A Correlational Study on Resting Metabolic Rate

This project makes no effort to suggest generalizability. Instead, it was designed to demonstrate competency using lab equipment, capacity to integrate knowledge with application, and understanding of the scientific method.

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Introduction

According to De Lorenzo et al. (2001), the resting metabolic rate (RMR) is defined as the energy expenditure 10±12 hours after a meal, the subject lying supine and completely at physical and mental rest in a thermoneutral environment. It can be measured by direct (heat exchange) or indirect calorimetric (gas exchange) techniques and is fairly accurate with a subject coefficient variation of about 5%. Additionally, the best time to test RMR is in the morning when the person has just woken up because the person has not participated in physical activity or consumed any calories yet, which can greatly affect the RMR results (Heyward & Gibson, 2014).

It is important to know the minimal number of calories an individual must consume each day to sustain essential body functions such as breathing, blood circulation, and core temperature regulation. A MET is the metabolic equivalent of oxygen consumed while doing a task and is used to represent the intensity of an exercise by comparing the resting metabolic rate with the working metabolic rate (Heyward & Gibson, 2014). BMI is calculated from body mass and stature to assess an individual's body fat. To be classified as overweight, an individual would have a calculated BMI of 25 or higher. A BMI higher than 30 is classified as obese. Being in the moderate to severely overweight category indicates individuals are at an increased risk for cardiovascular complications such as hypertension, cancer, diabetes, Alzheimer's disease, gallstones, sleep apnea, osteoarthritis, rheumatoid arthritis, and renal disease (McArdle, Katch & Katch, 2015). Fat-free mass (FFM) is all the lipid-free chemicals and tissues in the body, which includes water, muscle, bone, connective tissue, and internal organs. It can be measured using a bioelectrical impedance analysis (BIA), which uses the body's water content to conduct electrical charges from one point to another. The current passes quicker through hydrated fat-free body tissue and extracellular water than through fat or bone tissues because of lower electrical resistance.

In this experiment, four young adults with various anthropometric measurements completed RMR tests. The purpose of this experiment is to find to what extent RMR increases in relation to FFM, BMI, height and weight. It is hypothesized that a higher RMR is associated with a higher FFM, and RMR will not indicate a strong correlation with the other variables.

Methods

Four subjects were all healthy college-aged male and female individuals. Before the subjects arrived for testing, a researcher was present in the lab to turn on the Parvo Medics TrueOne 2400 Metabolic Measurement System cart at least 30 minutes prior to testing and calibration. The total time approximated 90 minutes for the experiment. Additionally, the researchers assembled and prepared the resting metabolic rate (RMR) equipment. The first two subjects, who hadn't exercised in the past 12 hours, arrived at 8am to perform the test. The second set of subjects arrived at 9 am. The height and weight were taken for each subject, along with body mass index (BMI) and fat-free mass (FFM) using the Omron Handheld Body Fat Analyzers BIA tool. The table and cart were moved in a way that minimized traffic and allowed the HR monitor to reach the subject. The HR monitor was placed below the sternum of each subject. Per Parvo Medics protocol, the dilution pump controller was turned on, and then the canopy was placed on the subject. The canopy was tucked under the subject and the test began after the CO2 stabilized to 1.1%. The researchers instructed each subject to lie on the table. The RMR test were started for each subject. The RMR test took approximately 30 minutes to complete. After the test was completed, the dilution pump controller was turned off and the canopy was removed from each subject. The other equipment was removed from the subjects and the metabolic cart data was gathered. The following variables were measured: FFM, BMI, height, weight, time, RMR, age, and physical activity level. Then, the equipment was cleaned to rid the products of germs and potential biohazards. The process was repeated for each additional subject.

Results

Table 1
Subject Demographic Information

		Subject 1	Subject 2	Subject 3	Subject 4
Weight (kg)		65.77	61.24	79.38	61.69
Height (cm)		165.10	160.02	198.12	162.56
BMI (kg/m^2)		23.5	24.1	21.1	23.9
FFM (kg)		48.1	47.64	69.89	46.73
METS	Mean	0.98	0.97	1.03	1.15
	Standard Deviation	0.04	0.05	0.05	0.05
	Range	0.91-1.04	0.88-1.08	0.90-1.12	1.06-1.26
RMR (Kcal/day)	Mean	1623	1469	2015	1708
	Standard Deviation	61	81	110	72
	Range	1494-1723	1341-1633	1730-2193	1577-1883

In *Table 1*, the demographic information for each subject's height, weight, BMI, FFM, METS, and RMR are displayed. Subject 3 exhibited the highest RMR, with an average of 2015.01 kcal/day. Additionally, Subject 3 had a fat free mass value of 69.89 kg. Subject 2 had the lowest RMR, with an average of 1469.48 kcal/day. Subject 2's FFM was 47.64 kg.

Table 2
Mean Variable Correlation with RMR

	RMR Correlation
Weight	0.91
Height	0.01
BMI	-0.92
FFM	0.89

The demographic variables: weight, height, BMI, and FFM were averaged from each subject's information. The average of each variable was correlated with RMR results (*Table 1*), The correlation between RMR and FFM, weight, and BMI were strong correlations of 0.89, 0.91, and -0.92, respectively. Whereas, the correlation of RMR and height is only 0.01.

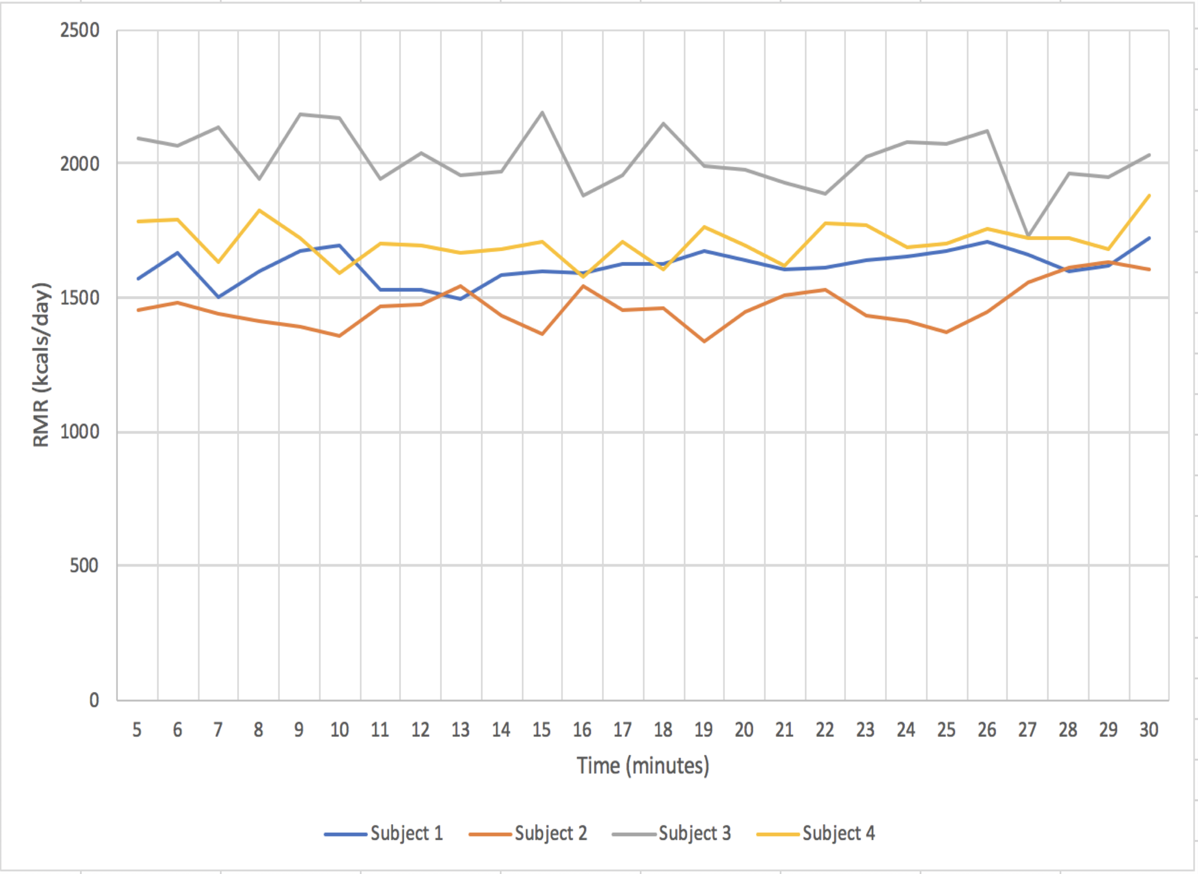

Figure 1: 30-Minute RMR Test Results for 4 Subjects

The RMR results for each subject during the 30 minute testing period is displayed in *Figure 1*. The first 5 minutes of the test are disregarded because the data collected during this time span does not reflect true resting values. In the figure, the stark difference in RMR in Subject 3 as compared to the other subjects is evident.

Discussion

According to Wardlaw & Insel (1996), resting metabolic rate (RMR) is the amount of energy used during rest without strict control of recent physical activity. According to the Dietary Reference Intakes (2005), the average RMR in women range from 1,200 to 1,600 kcals/day and the average RMR in men range from 1,600 - 2,000 kcals/day. Subjects 1 and 4 had a RMR above the average in women, whereas Subject 2 was within the average range. Subject 3 was the only male tested and was within normal range. RMR is positively affected by genetics, exercise, muscle mass, and hormones. RMR is negatively affected by age, reduction in energy intake and genetics (Wardlaw & Insel, 1996).

According to Mcmurray, R. G. et al. (2014), RMR is mostly dependent on the amount of metabolically active tissue in an individual; mainly muscle mass. When comparing the subjects in this study, Subject 3 had the largest amount of fat free body mass at 69.89 kg. Subject 3 also had the highest mean RMR of 2015.01 kcal/day. The correlation of FFM and RMR equaled 0.89, The strong positive correlation throughout the results is because approximately 60% to 70% of RMR is dependent on the amount of fat free body mass (Wardlaw, G. M., & Insel, P. M.,1996).The tissues involved such as the heart, liver and brain have a high metabolic activity at rest that greatly influences energy needs. It is noted that Subject 4 has the least amount of fat free mass, yet has a higher RMR than both Subjects 1 and 2. Although this finding contradicts the hypothesis which states that the higher the fat free mass, the higher the RMR, it was found that other variables will correlate with RMR. Weight shown a positive correlation of 0.91 with RMR. BMI presented a strong negative correlation of -0.92 with RMR. Height was the main variable that indicated no correlation with RMR.

According to Porcari, Bryant, & Comana (2015), normal BMI ranges from 19 - 24.9 kg/m^2. Using a bioelectrical impedance, all four subjects were found to have a BMI within the normal range. According to Porcari, Bryant & Comana (2015), BMI is not a measure of body composition but a calculated ratio of height and weight because it doesn't take into consideration the difference between overfat and athletic/more muscular body types.

Conclusion

The data does support a positive correlation between RMR and FFM with a correlation value of 0.89, so it may be deduced that a FFM is a determinant of RMR. According to Blundell, Caudwell, Gibbons, Hopkins, Naslund, King, and Finlayson (2012), FFM contributes 60% to 70% to RMR. The correlation between the two variables may be more apparent if more test subjects completed the study. BMI and weight also provide strong correlations to RMR. Height was found to be the only variable that provided a weak correlation to RMR. FFM, weight, and BMI exhibit the most significant relationship with RMR. In order to improve the experiment, a greater number of subjects could be used to provide more data points. It is important to have knowledge of how many kcals the body requires to adequately function. From the results of this lab, FFM, weight, and BMI may be used as reference points when calculating an individual's RMR because of the strong correlations.

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