Original Research

Bioimpedance Analysis on The Effects of Ramadan Fasting

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ABSTRACT

Analysis and assessments of body composition are very important for evaluating the efficacy of any dietary interventions and tracking changes related to health and illness. The purpose of this study is to investigate the effect of Ramadan fasting on body composition of the human body. Bioelectrical Impedance Analysis using bioimpedance analyzer device is used throughout this study for the analysis and assessments of body composition. The main objectives of this study to determine Body composition including BMI (Body Mass Index), FFM (Fat Free Mass), FM (Fat Mass) and TBW (Total Body Water), from the raw BIA measurements and to compare body composition values before and after undergoing Ramadan fasting. The study was conducted on total of thirty (15 men and 15 women) Healthy students from Universiti Teknologi Malaysia between the age of 18 and 27 undergoing Ramadan fasting for 30 days from April 12 until May 12, 2022 in Johor, Malaysia. Bioimpedance analysis was taken before and after the month of Ramadan. A statistical analysis of T-test for dependent samples was performed using Excel to compare body composition before and after fasting period. The results of Body mass index and weight lost during the fasting period were found to be significantly different. Between pre- and post-Ramadan, there was also a significant decrease in fat mass and a slight increase in lean body mass. Furthermore, the findings revealed that it had no adverse effects on total body water.

INTRODUCTION

Body composition analysis is utilized in a variety of settings, including prevention, therapy, and research applications including Bioelectrical impedance analysis (BIA), which is a non-invasive clinical approach for determining body composition that examines the electrical properties of the human body by measuring the resistance of the flow of electric current through bodily fluids. bioimpedance is used for a variety of purposes in health systems, including clinical diagnosis and body vital status monitoring (Khalil et al., 2014). When biological tissues are simulated using an external electrical current source, a passive reaction happens (Kyle et al., 2004). The capacity of biological tissue to obstruct electric current is known as bioimpedance or biological impedance.

Bioelectrical impedance analysis is one of the most effective methods for determining body composition. It provides the speed and strength of the electrical signal sent through the body. This approach employs several data such as age, height, gender, and weight to predict basic body composition measurements such as the amount of fat, total body water, bone mineral mass, and muscle mass the body contains (Kuriyan, 2018). In addition, metabolic parameters such as physique rating (body type), basal metabolic rate, and metabolic age are calculated using Bioelectrical impedance analyzer. It is very crucial to understand body fat to maintain a physically healthy physique with muscle weighs more than fat (Marthoenis et al., 2022). The data of bioelectrical impedance analysis are instantly available and repeatable with a 1% error rate on multiple testing. This approach was first commercially accessible in the mid-1980s (Buchholz et al., 2004), with a low-cost, portable device, making it a suitable option for determining body composition in epidemiological research.

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Although the effects of Ramadan fasting on weight are now well-known, their effects on body composition (i.e., fat mass and fat-free mass) are still uncertain. Fasting during Ramadan may have an effect on body composition since it has been shown to affect physical performance and activity. Heart rate and ventilatory responses to moderate-intensity aerobic exercise were significantly lower in inactive individuals after Ramadan fasting than before, indicating a deterioration in performance. The impacts of the daily fast are greatly influenced by environmental conditions, which are more severe in the summer than at other times of the year. This lunar month may occur in any season of the year. Daily habits are significantly altered during Ramadan. These modifications have an impact on eating habits, food intake quantity and timing. For example, even though Ramadan is a month of fasting, most cultures regularly consume high-calorie, high-fat, and carbohydrate-rich meals throughout the nighttime (Tootee and Larijan, 2021). In addition, fluid intake, sleeping patterns, physical activity length and intensity, leisure activity duration and intensity, and ritual commitment type are all factors that can be altered during Ramadan (Doutreleau et al., 2017).

Both the energy balance and the makeup of the diet are significantly altered by Ramadan fasting (Alkandari et al., 2012). This study is important in examining the possible benefits of following Ramadan fasting in terms of improving body composition and testing whether it holds differential effects on body composition. Hence, there are several objectives to be achieved throughout this study which are to determine Body composition including TBW (Total Body Water), FFM (Fat Free Mass), FM (Fat Mass) and BMI (Body Mass Index) from the raw BIA measurements and to compare the observed values with that of standard for Ramadan fasting group compared with control group.

MATERIALS AND METHOD

The study plan is divided into three phases:

Phase 1 which consist of the preparation of subjects, and testing of the device for more accurate measurements.
Phase 2 includes raw data collection of body composition for both groups using BIA450 analyzer.
Phase 3 involves the performance of statistical analysis and comparisons of measurements for both groups and finally drawing conclusions based on the analysis and documentation.

Subjects

A total of thirty (15 men and 15 women) Healthy (free of chronic disease) students from Universiti Teknologi Malaysia between the age of 18 and 27 for men and between 19 and 25 for women, undergoing Ramadan fasting for 30 days from April 12 until May 12, 2022 in Johor, Malaysia where's fasting period was 10 hours a day from sunrise until sunset. The initial measurements were collected 3 to 4 days before the beginning of Ramadan, and the second measurements were taken 3 to 4 days following the completion of Ramadan. Anthropometric measurements (weight & height) were taken before using the analyzer. Exclusion and Inclusion criteria include drugs/medications consumption, any kind of physical activity directives, diet plan, and skipping fasting for more than 2 days for male participants, and more than 7 days for female participants.

Anthropometric & BIA measurements

After a minimum of four hours of fasting beginning at sunrise, the test was performed while the subjects were in a standing position. The arms were held 6 inches away from the torso and the patient's legs were stretched shoulder-width apart. two pairs of sensor electrodes (ECG pads) are positioned on the right wrist and hand, as well as the right ankle and foot, the subject's gender, age, height, and weight are input using the analyzer's keypad. The test is then performed, and a printout is produced. The duration of the test takes around three minutes.

Bioimpedance Analyzer BIA 450

Bioimpedance analyzer BIA450 is a non-invasive tool that allows health care providers to objectively assess body composition using electrical tissue conductivity, these metrics help the practitioner build and prioritise nutrition and supplement plans and methods, increasing the probability of an accurate evaluation. BIA 450 measures the impedance of the human body directly. Estimate mass distribution and body water compartments by comparing body measurements (age, gender, weight, height, resistance, and reactance).

Statistical Analysis

The paired sample t-test, also known as the dependent sample t-test, is a statistical procedure for determining whether the mean difference between two groups of observations is zero. Each subject is measured twice in a paired sample t-test, resulting in pairs of observations. Case-control studies and repeated-measures designs are two common applications of the paired sample t-test. T-test for paired samples is used when each subject has a pair of measurements, such as a before and after score, for example, assessing the effectiveness of a company training program, performance of a sample of employees before and after they complete the program must be considered, and next is analyzing the differences with a paired sample t-test. Because it is based on the normal distribution, the paired sample t-test requires numeric and continuous sample data. Continuous data can have any value within a given range (income, height, weight, etc.). Continuous data is the inverse of discrete data, which can only take on a few values (Low, Medium, High, etc.).

The p-value is used to determine statistical significance. It gives the probability of observing the test results under the null hypothesis, which is defined as the probability that the results from sample data occurred by chance. The lower the p-value, the less likely it is that a result similar to the one observed would be obtained if the null hypothesis was true. As a result, a low p-value indicates less support for the null hypothesis. However, the likelihood that the null hypothesis is correct and that we simply acquired a very rare result cannot be completely ruled out. The cutoff value for determining statistical significance is ultimately determined by the researcher, but.05 or less is usually chosen. This corresponds to a 5% (or less) chance of obtaining the same result as observed if the null hypothesis was true (Lewinger & Bull, 2005).

RESULT AND DISCUSSION

Ramadan Fasting Effects on Weight and Body Mass Index

The chart in Figure 1 shows the results of BMI for both men and women, both before and after Ramadan. Male participants' pre-
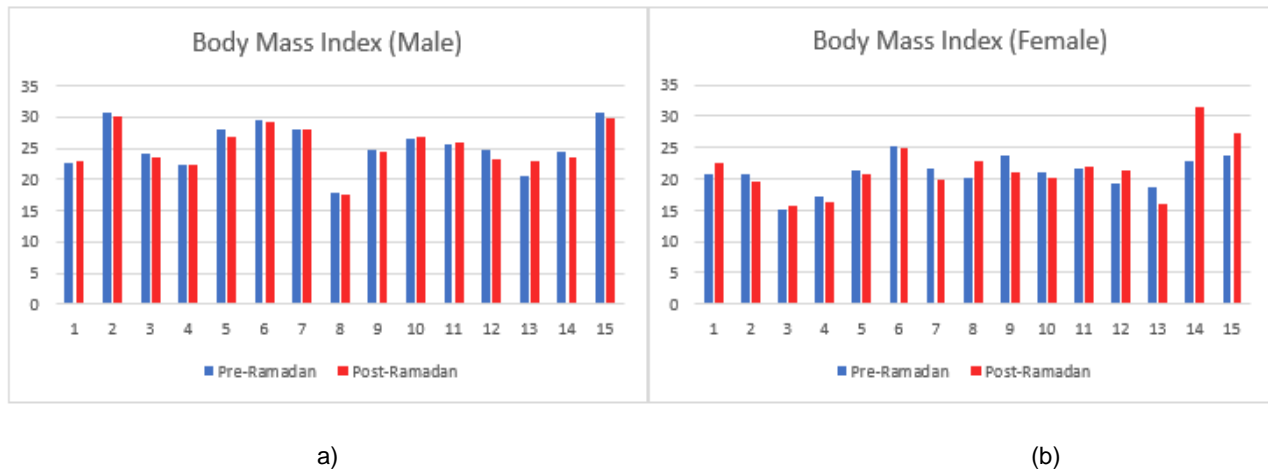
Fig 1 BMI Value of Pre-Ramadan and Post-Ramadan for (a) Male (b) Female

R and post-R BMI average value were 25.35 and 25.13, respectively. Female participants' pre-R and post-R BMI average value were 21.65 and 20.71, respectively. Both genders' data collection rates are greater within the pre-R group. Great reduction in weight appear more in female participants than male.

Ramadan Fasting Effects on Lean Body Mass and Fat Mass

The average LBM value for pre-R and post-R for male participants are 60.58 and 61.88 respectively. The average LBM value for pre-R and post-R for female participants are 39.51 and 40.62 respectively. Figure 2 illustrates the distribution of lean body mass. The results from T-test analysis for paired samples (95% CI) showed that male participants from the pre-Ramadan (M = 60.58, SD = 7.93) and post-Ramadan (M = 61.88, SD = 8.58) indicate that the fasting had a significant effect on muscles resulted in an increment of lean body mass, $t(14) = -2.19$, $p = .046$. On the other hand, female participants with T-test for pre-Ramadan (M = 39.51, SD = 4.42) and post-Ramadan (M = 40.62, SD = 7.21) indicate that the fasting had no adverse effect on lean body mass, $t(14) = -1.2$, $p = .25$

The average FM value for pre-R and post-R for male participant are 11.53 and 10.15 respectively whereas the average FM value for pre-R and post-R for female participant are 12.63 and 11.43 respectively. Figure 3 illustrates the distribution of lean body mass. The results from T-test analysis for paired samples (95% CI) showed that male participants from the pre-Ramadan (M = 11.53, SD = 4.27) and post-Ramadan (M = 10.15, SD = 3.99) indicate that the fasting had an effect resulted in a significant decrement of lean body mass, $t(14) = 3.77$, $p = .002$. Additionally, t-test for female participants with T-test for pre-Ramadan (M = 12.63, SD = 2.34) and post-Ramadan (M = 11.43, SD = 2.98) indicate that Ramadan fasting had an effect on fat mass, $t(14) = 2.74$, $p = .015$.

The results of the statistical analysis showed that there was a great improvement in lean body mass in males, compared to a very small improvement for females. It is also shown that the reduction of fat mass in male participants are much more than female participants. This could be due to the fact that males are more physically active than females. The results shows that Ramadan fasting is directly linked to both LBM and FM (Akın et al., 2019)
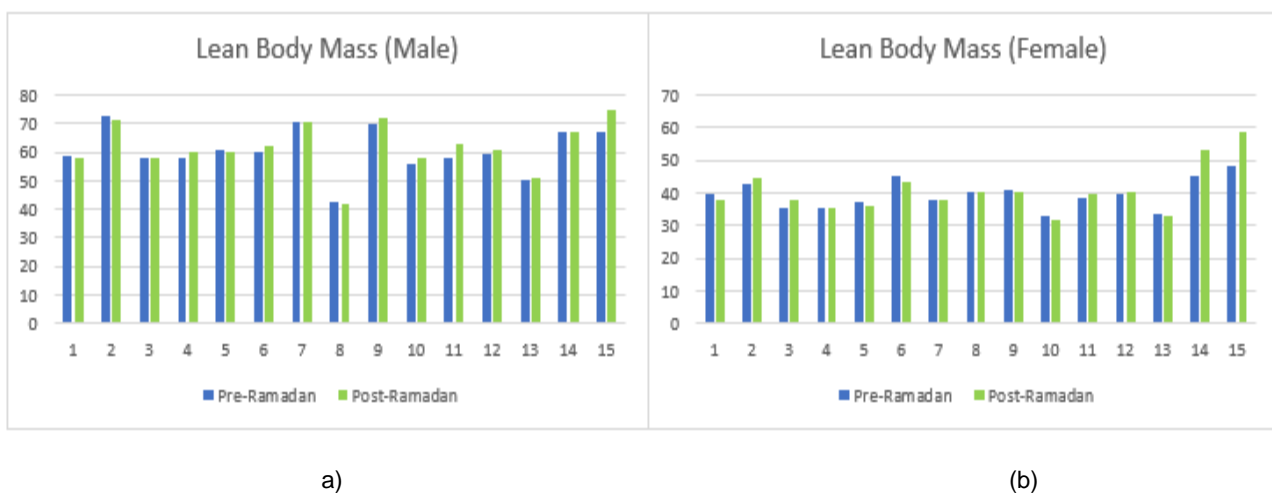
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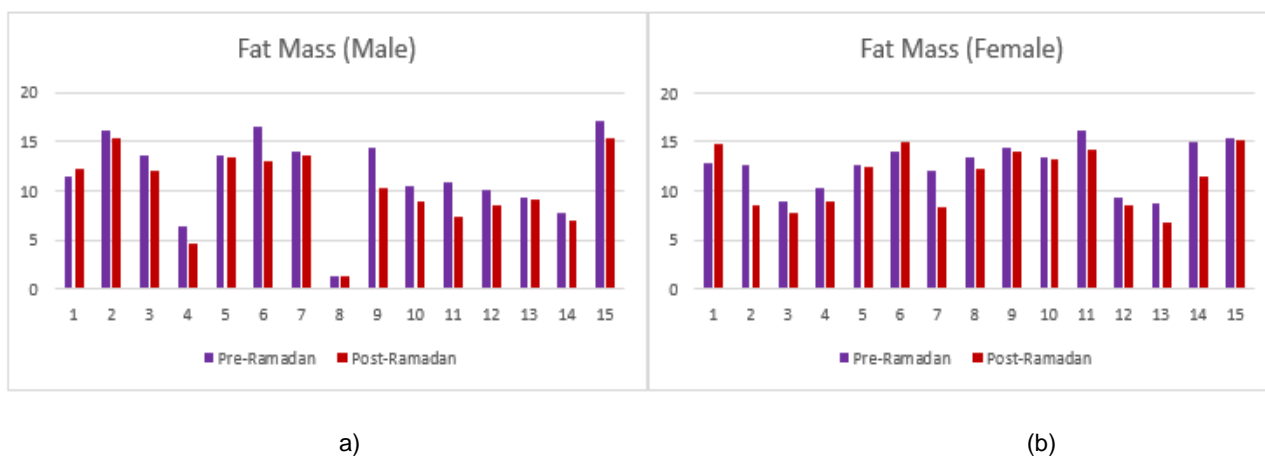**Fig 2** Lean Body Mass Value of Pre-Ramadan and Post-Ramadan for (a) Male (b) Female

Fig 3 Fat Mass Value of Pre-Ramadan and Post-Ramadan for (a) Male (b) Female
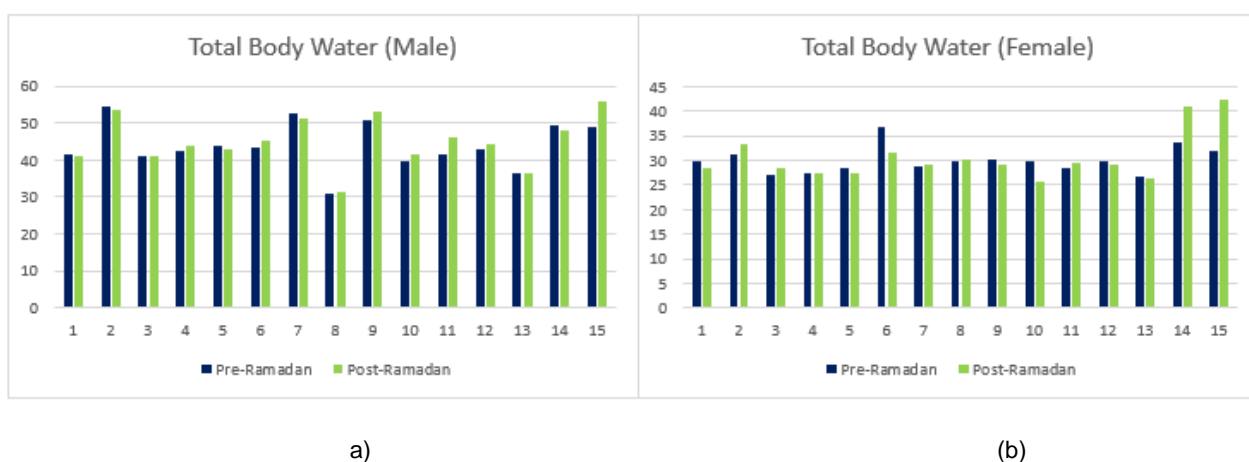

Fig 4 TBW Value of Pre-Ramadan and Post-Ramadan for (a) Male (b) Female

The construction of equations that convert the raw data into liters of body water or kilograms of fat-free mass (FFM) or fat mass is the result of the empiric nature of the relationship between resistance and reactance determined by BIA and body composition. If the populations differ greatly in key factors that affect body composition, such as age, obesity, and disease, these equations could be difficult to apply to different groups.

The physiological and physiochemical condition of biological tissues greatly influences their frequency response of electrical impedance, Even the complicated bioelectrical impedance in a specific body varies from tissue to tissue and changes when the subject's health condition changes. which differs from subject to subject even though these subjects might have similar body mass indexes.

Ramadan Fasting Effects on Total Body Water

The average TBW value for pre-R and post-R for male participant are 43.99 and 45.11 respectively while the average TBW value for pre-R and post-R for female participant are 30.02 and 30.57 respectively. Figure 4 illustrates TBW distribution. The results from T-test analysis for paired samples (95% CI) showed that male participants from the pre-Ramadan (M = 71.53, SD = 11.78) and post-Ramadan (M = 72.01, SD = 11.73) indicate that the fasting had no effect on total body water, $t(14)$ = -0.71, p = .49. Additionally, t-test for female participants with

T-test for pre-Ramadan (M = 48.56, SD = 13.24) and post-Ramadan (M = 53.57, SD = 10.92) indicate that Ramadan fasting had no adverse effect on total body water, $t(14)$ = -0.36, p = .72.

The results of the statistical analysis showed no significance difference in total body water for pre-Ramadan and post-Ramadan state. During the daylight hours of Ramadan fasting, practicing Muslims are undoubtedly dehydrating, but it is not clear whether they are chronically hypo hydrated during the month of Ramadan. No detrimental effects on health have as yet been directly linked to water balance at the levels produced during Ramadan (Leiper et al., 2003).

CONCLUSION

There are thousands of millions of Muslims who practice fasting the month of Ramadan, which includes refraining from food and drink from dawn to dusk. Given that Ramadan fasting has been found to have an impact on physical activity and performance, it is possible that it will change body composition. This study concludes that as a result of Ramadan fasting, body mass index, fat mass decreased while lean body mass increased, and total body water had no significant changes.

Body composition, bioelectrical impedance analysis (BIA) is widely used as a noninvasive way of producing information through portable, simple-to-use, and reasonably priced

equipment that predicts the distribution of body fluids in the intra- and intercellular spaces in addition to the body components. This method uses cables attached to electrodes or conducting surfaces positioned in contact with the skin to apply a painless, low-amplitude electrical current that allows the estimation of total body water, fat mass, and fat-free mass.

Differentiating between healthy and unhealthy diets, particularly when it comes to fat, is crucial to understand a person's health. The distinctions between being thin, lean, overweight, and obese are crucial for both individuals and health professionals to understand. With a better understanding of body composition, people will be able to create a thorough health assessment, track changes in body fat and Muscle mass, and define appropriate changes in diet, exercise, and lifestyle. This will enable people to take better control of their health. Understanding body composition enables to create practical strategies for the future that will help to achieve fitness and health objectives.

ACKNOWLEDGEMENT

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