as a whole as human body can be represented as five cylinders excluding head (Kushner, 1992). All the five cylinders are different in cross sectional area resulting in different measurement of resistance (Baumgartner *et al*., 1989). Thus, to cater all the differences in the body segment, the equation of volume become: $V = 2\left(\dfrac{\rho L^2}{z}\right)_{leg} + 2\left(\dfrac{\rho L^2}{z}\right)_{arm} + \left(\dfrac{\rho L^2}{z}\right)_{trunk}$.

2.5.1.3 Calculation of body composition

There are a few formulas in calculating the body composition components like TBW, FFM, FM, and % BF. Using BIA method, these readings can be measured at the frequency of 50 kHz using the formulas below (Lukaski, Bolonchuk, 1988):

$$TBW = 0.372\left(\frac{height^2}{\mathrm{Re}\,sis\tan ce}\right) + 3.05(sex) + 0142(weight) - 0.069(age)$$
---------- (2)

- Height is in *cm*
- Sex: Male = 1, Female = 0
- Weight is in *kg*
- Age is in years

$$FFM = \frac{TBW}{0.73}$$ -- (3)

- 0.73 is known as the hydration constant

$$FM = Weight - FFM$$ --- (4)

$$\%BF = \frac{FM}{weight} \times 100\%$$ --- (5)

25

2.5.2   BIA models and approaches

There are a few models and approaches that have been used in determining the TBW and FFM in the body for BIA. However, the concept still applies the same where two electrodes namely source and sink is used to determine the current flow pass through it. The current that pass through the body will go through all the conducting material and voltage drop across the source and sink can be measured. These conductors are normally in the form of charged ions like sodium and chloride ions.

2.5.2.1 Single frequency BIA (SF-BIA)

In this method, only one frequency which is at 50 kHz is used to measure the impedance across the electrode that is paced on the hand and foot. However, some are placing the electrodes across hand to hand and even foot to foot (Jebb *et al*., 2000; Utter *et al*., 1999).

2.5.2.1.1 Series model

This is one of the traditional models where the assumption is considering only one conducting path and human body consists of series of resistors. Using a single frequency of 50 kHz, the impedance value will be used to determine the TBW and FFM. However, this method is only suitable for patient with normal ratio of ECW to ICW.

2.5.2.1.2   Parallel model

This model made of assumptions where the body is not just a series of resistors but parallel as it suits more of the human physiology. The parallel model is the reciprocal of the series model and preferred to be used for patient with fluid imbalance as it is suitable for estimation of ICW and BCM.

2.5.2.2 Multi-frequency BIA (MF-BIA)

Since single frequency BIA cannot penetrate cell, multi-frequency BIA can achieved more in order to estimate the FM, ECW, ICW and TBW. The range of frequencies start from 0 up to 500 kHz is used to give more accurate and less biased value than SF-BIA.

2.5.2.2.1 Bioelectrical impedance spectroscopy (BIS)

The BIS is more to prediction using the mathematical modelling and mixture equation. The mixture equation like Cole model can show improvement in accuracy than regression approach as BIS utilizing correlation between R and body fluid compartments. From there, prediction equation can be derived provided reliable data fitting and valid fluid distribution model is included (Kyle *et al.,* 2004).

2.5.2.2.2 Segmental model

The value of impedance is greatly influenced by the cross sectional area of the body. Comparing the five model cylinder, trunk will represent most of the FFM value than others. Therefore, segmented model can give more accurate value than the whole body BIA. Segmental BIA is able to calculate the distribution of body composition segment by segment thus useful in patient with distorted fluid distribution. In addition, to used segmental model requires additional two more electrodes in any part like torso, leg or arm.

2.5.2.2.3   Localized bioelectrical impedance analysis

Localized BIA is also one of the methods that can give specific segment value. As the traditional BIA concluded population specific, localized BIA can be more focus to avoid the interference effect for example in measuring the local abdominal fat by using the localized BIA (Scharfetter *et al*., 2001).

2.5.2.2.4   Bioelectrical impedance vector analysis (BIVA)

BIVA is type of analysis that is consider as a standalone model that can give direct assessment of patient from direct impedance measurements plotted in bivariate vector standardized by the subject's height. This method is useful and advantageous in the clinical settings as the result is not biased due to choice of regression equation since no conversion of raw data to body composition is required. The result can be plot in R-X_c plane and stratified accordingly due to different vector distribution pattern (Piccoli *et al.,* 1995; Piccoli *et al*., 2002).

2.6   Statistical test

Statistical test is important in organizing data and making conclusion from the raw data. It's a powerful tool in which one can represent a set of raw data in graphical or tabulated form and relate the variable while making estimation and get better understanding of situation of the data portrayed. Some of the statistical analysis that is common to researchers is t-test and analysis of variance (ANOVA) that involves the description of mean.

2.6.1 T-test

T-test is a test which able to determine the separateness of two sets of measurement. Therefore, mean or average value and distribution can be depicted by using t-test. There are three types of t-test which is independent t-test and dependent t-test and one sample t-test.

2.6.1.1 Independent t-test

This test is applicable for comparing two different population or sample for one variable. Normally, for a simple experiment the result of the experiment and the control group can be compared and analyse by using the independent t-test.

2.6.1.2 Dependent t-test

The dependent t-test is used to evaluate data by comparing average of one single group for two different variables. This is normally called as paired sample test as the result from the two mean is from the same group of interest. The dependent t-test usually been applied in before and after situation where the effect of the variable is determine by comparing the mean.

2.6.1.3 One sample t-test

This type of test is more direct as we only compare mean of a variable with a constant value that is usually a hypothesized value that already calculated before the test is conduct. It can determine the validity of the measurement or maybe directing to another conclusion of the test.

2.6.2 ANOVA

ANOVA is more powerful than t-test as it can compare means more than two groups. The reliability of t-test is valid up until two groups thus urging the ANOVA method to be used to get result and see the relationship from different group or variables. Generally, there are two main types of ANOVA namely one-way ANOVA and two-way ANOVA.

2.6.2.1 One way ANOVA

One way ANOVA is the upgraded version of independent t-test where it can evaluate a mean for more than two groups. Sometimes, in real situation cross evaluation for several samples is required to get a confirmation of the hypothesis of an experiment.

2.6.2.2 Two-way ANOVA

This method is different in terms of evaluation of mean can be compared with two different variable for the same group. This will allow the researcher to determine the combined effect of the independent variables plus assessing the interaction between the variables in influencing the mean on the dependent variable.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

The effect of the leech therapy on body composition is a basic research on determining the difference in impedance measurement before and after the treatment. The process of the study can be depicted by the flowchart in Figure 3.1 below.

Preparation for demographic data and measurement setup at leech therapy treatment center in Pantai Dalam, KL

↓

Completion of data by subjects with 2 forms:
    i- Personal information   ii- Consent form

↓

Conducting measurement for pre-treatment data

↓

Keying in information and data measurement before leech therapy

↓

Completion of treatment within 1 hour

↓

Keying in information and measurement after treatment of leech therapy

↓

Analyzing data using the statistical tool

Figure 3.1: Flowchart of study

3.1   Subjects / patient

The criteria of the subjects of this study are constrained by the method of the analysis which uses the BIA measurement and the treatment of leech therapy. For BIA measurement, a subject should not be in the early pregnancy stage or implanted with any electronic devices such as a pace maker. Moreover, leech therapy treatment also could not be performed on pregnant women due to the influence of treatment in the course of developing pregnancy and sometimes causing miscarriage. In addition, the leech therapy patient must not experiencing any symptoms of low blood pressure, anemia or anything similar as well as taking any medication that has the same effect as *Hirudin* enzyme. This will make the conditions of the patient become worse and thus is not eligible to be the subject of this study.

Overall, there are 50 patients that agree to take part in this study. All information regarding this study was brief thoroughly.

3.2 Measurement setup

Before measurement begins, the patient must be sure to be in the supine position. The measurement is taken from the right hand and right foot of the patient. So, the placement of the electrode on proximal part is placed on the dorsal surface of the wrist so that the upper border of the electrode bisects the styloids processes of the ulna and radius and dorsal surface of the ankle that it able to bisects medial and lateral malleoli. In addition, the right foot and right hand where the distal placement of electrodes is done at the base of the second or third metacarpal phalangeal joints. These distance at the proximal and distal are always check to be in the distance of at least 5cm.

Then, the clip wire is attached to the self adhesive disposable electrodes to take the measurement. Basically, there are 2 main wires that are used which are red and

black. The position of the red wire is placed at the distal and black is always positions at the proximal distance. This can be illustrated below.
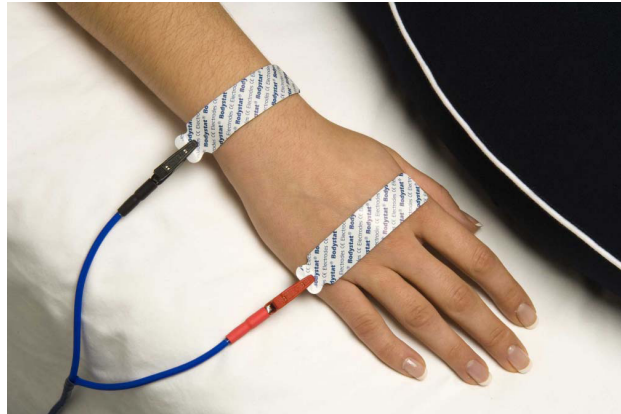
Figure 3.2 Placement of electrodes at hand
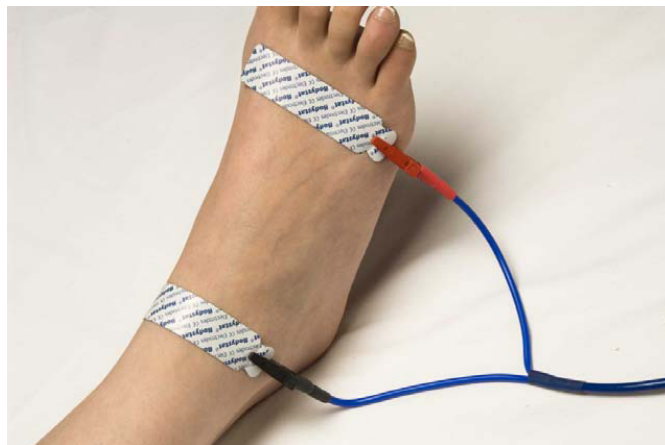
Figure 3.3 Placement of electrodes at leg

3.3 Data measurement

The procedure could be outline as below:

1. After the patient is in the correct position, then the body must be check so that it won't touch one and other. This is to avoid any short circuit in the path of the current inside the body

2. The electrodes is placed on the correct position

3. The crocodile clips is attached to the metal tab strip of the electrode.

4. The bioimpedance machine which is Quadscan 4000 is switch on.

5. All the data from the patient were insert one by one before the measurement start.

6. After 3 to 4 minutes, the measurement start to take place and results are display on the LCD screen.

7. Then the data could be downloaded via Bluetooth connection at any time for analysis.

3.4 Statistical analysis

This analysis is divided into a few parts that are bar graphs, descriptive statistics, independent t-test, paired sample t-test and ANOVA. The steps are depicted more on appendix A.

3.4.1 Bar graph

The step by step procedures are by clicking this one by one.

Analyze $\longrightarrow$ descriptive statistics $\longrightarrow$ frequencies $\longrightarrow$ chart.

Since the bar graph is set in percentage, all the frequencies given are automatically converted.

3.4.2 Descriptive statistics

This can be done as follows.

Analyze $\longrightarrow$ descriptive statistics $\longrightarrow$ frequencies $\longrightarrow$ descriptives $\longrightarrow$ options $\longrightarrow$ ok.

All the important descriptive parameters are chosen for the analysis. These include mean, standard mean error, kurtosis, variance and standard deviation.

3.4.3   Independent sample t-test

Following the order below, the results are obtained from independent t-test.

Analyze ⟶ compare means ⟶ independent sample t-test ⟶ ok

The entire test variables are put on the box and grouping variable is defined.

3.4.4 Paired sample t-test

Following the order below, the results are obtained from paired sample t-test.

Analyze ⟶ compare means ⟶ paired sample t-test ⟶ ok

The entire paired variables are put on the box for analysis.

3.4.5 ANOVA

This can be done as follows.

Analyze ⟶ compare means ⟶ one way ANOVA ⟶ post hoc ⟶ ok

CHAPTER FOUR

RESULTS

4.0   Statistical analysis

The data that were collected from the Quadscan 4000 are all analyzed closely by using the SPSS tool. The involve test are pair t-test, independent sample t-test and ANOVA which stands for analysis of variance. The effect of body composition is measured based in the bioimpedance parameter which are divided into 2 called as primary and secondary bioimpedance parameter. The parameter involves were listed in Table 4.0 as below.

Table 4.0: Bioimpedance parameter

Main bioimpedance parameter	Secondary bioimpedance parameter
Impedance at 5K	Percentage of fat before test
Impedance at 50K	Min fat before test
Impedance at 100K	Max fat before test
Impedance at 200K	Percentage of lean before test
Reactance at 50K	Min lean before test
Resistance at 50K	Max lean before test
Phase Angle at 50 kHz	Dry lean weight before test
Basal metabolic rate	Percentage of water before test
Intracellular water	Min water before test
Normal value of intra cellular water	Max water before test
Extra-cellular water	Density before test
Normal value of extra cellular water	Nutrition before test
Total body water volume	Normal nutrition before test
Min total body water	Third space value before test
Max total body water volume before test	
Body cell mass before test	

4.1   Demographic data

The demographic data is basically a requirement for the patient to complete in order to enrol in this study. Important background information were listed such as gender, marital status, occupation, age, illness, number of treatment and subject's daily activity. BMI measurements are derived from the demographic information and compare with the analysis data from Quadscan 4000.
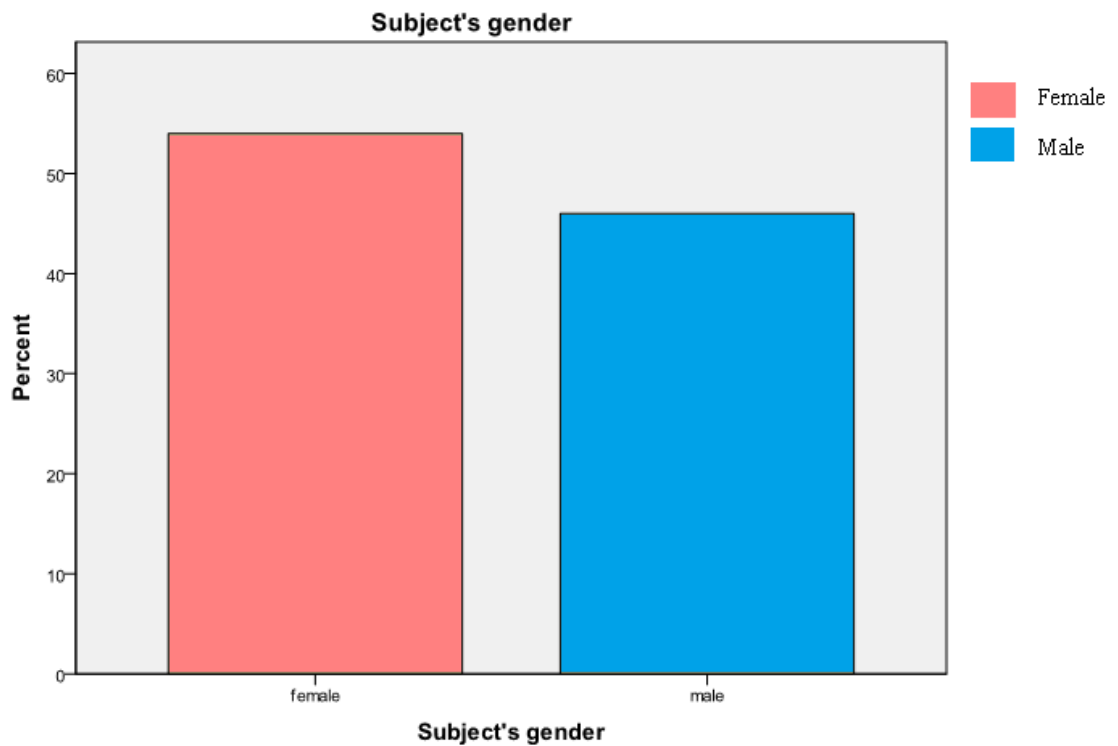
Figure 4.1: Bar graph for subject's gender

Based on figure 4.1, gender of patient can be classified for the leech therapy treatment that is dominated by female by 54% of the participant of this study which is more than half. Therefore, the male participants were identified to be only 46% from the 50 patients that enrolled. These participants were randomly picked from the patients who come to get the leech therapy treatment in the treatment center. Thus, this shows that this treatment is more popular among females than males by 8% difference.
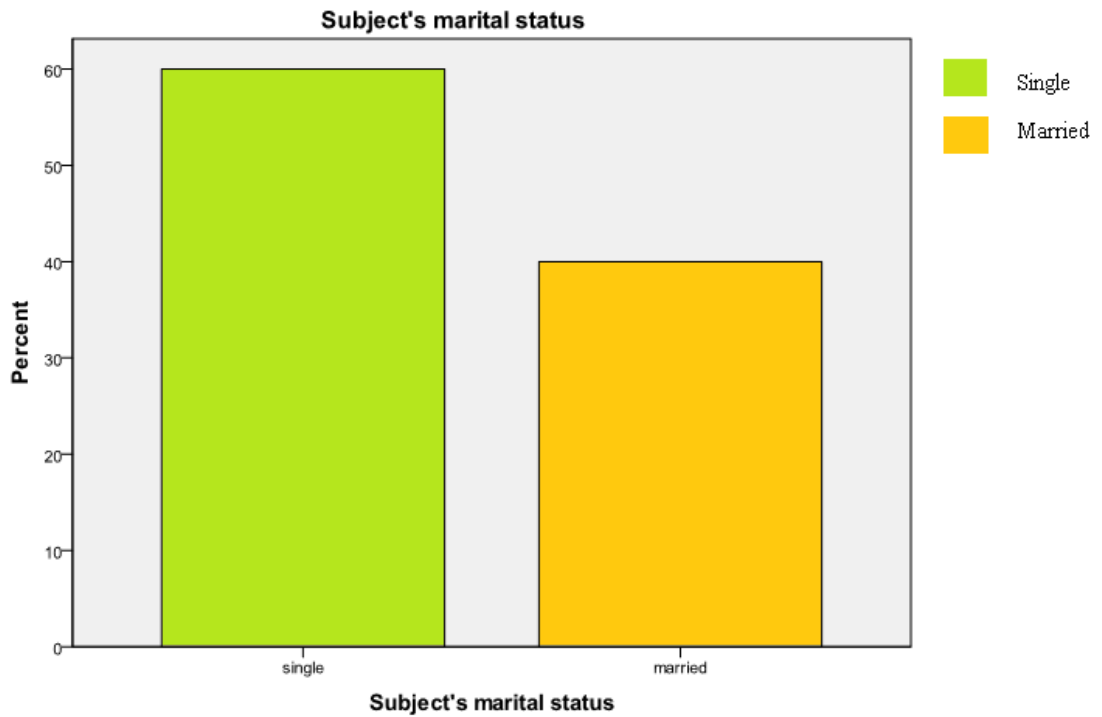
Figure 4.2: Bar graph for subject's marital status

For the above figure 4.2, the variables involve is the marital status of the subjects. The bar graph shows that the patients that come to get the treatment are mostly single person rather than married. This is depicted by the value of single patient that covers 60% than the total patient that come to get treatment. Married person that are chosen were only 20 persons that brings the statistical percentage up to 40% only.
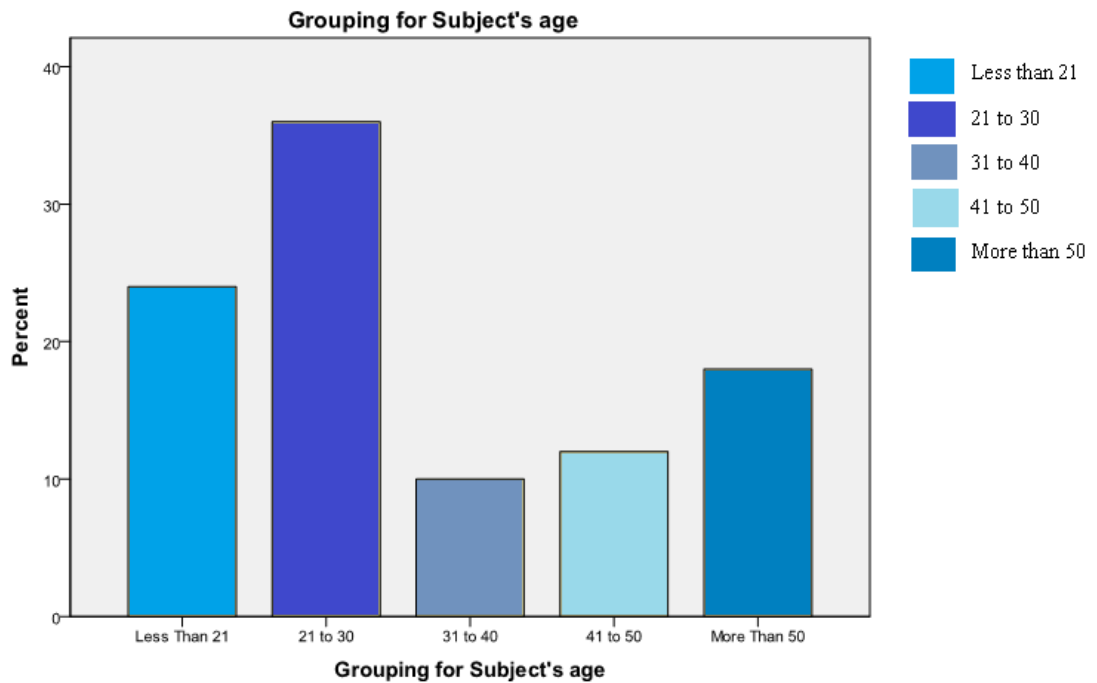
Figure 4.3: Bar graph for range of subject's age

From figure 4.3, the ranges of subject's age are determined from the maximum and minimum value of the data. Using cross tabulation method, there are 5 significance ranges which dominated by the patient from age 21-30 years by 36%. This is followed by those who are younger in the category of age less than 21 by 24%. Then, the percentage is decreases from age of more than 50 by 18%, 41 to 50 by 12% and least participant for range of 31 to 40 years by only 10%.
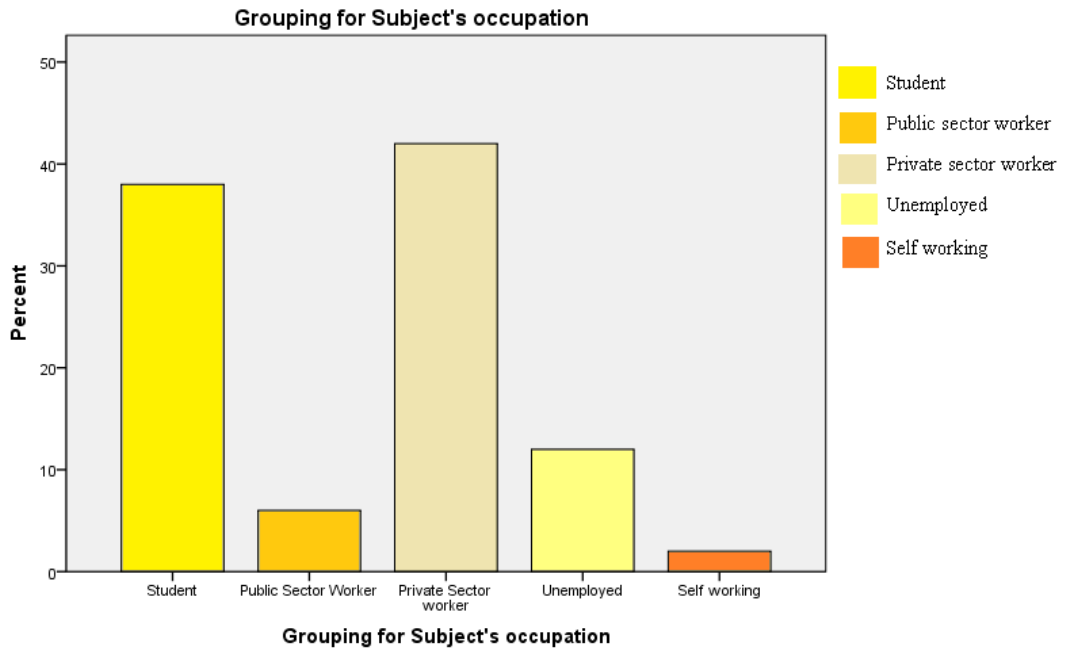
Figure 4.4: Bar graph for subject's occupation

From the chart of figure 4.4, most of the subjects are working in the private sector showing 42% participation rate where those who fall in this category are consultant, driver, secretary, artist, lecturer, executive, technician, manager, banker, clerk, engineer and hotelier. However, 38% out of 50 subjects were categorized as students where this covers student from primary to tertiary level of education. The public sector is fall behind with 6% in which subjects currently working as nurse or research assistant in the public university. Furthermore, unemployed participants were categorized as housewife or retiree with overall 12% from the total patients. Self-working subject is only one where it contributes 2% of the total statistics.
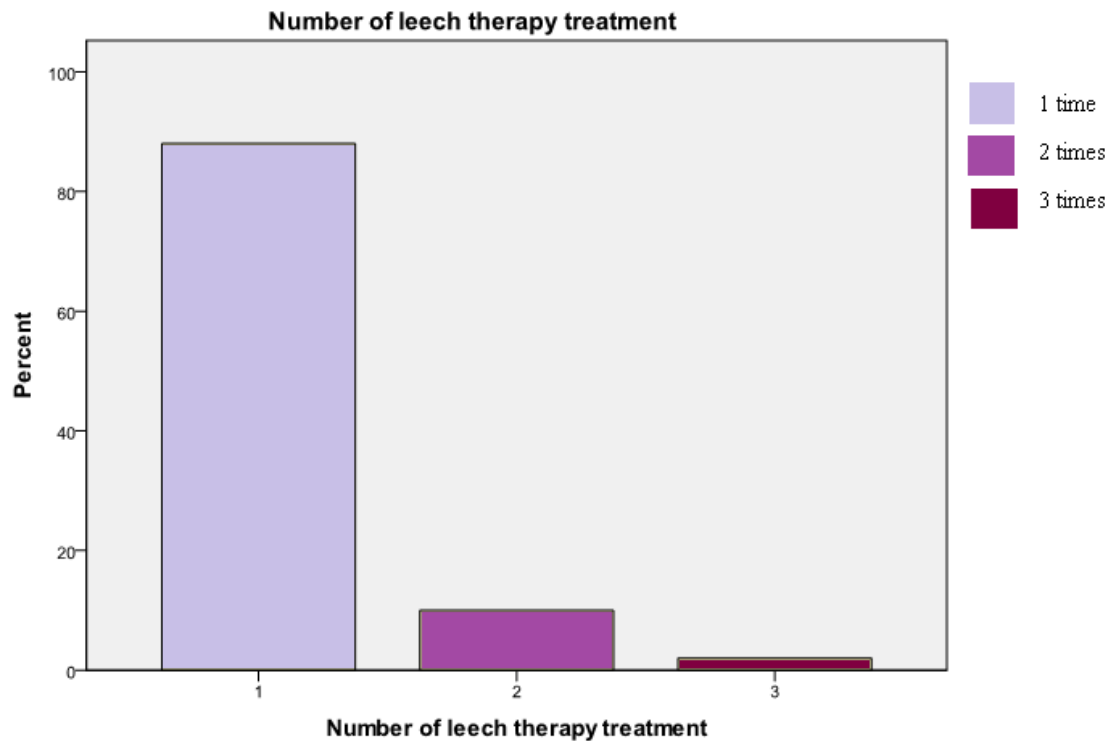
Figure 4.5: Bar graph for number of leech therapy treatment

The bar graph is indicating that most of the participants were a first timer in getting a leech therapy treatment with 88% and the rest were the second time getting this treatment and third time with percentages 10% and 2% respectively.
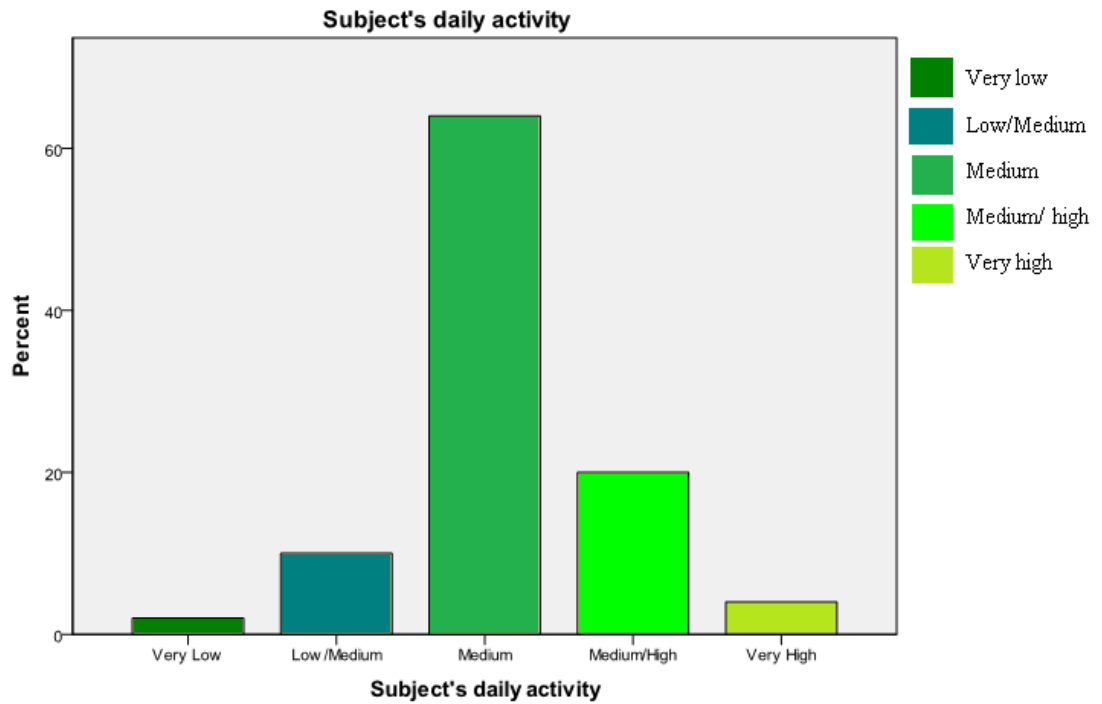
Figure 4.6: Bar graph for subject's daily activity

The above figure indicating that majority of the subject is regarded as having a medium level of daily activity with 64% from total statistics. However, those who fall under low to medium and medium to high level of activity were identified as 10% and 20% respectively. This is trailed by another two category that are activity level is considered very low with 2 % and double by 4% for very high level of activity.
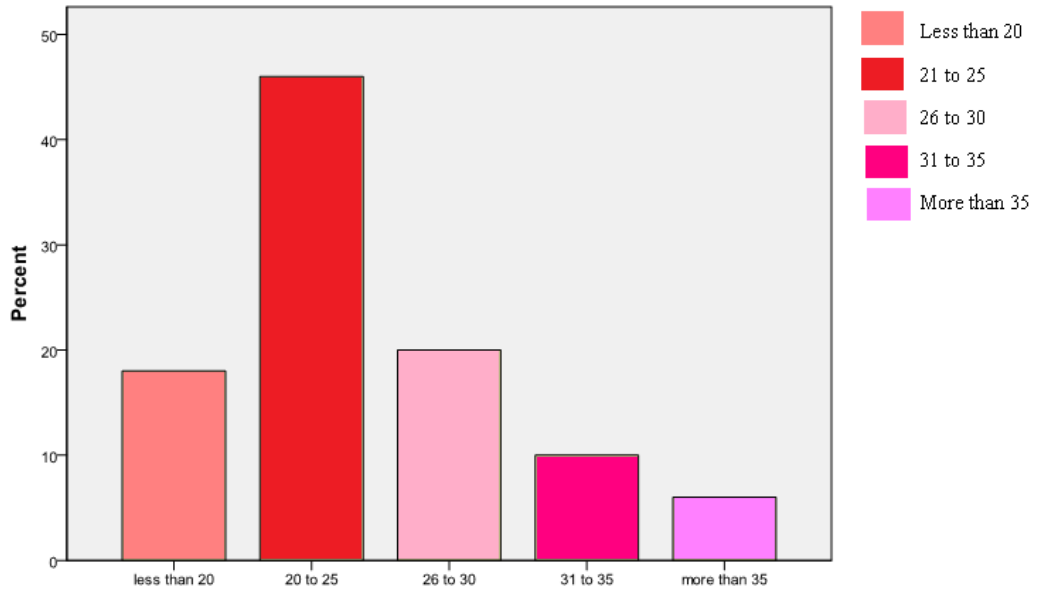
Figure 4.7: Bar graph for BMI readings

The BMI readings were taken before and after the leech therapy treatment and most of the participant of this study are having a BMI from 20 to 25 with 46% in total. The BMI range from 26 to 30 was more with 20% than BMI range of less than 20 that is only 18%. About 6% of total patient is having BMI of more than 35.

4.4   Comparison of bioimpedance parameter

This is the analysis to see the comparison of bioimpedance parameter with the demographic variable namely age and BMI groups

4.4.1 Comparison of Bioimpedance Parameters with Patient's Age Group.

In this section Comparison of Bioimpedance Parameters with Patient's Age Group are shown here. For ease of reporting and analysis age group also divided into four groups here. For analysis the bioimpedance parameters are divided into two groups here. They are primary and secondary bioimpedance parameters. Also need to consider the condition before and after treatment here. Independent T test and ANOVA test was used here for this analysis. The value of P should be less than 5% for significance.

The age group 2 until age group 5 have almost the same pattern in age group 1 and some have some missing value because insufficiency of parameters for analysis.

Table 4.30 Comparisons of Main Bioimpedance Parameters before Treatment for Female age group 1.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	Diseases Grp(p)
Impedance value at 5KHz	0.000	0.000	0.000
Impedance value at 50KHz	0.000	0.000	0.000
Impedance value at 100KHz	0.000	0.000	0.000
Impedance value at 200KHz	0.000	0.000	0.000
Reactance at 50KHz	0.002	0.000	0.000
Resistance at 50KHz	0.000	0.000	0.000
Phase Angle at 50 KHz	0.000	0.000	0.000
Basal metabolic rate	0.099	0.000	0.000
Intracellular water	0.720	0.000	0.000
Normal value of intracellular water	0.345	0.000	0.000
Extra-cellular water	0.534	0.000	0.000
Normal extra cellular water	0.710	0.000	0.000
Total body water volume	0.749	0.000	0.000
Min total body water volume	0.011	0.000	0.000
Max total body water volume	0.182	0.000	0.000
Body cell mass	0.724	0.000	0.000

* No of treatment does not have enough parameter for analysis.

Table 4.31 Comparisons of Secondary Bioimpedance Parameters before Treatment for Female Age group 1.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	Diseases Grp(p)
Percentage of fat	0.294	0.000	0.000
Min fat	0.186	0.000	0.001
Max fat	0.439	0.000	0.001
Percentage of lean	0.294	0.000	0.000
Min lean	0.244	0.000	0.000
Max lean	0.246	0.000	0.000
Dry lean weight	0.049	0.000	0.004
Percentage of water	0.575	0.000	0.000
Min water	0.011	0.000	0.000
Max water	0.182	0.000	0.000
Density	0.852	0.000	0.000
Nutrition	0.001	0.000	0.000
Normal nutrition	-	1.000	1.000
Third space	0.000	0.000	0.000

* No of treatment does not have enough parameter for analysis.

Table 4.32 Comparisons of Main Bioimpedance Parameters after Treatment for Female Age group 1.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	Diseases Grp(p)
Impedance value at 5KHz	0.001	0.000	0.000
Impedance value at 50KHz	0.001	0.000	0.000
Impedance value at 100KHz	0.002	0.000	0.000
Impedance value at 200KHz	0.003	0.000	0.000
Reactance at 50KHz	0.007	0.000	0.000
Resistance at 50KHz	0.002	0.000	0.000
Phase Angle at 50 KHz	0.058	0.000	0.000
Basal metabolic rate	0.079	0.000	0.000
Intracellular water	0.693	0.000	0.000
Normal value of intracellular water	0.345	0.000	0.000
Extra-cellular water	0.753	0.000	0.000
Normal extra cellular water	0.710	0.000	0.000
Total body water volume	0.582	0.000	0.000
Min total body water volume	0.011	0.000	0.000
Max total body water volume	0.182	0.000	0.000
Body cell mass	0.698	0.000	0.000

* No of treatment does not have enough parameter for analysis.

Table 4.33 Comparisons of Secondary Bioimpedance Parameters after Treatment For Female Age group 1.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	Diseases Grp(p)
Percentage of fat	0.246	0.000	0.000
Min fat	0.235	0.000	0.005
Max fat	0.633	0.000	0.000
Percentage of lean	0.246	0.000	0.000
Min lean	0.160	0.000	0.000
Max lean	0.204	0.000	0.000
Dry lean weight	0.047	0.000	0.005
Percentage of water	0.347	0.000	0.000
Min water	0.011	0.000	0.000
Max water	0.182	0.000	0.000
Density	0.852	0.000	0.000
Nutrition	0.000	0.000	0.000
Normal nutrition	-	1.000	1.000
Third space	0.001	0.000	0.000

* No of treatment does not have enough parameter for analysis.

Table 4.34 Comparisons of Main Bioimpedance Parameters before Treatment for male age group 1.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.000	0.104	0.640	0.000
Impedance value at 50KHz	0.000	0.024	0.688	0.001
Impedance value at 100KHz	0.000	0.022	0.640	0.001
Impedance value at 200KHz	0.000	0.024	0.574	0.000
Reactance at 50KHz	0.002	0.001	0.207	0.154
Resistance at 50KHz	0.000	0.023	0.686	0.001
Phase Angle at 50 KHz	0.000	0.003	0.280	0.001
Basal metabolic rate	0.099	0.000	0.194	0.322
Intracellular water	0.720	0.000	0.324	0.142
Normal value of intracellular water	0.345	0.000	0.217	0.781
Extra-cellular water	0.534	0.000	0.211	0.089
Normal extra cellular water	0.710	0.000	0.217	0.790
Total body water volume	0.749	0.000	0.246	0.057
Min total body water volume	0.011	0.000	0.232	0.769
Max total body water volume	0.182	0.000	0.209	0.799
Body cell mass	0.724	0.000	0.328	0.140

Table 4.35 Comparisons of Secondary Bioimpedance Parameters before Treatment for Male Age group 1.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.294	0.365	0.616	0.000
Min fat	0.186	0.000	0.380	0.170
Max fat	0.439	0.000	0.116	0.645
Percentage of lean	0.294	0.365	0.616	0.000
Min lean	0.244	0.000	0.213	0.257
Max lean	0.246	0.000	0.186	0.337
Dry lean weight	0.049	0.000	0.163	0.904
Percentage of water	0.575	0.000	0.258	0.003
Min water	0.011	0.000	0.232	0.769
Max water	0.182	0.000	0.209	0.799
Density	0.852	0.224	1.000	0.000
Nutrition	0.001	0.000	0.585	0.396
Normal nutrition	-	1.000	1.000	1.000
Third space	0.000	0.001	0.336	0.000

Table 4.36 Comparisons of Main Bioimpedance Parameters after Treatment for Male Age group 1.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.001	0.031	0.482	0.000
Impedance value at 50KHz	0.001	0.016	0.553	0.001
Impedance value at 100KHz	0.002	0.015	0.512	0.001
Impedance value at 200KHz	0.003	0.015	0.497	0.001
Reactance at 50KHz	0.007	0.000	0.562	0.733
Resistance at 50KHz	0.002	0.016	0.550	0.001
Phase Angle at 50 KHz	0.058	0.000	0.350	0.012
Basal metabolic rate	0.079	0.000	0.221	0.299
Intracellular water	0.693	0.000	0.383	0.147
Normal value of intracellular water	0.345	0.000	0.217	0.781
Extra-cellular water	0.753	0.000	0.278	0.073
Normal extra cellular water	0.710	0.000	0.217	0.790
Total body water volume	0.582	0.000	0.322	0.048
Min total body water volume	0.011	0.000	0.232	0.769
Max total body water volume	0.182	0.000	0.209	0.799
Body cell mass	0.698	0.000	0.384	0.150

Table 4.37 Comparisons of Secondary Bioimpedance Parameters after Treatment for Male Age group 1.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.246	0.577	0.719	0.000
Min fat	0.235	0.000	0.286	0.094
Max fat	0.633	0.000	0.116	0.645
Percentage of lean	0.246	0.000	0.719	0.000
Min lean	0.160	0.000	0.237	0.249
Max lean	0.204	0.000	0.202	0.347
Dry lean weight	0.047	0.000	0.159	0.917
Percentage of water	0.347	0.000	0.199	0.001
Min water	0.011	0.000	0.232	0.769
Max water	0.182	0.000	0.209	0.799
Density	0.852	0.224	1.000	0.000
Nutrition	0.000	0.000	0.448	0.237
Normal nutrition	0.000	1.000	1.000	1.000
Third space	0.001	0.018	0.548	0.000

4.4.6 Comparison of Bioimpedance Parameters with Patient's BMI Group.

In this section Comparison of Bioimpedance Parameters with Patient's BMI Group are shown here. For ease of reporting and analysis BMI group divided into five groups here.BMI less than 20 in group 1,BMI 20 to 25 in group 2,BMI 25 to 30 in group 3,BMI 30 to BMI greater than 35 in group 5. .For analysis the bioimpedance parameters are divided into two groups here. They are primary and secondary bioimpedance parameters. Also need to consider the condition before and after treatment here. Independent T test and ANOVA test was used here for this analysis. The value of P should be less than 5% for significance

Table 4.66 Comparisons of Main Bioimpedance Parameters before Treatment for Female BMI group 1.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.004	0.008	0.000	0.000
Impedance value at 50KHz	0.043	0.013	0.000	0.000
Impedance value at 100KHz	0.122	0.014	0.000	0.001
Impedance value at 200KHz	0.184	0.016	0.000	0.001
Reactance at 50KHz	0.001	0.150	0.178	0.000
Resistance at 50KHz	0.051	0.013	0.000	0.000
Phase Angle at 50 KHz	0.045	0.503	0.000	0.025
Basal metabolic rate	0.093	0.553	0.301	0.000
Intracellular water	0.133	0.911	0.184	0.000
Normal value of intracellular water	0.046	0.517	0.378	0.000
Extra-cellular water	0.117	0.649	0.224	0.000
Normal extra cellular water	0.017	0.517	0.378	0.743
Total body water volume	0.053	0.574	0.183	1.000
Min total body water volume	0.202	0.232	0.257	0.000
Max total body water volume	0.068	1.000	0.597	0.000
Body cell mass	0.142	0.876	0.176	0.000

Table 4.67 Comparisons of Secondary Bioimpedance Parameters before Treatment for Female BMI group 1.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.744	0.024	0.014	0.000
Min fat	0.613	0.002	0.006	0.006
Max fat	0.273	0.024	0.067	0.003
Percentage of lean	0.744	0.024	0.014	0.000
Min lean	0.218	0.074	0.807	0.000
Max lean	0.252	0.108	0.141	0.000
Dry lean weight	0.008	0.537	0.416	0.472
Percentage of water	0.000	0.000	0.000	0.000
Min water	0.202	0.232	0.257	0.000
Max water	0.068	1.000	0.597	0.000
Density	0.228	0.074	0.087	0.000
Nutrition	0.708	0.526	0.044	0.000
Normal nutrition	-	1.000	1.000	1.000
Third space	0.000	0.000	0.000	0.000

Table 4.68 Comparisons of Main Bioimpedance Parameters after Treatment for Female BMI group 1.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.337	0.012	0.000	0.003
Impedance value at 50KHz	0.676	0.024	0.000	0.005
Impedance value at 100KHz	0.783	0.033	0.000	0.005
Impedance value at 200KHz	0.640	0.055	0.000	0.004
Reactance at 50KHz	0.039	0.002	0.001	0.000
Resistance at 50KHz	0.750	0.026	0.000	0.005
Phase Angle at 50 KHz	0.925	0.331	0.000	0.000
Basal metabolic rate	0.098	0.531	0.212	0.000
Intracellular water	0.140	0.967	0.062	0.000
Normal value of intracellular water	0.046	0.517	0.378	0.000
Extra-cellular water	0.201	0.546	0.111	0.000
Normal extra cellular water	0.017	0.517	0.378	0.743
Total body water volume	0.071	0.518	0.070	1.000
Min total body water volume	0.202	0.232	0.257	0.000
Max total body water volume	0.068	1.000	0.597	0.000
Body cell mass	0.131	0.992	0.062	0.000

Table 4.69 Comparisons of Secondary Bioimpedance Parameters after Treatment. For Female BMI group 1.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	Diseases Grp(p)
Percentage of fat	0.246	0.000	0.000
Min fat	0.235	0.000	0.005
Max fat	0.633	0.000	0.000
Percentage of lean	0.246	0.000	0.000
Min lean	0.160	0.000	0.000
Max lean	0.204	0.000	0.000
Dry lean weight	0.047	0.000	0.005
Percentage of water	0.347	0.000	0.000
Min water	0.011	0.000	0.000
Max water	0.182	0.000	0.000
Density	0.852	0.000	0.000
Nutrition	0.000	0.000	0.000
Normal nutrition	-	1.000	1.000
Third space	0.001	0.000	0.000

* No of treatment does not have enough parameter for analysis.

Table 4.70 Comparisons of Main Bioimpedance Parameters before Treatment for male BMI group 1.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.000	0.104	0.640	0.000
Impedance value at 50KHz	0.000	0.024	0.688	0.001
Impedance value at 100KHz	0.000	0.022	0.640	0.001
Impedance value at 200KHz	0.000	0.024	0.574	0.000
Reactance at 50KHz	0.002	0.001	0.207	0.154
Resistance at 50KHz	0.000	0.000	0.686	0.001
Phase Angle at 50 KHz	0.099	0.023	0.280	0.001
Basal metabolic rate	0.720	0.003	0.194	0.322
Intracellular water	0.345	0.000	0.324	0.142
Normal value of intracellular water	0.534	0.000	0.217	0.781
Extra-cellular water	0.710	0.000	0.211	0.089
Normal extra cellular water	0.749	0.000	0.217	0.790
Total body water volume	1.000	0.000	0.246	0.057
Min total body water volume	0.011	0.000	0.232	0.769
Max total body water volume	0.182	0.000	0.209	0.799
Body cell mass	0.724	0.000	0.328	0.140

Table 4.71 Comparisons of Secondary Bioimpedance Parameters before Treatment for Male BMI group 1.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.294	0.365	0.616	0.000
Min fat	0.186	0.000	0.380	0.170
Max fat	0.439	0.000	0.116	0.645
Percentage of lean	0.294	0.365	0.616	0.000
Min lean	0.244	0.000	0.231	0.257
Max lean	0.246	0.000	0.186	0.337
Dry lean weight	0.49	0.000	0.163	0.904
Percentage of water	0.575	0.000	0.258	0.003
Min water	0.11	0.000	0.232	0.769
Max water	0.182	0.000	0.209	0.799
Density	0.852	0.224	1.000	0.000
Nutrition	0.001	0.000	0.585	0.396
Normal nutrition	-	1.000	1.000	1.000
Third space	0.000	0.001	0.336	0.000

Table 4.72 Comparisons of Main Bioimpedance Parameters after Treatment for Male BMI group 1.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.001	0.031	0.482	0.000
Impedance value at 50KHz	0.001	0.016	0.553	0.001
Impedance value at 100KHz	0.002	0.015	0.512	0.001
Impedance value at 200KHz	0.003	0.015	0.497	0.001
Reactance at 50KHz	0.007	0.000	0.562	0.733
Resistance at 50KHz	0.002	0.000	0.550	0.001
Phase Angle at 50 KHz	0.058	0.016	0.350	0.012
Basal metabolic rate	0.079	0.000	0.221	0.299
Intracellular water	0.693	0.000	0.383	0.147
Normal value of intracellular water	0.345	0.000	0.217	0.781
Extra-cellular water	0.753	0.000	0.278	0.073
Normal extra cellular water	0.710	0.000	0.217	0.790
Total body water volume	0.582	0.000	0.333	0.048
Min total body water volume	0.011	0.000	0.232	0.769
Max total body water volume	0.182	0.000	0.209	0.799
Body cell mass	0.698	0.000	0.384	0.150

Table 4.73 Comparisons of Secondary Bioimpedance Parameters after Treatment for Male BMI group 1.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.246	0.577	0.719	0.000
Min fat	0.235	0.000	0.286	0.094
Max fat	0.633	0.000	0.116	0.645
Percentage of lean	0.246	0.577	0.719	0.000
Min lean	0.160	0.000	0.237	0.249
Max lean	0.204	0.000	0.202	0.347
Dry lean weight	0.047	0.000	0.159	0.917
Percentage of water	0.347	0.000	0.199	0.001
Min water	0.011	0.000	0.232	0.769
Max water	0.182	0.000	0.209	0.799
Density	0.852	0.000	1.000	0.000
Nutrition	0.000	0.000	0.448	0.237
Normal nutrition	-	0.224	1.000	1.000
Third space	0.001	0.000	0.548	0.000

4.5 Interaction of Bioimpedance Parameters with Demographic Variables.

In this section the interaction of Bioimpedance Parameters with demographic variables such as gender, occupation, diseases, number of treatment are shown. The significance value of P should be less than 5%. These interaction of the parameter is investigate further to see the relationship between them.

4.5.1 Interaction of Bioimpedance Parameters with Patient's Gender.

According to gender the interaction between age group, BMI group and diseases groups for the main and secondary bioimpedance parameters before and after test are shown here. The value of P is valid when $p < 0.05$.

Table 4.102 Interaction of Main Bioimpedance Parameters before Treatment for Female.

Main Bioimpedance Parameters	Age Grp(p)	BMI Grp (p)	Disease (p)
Impedance value at 5KHz	0.000	0.000	0.000
Impedance value at 50KHz	0.000	0.000	0.000
Impedance value at 100KHz	0.000	0.000	0.000
Impedance value at 200KHz	0.000	0.000	0.000
Reactance at 50KHz	0.000	0.000	0.000
Resistance at 50KHz	0.000	0.000	0.000
Phase Angle at 50 KHz	0.000	0.000	0.032
Basal metabolic rate	0.000	0.000	0.000
Intracellular water	0.000	0.000	0.000
Normal intracellular water	0.000	0.000	0.000
Extra-cellular water	0.000	0.000	0.000
Normal extra cellular water	0.000	0.000	0.000
Total body water volume	0.000	0.000	0.000
Min total body water volume	0.000	0.000	0.000
Max total body water volume	0.000	0.000	0.000
Body cell mass	0.000	0.000	0.000

Table 4.103 Interaction of Main Bioimpedance Parameters after Treatment for Female.

Main Bioimpedance Parameters	Age Grp(p)	BMI Grp (p)	Disease (p)
Impedance value at 5KHz	0.000	0.000	0.000
Impedance value at 50KHz	0.000	0.000	0.000
Impedance value at 100KHz	0.000	0.000	0.000
Impedance value at 200KHz	0.000	0.000	0.000
Reactance at 50KHz	0.000	0.000	0.000
Resistance at 50KHz	0.000	0.000	0.000
Phase Angle at 50 KHz	0.000	0.000	0.000
Basal metabolic rate	0.000	0.000	0.000
Intracellular water	0.000	0.000	0.000
Normal intracellular water	0.000	0.000	0.000
Extra-cellular water	0.000	0.000	0.000
Normal extra cellular water	0.000	0.000	0.000
Total body water volume	0.000	0.000	0.000
Min total body water volume	0.000	0.000	0.000
Max total body water volume	0.000	0.000	0.000
Body cell mass	0.000	0.000	0.000

Table 4.104 Comparisons of Secondary Bioimpedance Parameters before Treatment for Female.

Secondary Bioimpedance Parameters	Age Grp(p)	BMI Grp (p)	Disease (p)
Percentage of fat	0.000	0.000	0.000
Min fat	0.000	0.000	0.000
Max fat	0.000	0.000	0.000
Percentage of lean	0.000	0.000	0.000
Min lean	0.000	0.000	0.000
Max lean	0.000	0.000	0.000
Dry lean weight	0.000	0.000	0.000
Percentage of water	0.000	0.000	0.000
Min water	0.000	0.000	0.000
Max water	0.000	0.000	0.000
Density	0.000	0.000	0.000
Nutrition	0.000	0.000	0.000
Normal nutrition	1.000	1.000	1.000
Third space value	0.000	0.000	0.000

Table 4.105 Interactios of Secondary Bioimpedance Parameters after Treatment for Female.

Secondary Bioimpedance Parameters	Age Grp(p)	BMI Grp (p)	Disease (p)
Percentage of fat	0.000	0.000	0.000
Min fat	0.000	0.000	0.000
Max fat	0.000	0.000	0.000
Percentage of lean	0.000	0.000	0.000
Min lean	0.000	0.000	0.000
Max lean	0.000	0.000	0.000
Dry lean weight	0.000	0.000	0.000
Percentage of water	0.001	0.000	0.000
Min water	0.000	0.000	0.000
Max water	0.000	0.000	0.000
Density	0.000	0.000	0.000
Nutrition	0.000	0.000	0.000
Normal nutrition	1.000	1.000	1.000
Third space value	0.002	0.000	0.000

Table 4.106 Interaction of Main Bioimpedance Parameters before Treatment for Male.

Main Bioimpedance Parameters	Age Grp(p)	BMI Grp (p)	Diseases (p)
Impedance value at 5KHz	0.000	0.000	0.003
Impedance value at 50KHz	0.000	0.000	0.005
Impedance value at 100KHz	0.000	0.000	0.007
Impedance value at 200KHz	0.000	0.000	0.010
Reactance at 50KHz	0.000	0.050	0.000
Resistance at 50KHz	0.000	0.000	0.006
Phase Angle at 50 KHz	0.000	0.000	0.000
Basal metabolic rate	0.004	0.000	0.686
Intracellular water	0.000	0.000	0.004
Normal intracellular water	0.000	0.000	0.000
Extra-cellular water	0.000	0.000	0.004
Normal extra cellular water	0.000	0.000	0.000
Total body water volume	0.000	0.000	0.006
Min total body water volume	0.000	0.000	0.001
Max total body water volume	0.000	0.000	0.000
Body cell mass	0.000	0.000	0.004

Table 4.107 Interaction of Main Bioimpedance Parameters after Treatment for Male.

Main Bioimpedance Parameters	Age Grp(p)	BMI Grp (p)	Diseases (p)
Impedance value at 5KHz	0.000	0.000	0.004
Impedance value at 50KHz	0.000	0.000	0.008
Impedance value at 100KHz	0.001	0.000	0.009
Impedance value at 200KHz	0.001	0.000	0.010
Reactance at 50KHz	0.000	0.415	0.000
Resistance at 50KHz	0.000	0.000	0.009
Phase Angle at 50 KHz	0.000	0.000	0.002
Basal metabolic rate	0.001	0.000	0.785
Intracellular water	0.000	0.000	0.004
Normal intracellular water	0.000	0.000	0.000
Extra-cellular water	0.000	0.000	0.005
Normal extra cellular water	0.000	0.000	0.000
Total body water volume	0.000	0.000	0.007
Min total body water volume	0.000	0.000	0.001
Max total body water volume	0.000	0.000	0.000
Body cell mass	0.000	0.000	0.004

Table 4.108 Interactions of Secondary Bioimpedance Parameters before Treatment for Male.

Secondary Bioimpedance Parameters	Age Grp(p)	BMI Grp (p)	Disease (p)
Percentage of fat	0.000	0.000	0.000
Min fat	0.000	0.000	0.000
Max fat	0.000	0.000	0.000
Percentage of lean	0.000	0.000	0.000
Min lean	0.002	0.000	0.205
Max lean	0.001	0.000	0.152
Dry lean weight	0.000	0.000	0.234
Percentage of water	0.000	0.000	0.000
Min water	0.000	0.000	0.001
Max water	0.000	0.000	0.000
Density	0.000	0.000	0.000
Nutrition	0.000	0.000	0.000
Normal nutrition	1.000	1.000	1.000
Third space value	0.000	0.000	0.001

Table 4.109 Interactions of Secondary Bioimpedance Parameters after Treatment for Male.

Secondary Bioimpedance Parameters	Age Grp(p)	BMI Grp (p)	Disease (p)
Percentage of fat	0.000	0.000	0.000
Min fat	0.000	0.000	0.000
Max fat	0.000	0.000	0.000
Percentage of lean	0.000	0.000	0.000
Min lean	0.002	0.000	0.260
Max lean	0.001	0.000	0.234
Dry lean weight	0.000	0.000	0.230
Percentage of water	0.001	0.000	0.000
Min water	0.000	0.000	0.001
Max water	0.000	0.000	0.000
Density	0.000	0.000	0.000
Nutrition	0.000	0.000	0.000
Normal nutrition	1.000	1.000	1.000
Third space value	0.002	0.000	0.000

4.5.2 Interaction of Bioimpedance Parameters with Patient's Age Group.

According to Age group the interaction between gender, BMI group and diseases groups for the main and secondary bioimpedance parameters before and after test are shown here. The value of P is valid when $p < 0.05$.

Table 4.110 Interaction of Main Bioimpedance Parameters before Treatment for Age Group1.

Main Bioimpedance Parameters	Gender (p)	BMI group (p)	Disease (p)
Impedance value at 5KHz	0.001	0.000	0.005
Impedance value at 50KHz	0.001	0.000	0.017
Impedance value at 100KHz	0.002	0.000	0.023
Impedance value at 200KHz	0.003	0.000	0.027
Reactance at 50KHz	0.007	0.000	0.000
Resistance at 50KHz	0.002	0.000	0.018
Phase Angle at 50 KHz	0.058	0.000	0.586
Basal metabolic rate	0.079	0.000	0.160
Intracellular water	0.693	0.000	0.120
Normal intracellular water	0.345	0.000	0.001
Extra-cellular water	0.753	0.000	0.003
Normal extra cellular water	0.710	0.000	0.037
Total body water volume	0.582	0.000	0.079
Min total body water volume	0.011	0.000	0.000
Max total body water volume	0.182	0.000	0.000
Body cell mass	0.698	0.000	0.124

Table4.111 Interaction of Main Bioimpedance Parameters after Treatment for Age Group1.

Main Bioimpedance Parameters	Gender (p)	BMI group (p)	Disease (p)
Impedance value at 5KHz	0.001	0.000	0.005
Impedance value at 50KHz	0.001	0.000	0.017
Impedance value at 100KHz	0.002	0.000	0.023
Impedance value at 200KHz	0.003	0.000	0.027
Reactance at 50KHz	0.007	0.000	0.000
Resistance at 50KHz	0.002	0.000	0.018
Phase Angle at 50 KHz	0.058	0.000	0.586
Basal metabolic rate	0.079	0.000	0.160
Intracellular water	0.693	0.000	0.120
Normal intracellular water	0.345	0.000	0.001
Extra-cellular water	0.753	0.000	0.003
Normal extra cellular water	0.710	0.000	0.037
Total body water volume	0.582	0.000	0.079
Min total body water volume	0.011	0.000	0.000
Max total body water volume	0.182	0.000	0.000
Body cell mass	0.698	0.000	0.124

Table 4.112 Comparisons of Secondary Bioimpedance Parameters before Treatment for Age Group1.

Secondary Bioimpedance Parameters	Gender (p)	BMI group (p)	Disease (p)
Percentage of fat	0.294	0.000	0.000
Min fat	0.186	0.000	0.000
Max fat	0.439	0.000	0.000
Percentage of lean	0.294	0.000	0.000
Min lean	0.244	0.000	0.160
Max lean	0.246	0.000	0.157
Dry lean weight	0.049	0.000	0.421
Percentage of water	0.575	0.000	0.000
Min water	0.011	0.000	0.000
Max water	0.182	0.000	0.000
Density	0.852	0.000	0.000
Nutrition	0.001	0.000	0.928
Normal nutrition	-	0.000	0.020
Third space value	0.000	0.000	0.000

Table 4.113 Interactions of Secondary Bioimpedance Parameters after Treatment for Age Group1.

Secondary Bioimpedance Parameters	Gender (p)	BMI Grp (p)	Disease (p)
Percentage of fat	0.246	0.000	0.000
Min fat	0.235	0.000	0.000
Max fat	0.633	0.000	0.000
Percentage of lean	0.246	0.000	0.000
Min lean	0.160	0.000	0.169
Max lean	0.204	0.000	0.142
Dry lean weight	0.047	0.000	0.444
Percentage of water	0.347	0.000	0.000
Min water	0.011	0.000	0.000
Max water	0.182	0.000	0.000
Density	0.852	0.000	0.000
Nutrition	0.000	0.000	0.941
Normal nutrition	-	0.006	0.020
Third space value	0.001	0.000	0.000

4.5.3 Interaction of Bioimpedance Parameters with Age Patient BMI.

According to BMI group the interaction between gender, BMI group and diseases groups for the main and secondary bioimpedance parameters before and after test are shown here. The value of P is valid when $p < 0.05$.

Table 4.130 Interaction of Main Bioimpedance Parameters before Treatment for BMI group1.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	Diseases (p)
Impedance value at 5KHz	0.004	0.001	0.00029
Impedance value at 50KHz	0.043	0.002	0.00077
Impedance value at 100KHz	0.122	0.004	0.00127
Impedance value at 200KHz	0.184	0.005	0.00187
Reactance at 50KHz	0.001	0.000	0.00000
Resistance at 50KHz	0.051	0.003	0.00084
Phase Angle at 50 KHz	0.045	0.513	0.33359
Basal metabolic rate	0.093	0.686	0.00001
Intracellular water	0.133	0.051	0.00019
Normal intracellular water	0.046	0.008	0.00012
Extra-cellular water	0.117	0.013	0.00000
Normal extra cellular water	0.017	0.014	0.00037
Total body water volume	0.053	0.022	0.00001
Min total body water volume	0.202	0.178	0.00000
Max total body water volume	0.068	0.017	0.00002
Body cell mass	0.142	0.053	0.00019

Table 4.131 Interaction of Main Bioimpedance Parameters after Treatment for BMI group1.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	Diseases (p)
Impedance value at 5KHz	0.337	0.0005	0.0004
Impedance value at 50KHz	0.676	0.0023	0.0013
Impedance value at 100KHz	0.783	0.0036	0.0022
Impedance value at 200KHz	0.640	0.0047	0.0032
Reactance at 50KHz	0.039	0.0000	0.0000
Resistance at 50KHz	0.750	0.0025	0.0014
Phase Angle at 50 KHz	0.925	0.1267	0.2713
Basal metabolic rate	0.098	0.6976	0.0000
Intracellular water	0.140	0.0489	0.0002
Normal intracellular water	0.046	0.0083	0.0001
Extra-cellular water	0.201	0.0163	0.0000
Normal extra cellular water	0.017	0.0136	0.0004
Total body water volume	0.071	0.0242	0.0000
Min total body water volume	0.202	0.1776	0.0000
Max total body water volume	0.068	0.0170	0.0000
Body cell mass	0.131	0.0481	0.0002

Table 4.132 Interactions of Secondary Bioimpedance Parameters before Treatment for BMI group1.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	Disease (p)
Percentage of fat	0.744	0.123	0.0000
Min fat	0.613	0.003	0.0000
Max fat	0.273	0.004	0.0002
Percentage of lean	0.744	0.123	0.0000
Min lean	0.218	0.031	0.0000
Max lean	0.252	0.032	0.0000
Dry lean weight	0.008	0.040	0.0000
Percentage of water	0.000	0.000	0.0196
Min water	0.202	0.178	0.0000
Max water	0.068	0.017	0.0000
Density	0.228	0.269	0.0000
Nutrition	0.708	0.463	0.0605
Normal nutrition	-	0.109	0.0076
Third space value	0.000	0.000	0.0064

Table 4.133 Interactions of Secondary Bioimpedance Parameters after Treatment for BMI group1.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	Disease (p)
Percentage of fat	0.766	0.114	0.0000
Min fat	0.613	0.003	0.0000
Max fat	0.273	0.004	0.0002
Percentage of lean	0.766	0.114	0.0000
Min lean	0.167	0.018	0.0000
Max lean	0.221	0.020	0.0000
Dry lean weight	0.009	0.039	0.0000
Percentage of water	0.003	0.000	0.0349
Min water	0.202	0.178	0.0000
Max water	0.068	0.017	0.0000
Density	0.740	0.250	0.0000
Nutrition	0.708	0.475	0.0943
Normal nutrition	0.000	0.109	0.0076
Third space value	0.766	0.000	0.0081

4.5.4 Interaction of Bioimpedance Parameters with Patient Disease.

According to Diseases group the interaction between gender, BMI group and age groups for the main and secondary bioimpedance parameters before and after test are shown here. The value of P is valid when $p < 0.05$. For analysis from diseases group only arthritis, high blood pressure,, diabetes, migraine and stoke patients are chosen.

Table 4.150 Interaction of Main Bioimpedance Parameters before Treatment for diseases group 1.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp(p)
Impedance value at 5KHz	0.104	0.273	0.000
Impedance value at 50KHz	0.101	0.340	0.000
Impedance value at 100KHz	0.126	0.390	0.000
Impedance value at 200KHz	0.182	0.446	0.000
Reactance at 50KHz	0.020	0.000	0.062
Resistance at 50KHz	0.105	0.348	0.000
Phase Angle at 50 KHz	0.746	0.225	0.000
Basal metabolic rate	0.161	0.715	0.000
Intracellular water	0.182	0.143	0.000
Normal intracellular water	0.287	0.209	0.000
Extra-cellular water	0.069	0.041	0.000
Normal extra cellular water	0.112	0.174	0.000
Total body water volume	0.008	0.054	0.000
Min total body water volume	0.070	0.156	0.000
Max total body water volume	0.221	0.185	0.000
Body cell mass	0.188	0.145	0.000

Table 4.151 Interaction of Main Bioimpedance Parameters after Treatment for diseases group 1.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp(p)
Impedance value at 5KHz	0.078	0.300	0.000
Impedance value at 50KHz	0.088	0.391	0.000
Impedance value at 100KHz	0.074	0.447	0.000
Impedance value at 200KHz	0.108	0.509	0.000
Reactance at 50KHz	0.431	0.000	0.000
Resistance at 50KHz	0.088	0.403	0.000
Phase Angle at 50 KHz	0.363	0.070	0.000
Basal metabolic rate	0.108	0.989	0.000
Intracellular water	0.285	0.359	0.000
Normal intracellular water	0.287	0.209	0.000
Extra-cellular water	0.150	0.330	0.000
Normal extra cellular water	0.112	0.174	0.000
Total body water volume	0.035	0.336	0.000
Min total body water volume	0.070	0.156	0.000
Max total body water volume	0.221	0.185	0.000
Body cell mass	0.270	0.365	0.000

Table 4.152 Interactions of Secondary Bioimpedance Parameters before Treatment for Diseases group 1.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp (p)
Percentage of fat	0.009	0.533	0.027
Min fat	0.406	0.009	0.000
Max fat	0.301	0.167	0.000
Percentage of lean	0.009	0.533	0.027
Min lean	0.068	0.260	0.000
Max lean	0.099	0.361	0.000
Dry lean weight	0.513	0.958	0.000
Percentage of water	0.468	0.651	0.000
Min water	0.070	0.156	0.000
Max water	0.221	0.185	0.000
Density	0.001	0.219	0.059
Nutrition	0.000	0.654	0.000
Normal nutrition	-	0.160	0.014
Third space value	0.787	0.003	0.001

Table 4.153 Interactions of Secondary Bioimpedance Parameters after Treatment for diseases group 1.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp (p)
Percentage of fat	0.017	0.161	0.054
Min fat	0.059	0.109	0.000
Max fat	0.533	0.482	0.054
Percentage of lean	0.017	0.161	0.000
Min lean	0.187	0.541	0.000
Max lean	0.132	0.665	0.000
Dry lean weight	0.462	0.927	0.000
Percentage of water	0.624	0.688	0.000
Min water	0.070	0.156	0.000
Max water	0.221	0.185	0.000
Density	0.003	0.050	0.082
Nutrition	0.000	0.388	0.000
Normal nutrition	-	0.160	0.014
Third space value	0.088	0.809	0.001

CHAPTER FIVE

DISCUSSION

5.1　Demographic analysis

The demographic analysis was done and depicted clearly in the previous chapter by the bar charts for all the independent parameter which are categorized as gender, marital status, age, occupations, number of treatment, subject's activity and BMI readings.

For a bar graph, the information that could be extracted are the comparison between groups of data and make a generalization or simple conclusion about the data in a glance. From the first bar graph of figure 4.1, the females are the dominating gender in getting a leech therapy treatment as more than half of the patients are females. This could be affected by many factors as women are prone to any treatment for cosmetic improvement, and more health conscious than men. In Singapore, a study by ministry of health showed that there is a significance difference between male and female health practices that strike out female with the better overall health behavior (A.V., Chua, 2009).

In addition, those who are single also are more than half of the total patient. Even in a study about the healthy lifestyle of vegetarian, the demographic data of the marital status gives a significance difference in the distribution where most of them are single (Bedford, J., Barr, S. I., 2005). However, there are no specific study on the effect of the marital status and leech therapy.

From figure 4.3, there are a huge gap for those who are younger that fall within the range of less than or equal 30 years old with those who are older or equal to 31 years old. It means a deduction can be made of younger people are willing to try alternative way for cure than older generations. This can be compared to the study of the age

related differences in complimentary medicine. It was concluded that the use of complementary medicine is stronger among midlife and younger adults rather than older adults (Grzywacz, J.G., et al,, 2007).

The occupations of the subject are also taken into account where there are 2 obvious frequencies which belong to the category of students and private sector worker. This might due to many reasons as it can be deducted that level of stress is always associated with the job of the participants. Higher stress could harm the health level and students are also having a higher risk which involve problems in study or peer stress.

In addition, the information on the subject's involvement in the treatment is also recorded where there is a clear trend that notes on the treatment is done for a first timer. This might be because of the center itself which promote the treatment so that it can reach more people in experiencing the new sensation of alternative medicine treatment that rarely commercialized.

Besides that, the profile of the subject is also collected by the information on daily activity of subject. Most of the participants were having a medium level of activity where this can be related by the majority of the public sector worker and students involvement in this study. These groups of people are mostly engage in activity that sufficient to be characterized as average rather than unemployed subject that has minimal use of body daily.

Also, the BMI index for both before and after the treatment remain the same as BMI is hardly changes over a short period of time. Thus, from the data it is found that most of the participants are healthy which ranges from 20 to 25. Nevertheless, there are also participants which need an extra reminder on health level based on their current BMI.

The standard BMI chart is divided into 3 main categories which are underweight, normal and overweight. Thus the distributions of the sampling of

participants are considered majority normal since obesity is not a big factor in determining the course of leech therapy treatment.

5.2.0   Descriptive statistics analysis

5.2.1   Relationship between characteristics of descriptive statistic

Descriptive statistics is an analysis which describes the attribute of grouped data. The main features of the bioimpedance parameter can be used to describe the distribution, central tendency and the dispersion of the data. The distribution of the collected data already had been discussed in the previous topic where the demographic data gives the general overview of the distribution from the bar graphs frequency. However another value that can depict the distribution of the data is kurtosis. It measures the shape of the peak that could be described as flat or sharp peak. Higher value of kurtosis will give the description of the peak of the distribution that tends to be pointed than normal distribution and the opposite for lower value of kurtosis.

Accordingly, the central tendency of the bioimpedance parameter is calculated by the statistical tool namely expected value or also knows as mean or average. The mean will gives the center of distribution of values which are common within the data. In other words, the characteristics could be use to make a general conclusion about the distribution.

Also, the dispersion characteristics can be described by the value of the standard deviation and variance. However, standard deviation is more common to see the dispersion of the data. Significantly, variance could be associated with the kurtosis where if the value of the kurtosis is higher it means that the value of the variance is inversely decreasing.

5.2.2 Bioimpedance parameter distribution characteristics

From the overall characteristics of the bioimpedance parameter, the 50 kHz impedance readings give a trend that shows the changes before and after treatment of leech therapy. It is found that the overall characteristic of the main and secondary bioimpedance parameter are increasingly towards a better level. This is proven from the increasing mean value from the measurement of both parameters before and after the treatment.

Moreover, to compare the attributes of gender towards the parameter gives a result where the impedance mean of the female is much higher than the impedance of male. In contrast, the dispersion value of data from the standard deviation shows that data for male are less disperses than female. The impedance value for male is normally higher than female but contradict the normality due to the sample size and the range of age is higher for male than female.

Furthermore, the BMI group characterization shows that the bioimpedance parameter also shows positive increasing result. This is again depicted by the increasing mean value of the parameter before and after the treatment. In addition, as the comparison is done between all the 5 groups, it is identified that the impedance value is decreasing as the BMI group increases. The increasing value of BMI group indicates the effect of leech treatment follow the group of patient that are categorize as underweight subject to overweight subject. Thus, it is normal to the assumption that overweight person has higher fat and so affecting the impedance value to become lower than the normal person.

5.3   Analysis of bioimpedance parameter

The result from the section 4.3 is basically showing the significance value of main and secondary bioimpedance parameter before and after the treatment. This is important to analyze as the significance value for the pair t-test can tell the effect of before treatment and after treatment will gives any difference in mean value or no changes at all.

The desired result is to see that the mean value of the parameter of this treatment will change after the therapy. Therefore, it is shown that for $p < 0.05$ gives the outcome that there is difference in mean before and after the treatment. Later part of the analysis takes into the consideration of different independent factor that could affect the reading before and after treatment. The tested parameters are gender, BMI groups, Disease groups, occupation groups, age groups and number of treatment groups.

In gender difference, the impedance value at 50 kHz indicates accepted significance value where both are less than 0.05. This is because the gender could directly affect the reading of the bioimpedance parameter. For example like the fat percentage from the previous discussion shows difference in mean before and after treatment, it also has different value from female to male. Thus, this proved that it is significance to classify the impedance value for both female and male in a different range.

For BMI groups, it is positively showing the p value that accept the difference in mean for different subject group that is classified with 5 different groups of BMI. However BMI group 4 did not bring any significance value before and after the treatment. This could be affected by the sampling size of the BMI group 4 and distribution of gender group with BMI group 4.

The problem of sampling size also affects the p value of age groups. It is insignificant for group age 3 but significant for the rest of the group. Thus, it shows that

older people and younger people has different value of bioimpedance parameter and significantly will have diverse readings if the body composition is tested before and after the leech treatment.

In extension, the impedance value at 50 kHz denotes significant value for different disease group. A deduction can be made where not only treatment is different, the body composition of the patient will also be poles apart from one disease to another.

However, the occupation groups' show accepted value of different mean for all group except for group 3. Even the sample size is quite big, the varieties and diversities of occupation in group 3 must be taken into account. Since the daily activities also affecting the type of job that patients are involve in, private sector group could be more detailed based on the level of activeness. This is because, subject that require higher level of fitness will have different body composition than some other job that also fall under the category of private sector.

The number of treatment group also show effect to the reading of before and after the treatment of leech therapy. The significance value shows that first time patient will experience different body composition measurement than the second or third. However, this analysis does not cover the duration of one treatment to another treatment.

5.4   Comparison between bioimpedance parameter

The comparison of bioimpedance parameter can also be analyzed in detail within the same age groups and BMI groups. These 2 factors are chosen as it has significant effect to the bioimpedance parameter both primary and secondary. In terms of age group 1, there are significant different if it compare with BMI and disease groups. However, the number of treatment can't be compared due to insufficient parameter for the analysis.

This is different with the patient with age group 2 where the majority of the data are representative thus giving it possible value to be analyzed and compared with BMI, number of treatment and disease groups. In contrast, the comparison for age group 3 is not possible since it has fewer patients and a lot of missing data. Furthermore, there is no male subject that falls under the category of age group 3. Also, the independent t-test is not possible to key in since gender group has only 1 mean.

In the analysis of age group 4 which is between 41 to 50 are also majority unavailable since the female group that fall under this category is none. Thus, comparison failed to be done. Only male has some comparison value with BMI and disease group. For age group 5, the male gender has more significant value if to be compared to the bioimpedance analysis. Female are mostly insignificant if to be compared to all the bioimpedance parameter.

Overall comparison of bioimpedance parameter within the same BMI groups also shows not many that are significant. In contrary, for BMI group 2 which are the majority data gives a positive result where the comparison between those measurements that falls under this category is significant. However, since the comparison is more detail than the previous discussion, it is found that most of the tables are empty due to not enough data for the analysis.

5.5   Interaction of bioimpedance parameters with demographic variable

In this analysis, the demographic variable that has been discussed earlier is look into details where the bioimpedance parameters that are affecting the results were studied. In this topic, the variables that are affecting the main and secondary bioimpedance parameter are gender, age, BMI and disease groups.

For interaction of the bioimpedance parameter with the age, BMI and disease group based on gender it is proven that there are significance value that shows all the interaction have different effect. Whether it is male or female, the value can be further classified with different category of patient based on their age group, BMI group and disease group. This is because percentage of fat or fat free mass could be varies in different individuals as female and male has diverse category of patients.

Furthermore, the interactions between Age group and gender, BMI group and disease group also show value of $p < 0.05$. This denotes that all of them are significant except for age group 5. Those with age group 5 could have the same value of mean for all their interactions with gender, BMI groups and disease groups. There's a lot of factor that affecting this age group since it is define for age that is more than 50 years old. In term of gender, BMI group and disease group, those who are in this age have almost an equal average value. Moreover, those who are more than 50 tend to have similar daily activities and similar group of diseases.

For BMI groups' interaction, it is found that BMI group 1 has no significant effect toward gender and age groups. However, they are mostly affected by factor of disease groups. Group2 and group 3 BMI have more significant interaction with the demographic variables. This is again because of the diversity of range for a normal BMI groups that are assumes healthy in terms of their ratio of weight and height. However, those patient in BMI group 5 which experience obesity or overweight has different value of effect on age and disease except their gender. Moreover, it could also because

of number of sampling or due to non-sampling error because of some limitations in taking the measurement for overweight patient.

Finally, the interactions of disease group show different kind of result. For those subject with sinus does not show any significant difference in terms of their gender and age. The only factor that has value of $p < 0.05$ is available for BMI groups. This is different with those patient with acne problem where their body composition different in term of gender and age only. This is more obvious for the second bioimpedance parameter analysis. Moreover, those with eczema and get treated for detoxifying process shows all changes before and after the treatment. Since other illness for group 6 has small sample value, it is showing no significant difference before and after the treatment.

CHAPTER SIX

CONCLUSION

From the study it is known that the bioimpedance parameter changes with demographic variables and it shows some significant result. The characteristics of the bioimpedance analysis has been analyze in many ways to see the relationship, interactions and comparison between the data. It is known that overall, the leech therapy treatment has a significant effect to the human body composition. Summarizing the analysis, the human body compositions do change after a treatment is done.

Some limitations of the study is the bioimpedance machine that is limited and a lot of time has to allocate just for machine reservation. Besides, the sampling is not sufficient given the time and amount of therapy center in Malaysia.

However, this study could be further improvised and a lot of factor can be taken into consideration to see more significant effect of leech therapy to human body.

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Appendix A: Statistical method

1. Bar graph using SPSS
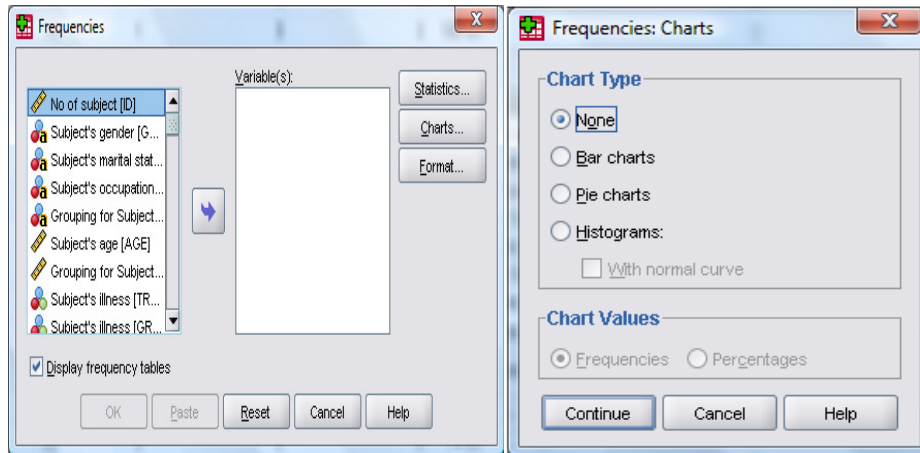
2. Descriptive statistics using SPSS
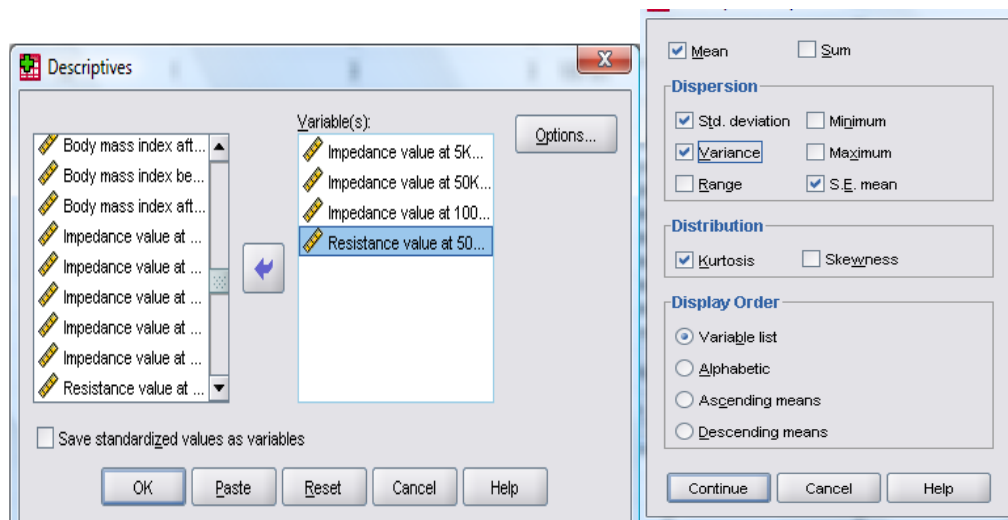
3. Independent sample t-test using SPSS
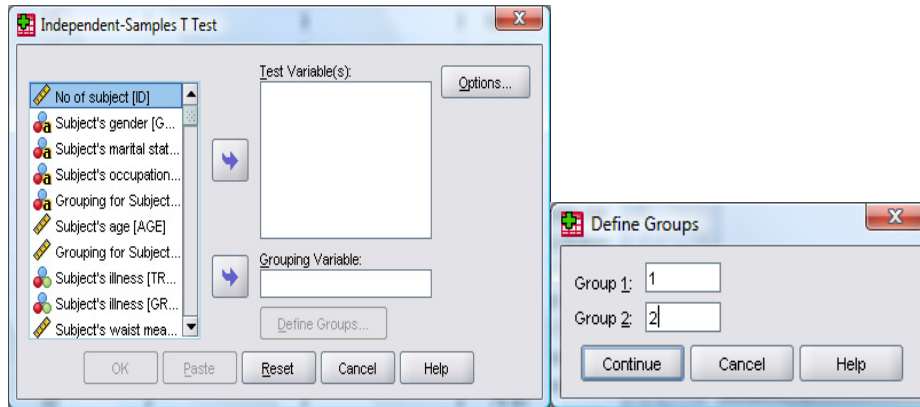
4. Paired sample t-test using SPSS
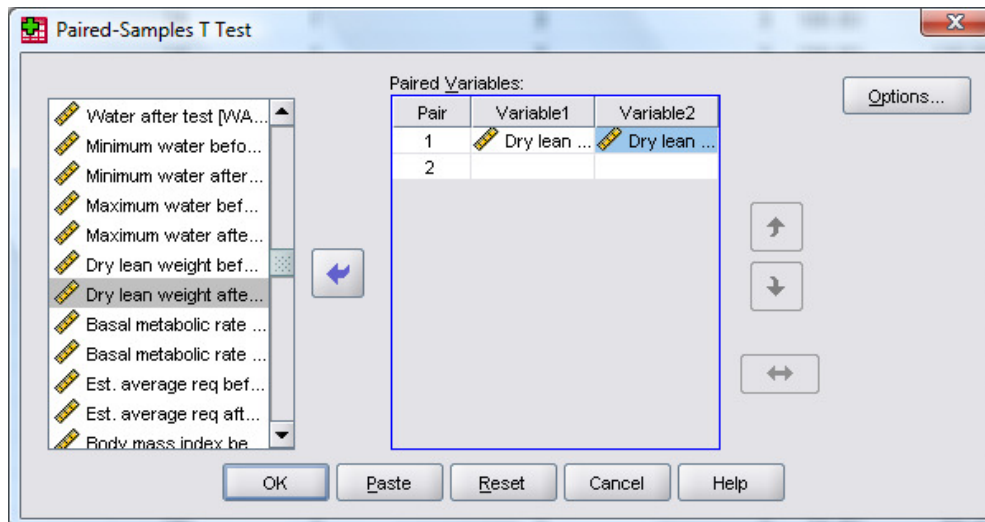
5. ANOVA using SPSS
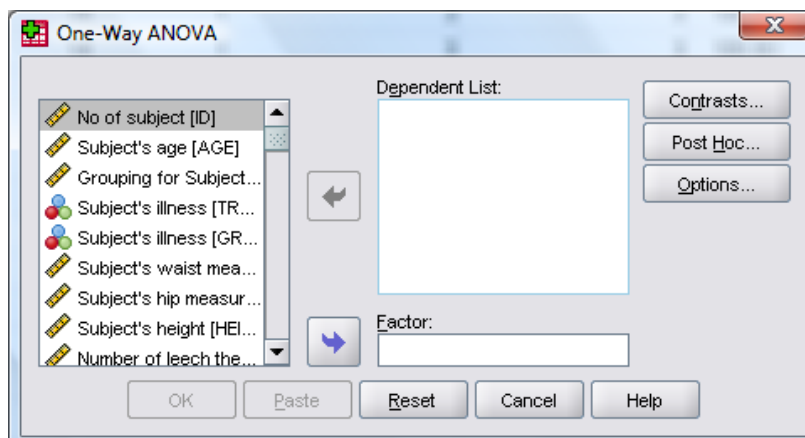
Appendix B:

Table 4.38 Comparisons of Main Bioimpedance Parameters before Treatment for Female age group 2.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.058	0.000	0.000	0.000
Impedance value at 50KHz	0.030	0.000	0.000	0.000
Impedance value at 100KHz	0.031	0.000	0.000	0.000
Impedance value at 200KHz	0.026	0.000	0.000	0.000
Reactance at 50KHz	0.576	0.000	0.595	0.000
Resistance at 50K	0.029	0.000	0.000	0.000
Phase Angle at 50 KHz	0.026	0.000	0.000	0.005
Basal metabolic rate	0.016	0.000	0.000	0.000
Intracellular water	0.613	0.000	0.000	0.000
Normal value of intracellular water	0.865	0.000	0.000	0.000
Extra-cellular water	0.374	0.000	0.000	0.000
Normal extra cellular water	0.378	0.000	0.000	0.000
Total body water volume	0.025	0.000	0.000	0.000
Min total body water volume	0.967	0.000	0.000	0.000
Max total body water volume	0.874	0.000	0.000	0.000
Body cell mass	0.634	0.000	0.000	0.000

Table 4.39 Comparisons of Secondary Bioimpedance Parameters before Treatment for Female Age group 2.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.051	0.000	0.019	0.369
Min fat	0.092	0.000	0.466	0.000
Max fat	0.588	0.000	0.391	0.000
Percentage of lean	0.051	0.000	0.019	0.369
Min lean	0.005	0.000	0.169	0.000
Max lean	0.003	0.000	0.163	0.000
Dry lean weight	0.111	0.000	0.000	0.000
Percentage of water	0.298	0.000	0.001	0.343
Min water	0.967	0.000	0.000	0.000
Max water	0.874	0.000	0.000	0.000
Density	0.506	0.000	0.015	0.306
Nutrition	0.000	0.000	0.000	0.000
Normal nutrition	-	1.000	1.000	1.000
Third space	0.018	0.000	0.001	0.041

Table 4.40 Comparisons of Main Bioimpedance Parameters after Treatment for Female Age group 2.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.204	0.000	0.000	0.000
Impedance value at 50KHz	0.185	0.000	0.000	0.000
Impedance value at 100KHz	0.168	0.000	0.000	0.000
Impedance value at 200KHz	0.191	0.000	0.000	0.000
Reactance at 50KHz	0.724	0.000	0.100	0.000
Resistance at 50KHz	0.185	0.000	0.000	0.000
Phase Angle at 50 KHz	0.183	0.000	0.000	0.000
Basal metabolic rate	0.017	0.000	0.000	0.000
Intracellular water	0.504	0.000	0.000	0.000
Normal value of intracellular water	0.865	0.000	0.000	0.000
Extra-cellular water	0.446	0.000	0.000	0.000
Normal extra cellular water	0.378	0.000	0.000	0.000
Total body water volume	0.036	0.000	0.000	0.000
Min total body water volume	0.967	0.000	0.000	0.000
Max total body water volume	0.874	0.000	0.000	0.000
Body cell mass	0.487	0.000	0.000	0.000

Table 4.41 Comparisons of Secondary Bioimpedance Parameters after Treatment. For Female Age group 2.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.342	0.000	0.001	0.725
Min fat	0.006	0.000	0.418	0.000
Max fat	0.583	0.000	0.421	0.000
Percentage of lean	0.342	0.000	0.001	0.725
Min lean	0.025	0.000	0.194	0.000
Max lean	0.013	0.000	0.225	0.000
Dry lean weight	0.115	0.000	0.000	0.000
Percentage of water	0.154	0.000	0.000	0.200
Min water	0.967	0.000	0.000	0.000
Max water	0.874	0.000	0.000	0.000
Density	0.871	0.000	0.000	0.442
Nutrition	0.000	0.000	0.003	0.001
Normal nutrition	-	1.000	1.000	1.000
Third space	0.280	0.000	0.000	0.046

Table 4.42 Comparisons of Main Bioimpedance Parameters before Treatment for male age group 2.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.058	0.000	0.001	0.003
Impedance value at 50KHz	0.030	0.000	0.001	0.002
Impedance value at 100KHz	0.031	0.000	0.001	0.001
Impedance value at 200KHz	0.026	0.000	0.001	0.001
Reactance at 50KHz	0.576	0.000	0.002	0.075
Resistance at 50KHz	0.029	0.000	0.001	0.002
Phase Angle at 50 KHz	0.026	0.000	0.089	0.000
Basal metabolic rate	0.016	0.000	0.031	0.000
Intracellular water	0.613	0.000	0.009	0.001
Normal value of intracellular water	0.865	0.000	0.173	0.001
Extra-cellular water	0.374	0.000	0.003	0.005
Normal extra cellular water	0.378	0.000	0.189	0.001
Total body water volume	0.025	0.000	0.003	0.002
Min total body water volume	0.967	-	0.188	0.001
Max total body water volume	0.874	-	0.225	0.002
Body cell mass	0.634	0.000	0.009	0.001

Table 4.43 Comparisons of Secondary Bioimpedance Parameters before Treatment for Male Age group 2.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.051	0.003	0.174	0.329
Min fat	0.092	0.000	0.016	0.005
Max fat	0.588	0.000	0.000	0.020
Percentage of lean	0.051	0.003	0.174	0.329
Min lean	0.005	0.000	0.009	0.008
Max lean	0.003	0.000	0.005	0.011
Dry lean weight	0.111	0.000	0.404	0.000
Percentage of water	0.298	0.000	0.211	0.090
Min water	0.967	0.000	0.188	0.001
Max water	0.874	0.000	0.225	0.002
Density	0.506	0.003	0.208	0.443
Nutrition	0.000	0.000	0.176	0.000
Normal nutrition	-	1.000	1.000	1.000
Third space	0.018	0.004	0.000	0.257

Table 4.44 Comparisons of Main Bioimpedance Parameters after Treatment for Male Age group 2.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.204	0.001	0.000	0.006
Impedance value at 50KHz	0.185	0.000	0.000	0.003
Impedance value at 100KHz	0.168	0.000	0.001	0.002
Impedance value at 200KHz	0.191	0.000	0.001	0.001
Reactance at 50KHz	0.724	0.002	0.100	0.229
Resistance at 50KHz	0.185	0.000	0.000	0.002
Phase Angle at 50 KHz	0.183	0.000	0.354	0.000
Basal metabolic rate	0.017	0.000	0.026	0.000
Intracellular water	0.504	0.000	0.010	0.001
Normal value of intracellular water	0.865	0.000	0.173	0.001
Extra-cellular water	0.446	0.000	0.002	0.006
Normal extra cellular water	0.378	0.000	0.189	0.001
Total body water volume	0.036	0.000	0.001	0.006
Min total body water volume	0.967	0.000	0.188	0.001
Max total body water volume	0.874	0.000	0.225	0.002
Body cell mass	0.487	0.000	0.010	0.001

Table 4.45 Comparisons of Secondary Bioimpedance Parameters after Treatment for Male Age group 2.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.342	0.002	0.134	0.279
Min fat	0.006	0.000	0.006	0.000
Max fat	0.583	0.000	0.001	0.016
Percentage of lean	0.342	0.002	0.134	0.279
Min lean	0.025	0.000	0.002	0.014
Max lean	0.013	0.000	0.001	0.025
Dry lean weight	0.115	0.000	0.439	0.000
Percentage of water	0.154	0.000	0.150	0.084
Min water	0.967	0.000	0.188	0.001
Max water	0.874	0.000	0.225	0.002
Density	0.871	0.003	0.208	0.443
Nutrition	0.000	0.000	0.001	0.002
Normal nutrition	-	1.000	1.000	1.000
Third space	0.280	0.003	0.021	0.141

Table 4.46 Comparisons of Main Bioimpedance Parameters before Treatment for Female age group 3.

Main Bioimpedance Parameters	BMI (P)	Diseases Grp(p)
Impedance value at 5KHz	0.000	0.108
Impedance value at 50KHz	0.000	0.017
Impedance value at 100KHz	0.000	0.018
Impedance value at 200KHz	0.000	0.020
Reactance at 50KHz	0.000	0.000
Resistance at 50KHz	0.000	0.016
Phase Angle at 50 KHz	0.000	0.000
Basal metabolic rate	0.329	0.000
Intracellular water	0.007	0.000
Normal value of intracellular water	0.000	0.000
Extra-cellular water	0.070	0.000
Normal extra cellular water	0.000	0.000
Total body water volume	0.245	0.000
Min total body water volume	0.000	0.000
Max total body water volume	0.000	0.000
Body cell mass	0.007	0.000

* No of treatment does not have enough parameter for analysis.

** Overall value does not have enough parameter for analysis.

Table 4.47 Comparisons of Secondary Bioimpedance Parameters before Treatment for Female Age group 3.

Secondary Bioimpedance Parameters	BMI (p)	Diseases Grp(p)
Percentage of fat	0.000	0.000
Min fat	0.376	-
Max fat	0.065	0.000
Percentage of lean	0.000	0.000
Min lean	0.363	0.000
Max lean	0.179	0.000
Dry lean weight	0.075	0.000
Percentage of water	0.000	0.000
Min water	0.000	0.000
Max water	0.000	0.000
Density	0.000	0.000
Nutrition	0.000	0.000
Normal nutrition	1.000	1.000
Third space	0.000	0.000

* No of treatment does not have enough parameter for analysis.

** Overall value does not have enough parameter for analysis.

Table 4.48 Comparisons of Main Bioimpedance Parameters after Treatment for Female Age group 3.

Main Bioimpedance Parameters	BMI (P)	Diseases Grp(p)
Impedance value at 5KHz	0.000	0.229
Impedance value at 50KHz	0.000	0.187
Impedance value at 100KHz	0.000	0.178
Impedance value at 200KHz	0.000	0.173
Reactance at 50KHz	0.000	0.012
Resistance at 50KHz	0.000	0.186
Phase Angle at 50 KHz	0.000	0.000
Basal metabolic rate	0.048	0.000
Intracellular water	0.000	0.000
Normal value of intracellular water	0.000	0.000
Extra-cellular water	0.002	0.000
Normal extra cellular water	0.000	0.000
Total body water volume	0.013	0.000
Min total body water volume	0.000	0.000
Max total body water volume	0.000	0.000
Body cell mass	0.000	0.000

* No of treatment does not have enough parameter for analysis.

** Overall value does not have enough parameter for analysis.

Table 4.49 Comparisons of Secondary Bioimpedance Parameters after Treatment For Female Age group 3.

Secondary Bioimpedance Parameters	BMI (p)	Diseases Grp(p)
Percentage of fat	0.000	0.000
Min fat	0.054	0.000
Max fat	0.121	0.000
Percentage of lean	0.000	0.000
Min lean	0.036	0.000
Max lean	0.052	0.000
Dry lean weight	0.069	0.000
Percentage of water	0.000	0.000
Min water	0.000	0.000
Max water	0.000	0.000
Density	0.000	0.000
Nutrition	0.000	0.000
Normal nutrition	1.000	1.000
Third space	0.000	0.000

* No of treatment does not have enough parameter for analysis.

** Overall value does not have enough parameter for analysis.

Comparisons of Main Bioimpedance Parameters before Treatment for Male age group 3.

***Not enough parameter for analysis**

Comparisons of Secondary Bioimpedance Parameters before Treatment for Male Age group 3.

***Not enough parameter for analysis**

Comparisons of Main Bioimpedance Parameters after Treatment for Male Age group 3.

***Not enough parameter for analysis**

Comparisons of Secondary Bioimpedance Parameters after Treatment for Male Age group 3.

***Not enough parameter for analysis**

Table 4.50: Comparisons of Main Bioimpedance Parameters before Treatment for Female age group 4.

Main Bioimpedance Parameters	Overall (p)
Impedance value at 5KHz	0.003
Impedance value at 50KHz	0.002
Impedance value at 100KHz	0.002
Impedance value at 200KHz	0.001
Reactance at 50KHz	0.012
Resistance at 50KHz	0.002
Phase Angle at 50 KHz	0.000
Basal metabolic rate	0.000
Intracellular water	0.000
Normal value of intracellular water	0.000
Extra-cellular water	0.000
Normal extra cellular water	0.000
Total body water volume	0.000
Min total body water volume	0.000
Max total body water volume	0.000
Body cell mass	0.000

***Only overall parameter has enough parameter for analysis**

Table 4.51 Comparisons of Secondary Bioimpedance Parameters before Treatment for Female Age group 4.

Secondary Bioimpedance Parameters	Overall (p)
Percentage of fat	0.001
Min fat	0.000
Max fat	0.000
Percentage of lean	0.001
Min lean	0.000
Max lean	0.000
Dry lean weight	0.000
Percentage of water	0.001
Min water	0.000
Max water	0.000
Density	0.000
Nutrition	0.000
Normal nutrition	-
Third space	0.000

*Only overall parameter has enough parameter for analysis

Table 4.52 Comparisons of Main Bioimpedance Parameters after Treatment for Female Age group 4.

Main Bioimpedance Parameters	Overall (p)
Impedance value at 5KHz	0.004
Impedance value at 50KHz	0.006
Impedance value at 100KHz	0.006
Impedance value at 200KHz	0.004
Reactance at 50KHz	0.029
Resistance at 50KHz	0.005
Phase Angle at 50 KHz	0.010
Basal metabolic rate	0.001
Intracellular water	0.000
Normal value of intracellular water	0.000
Extra-cellular water	0.000
Normal extra cellular water	0.000
Total body water volume	0.000
Min total body water volume	0.000
Max total body water volume	0.000
Body cell mass	0.000

*Only overall parameter has enough parameter for analysis

Table 4.53 Comparisons of Secondary Bioimpedance Parameters after Treatment. For Female Age group 4.

Secondary Bioimpedance Parameters	Overall (p)
Percentage of fat	0.000
Min fat	0.000
Max fat	0.000
Percentage of lean	0.000
Min lean	0.000
Max lean	0.000
Dry lean weight	0.000
Percentage of water	0.001
Min water	0.000
Max water	0.000
Density	0.000
Nutrition	0.365
Normal nutrition	-
Third space	0.000

*Only overall parameter has enough parameter for analysis

Table 4.54 Comparisons of Main Bioimpedance Parameters before Treatment for male age group 4.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	Diseases Grp(p)
Impedance value at 5KHz	0.004	0.000	0.666
Impedance value at 50KHz	0.006	0.000	0.751
Impedance value at 100KHz	0.006	0.000	0.659
Impedance value at 200KHz	0.004	0.000	0.483
Reactance at 50KHz	0.029	0.000	0.958
Resistance at 50KHz	0.005	0.000	0.746
Phase Angle at 50 KHz	0.010	0.000	0.679
Basal metabolic rate	0.000	0.003	0.003
Intracellular water	0.000	0.001	0.006
Normal value of intracellular water	0.000	0.000	0.022
Extra-cellular water	0.000	0.004	0.004
Normal extra cellular water	0.000	0.000	0.020
Total body water volume	0.000	0.003	0.003
Min total body water volume	0.000	0.000	0.022
Max total body water volume	0.000	0.000	0.021
Body cell mass	0.000	0.001	0.006

* No of treatment does not have enough parameter for analysis.

Table 4.55 Comparisons of Secondary Bioimpedance Parameters before Treatment for Male Age group 4.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	Diseases Grp(p)
Percentage of fat	0.001	0.000	0.001
Min fat	0.000	0.008	0.008
Max fat	0.000	0.002	0.002
Percentage of lean	0.001	0.000	0.001
Min lean	0.000	0.003	0.008
Max lean	0.000	0.002	0.005
Dry lean weight	0.000	0.006	0.001
Percentage of water	0.001	0.000	0.001
Min water	0.000	0.000	0.022
Max water	0.000	0.000	0.021
Density	0.000	0.000	0.006
Nutrition	0.000	0.064	0.000
Normal nutrition	-	1.000	1.000
Third space	0.000	0.000	0.000

* No of treatment does not have enough parameter for analysis.

Table 4.56 Comparisons of Main Bioimpedance Parameters after Treatment for Male Age group 4.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	Diseases Grp(p)
Impedance value at 5KHz	0.004	0.000	0.001
Impedance value at 50KHz	0.006	0.000	0.666
Impedance value at 100KHz	0.006	0.000	0.751
Impedance value at 200KHz	0.004	0.000	0.659
Reactance at 50KHz	0.029	0.000	0.958
Resistance at 50KHz	0.005	0.000	0.746
Phase Angle at 50 KHz	0.010	0.000	0.679
Basal metabolic rate	0.000	0.000	0.003
Intracellular water	0.000	0.003	0.006
Normal value of intracellular water	0.000	0.001	0.022
Extra-cellular water	0.000	0.004	0.004
Normal extra cellular water	0.000	0.000	0.020
Total body water volume	-	0.003	0.003
Min total body water volume	0.000	0.000	0.022
Max total body water volume	0.000	0.000	0.021
Body cell mass	0.000	0.001	0.006

* No of treatment does not have enough parameter for analysis.

Table 4.57 Comparisons of Secondary Bioimpedance Parameters after Treatment for Male Age group 4.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	Diseases Grp(p)
Percentage of fat	0.004	0.000	0.004
Min fat	0.006	0.000	0.006
Max fat	0.006	0.000	0.006
Percentage of lean	0.004	0.000	0.004
Min lean	0.029	0.000	0.029
Max lean	0.005	0.000	0.005
Dry lean weight	0.010	0.003	0.010
Percentage of water	0.000	0.000	0.000
Min water	0.000	0.000	0.000
Max water	0.000	0.000	0.000
Density	0.000	0.000	0.000
Nutrition	0.365	0.743	0.000
Normal nutrition	-	1.000	-
Third space	0.000	0.000	0.000

* No of treatment does not have enough parameter for analysis.

Table 4.58 Comparisons of Main Bioimpedance Parameters before Treatment for Female age group 5.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.000	0.000	0.494	0.085
Impedance value at 50KHz	0.003	0.000	0.509	0.153
Impedance value at 100KHz	0.003	0.000	0.551	0.153
Impedance value at 200KHz	0.002	0.000	0.589	0.158
Reactance at 50KHz	0.000	0.000	0.380	0.001
Resistance at 50KHz	0.004	0.000	0.514	0.157
Phase Angle at 50 KHz	0.760	0.000	0.567	0.000
Basal metabolic rate	0.068	0.000	0.086	0.078
Intracellular water	0.529	0.000	0.028	0.006
Normal value of intracellular water	0.018	0.000	0.005	0.002
Extra-cellular water	0.711	0.000	0.048	0.032
Normal extra cellular water	0.020	0.000	0.005	0.002
Total body water volume	0.723	0.000	0.093	0.038
Min total body water volume	0.006	0.000	0.007	0.003
Max total body water volume	0.010	0.000	0.005	0.003
Body cell mass	0.537	0.000	0.029	0.006

Table 4.59 Comparisons of Secondary Bioimpedance Parameters before Treatment for Female Age group 5.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.000	0.000	0.000	0.000
Min fat	0.000	0.000	0.114	0.034
Max fat	0.000	0.000	0.181	0.098
Percentage of lean	0.000	0.000	0.000	0.000
Min lean	0.000	0.000	0.145	0.061
Max lean	0.001	0.000	0.168	0.083
Dry lean weight	0.790	0.000	0.087	0.159
Percentage of water	0.000	0.000	0.000	0.000
Min water	0.000	0.000	0.007	0.003
Max water	0.751	0.000	0.005	0.003
Density	0.604	0.000	0.000	0.000
Nutrition	0.000	0.000	0.740	0.012
Normal nutrition	0.000	1.000	1.000	1.000
Third space	0.000	0.000	0.026	0.000

Table 4.60 Comparisons of Main Bioimpedance Parameters after Treatment for Female Age group 5.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.015	0.000	0.494	0.085
Impedance value at 50KHz	0.011	0.000	0.509	0.153
Impedance value at 100KHz	0.008	0.000	0.551	0.153
Impedance value at 200KHz	0.005	0.000	0.589	0.158
Reactance at 50KHz	0.676	0.001	0.380	0.001
Resistance at 50KHz	0.011	0.000	0.514	0.157
Phase Angle at 50 KHz	0.149	0.170	0.567	0.000
Basal metabolic rate	0.010	0.000	0.086	0.078
Intracellular water	0.000	0.000	0.028	0.006
Normal value of intracellular water	0.802	0.000	0.005	0.002
Extra-cellular water	0.049	0.000	0.048	0.032
Normal extra cellular water	0.009	0.000	0.005	0.002
Total body water volume	0.000	0.000	0.093	0.038
Min total body water volume	0.751	0.000	0.007	0.003
Max total body water volume	0.604	0.000	0.005	0.003
Body cell mass	0.000	0.000	0.029	0.006

Table 4.61 Comparisons of Secondary Bioimpedance Parameters after Treatment. For Female Age group 5.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.000	0.000	0.000	0.000
Min fat	0.000	0.000	0.114	0.034
Max fat	0.000	0.000	0.152	0.034
Percentage of lean	0.000	0.000	0.000	0.000
Min lean	.000	0.000	0.077	0.070
Max lean	0.001	0.000	0.090	0.064
Dry lean weight	0.921	0.000	0.081	0.162
Percentage of water	0.000	0.000	0.000	0.000
Min water	0.751	0.000	0.007	0.003
Max water	0.604	0.000	0.005	0.003
Density	0.000	0.000	0.000	0.000
Nutrition	0.000	0.000	0.061	0.000
Normal nutrition	0.000	1.000	1.000	1.000
Third space	0.000	0.000	0.003	0.000

Table 4.62 Comparisons of Main Bioimpedance Parameters before Treatment for male age group 5.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.021	0.979	0.000	0.000
Impedance value at 50KHz	0.017	0.434	0.002	0.000
Impedance value at 100KHz	0.020	0.343	0.003	0.000
Impedance value at 200KHz	0.019	0.377	0.003	0.000
Reactance at 50KHz	0.772	0.008	0.000	0.000
Resistance at 50KHz	0.017	0.407	0.002	0.000
Phase Angle at 50 KHz	0.390	0.000	0.026	0.000
Basal metabolic rate	0.003	0.000	0.002	0.000
Intracellular water	0.000	0.000	0.013	0.000
Normal value of intracellular water	0.802	0.000	0.018	0.000
Extra-cellular water	0.008	0.000	0.010	0.000
Normal extra cellular water	0.009	-	0.020	0.000
Total body water volume	0.000	.0000	0.009	0.000
Min total body water volume	0.751	0.000	0.006	0.000
Max total body water volume	0.604	0.000	0.010	0.000
Body cell mass	0.000	0.000	0.015	0.000

Table 4.63 Comparisons of Secondary Bioimpedance Parameters before Treatment for Male Age group 5.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.000	0.345	0.000	0.000
Min fat	0.000	.	0.058	.
Max fat	0.000	.	0.058	.
Percentage of lean	0.000	0.345	0.000	0.000
Min lean	0.000	0.000	0.000	.
Max lean	0.001	0.000	0.000	.
Dry lean weight	0.790	0.000	0.000	0.000
Percentage of water	0.000	0.000	0.044	0.000
Min water	0.751	0.000	0.006	.
Max water	0.604	0.000	0.010	.
Density	0.000	0.058	0.000	0.000
Nutrition	0.000	0.000	0.058	0.000
Normal nutrition	0.000	1.000	1.000	1.000
Third space	0.000	0.001	0.695	0.000

Table 4.64 Comparisons of Main Bioimpedance Parameters after Treatment for Male Age group 5.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.015	0.628	0.628	0.000
Impedance value at 50KHz	0.011	0.343	0.343	0.003
Impedance value at 100KHz	0.008	0.340	0.340	0.003
Impedance value at 200KHz	0.005	0.399	0.399	0.002
Reactance at 50KHz	0.676	0.055	0.055	0.000
Resistance at 50KHz	0.011	0.337	0.337	0.004
Phase Angle at 50 KHz	0.149	0.000	0.000	0.760
Basal metabolic rate	0.010	0.000	0.000	0.068
Intracellular water	0.000	0.000	0.000	0.529
Normal value of intracellular water	0.802	0.000	0.000	0.018
Extra-cellular water	0.763	0.000	0.000	0.711
Normal extra cellular water	0.049	-	0.000	0.020
Total body water volume	0.009	0.000	0.000	0.723
Min total body water volume	0.000	0.000	0.000	0.006
Max total body water volume	0.751	0.000	0.000	0.010
Body cell mass	0.604	0.000	0.000	0.537

Table 4.65 Comparisons of Secondary Bioimpedance Parameters after Treatment for Male Age group 5.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.000	0.069	0.000	0.000
Min fat	0.000	0.058	0.058	.
Max fat	0.000	0.000	1.000	.
Percentage of lean	0.000	0.069	0.000	0.000
Min lean	0.000	0.000	0.070	0.000
Max lean	0.001	0.000	0.069	0.000
Dry lean weight	0.921	0.000	0.001	0.000
Percentage of water	0.000	0.000	0.000	0.000
Min water	0.751	0.000	0.006	.
Max water	0.604	0.000	0.010	.
Density	0.000	0.058	0.000	0.000
Nutrition	0.000	0.000	0.000	0.000
Normal nutrition	0.000	1.000	1.000	1.000
Third space	0.000	0.003	0.000	0.000

Appendix C:

Table 4.74 Comparisons of Main Bioimpedance Parameters before Treatment for Female BMI group 2.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.058	0.000	0.000	0.000
Impedance value at 50KHz	0.030	0.000	0.000	0.000
Impedance value at 100KHz	0.031	0.000	0.000	0.000
Impedance value at 200KHz	0.026	0.000	0.000	0.000
Reactance at 50KHz	0.576	0.000	0.000	0.000
Resistance at 50KHz	0.029	0.000	0.000	0.000
Phase Angle at 50 KHz	0.026	0.000	0.000	0.000
Basal metabolic rate	0.016	0.000	0.000	0.000
Intracellular water	0.613	0.000	0.000	0.000
Normal value of intracellular water	0.865	0.000	0.000	0.000
Extra-cellular water	0.374	0.000	0.000	0.000
Normal extra cellular water	0.378	0.000	0.000	0.000
Total body water volume	0.025	0.000	0.000	0.000
Min total body water volume	0.967	0.000	0.000	0.000
Max total body water volume	0.874	0.000	0.000	0.000
Body cell mass	0.634	0.000	0.000	0.000

Table 4.75 Comparisons of Secondary Bioimpedance Parameters before Treatment for Female BMI group 2.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.051	0.000	0.019	0.369
Min fat	0.092	0.000	0.466	0.000
Max fat	0.588	0.000	0.391	0.369
Percentage of lean	0.051	0.000	0.019	0.000
Min lean	0.005	0.000	0.169	0.000
Max lean	0.003	0.000	0.163	0.000
Dry lean weight	0.111	0.000	0.000	0.000
Percentage of water	0.298	0.000	0.001	0.343
Min water	0.967	0.000	0.000	0.000
Max water	0.874	0.000	0.000	0.000
Density	0.506	0.000	0.015	0.306
Nutrition	0.000	0.000	0.000	0.000
Normal nutrition	-	1.000	1.000	1.000
Third space	0.018	0.000	0.001	0.041

Table 4.76 Comparisons of Main Bioimpedance Parameters after Treatment for Female BMI group 2.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.204	0.000	0.000	0.000
Impedance value at 50KHz	0.185	0.000	0.000	0.000
Impedance value at 100KHz	0.168	0.000	0.000	0.000
Impedance value at 200KHz	0.191	0.000	0.000	0.000
Reactance at 50KHz	0.724	0.000	0.100	0.000
Resistance at 50KHz	0.185	0.000	0.000	0.000
Phase Angle at 50 KHz	0.183	0.000	0.000	0.000
Basal metabolic rate	0.017	0.000	0.000	0.000
Intracellular water	0.504	0.000	0.000	0.000
Normal value of intracellular water	0.865	0.000	0.000	0.000
Extra-cellular water	0.446	0.000	0.000	0.000
Normal extra cellular water	0.378	0.000	0.000	0.000
Total body water volume	0.036	0.000	0.000	0.000
Min total body water volume	0.967	0.000	0.000	0.000
Max total body water volume	0.874	0.000	0.000	0.000
Body cell mass	0.487	0.000	0.000	0.000

Table 4.77 Comparisons of Secondary Bioimpedance Parameters after Treatment. For Female BMI group 2.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.164	0.000	0.476	0.000
Min fat	0.203	0.000	0.005	0.066
Max fat	0.752	0.000	0.008	0.157
Percentage of lean	0.164	0.000	0.476	0.000
Min lean	0.169	0.000	0.669	0.059
Max lean	0.146	0.000	0.881	0.038
Dry lean weight	0.935	0.000	0.014	0.000
Percentage of water	0.009	0.000	0.000	0.000
Min water	0.015	0.000	0.616	0.001
Max water	0.028	0.000	0.862	0.001
Density	0.049	0.000	0.259	0.000
Nutrition	0.002	0.000	0.094	0.060
Normal nutrition	-	1.000	1.000	1.000
Third space	0.001	0.000	0.000	0.000

Table 4.78 Comparisons of Main Bioimpedance Parameters before Treatment for male BMI group 2.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.001	0.128	0.000	0.024
Impedance value at 50KHz	0.000	0.088	0.000	0.019
Impedance value at 100KHz	0.000	0.089	0.000	0.009
Impedance value at 200KHz	0.000	0.097	0.000	0.005
Reactance at 50KHz	0.000	0.000	0.627	0.000
Resistance at 50KHz	0.000	0.087	0.000	0.016
Phase Angle at 50 KHz	0.802	0.000	0.001	0.000
Basal metabolic rate	0.129	0.000	0.283	0.000
Intracellular water	0.087	0.000	0.044	0.000
Normal value of intracellular water	0.020	0.000	0.365	0.000
Extra-cellular water	0.005	0.000	0.148	0.000
Normal extra cellular water	0.006	0.000	0.400	0.000
Total body water volume	0.003	0.000	0.095	0.000
Min total body water volume	0.015	0.000	0.625	0.000
Max total body water volume	0.028	0.000	0.505	0.000
Body cell mass	0.086	0.000	0.041	0.000

Table 4.79 Comparisons of Secondary Bioimpedance Parameters before Treatment for Male BMI group 2.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.683	0.000	0.451	0.000
Min fat	0.262	0.000	0.482	0.000
Max fat	0.818	0.000	0.232	0.000
Percentage of lean	0.683	0.000	0.451	0.000
Min lean	0.419	0.000	0.265	0.000
Max lean	0.322	0.000	0.230	0.000
Dry lean weight	0.780	0.000	0.909	0.075
Percentage of water	0.205	0.090	0.216	0.000
Min water	0.015	0.000	0.615	0.000
Max water	0.028	0.000	0.505	0.000
Density	0.273	0.000	0.238	0.000
Nutrition	0.059	0.000	0.001	0.000
Normal nutrition	-	1.000	1.000	1.000
Third space	0.001	0.003	0.866	0.195

Table 4.80 Comparisons of Main Bioimpedance Parameters after Treatment for Male BMI group 2.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	No of treatment (p)	Diseases Grp(p)
Impedance value at 5KHz	0.006	0.189	0.000	0.006
Impedance value at 50KHz	0.007	0.234	0.000	0.006
Impedance value at 100KHz	0.013	0.231	0.000	0.004
Impedance value at 200KHz	0.018	0.236	0.000	0.002
Reactance at 50KHz	0.116	0.240	0.000	0.006
Resistance at 50KHz	0.007	0.000	0.636	0.000
Phase Angle at 50 KHz	0.005	0.000	0.000	0.000
Basal metabolic rate	0.036	0.000	0.048	0.000
Intracellular water	0.011	0.000	0.002	0.000
Normal value of intracellular water	0.020	0.000	0.365	0.000
Extra-cellular water	0.007	0.000	0.007	0.000
Normal extra cellular water	0.006	0.000	0.400	0.000
Total body water volume	0.001	0.000	0.003	0.000
Min total body water volume	0.015	0.000	0.615	0.000
Max total body water volume	0.028	0.000	0.505	0.000
Body cell mass	0.012	0.000	0.002	0.000

Table 4.81 Comparisons of Secondary Bioimpedance Parameters after Treatment for Male BMI group 2.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	No of treatment (p)	Diseases Grp(p)
Percentage of fat	0.164	0.000	0.030	0.000
Min fat	0.203	0.000	0.196	0.000
Max fat	0.752	0.000	0.096	0.000
Percentage of lean	0.164	0.000	0.030	0.000
Min lean	0.169	0.000	0.024	0.000
Max lean	0.146	0.000	0.025	0.000
Dry lean weight	0.935	0.061	0.772	0.000
Percentage of water	0.009	0.000	0.005	0.116
Min water	0.015	0.000	0.615	0.000
Max water	0.028	0.000	0.505	0.000
Density	0.049	0.000	0.010	0.000
Nutrition	0.002	0.000	0.439	0.000
Normal nutrition	-	1.000	1.000	1.000
Third space	0.001	0.535	0.021	0.077

Table 4.82 Comparisons of Main Bioimpedance Parameters before Treatment for Female BMI group 3.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	Diseases Grp(p)
Impedance value at 5KHz	0.000	0.000	0.000
Impedance value at 50KHz	0.000	0.000	0.000
Impedance value at 100KHz	0.000	0.000	0.000
Impedance value at 200KHz	0.000	0.000	0.000
Reactance at 50KHz	0.000	0.000	0.000
Resistance at 50KHz	0.000	0.000	0.000
Phase Angle at 50 KHz	0.004	0.000	0.000
Basal metabolic rate	0.000	0.000	0.000
Intracellular water	0.707	0.007	0.000
Normal value of intracellular water	0.000	0.000	0.000
Extra-cellular water	0.016	0.000	0.000
Normal extra cellular water	0.000	0.007	0.000
Total body water volume	0.006	0.000	0.000
Min total body water volume	0.003	0.022	0.000
Max total body water volume	0.002	0.000	0.000
Body cell mass	0.630	0.000	0.000

*no of treatment does not have enough parameter for analysis

Table 4.83 Comparisons of Secondary Bioimpedance Parameters before Treatment for Female BMI group 3.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	Diseases Grp(p)
Percentage of fat	0.000	0.000	0.025
Min fat	0.000	0.000	0.000
Max fat	0.000	0.000	0.000
Percentage of lean	0.000	0.000	0.025
Min lean	0.000	0.002	0.009
Max lean	0.000	0.001	0.001
Dry lean weight	0.004	0.000	0.000
Percentage of water	0.000	0.000	0.000
Min water	0.707	0.022	0.004
Max water	0.000	0.001	0.001
Density	0.016	0.001	0.000
Nutrition	0.000	0.000	0.003
Normal nutrition	0.006	1.000	1.000
Third space	0.003	0.000	0.000

*no of treatment does not have enough parameter for analysis

Table 4.84. Comparisons of Main Bioimpedance Parameters after Treatment for Female BMI group 3.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	Diseases Grp(p)
Impedance value at 5KHz	0.000	0.000	0.025
Impedance value at 50KHz	0.000	0.000	0.000
Impedance value at 100KHz	0.000	0.000	0.000
Impedance value at 200KHz	0.000	0.000	0.025
Reactance at 50KHz	0.002	0.002	0.009
Resistance at 50KHz	0.000	0.001	0.001
Phase Angle at 50 KHz	0.001	0.000	0.000
Basal metabolic rate	0.000	0.000	0.293
Intracellular water	0.286	0.000	0.000
Normal value of intracellular water	0.000	0.007	0.000
Extra-cellular water	0.016	0.000	0.000
Normal extra cellular water	0.000	0.007	0.000
Total body water volume	0.172	0.000	0.000
Min total body water volume	0.003	0.022	0.001
Max total body water volume	0.002	0.001	0.000
Body cell mass	0.298	0.000	0.000

*no of treatment does not have enough parameter for analysis

Table 4.85 Comparisons of Secondary Bioimpedance Parameters after Treatment. For Female BMI group 3.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	Diseases Grp(p)
Percentage of fat	0.258	0.000	0.025
Min fat	0.003	0.000	0.000
Max fat	0.000	0.000	0.000
Percentage of lean	0.258	0.000	0.067
Min lean	0.000	0.002	0.009
Max lean	0.003	0.002	0.001
Dry lean weight	0.015	0.001	0.000
Percentage of water	0.003	0.000	0.007
Min water	0.702	0.022	0.001
Max water	0.002	0.001	0.000
Density	0.004	0.000	0.021
Nutrition	0.002	0.001	0.000
Normal nutrition	-	1.000	1.000
Third space	0.022	0.000	0.000

*no of treatment does not have enough parameter for analysis

Table 4.86 Comparisons of Main Bioimpedance Parameters before Treatment for Male BMI group 3.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	Diseases Grp(p)
Impedance value at 5KHz	0.000	0.000	0.046
Impedance value at 50KHz	0.000	0.000	0.043
Impedance value at 100KHz	0.000	0.000	0.044
Impedance value at 200KHz	0.000	0.000	0.030
Reactance at 50KHz	0.000	0.000	0.000
Resistance at 50KHz	0.000	0.000	0.045
Phase Angle at 50 KHz	0.004	0.000	0.000
Basal metabolic rate	0.000	0.000	0.000
Intracellular water	0.707	0.000	0.000
Normal value of intracellular water	0.000	0.031	0.000
Extra-cellular water	0.016	0.001	0.000
Normal extra cellular water	0.000	0.035	0.000
Total body water volume	0.006	0.000	0.000
Min total body water volume	0.003	0.013	0.000
Max total body water volume	0.002	0.085	0.000
Body cell mass	0.630	0.000	0.000

*no of treatment does not have enough parameter for analysis

Table 4.87 Comparisons of Secondary Bioimpedance Parameters before Treatment for Male BMI group 3.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	Diseases Grp(p)
Percentage of fat	0.022	0.000	0.002
Min fat	0.000	0.032	-
Max fat	0.000	0.000	0.000
Percentage of lean	0.022	0.000	0.002
Min lean	0.000	0.000	0.000
Max lean	0.005	0.000	0.000
Dry lean weight	0.002	0.000	0.000
Percentage of water	0.030	0.005	0.003
Min water	0.003	0.013	0.000
Max water	0.002	0.085	0.000
Density	0.000	0.003	0.003
Nutrition	0.007	0.032	0.032
Normal nutrition	-	1.000	1.000
Third space	0.006	0.000	0.002

*no of treatment does not have enough parameter for analysis

Table 4.88 Comparisons of Main Bioimpedance Parameters after Treatment for Male BMI group 3.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	Diseases Grp(p)
Impedance value at 5KHz	0.000	0.000	0.014
Impedance value at 50KHz	0.000	0.000	0.011
Impedance value at 100KHz	0.000	0.000	0.011
Impedance value at 200KHz	0.000	0.000	0.013
Reactance at 50KHz	0.002	0.000	0.000
Resistance at 50KHz	0.000	0.000	0.011
Phase Angle at 50 KHz	0.001	0.000	0.000
Basal metabolic rate	0.000	0.000	0.000
Intracellular water	0.268	0.000	0.000
Normal value of intracellular water	0.000	0.031	0.001
Extra-cellular water	0.099	0.000	0.000
Normal extra cellular water	0.000	0.035	0.003
Total body water volume	0.172	0.000	1.000
Min total body water volume	0.003	0.013	0.000
Max total body water volume	0.002	0.085	0.000
Body cell mass	0.298	0.000	0.000

*no of treatment does not have enough parameter for analysis

Table 4.89 Comparisons of Secondary Bioimpedance Parameters after Treatment for Male BMI group 3.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	Diseases Grp(p)
Percentage of fat	0.258	0.000	0.000
Min fat	0.003	-	0.003
Max fat	0.000	0.000	0.000
Percentage of lean	0.258	0.000	0.000
Min lean	0.000	0.000	0.000
Max lean	0.000	0.000	0.000
Dry lean weight	0.003	0.000	0.000
Percentage of water	0.015	0.004	0.328
Min water	0.003	0.013	0.000
Max water	0.002	0.085	0.000
Density	0.003	0.003	0.003
Nutrition	0.002	1.000	1.000
Normal nutrition	-	1.000	1.000
Third space	0.022	0.000	0.187

*no of treatment does not have enough parameter for analysis

Table 4.90 Comparisons of Main Bioimpedance Parameters before Treatment for Female BMI group 4.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	Diseases Grp(p)
Impedance value at 5KHz	0.000	0.002	0.000
Impedance value at 50KHz	0.000	0.008	0.003
Impedance value at 100KHz	0.000	0.002	0.003
Impedance value at 200KHz	0.000	0.000	0.003
Reactance at 50KHz	0.000	0.000	0.000
Resistance at 50KHz	0.000	0.006	0.003
Phase Angle at 50 KHz	0.006	0.000	0.002
Basal metabolic rate	0.009	0.454	0.000
Intracellular water	0.001	0.215	0.000
Normal value of intracellular water	0.000	0.019	0.000
Extra-cellular water	0.000	0.213	0.000
Normal extra cellular water	0.000	0.019	0.000
Total body water volume	0.000	0.364	0.000
Min total body water volume	0.000	0.019	0.000
Max total body water volume	0.000	0.009	0.000
Body cell mass	0.001	0.204	0.000

*no of treatment does not have enough parameter for analysis

Table 4.91 Comparisons of Secondary Bioimpedance Parameters before Treatment for Female BMI group 4.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	Diseases Grp(p)
Percentage of fat	0.003	0.000	0.000
Min fat	0.000	0.032	0.000
Max fat	0.000	0.000	-
Percentage of lean	0.003	0.000	0.000
Min lean	0.016	0.881	0.000
Max lean	0.000	0.337	0.000
Dry lean weight	0.017	0.841	0.000
Percentage of water	0.006	0.000	0.000
Min water	0.000	0.019	0.000
Max water	0.000	0.009	0.000
Density	0.001	0.000	0.000
Nutrition	0.000	0.000	0.032
Normal nutrition	-	1.000	1.000
Third space	0.047	0.000	0.000

*no of treatment does not have enough parameter for analysis

Table 4.92 Comparisons of Main Bioimpedance Parameters after Treatment for Female BMI group 4.

Main Bioimpedance Parameters	Overall (p)	BMI (P)	Diseases Grp(p)
Impedance value at 5KHz	0.070	0.000	0.000
Impedance value at 50KHz	0.059	0.001	0.000
Impedance value at 100KHz	0.049	0.001	0.000
Impedance value at 200KHz	0.046	0.000	0.000
Reactance at 50KHz	0.040	0.000	0.182
Resistance at 50KHz	0.059	0.001	0.000
Phase Angle at 50 KHz	0.005	0.000	0.000
Basal metabolic rate	0.008	0.052	0.000
Intracellular water	0.001	0.278	0.000
Normal value of intracellular water	0.000	0.019	0.000
Extra-cellular water	0.001	0.231	0.000
Normal extra cellular water	0.000	0.019	0.000
Total body water volume	0.006	0.329	0.000
Min total body water volume	0.000	0.019	0.000
Max total body water volume	0.000	0.009	0.000
Body cell mass	0.001	0.000	0.000

*no of treatment does not have enough parameter for analysis

Table 4.93 Comparisons of Secondary Bioimpedance Parameters after Treatment. For Female BMI group 4.

Secondary Bioimpedance Parameters	Overall (p)	BMI (p)	Diseases Grp(p)
Percentage of fat	0.041	0.000	0.000
Min fat	0.000	0.010	0.000
Max fat	0.000	0.001	0.000
Percentage of lean	0.041	0.000	0.000
Min lean	0.014	0.382	0.182
Max lean	0.011	0.436	0.000
Dry lean weight	0.012	0.628	0.000
Percentage of water	0.070	0.001	0.000
Min water	0.000	0.019	0.000
Max water	0.000	0.009	0.000
Density	0.031	0.000	0.000
Nutrition	0.007	0.054	0.000
Normal nutrition	-	1.000	0.000
Third space	0.029	0.002	0.000

*no of treatment does not have enough parameter for analysis

Table 4.94 Comparisons of Main Bioimpedance Parameters before Treatment for male BMI group 4.

Main Bioimpedance Parameters	Overall (p)
Impedance value at 5KHz	0.000
Impedance value at 50KHz	0.000
Impedance value at 100KHz	0.000
Impedance value at 200KHz	0.000
Reactance at 50KHz	0.000
Resistance at 50KHz	0.000
Phase Angle at 50 KHz	0.006
Basal metabolic rate	0.009
Intracellular water	0.000
Normal value of intracellular water	0.000
Extra-cellular water	0.000
Normal extra cellular water	0.000
Total body water volume	0.000
Min total body water volume	0.000
Max total body water volume	0.000
Body cell mass	0.001

*Only overall parameter has enough data for analysis.

Table 4.95 Comparisons of Secondary Bioimpedance Parameters before Treatment for Male BMI group 4.

Secondary Bioimpedance Parameters	Overall (p)
Percentage of fat	0.003
Min fat	0.000
Max fat	0.000
Percentage of lean	0.003
Min lean	0.016
Max lean	0.000
Dry lean weight	0.017
Percentage of water	0.006
Min water	0.000
Max water	0.000
Density	0.001
Nutrition	0.000
Normal nutrition	-
Third space	0.047

*Only overall parameter has enough data for analysis.

Table 4.96 Comparisons of Main Bioimpedance Parameters after Treatment for Male BMI group 4.

Main Bioimpedance Parameters	Overall (p)
Impedance value at 5KHz	0.070
Impedance value at 50KHz	0.059
Impedance value at 100KHz	0.049
Impedance value at 200KHz	0.046
Reactance at 50KHz	0.040
Resistance at 50KHz	0.059
Phase Angle at 50 KHz	0.005
Basal metabolic rate	0.008
Intracellular water	0.001
Normal value of intracellular water	0.000
Extra-cellular water	0.001
Normal extra cellular water	0.000
Total body water volume	0.006
Min total body water volume	0.000
Max total body water volume	0.000
Body cell mass	0.001

*Only overall parameter has enough data for analysis.

Table 4.97 Comparisons of Secondary Bioimpedance Parameters after Treatment for Male BMI group 4.

Secondary Bioimpedance Parameters	Overall (p)
Percentage of fat	0.041
Min fat	0.000
Max fat	0.000
Percentage of lean	0.041
Min lean	0.014
Max lean	0.011
Dry lean weight	0.012
Percentage of water	0.070
Min water	0.000
Max water	0.000
Density	0.031
Nutrition	0.007
Normal nutrition	-
Third space	0.029

*Only overall parameter has enough data for analysis.

Table 4.98 Comparisons of Main Bioimpedance Parameters before Treatment for Female BMI group 5.

Main Bioimpedance Parameters	BMI (P)	Diseases Grp(p)
Impedance value at 5KHz	0.000	0.000
Impedance value at 50KHz	0.000	0.000
Impedance value at 100KHz	0.000	0.000
Impedance value at 200KHz	0.000	0.000
Reactance at 50KHz	0.000	0.000
Resistance at 50KHz	0.000	0.000
Phase Angle at 50 KHz	0.000	0.000
Basal metabolic rate	0.000	0.000
Intracellular water	0.000	0.000
Normal value of intracellular water	0.000	0.000
Extra-cellular water	0.000	0.000
Normal extra cellular water	0.000	0.000
Total body water volume	0.000	0.000
Min total body water volume	-	-
Max total body water volume	-	-
Body cell mass	0.000	0.000

*Overall and no of treatment does not have enough parameter for analysis

Table 4.99 Comparisons of Secondary Bioimpedance Parameters before Treatment for Female BMI group 5.

Secondary Bioimpedance Parameters	BMI (p)	Diseases Grp(p)
Percentage of fat	0.000	0.000
Min fat	-	-
Max fat	-	-
Percentage of lean	0.000	0.000
Min lean	-	0.000
Max lean	-	0.000
Dry lean weight	0.000	0.000
Percentage of water	0.000	0.000
Min water	-	-
Max water	-	-
Density	0.000	0.000
Nutrition	0.001	0.001
Normal nutrition	1.000	1.000
Third space	0.000	0.000

*Overall and no of treatment does not have enough parameter for analysis

Table 4.100 Comparisons of Main Bioimpedance Parameters after Treatment for Female BMI group 5.

Main Bioimpedance Parameters	BMI (P)	Diseases Grp(p)
Impedance value at 5KHz	0.000	0.000
Impedance value at 50KHz	0.000	0.000
Impedance value at 100KHz	0.000	0.000
Impedance value at 200KHz	0.000	0.000
Reactance at 50KHz	0.000	0.000
Resistance at 50KHz	0.000	0.000
Phase Angle at 50 KHz	0.000	0.000
Basal metabolic rate	0.000	0.000
Intracellular water	0.000	0.000
Normal value of intracellular water	0.000	0.000
Extra-cellular water	0.000	0.000
Normal extra cellular water	0.000	0.000
Total body water volume	0.000	0.000
Min total body water volume	-	-
Max total body water volume	-	-
Body cell mass	0.000	0.000

*Overall and no of treatment does not have enough parameter for analysis

Table 4.101 Comparisons of Secondary Bioimpedance Parameters after Treatment. For Female BMI group 5.

Secondary Bioimpedance Parameters	BMI (p)	Diseases Grp(p)
Percentage of fat	0.000	0.000
Min fat	-	-
Max fat	-	-
Percentage of lean	0.000	0.000
Min lean	-	-
Max lean	-	-
Dry lean weight	0.000	0.000
Percentage of water	0.000	0.000
Min water	-	-
Max water	-	-
Density	0.000	0.000
Nutrition	1.000	1.000
Normal nutrition	1.000	1.000
Third space	0.000	0.000

*Overall and no of treatment does not have enough parameter for analysis

Comparisons of Main Bioimpedance Parameters before Treatment for male BMI group 5.

***Not enough parameter for analysis**

Comparisons of Secondary Bioimpedance Parameters before Treatment for Male BMI group 5.

***Not enough parameter for analysis**

Comparisons of Main Bioimpedance Parameters after Treatment for Male BMI group 5.

***Not enough parameter for analysis**

Comparisons of Secondary Bioimpedance Parameters after Treatment for Male BMI group 5.

***Not enough parameter for analysis**

Appendix D:

Table 4.114 Interaction of Main Bioimpedance Parameters before Treatment for Age Group2.

Main Bioimpedance Parameters	Gender (p)	BMI group (p)	Disease (p)
Impedance value at 5KHz	0.058	0.000	0.016
Impedance value at 50KHz	0.030	0.000	0.032
Impedance value at 100KHz	0.031	0.000	0.032
Impedance value at 200KHz	0.026	0.000	0.034
Reactance at 50KHz	0.576	0.000	0.000
Resistance at 50KHz	0.029	0.014	0.033
Phase Angle at 50 KHz	0.026	0.000	0.014
Basal metabolic rate	0.016	0.000	0.000
Intracellular water	0.613	0.000	0.000
Normal intracellular water	0.865	0.001	0.000
Extra-cellular water	0.374	0.000	0.000
Normal extra cellular water	0.378	0.000	0.000
Total body water volume	0.025	0.000	0.000
Min total body water volume	0.967	0.006	0.000
Max total body water volume	0.874	0.000	0.000
Body cell mass	0.634	0.001	0.000

Table 4.115 Interaction of Main Bioimpedance Parameters after Treatment for Age Group2.

Main Bioimpedance Parameters	Gender (p)	BMI group (p)	Disease (p)
Impedance value at 5KHz	0.204	0.000	0.042
Impedance value at 50KHz	0.185	0.000	0.054
Impedance value at 100KHz	0.168	0.000	0.057
Impedance value at 200KHz	0.191	0.000	0.050
Reactance at 50KHz	0.724	0.001	0.007
Resistance at 50KHz	0.185	0.000	0.054
Phase Angle at 50 KHz	0.183	0.001	0.001
Basal metabolic rate	0.017	0.000	0.000
Intracellular water	0.504	0.001	0.000
Normal intracellular water	0.865	0.000	0.000
Extra-cellular water	0.446	0.000	0.000
Normal extra cellular water	0.378	0.000	0.000
Total body water volume	0.036	0.006	0.000
Min total body water volume	0.967	0.000	0.000
Max total body water volume	0.874	0.000	0.000
Body cell mass	0.487	0.001	0.000

Table 4.116 Interactions of Secondary Bioimpedance Parameters before Treatment for Age Group2.

Secondary Bioimpedance Parameters	Gender (p)	BMI Grp (p)	Disease (p)
Percentage of fat	0.051	0.000	0.000
Min fat	0.092	0.000	0.000
Max fat	0.588	0.000	0.000
Percentage of lean	0.051	0.000	0.000
Min lean	0.005	0.001	0.000
Max lean	0.003	0.002	0.000
Dry lean weight	0.111	0.000	0.000
Percentage of water	0.298	0.000	0.001
Min water	0.967	0.000	0.000
Max water	0.874	0.000	0.000
Density	0.506	0.000	0.000
Nutrition	0.000	0.098	0.000
Normal nutrition	-	0.218	0.000
Third space value	0.019	0.000	0.009

Table4.117 Interactions of Secondary Bioimpedance Parameters after Treatment for Age group 2.

Secondary Bioimpedance Parameters	Gender (p)	BMI Grp (p)	Disease (p)
Percentage of fat	0.342	0.000	0.000
Min fat	0.006	0.000	0.000
Max fat	0.583	0.000	0.000
Percentage of lean	0.342	0.000	0.000
Min lean	0.025	0.000	0.002
Max lean	0.013	0.000	0.002
Dry lean weight	0.115	0.000	0.000
Percentage of water	0.154	0.001	0.000
Min water	0.967	0.000	0.000
Max water	0.874	0.000	0.000
Density	0.871	0.000	0.000
Nutrition	0.000	0.000	0.138
Normal nutrition	-	0.000	0.218
Third space value	0.280	0.009	0.000

Table 4.118 Interaction of Main Bioimpedance Parameters before Treatment for Age Group3.

Main Bioimpedance Parameters	BMI group (p)	Disease (p)
Impedance value at 5KHz	0.000	0.108
Impedance value at 50KHz	0.000	0.017
Impedance value at 100KHz	0.000	0.018
Impedance value at 200KHz	0.000	0.020
Reactance at 50KHz	0.000	0.000
Resistance at 50KHz	0.000	0.016
Phase Angle at 50 KHz	0.000	0.000
Basal metabolic rate	0.329	0.000
Intracellular water	0.007	0.000
Normal intracellular water	0.000	0.000
Extra-cellular water	0.070	0.000
Normal extra cellular water	0.000	0.000
Total body water volume	0.245	0.000
Min total body water volume	0.000	0.000
Max total body water volume	0.000	0.000
Body cell mass	0.007	0.000

* Gender does not have enough parameter for analysis.

Table 4.119 Interaction of Main Bioimpedance Parameters after Treatment for Age Group3.

Main Bioimpedance Parameters	BMI group (p)	Disease (p)
Impedance value at 5KHz	0.000	0.229
Impedance value at 50KHz	0.000	0.187
Impedance value at 100KHz	0.000	0.178
Impedance value at 200KHz	0.000	0.173
Reactance at 50KHz	0.000	0.012
Resistance at 50KHz	0.000	0.186
Phase Angle at 50 KHz	0.000	0.000
Basal metabolic rate	0.048	0.000
Intracellular water	0.000	0.000
Normal intracellular water	0.000	0.000
Extra-cellular water	0.002	0.000
Normal extra cellular water	0.000	0.000
Total body water volume	0.013	0.000
Min total body water volume	0.000	0.000
Max total body water volume	0.000	0.000
Body cell mass	0.000	0.000

* Gender does not have enough parameter for analysis.

Table 4.120 Interaction of Secondary Bioimpedance Parameters before Treatment for Age Group3.

Secondary Bioimpedance Parameters	BMI Grp (p)	Disease (p)
Percentage of fat	0.000	0.000
Min fat	0.376	-
Max fat	0.065	0.000
Percentage of lean	0.000	0.000
Min lean	0.363	0.000
Max lean	0.179	0.000
Dry lean weight	0.075	0.000
Percentage of water	0.000	0.000
Min water	0.000	0.000
Max water	0.000	0.000
Density	0.000	0.000
Nutrition	0.000	0.000
Normal nutrition	1.000	1.000
Third space value	0.000	0.000

* Gender does not have enough parameter for analysis.

Table 4.121 Interactions of Secondary Bioimpedance Parameters after Treatment for Age Group3.

Secondary Bioimpedance Parameters	BMI Grp (p)	Disease (p)
Percentage of fat	0.000	0.000
Min fat	0.054	0.000
Max fat	0.121	0.000
Percentage of lean	0.000	0.000
Min lean	0.036	0.000
Max lean	0.052	0.000
Dry lean weight	0.069	0.000
Percentage of water	0.000	0.000
Min water	0.000	0.000
Max water	0.000	0.000
Density	0.000	0.000
Nutrition	0.000	0.000
Normal nutrition	1.000	1.000
Third space value	0.000	0.000

* Gender does not have enough parameter for analysis.

Table 4.122 Interaction of Main Bioimpedance Parameters before Treatment for Age Group4.

Main Bioimpedance Parameters	Gender (p)	BMI group (p)	Disease (p)
Impedance value at 5KHz	0.003	0.000	0.050
Impedance value at 50KHz	0.002	0.000	0.015
Impedance value at 100KHz	0.002	0.000	0.013
Impedance value at 200KHz	0.001	0.000	0.013
Reactance at 50KHz	0.012	0.000	0.746
Resistance at 50KHz	0.002	0.000	0.015
Phase Angle at 50 KHz	0.000	0.000	0.082
Basal metabolic rate	0.000	0.000	0.000
Intracellular water	0.000	0.000	0.000
Normal intracellular water	0.000	0.000	0.000
Extra-cellular water	0.000	0.000	0.000
Normal extra cellular water	0.000	0.000	0.000
Total body water volume	0.000	0.000	0.000
Min total body water volume	0.000	0.000	0.000
Max total body water volume	0.000	0.000	0.000
Body cell mass	0.000	0.000	0.000

Table 4.123 Interaction of Main Bioimpedance Parameters after Treatment for Age Group4

Main Bioimpedance Parameters	Gender (p)	BMI group (p)	Disease (p)
Impedance value at 5KHz	0.004	0.000	0.089
Impedance value at 50KHz	0.006	0.000	0.020
Impedance value at 100KHz	0.006	0.000	0.016
Impedance value at 200KHz	0.004	0.000	0.016
Reactance at 50KHz	0.029	0.000	0.282
Resistance at 50KHz	0.005	0.000	0.019
Phase Angle at 50 KHz	0.000	0.000	0.028
Basal metabolic rate	0.010	0.000	0.000
Intracellular water	0.000	0.000	0.000
Normal intracellular water	0.000	0.000	0.000
Extra-cellular water	0.000	0.000	0.000
Normal extra cellular water	0.000	0.000	0.000
Total body water volume	0.000	0.000	0.000
Min total body water volume	0.000	0.000	0.000
Max total body water volume	0.000	0.000	0.000
Body cell mass	0.000	0.000	0.000

Table 4.124 Interactions of Secondary Bioimpedance Parameters before Treatment for Age Group4.

Secondary Bioimpedance Parameters	Gender (p)	BMI Grp (p)	Disease (p)
Percentage of fat	0.001	0.000	0.071
Min fat	0.000	0.022	0.022
Max fat	0.000	0.001	0.001
Percentage of lean	0.001	0.000	0.071
Min lean	0.000	0.000	0.000
Max lean	0.000	0.000	0.000
Dry lean weight	0.000	0.000	0.000
Percentage of water	0.000	0.000	0.526
Min water	0.000	0.000	0.000
Max water	0.000	0.000	0.000
Density	0.000	0.000	0.021
Nutrition	0.000	0.002	0.000
Normal nutrition	0.000	0.001	0.001
Third space value	0.000	0.000	0.046

Table 4.125 Interactions of Secondary Bioimpedance Parameters after Treatment for Age Group4.

Secondary Bioimpedance Parameters	Gender (p)	BMI Grp (p)	Disease (p)
Percentage of fat	0.000	0.000	0.069
Min fat	0.000	0.022	0.022
Max fat	0.000	0.001	0.001
Percentage of lean	0.000	0.000	0.069
Min lean	0.000	0.000	0.000
Max lean	0.000	0.000	0.000
Dry lean weight	0.000	0.000	0.000
Percentage of water	0.002	0.000	0.575
Min water	0.000	0.000	0.000
Max water	0.000	0.000	0.000
Density	0.000	0.000	0.021
Nutrition	0.365	0.001	0.000
Normal nutrition	-	0.001	0.001
Third space value	0.000	0.000	0.016

Table 4.126 Interaction of Main Bioimpedance Parameters before Treatment for Age Group5.

Main Bioimpedance Parameters	Gender (p)	BMI group (p)	Disease (p)
Impedance value at 5KHz	0.188	0.034	0.000
Impedance value at 50KHz	0.175	0.185	0.001
Impedance value at 100KHz	0.241	0.455	0.001
Impedance value at 200KHz	0.283	0.617	0.002
Reactance at 50KHz	0.062	0.000	0.259
Resistance at 50KHz	0.187	0.214	0.001
Phase Angle at 50 KHz	0.076	0.003	0.527
Basal metabolic rate	0.367	0.227	0.000
Intracellular water	0.075	0.113	0.000
Normal intracellular water	0.017	0.000	0.088
Extra-cellular water	0.003	0.056	0.001
Normal extra cellular water	0.072	0.003	0.000
Total body water volume	0.202	0.685	0.000
Min total body water volume	0.012	0.000	0.248
Max total body water volume	0.018	0.000	0.300
Body cell mass	0.080	0.112	0.000

Table 4.127 Interaction of Main Bioimpedance Parameters after Treatment for Age Group5

Main Bioimpedance Parameters	Gender (p)	BMI group (p)	Disease (p)
Impedance value at 5KHz	0.298	0.036	0.000
Impedance value at 50KHz	0.398	0.117	0.000
Impedance value at 100KHz	0.575	0.182	0.000
Impedance value at 200KHz	0.764	0.239	0.000
Reactance at 50KHz	0.016	0.001	0.000
Resistance at 50KHz	0.413	0.123	0.000
Phase Angle at 50 KHz	0.045	0.043	0.000
Basal metabolic rate	0.977	0.121	0.000
Intracellular water	0.032	0.096	0.000
Normal intracellular water	0.017	0.000	0.088
Extra-cellular water	0.001	0.011	0.006
Normal extra cellular water	0.072	0.003	0.000
Total body water volume	0.039	0.613	0.000
Min total body water volume	0.012	0.000	0.248
Max total body water volume	0.018	0.000	0.300
Body cell mass	0.031	0.093	0.000

Table 4.128 Interactions of Secondary Bioimpedance Parameters before Treatment for Age Group5.

Secondary Bioimpedance Parameters	Gender (p)	BMI Grp (p)	Disease (p)
Percentage of fat	0.000	0.000	0.000
Min fat	0.000	0.000	0.152
Max fat	0.000	0.000	0.077
Percentage of lean	0.000	0.000	0.000
Min lean	0.211	0.749	0.000
Max lean	0.141	0.383	0.000
Dry lean weight	0.140	0.000	0.008
Percentage of water	0.139	0.000	0.001
Min water	0.012	0.000	0.248
Max water	0.018	0.000	0.200
Density	0.000	0.000	0.000
Nutrition	0.000	0.002	0.000
Normal nutrition	-	0.000	0.000
Third space value	0.000	0.000	0.002

Table 4.129 Interactions of Secondary Bioimpedance Parameters after Treatment for Age Group 5.

Secondary Bioimpedance Parameters	Gender (p)	BMI Grp (p)	Disease (p)
Percentage of fat	0.000	0.000	0.000
Min fat	0.000	0.000	0.026
Max fat	0.000	0.000	0.027
Percentage of lean	0.000	0.000	0.000
Min lean	0.011	0.595	0.000
Max lean	0.012	0.301	0.000
Dry lean weight	0.200	0.000	0.019
Percentage of water	0.587	0.000	0.002
Min water	0.012	0.000	0.248
Max water	0.018	0.000	0.300
Density	0.001	0.000	0.000
Nutrition	0.003	0.007	0.000
Normal nutrition	-	0.000	0.000
Third space value	0.000	0.000	0.005

Appendix E:

Table 4.134 Interaction of Main Bioimpedance Parameters before Treatment for BMI group2.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	Diseases (p)
Impedance value at 5KHz	0.001	0.0000	0.015
Impedance value at 50KHz	0.000	0.0001	0.060
Impedance value at 100KHz	0.000	0.0001	0.085
Impedance value at 200KHz	0.000	0.0002	0.118
Reactance at 50KHz	0.000	0.0000	0.000
Resistance at 50KHz	0.000	0.0001	0.065
Phase Angle at 50 KHz	0.802	0.0000	0.003
Basal metabolic rate	0.129	0.0000	0.000
Intracellular water	0.087	0.0000	0.000
Normal intracellular water	0.020	0.0000	0.000
Extra-cellular water	0.005	0.0000	0.000
Normal extra cellular water	0.006	0.0000	0.000
Total body water volume	0.003	0.0000	0.000
Min total body water volume	0.015	0.0000	0.000
Max total body water volume	0.028	0.0000	0.000
Body cell mass	0.086	0.0000	0.000

Table 4.135 Interaction of Main Bioimpedance Parameters after Treatment for BMI group2.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	Diseases (p)
Impedance value at 5KHz	0.006	0.0000	0.004
Impedance value at 50KHz	0.007	0.0001	0.011
Impedance value at 100KHz	0.013	0.0001	0.015
Impedance value at 200KHz	0.018	0.0001	0.019
Reactance at 50KHz	0.116	0.0000	0.000
Resistance at 50KHz	0.007	0.0001	0.012
Phase Angle at 50 KHz	0.005	0.0000	0.127
Basal metabolic rate	0.036	0.0000	0.000
Intracellular water	0.011	0.0000	0.000
Normal intracellular water	0.020	0.0000	0.000
Extra-cellular water	0.007	0.0000	0.000
Normal extra cellular water	0.006	0.0000	0.000
Total body water volume	0.001	0.0000	0.000
Min total body water volume	0.015	0.0000	0.000
Max total body water volume	0.028	0.0000	0.000
Body cell mass	0.012	0.0000	0.000

Table 4.136 Interactions of Secondary Bioimpedance Parameters before Treatment for BMI group2.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	Disease (p)
Percentage of fat	0.683	0.0000	0.0000
Min fat	0.262	0.0000	0.0000
Max fat	0.818	0.0000	0.0000
Percentage of lean	0.683	0.0000	0.0000
Min lean	0.419	0.0000	0.0000
Max lean	0.322	0.0000	0.0000
Dry lean weight	0.780	0.0000	0.0000
Percentage of water	0.205	0.1749	0.1815
Min water	0.015	0.0000	0.0000
Max water	0.028	0.0000	0.0000
Density	0.273	0.0004	0.0001
Nutrition	0.059	0.0000	0.0033
Normal nutrition	-	0.0001	0.0000
Third space value	0.001	0.0088	0.0367

Table 4.137 Interactions of Secondary Bioimpedance Parameters after Treatment for BMI group2.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	Disease (p)
Percentage of fat	0.164	0.000	0.000
Min fat	0.203	0.000	0.000
Max fat	0.752	0.000	0.000
Percentage of lean	0.164	0.000	0.000
Min lean	0.169	0.000	0.000
Max lean	0.146	0.000	0.000
Dry lean weight	0.935	0.000	0.000
Percentage of water	0.009	0.266	0.153
Min water	0.015	0.000	0.000
Max water	0.028	0.000	0.000
Density	0.049	0.000	0.001
Nutrition	0.002	0.000	0.000
Normal nutrition	-	0.000	0.000
Third space value	0.001	0.162	0.021

Table 4.138 Interaction of Main Bioimpedance Parameters before Treatment for BMI group3.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	Diseases (p)
Impedance value at 5KHz	0.000	0.000	0.0000
Impedance value at 50KHz	0.000	0.000	0.0000
Impedance value at 100KHz	0.000	0.000	0.0000
Impedance value at 200KHz	0.000	0.000	0.0000
Reactance at 50KHz	0.000	0.000	0.0000
Resistance at 50KHz	0.000	0.000	0.0000
Phase Angle at 50 KHz	0.004	0.000	0.0000
Basal metabolic rate	0.000	0.000	0.0000
Intracellular water	0.707	0.001	0.0000
Normal intracellular water	0.000	0.001	0.0000
Extra-cellular water	0.016	0.005	0.0000
Normal extra cellular water	0.000	0.000	0.0000
Total body water volume	0.006	0.005	0.0000
Min total body water volume	0.003	0.001	0.0000
Max total body water volume	0.002	0.003	0.0000
Body cell mass	0.630	0.001	0.0000

Table 4.139 Interaction of Main Bioimpedance Parameters after Treatment for BMI group3.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	Diseases (p)
Impedance value at 5KHz	0.000	0.000	0.000
Impedance value at 50KHz	0.000	0.000	0.000
Impedance value at 100KHz	0.000	0.000	0.000
Impedance value at 200KHz	0.000	0.000	0.000
Reactance at 50KHz	0.002	0.000	0.000
Resistance at 50KHz	0.000	0.000	0.000
Phase Angle at 50 KHz	0.001	0.000	0.000
Basal metabolic rate	0.000	0.000	0.000
Intracellular water	0.286	0.001	0.000
Normal intracellular water	0.000	0.001	0.000
Extra-cellular water	0.099	0.001	0.000
Normal extra cellular water	0.000	0.000	0.000
Total body water volume	0.172	0.002	0.000
Min total body water volume	0.003	0.001	0.000
Max total body water volume	0.002	0.003	0.000
Body cell mass	0.298	0.001	0.000

Table 4.140 Interactions of Secondary Bioimpedance Parameters before Treatment for BMI group3.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	Disease (p)
Percentage of fat	0.022	0.0000	0.0000
Min fat	0.000	0.0000	0.0000
Max fat	0.000	0.0000	0.0000
Percentage of lean	0.022	0.0000	0.0000
Min lean	0.000	0.0001	0.0000
Max lean	0.005	0.0002	0.0000
Dry lean weight	0.002	0.0000	0.0000
Percentage of water	0.030	0.0620	0.0000
Min water	0.003	0.0013	0.0000
Max water	0.002	0.0035	0.0000
Density	0.000	0.0002	0.0000
Nutrition	0.007	0.0000	0.0000
Normal nutrition	-	0.0002	0.0000
Third space value	0.006	0.0069	0.0000

Table 4.141 Interactions of Secondary Bioimpedance Parameters after Treatment for BMI group 3.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	Disease (p)
Percentage of fat	0.258	0.000	0.0000
Min fat	0.003	0.000	0.0000
Max fat	0.000	0.000	0.0000
Percentage of lean	0.258	0.000	0.0000
Min lean	0.000	0.000	0.0000
Max lean	0.000	0.000	0.0000
Dry lean weight	0.003	0.000	0.0000
Percentage of water	0.015	0.012	0.0000
Min water	0.003	0.001	0.0000
Max water	0.002	0.003	0.0000
Density	0.003	0.000	0.0000
Nutrition	0.002	0.000	0.0000
Normal nutrition	.	0.000	0.0000
Third space value	0.022	0.000	0.0000

Table 4.142 Interaction of Main Bioimpedance Parameters before Treatment for BMI group4.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	Diseases (p)
Impedance value at 5KHz	0.0000	0.0000	0.0000
Impedance value at 50KHz	0.0000	0.0000	0.0000
Impedance value at 100KHz	0.0000	0.0000	0.0000
Impedance value at 200KHz	0.0000	0.0000	0.0000
Reactance at 50KHz	0.0002	0.0000	0.0000
Resistance at 50KHz	0.0000	0.0000	0.0000
Phase Angle at 50 KHz	0.0056	0.0000	0.0000
Basal metabolic rate	0.0092	0.0000	0.0000
Intracellular water	0.0006	0.0000	0.0000
Normal intracellular water	0.0000	0.0000	0.0000
Extra-cellular water	0.0000	0.0000	0.0000
Normal extra cellular water	0.0000	0.0000	0.0000
Total body water volume	0.0003	0.0000	0.0000
Min total body water volume	0.0000	0.0000	0.0000
Max total body water volume	0.0001	0.0000	0.0000
Body cell mass	0.0005	0.0000	0.0000

Table 4.143 Interaction of Main Bioimpedance Parameters after Treatment for BMI group 4.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	Diseases (p)
Impedance value at 5KHz	0.070	0.0001	0.0000
Impedance value at 50KHz	0.059	0.0003	0.0001
Impedance value at 100KHz	0.049	0.0001	0.0000
Impedance value at 200KHz	0.046	0.0001	0.0000
Reactance at 50KHz	0.040	0.0000	0.0380
Resistance at 50KHz	0.059	0.0003	0.0001
Phase Angle at 50 KHz	0.005	0.0000	0.0000
Basal metabolic rate	0.008	0.0000	0.0000
Intracellular water	0.001	0.0000	0.0000
Normal intracellular water	0.000	0.0000	0.0000
Extra-cellular water	0.001	0.0000	0.0000
Normal extra cellular water	0.000	0.0000	0.0000
Total body water volume	0.006	0.0000	0.0000
Min total body water volume	0.000	0.0000	0.0000
Max total body water volume	0.000	0.0000	0.0000
Body cell mass	0.001	0.0000	0.0000

Table 4.144 Interactions of Secondary Bioimpedance Parameters before Treatment for BMI group 4.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	Disease (p)
Percentage of fat	0.003	0.0000	0.0000
Min fat	0.000	0.0015	0.0000
Max fat	0.000	0.0001	-
Percentage of lean	0.003	0.0000	0.0000
Min lean	0.016	0.0000	0.0000
Max lean	0.000	0.0000	0.0000
Dry lean weight	0.017	0.0000	0.0000
Percentage of water	0.006	0.0000	0.0000
Min water	0.000	0.0000	0.0000
Max water	0.000	0.0000	0.0000
Density	0.001	0.0000	0.0000
Nutrition	0.000	0.0000	0.0000
Normal nutrition	-	0.0000	0.0000
Third space value	0.047	0.0000	0.0000

Table 4.145 Interactions of Secondary Bioimpedance Parameters after Treatment for BMI group 4.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	Disease (p)
Percentage of fat	0.041	0.0000	0.0000
Min fat	0.000	0.0001	0.0000
Max fat	0.000	0.0001	0.0000
Percentage of lean	0.041	0.0000	0.0000
Min lean	0.014	0.0000	0.0000
Max lean	0.011	0.0000	0.0000
Dry lean weight	0.012	0.0000	0.0000
Percentage of water	0.070	0.0000	0.0000
Min water	0.000	0.0000	0.0000
Max water	0.000	0.0000	0.0000
Density	0.031	0.0000	0.0000
Nutrition	0.007	0.0000	0.0000
Normal nutrition	-	0.0000	0.0000
Third space value	0.029	0.0000	0.0000

Table 4.146 Interaction of Main Bioimpedance Parameters before Treatment for BMI group 5.

Main Bioimpedance Parameters	Age Grp (p)	Diseases (p)
Impedance value at 5KHz	0.000	0.000
Impedance value at 50KHz	0.000	0.000
Impedance value at 100KHz	0.000	0.000
Impedance value at 200KHz	0.000	0.000
Reactance at 50KHz	0.000	0.000
Resistance at 50KHz	0.000	0.000
Phase Angle at 50 KHz	0.000	0.000
Basal metabolic rate	0.000	0.000
Intracellular water	0.000	0.000
Normal intracellular water	0.000	0.000
Extra-cellular water	0.000	0.000
Normal extra cellular water	0.000	0.000
Total body water volume	0.000	0.000
Min total body water volume	-	-
Max total body water volume	-	-
Body cell mass	0.000	0.000

* Gender doesn't have enough parameter for analysis.

Table 4.147 Interaction of Main Bioimpedance Parameters after Treatment for BMI group 5.

Main Bioimpedance Parameters	Age Grp (p)	Diseases (p)
Impedance value at 5KHz	0.000	0.000
Impedance value at 50KHz	0.000	0.000
Impedance value at 100KHz	0.000	0.000
Impedance value at 200KHz	0.000	0.000
Reactance at 50KHz	0.000	0.000
Resistance at 50KHz	0.000	0.000
Phase Angle at 50 KHz	0.000	0.000
Basal metabolic rate	0.000	0.000
Intracellular water	0.000	0.000
Normal intracellular water	0.000	0.000
Extra-cellular water	0.000	0.000
Normal extra cellular water	0.000	0.000
Total body water volume	0.000	0.000
Min total body water volume	-	-
Max total body water volume	-	-
Body cell mass	0.000	0.000

* Gender does not have enough parameter for analysis.

Table 4.148 Interactions of Secondary Bioimpedance Parameters before Treatment for BMI group 5.

Secondary Bioimpedance Parameters	Age Grp (p)	Disease (p)
Percentage of fat	0.0000	0.0000
Min fat	-	-
Max fat	-	-
Percentage of lean	0.0000	0.0000
Min lean	-	-
Max lean	-	-
Dry lean weight	0.0000	0.0000
Percentage of water	0.0000	0.0000
Min water	-	-
Max water	-	-
Density	0.0000	0.0000
Nutrition	0.0011	0.0011
Normal nutrition	1.0000	1.0000
Third space value	0.0000	0.0000

* Gender does not have enough parameter for analysis.

Table 4.149 Interactions of Secondary Bioimpedance Parameters after Treatment for BMI group 5.

Secondary Bioimpedance Parameters	Age Grp (p)	Disease (p)
Percentage of fat	0.0000	0.0000
Min fat	-	-
Max fat	-	-
Percentage of lean	0.0000	0.0000
Min lean	-	-
Max lean	-	-
Dry lean weight	0.0000	0.0000
Percentage of water	0.0000	0.0000
Min water	-	-
Max water	-	-
Density	0.0000	0.0000
Nutrition	1.0000	1.0000
Normal nutrition	1.0000	1.0000
Third space value	0.0000	0.0000

* Gender does not have enough parameter for analysis.

Appendix F:

Table 4.154 Interaction of Main Bioimpedance Parameters before Treatment for diseases group 2.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp(p)
Impedance value at 5KHz	0.000	0.001	0.190
Impedance value at 50KHz	0.001	0.005	0.065
Impedance value at 100KHz	0.001	0.005	0.078
Impedance value at 200KHz	0.002	0.008	0.063
Reactance at 50KHz	0.010	0.000	0.000
Resistance at 50KHz	0.001	0.005	0.065
Phase Angle at 50 KHz	0.031	0.260	0.002
Basal metabolic rate	0.000	0.000	0.219
Intracellular water	0.000	0.000	0.359
Normal intracellular water	0.002	0.061	0.108
Extra-cellular water	0.000	0.000	0.457
Normal extra cellular water	0.000	0.006	0.913
Total body water volume	0.000	0.000	0.121
Min total body water volume	0.029	0.001	0.355
Max total body water volume	0.001	0.060	0.037
Body cell mass	0.000	0.000	0.366

Table 4.155 Interaction of Main Bioimpedance Parameters after Treatment for Diseases group 2.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp(p)
Impedance value at 5KHz	0.000	0.000	0.527
Impedance value at 50KHz	0.000	0.000	0.439
Impedance value at 100KHz	0.000	0.001	0.424
Impedance value at 200KHz	0.000	0.001	0.416
Reactance at 50KHz	0.002	0.000	0.000
Resistance at 50KHz	0.000	0.001	0.437
Phase Angle at 50 KHz	0.001	0.125	0.006
Basal metabolic rate	0.000	0.000	0.365
Intracellular water	0.000	0.000	0.498
Normal intracellular water	0.002	0.061	0.108
Extra-cellular water	0.000	0.000	0.621
Normal extra cellular water	0.000	0.006	0.913
Total body water volume	0.000	0.000	0.202
Min total body water volume	0.029	0.001	0.355
Max total body water volume	0.001	0.060	0.037
Body cell mass	0.000	0.000	0.500

Table 4.156 Interactions of Secondary Bioimpedance Parameters before Treatment for Diseases group 2.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp (p)
Percentage of fat	0.071	0.000	0.000
Min fat	0.000	0.018	0.000
Max fat	0.000	0.051	0.000
Percentage of lean	0.071	0.000	0.000
Min lean	0.000	0.000	0.238
Max lean	0.000	0.000	0.169
Dry lean weight	0.000	0.000	0.146
Percentage of water	0.508	0.000	0.000
Min water	0.029	0.001	0.355
Max water	0.001	0.060	0.037
Density	0.041	0.000	0.000
Nutrition	0.189	0.083	0.455
Normal nutrition	-	0.000	0.001
Third space value	0.259	0.000	0.000

Table 4.157 Interactions of Secondary Bioimpedance Parameters after Treatment for diseases group 2.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp (p)
Percentage of fat	0.419	0.000	0.000
Min fat	0.002	0.072	0.000
Max fat	0.00	0.066	0.000
Percentage of lean	0.419	0.000	0.000
Min lean	0.000	0.000	0.340
Max lean	0.000	0.000	0.229
Dry lean weight	0.000	0.000	0.172
Percentage of water	0.988	0.000	0.000
Min water	0.029	0.001	0.355
Max water	0.001	0.060	0.037
Density	0.220	0.000	0.000
Nutrition	0.281	0.041	0.394
Normal nutrition	-	0.000	0.001
Third space value	0.194	0.000	0.000

Table 4.158 Interaction of Main Bioimpedance Parameters before Treatment for diseases group 3.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp(p)
Impedance value at 5KHz	0.003	0.005	0.000
Impedance value at 50KHz	0.003	0.008	0.000
Impedance value at 100KHz	0.002	0.011	0.000
Impedance value at 200KHz	0.002	0.014	0.000
Reactance at 50KHz	0.017	0.000	0.000
Resistance at 50KHz	0.003	0.009	0.000
Phase Angle at 50 KHz	0.002	0.410	0.000
Basal metabolic rate	0.005	0.000	0.000
Intracellular water	0.004	0.000	0.000
Normal intracellular water	0.009	0.000	0.000
Extra-cellular water	0.008	0.000	0.000
Normal extra cellular water	0.009	0.000	0.000
Total body water volume	0.005	0.000	0.000
Min total body water volume	0.012	0.000	0.000
Max total body water volume	0.009	0.000	0.000
Body cell mass	0.004	0.000	0.000

Table 4.159 Interaction of Main Bioimpedance Parameters after Treatment for diseases group 3.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp(p)
Impedance value at 5KHz	0.002	0.005	0.000
Impedance value at 50KHz	0.002	0.008	0.000
Impedance value at 100KHz	0.002	0.010	0.000
Impedance value at 200KHz	0.002	0.011	0.000
Reactance at 50KHz	0.005	0.000	0.000
Resistance at 50KHz	0.002	0.009	0.000
Phase Angle at 50 KHz	0.011	0.063	0.002
Basal metabolic rate	0.009	0.000	0.000
Intracellular water	0.006	0.000	0.000
Normal intracellular water	0.009	0.000	0.000
Extra-cellular water	0.008	0.000	0.000
Normal extra cellular water	0.009	0.000	0.000
Total body water volume	0.005	0.000	0.000
Min total body water volume	0.012	0.000	0.000
Max total body water volume	0.009	0.000	0.000
Body cell mass	0.006	0.000	0.000

Table 4.160 Interactions of Secondary Bioimpedance Parameters before Treatment for Diseases group 3.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp (p)
Percentage of fat	0.001	0.001	0.000
Min fat	0.000	0.000	0.000
Max fat	0.016	0.000	0.000
Percentage of lean	0.001	0.001	0.000
Min lean	0.007	0.000	0.000
Max lean	0.005	0.000	-
Dry lean weight	0.009	0.000	0.000
Percentage of water	0.002	0.000	0.000
Min water	0.012	0.000	0.000
Max water	0.009	0.000	0.000
Density	0.001	0.000	0.000
Nutrition	0.004	0.007	0.000
Normal nutrition	-	0.000	0.000
Third space value	0.008	0.000	0.000

Table 4.161 Interactions of Secondary Bioimpedance Parameters after Treatment for diseases group 3.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp (p)
Percentage of fat	0.001	0.001	0.000
Min fat	0.001	0.002	0.000
Max fat	0.003	0.000	0.000
Percentage of lean	0.001	0.001	0.000
Min lean	0.009	0.000	0.000
Max lean	0.010	0.000	0.000
Dry lean weight	0.013	0.000	0.000
Percentage of water	0.001	0.000	0.000
Min water	0.012	0.000	0.000
Max water	0.009	0.000	0.000
Density	0.001	0.002	0.000
Nutrition	0.002	0.004	0.000
Normal nutrition	-	0.000	0.000
Third space value	0.006	0.000	0.000

Table 4.162 Interaction of Main Bioimpedance Parameters before Treatment for diseases group 4.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp(p)
Impedance value at 5KHz	0.000	0.000	0.001
Impedance value at 50KHz	0.000	0.000	0.001
Impedance value at 100KHz	0.000	0.000	0.003
Impedance value at 200KHz	0.000	0.000	0.005
Reactance at 50KHz	0.016	0.000	0.000
Resistance at 50KHz	0.000	0.000	0.001
Phase Angle at 50 KHz	0.013	0.000	0.002
Basal metabolic rate	0.643	0.001	0.000
Intracellular water	0.260	0.000	0.000
Normal intracellular water	0.346	0.000	0.000
Extra-cellular water	0.205	0.000	0.000
Normal extra cellular water	0.927	0.000	0.000
Total body water volume	0.795	0.000	0.000
Min total body water volume	0.234	0.000	0.000
Max total body water volume	0.245	0.000	0.000
Body cell mass	0.276	0.000	0.000

Table 4.163 Interaction of Main Bioimpedance Parameters after Treatment for Diseases group 4.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp(p)
Impedance value at 5KHz	0.000	0.000	0.000
Impedance value at 50KHz	0.001	0.000	0.000
Impedance value at 100KHz	0.001	0.000	0.000
Impedance value at 200KHz	0.001	0.000	0.000
Reactance at 50KHz	0.012	0.000	0.001
Resistance at 50KHz	0.001	0.000	0.000
Phase Angle at 50 KHz	0.001	0.000	0.004
Basal metabolic rate	0.809	0.000	0.000
Intracellular water	0.156	0.000	0.000
Normal intracellular water	0.346	0.000	0.000
Extra-cellular water	0.073	0.000	0.000
Normal extra cellular water	0.927	0.000	0.000
Total body water volume	0.505	0.000	0.000
Min total body water volume	0.234	0.000	0.000
Max total body water volume	0.245	0.000	0.000
Body cell mass	0.150	0.000	0.000

Table 4.164 Interactions of Secondary Bioimpedance Parameters before Treatment for Female Diseases group 4.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp (p)
Percentage of fat	0.037	0.000	0.000
Min fat	0.032	0.000	0.000
Max fat	0.016	0.000	0.001
Percentage of lean	0.037	0.000	0.000
Min lean	0.608	0.000	0.000
Max lean	0.472	0.000	0.000
Dry lean weight	0.901	0.000	0.000
Percentage of water	0.016	0.000	0.000
Min water	0.234	0.000	0.000
Max water	0.245	0.000	0.000
Density	0.315	0.000	0.000
Nutrition	0.000	0.000	0.069
Normal nutrition	-	0.000	0.007
Third space value	0.000	0.000	0.000

Table 4.165 Interactions of Secondary Bioimpedance Parameters after Treatment for diseases group 4.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp (p)
Percentage of fat	0.109	0.000	0.000
Min fat	0.048	0.000	0.000
Max fat	0.024	0.000	0.000
Percentage of lean	0.109	0.000	0.000
Min lean	0.514	0.000	0.000
Max lean	0.237	0.000	0.000
Dry lean weight	0.654	0.000	0.000
Percentage of water	0.035	0.000	0.000
Min water	0.234	0.000	0.000
Max water	0.245	0.000	0.000
Density	0.441	0.000	0.000
Nutrition	0.000	0.000	0.057
Normal nutrition	-	0.000	0.007
Third space value	0.000	0.000	0.000

Table 4.166 Interaction of Main Bioimpedance Parameters before Treatment for diseases group 5

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp(p)
Impedance value at 5KHz	0.012	0.000	0.000
Impedance value at 50KHz	0.000	0.000	0.000
Impedance value at 100KHz	0.000	0.000	0.000
Impedance value at 200KHz	0.000	0.000	0.000
Reactance at 50KHz	0.000	0.000	0.000
Resistance at 50KHz	0.000	0.000	0.000
Phase Angle at 50 KHz	0.000	0.000	0.000
Basal metabolic rate	0.000	0.000	0.000
Intracellular water	0.001	0.000	0.000
Normal intracellular water	0.000	0.003	0.000
Extra-cellular water	0.000	0.000	0.000
Normal extra cellular water	0.000	0.000	0.000
Total body water volume	0.000	0.000	0.000
Min total body water volume	0.000	0.007	-
Max total body water volume	0.000	0.012	-
Body cell mass	0.001	0.000	0.000

Table 4.167 Interaction of Main Bioimpedance Parameters after Treatment for Male diseases group 5.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp(p)
Impedance value at 5KHz	0.235	0.000	0.000
Impedance value at 50KHz	0.013	0.000	0.000
Impedance value at 100KHz	0.020	0.000	0.000
Impedance value at 200KHz	0.021	0.000	0.000
Reactance at 50KHz	0.000	0.000	0.000
Resistance at 50KHz	0.013	0.000	0.000
Phase Angle at 50 KHz	0.000	0.000	0.000
Basal metabolic rate	0.000	0.000	0.000
Intracellular water	0.001	0.000	0.000
Normal intracellular water	0.000	0.003	0.000
Extra-cellular water	0.000	0.000	0.000
Normal extra cellular water	0.000	0.000	0.000
Total body water volume	0.000	0.000	0.000
Min total body water volume	0.000	0.007	-
Max total body water volume	0.000	0.012	-
Body cell mass	0.001	0.000	0.000

Table 4.168 Interactions of Secondary Bioimpedance Parameters before Treatment for Diseases group 5.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp (p)
Percentage of fat	0.000	0.001	0.000
Min fat	0.000	0.000	-
Max fat	0.000	0.006	-
Percentage of lean	0.000	0.001	0.000
Min lean	0.001	0.000	-
Max lean	0.001	0.000	-
Dry lean weight	0.000	0.000	0.000
Percentage of water	0.000	0.169	0.000
Min water	0.000	0.007	-
Max water	0.000	0.012	-
Density	0.295	0.000	0.000
Nutrition	0.000	0.000	0.000
Normal nutrition	-	0.000	0.000
Third space value	0.090	0.058	0.000

Table 4.169 Interactions of Secondary Bioimpedance Parameters after Treatment for diseases group 5.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp (p)
Percentage of fat	0.000	0.001	0.000
Min fat	0.000	0.000	-
Max fat	0.000	0.019	-
Percentage of lean	0.000	0.001	0.000
Min lean	0.003	0.000	0.000
Max lean	0.001	0.000	0.000
Dry lean weight	0.000	0.000	0.000
Percentage of water	0.000	0.149	0.000
Min water	0.000	0.007	-
Max water	0.000	0.012	-
Density	0.295	0.000	0.000
Nutrition	0.000	0.000	0.000
Normal nutrition	-	0.000	0.000
Third space value	0.011	0.043	0.000

Table 4.170 Interaction of Main Bioimpedance Parameters before Treatment for diseases group 6.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp(p)
Impedance value at 5KHz	0.007	0.120	0.026
Impedance value at 50KHz	0.006	0.083	0.119
Impedance value at 100KHz	0.009	0.053	0.173
Impedance value at 200KHz	0.011	0.034	0.204
Reactance at 50KHz	0.009	0.000	0.000
Resistance at 50KHz	0.007	0.077	0.132
Phase Angle at 50 KHz	0.001	0.000	0.224
Basal metabolic rate	0.000	0.006	0.346
Intracellular water	0.034	0.077	0.054
Normal intracellular water	0.060	0.278	0.000
Extra-cellular water	0.034	0.430	0.005
Normal extra cellular water	0.060	0.063	0.000
Total body water volume	0.013	0.063	0.205
Min total body water volume	0.058	0.404	0.000
Max total body water volume	0.065	0.419	0.000
Body cell mass	0.032	0.077	0.052

Table 4.171 Interaction of Main Bioimpedance Parameters after Treatment for Diseases group 6.

Main Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp(p)
Impedance value at 5KHz	0.015	0.039	0.014
Impedance value at 50KHz	0.012	0.031	0.080
Impedance value at 100KHz	0.012	0.022	0.117
Impedance value at 200KHz	0.011	0.015	0.142
Reactance at 50KHz	0.000	0.030	0.000
Resistance at 50KHz	0.011	0.030	0.086
Phase Angle at 50 KHz	0.000	0.001	0.039
Basal metabolic rate	0.000	0.003	0.449
Intracellular water	0.036	0.082	0.070
Normal intracellular water	0.060	0.278	0.000
Extra-cellular water	0.022	0.414	0.009
Normal extra cellular water	0.060	0.063	0.000
Total body water volume	0.010	0.058	0.290
Min total body water volume	0.058	0.404	0.000
Max total body water volume	0.065	0.419	0.000
Body cell mass	0.034	0.084	0.069

Table 4.172 Interactions of Secondary Bioimpedance Parameters before Treatment for Diseases group 6.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp (p)
Percentage of fat	0.000	0.000	0.000
Min fat	0.021	0.011	0.000
Max fat	0.019	0.033	0.000
Percentage of lean	0.000	0.000	0.000
Min lean	0.003	0.008	0.302
Max lean	0.004	0.040	0.137
Dry lean weight	0.001	0.005	0.160
Percentage of water	0.002	0.006	0.000
Min water	0.058	0.404	0.000
Max water	0.065	0.419	0.000
Density	0.000	0.000	0.000
Nutrition	0.003	0.019	0.108
Normal nutrition	-	0.000	0.018
Third space value	0.005	0.065	0.000

Table 4.173 Interactions of Secondary Bioimpedance Parameters after Treatment for Female diseases group 6.

Secondary Bioimpedance Parameters	Gender (p)	Age Grp (p)	BMI Grp (p)
Percentage of fat	0.000	0.000	0.000
Min fat	0.021	0.011	0.000
Max fat	0.011	0.014	0.000
Percentage of lean	0.000	0.000	0.000
Min lean	0.003	0.010	0.287
Max lean	0.002	0.025	0.190
Dry lean weight	0.001	0.004	0.203
Percentage of water	0.003	0.004	0.000
Min water	0.058	0.404	0.000
Max water	0.065	0.419	0.000
Density	0.000	0.000	0.000
Nutrition	0.266	0.004	0.063
Normal nutrition	-	0.000	0.018
Third space value	0.020	0.020	0.000