Influence of Basal Metabolic Rate and Obesity on Lung Function Test

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ABSTRACT

Basal Metabolic Rate (BMR) is the rate of energy utilization in the body during absolute rest when the Person is awake. This study is aimed to ascertain the effect of BMR and obesity on lung function test among male and female medical students of 20-26 years of age. In Nnamdi Azikiwe University College of Health Science Nnewi. On average, 90 (50 male, 40 female) medical students took part in this study and their lung function was measured using a Spirometer. Whereas students BMR was calculated using two different predicted Basal metabolic rate equation Harris – Benedict equation (Harris and Benedict equation: BMR (kcal/day) for men \( P = (13.7516 \text{wt}/1 \text{kg} + 5.0033 \text{ht}/1 \text{cm} - 6.7550 \text{age}/1 \text{year} + 66.4730) \) and for women \( P = (9.5634 \text{wt}/1 \text{kg} + 1.8496 \text{ht}/1 \text{cm} - 4.6756 \text{age}/1 \text{year} + 655.0955) \) and also, Henry and Rees equation (Henry and Rees, 1991): BMR (kcal/day) for men (18–30 years old) = \((0.0560 \text{wt} + 2.800) \times 238.85\), and for women (18–38 years old) = \((0.0480 \text{wt} + 2.562) \times 238.85\). Where \( p \) = Total heat production at complete休息 weight in Kg. \( \text{ht} \) = height in cm. The values are constants (Roza AM, Shizgal HM (1984)). BMR is the amount of energy per unit time that a person needs to keep the body functioning at rest. Some of those processes are breathing, blood circulation, controlling body temperature, cell growth, brain and nerve function, and muscle contraindications. Lung functions was measured using the spirometer and the height and weight was measured using the stadiometer and weighing balance respectively.

From the result obtained when comparing among male and female subjects there is no significant value in male BMR, when comparing between obese and non-obese between male and female subjects weight, height and BMI has significant value. In conclusion this study showed that the relation between predicted basal metabolic rate and indicators of lung function tests was statistically insignificant.

1.1. BACKGROUND

Basal metabolic rate is the amount of energy per unit time that a person needs to keep the body functioning at rest. Some of those processes are breathing, blood circulation, controlling body temperature, cell growth, brain and nerve function, and muscle contraindications (McNab, 1997).

Basal metabolic rate (BMR) affects the rate that a person burns calories and ultimately whether that individual maintains, gains, or loses weight. The basal metabolic rate accounts for about 60 to 75% of the daily calorie expenditure by individuals. It is influenced by several factors. BMR typically declines by 1–2% per decade after age 20, mostly due to loss of fat-free mass, (Manini, 2010). Although the variability between individuals is high (McMurray et al., 2014). It is reported in energy units per unit time ranging from watt (joule/second) to ml O2/min or joule per hour per kg body mass J/(h·kg). Proper measurement requires a strict set of criteria be met. These criteria include being in a physically and psychologically undisturbed state, in a thermally neutral environment, while in the post-absorptive state (i.e., not actively digesting food) (McNab BK 1997).

BMR is measured under very restrictive circumstances when a person is awake. An accurate BMR measurement requires that the person's sympathetic nervous system not be stimulated, a condition which requires complete rest (Stiegl and Cunliffe, 2006).

BMR may be measured by gas analysis through either direct or indirect calorimetry, though a rough estimation can be acquired through an equation using age, sex, height, and weight. Studies of energy using both methods provide convincing evidence for the validity of the respiratory quotient (RQ), which measures the inherent composition and utilization of carbohydrates, fats and proteins as they are converted to energy substrate units that can be used by the body as energy.

Metabolism comprises the processes that the body needs to function (Ballesteros et al., 2018).

Lung function tests

Lung function tests (LFTs) are widely used to measure the performance of lungs during physiological and...
pathological conditions. LFTs determine lungs capability of holding air, amount of air moving in and out and how well lungs take in oxygen and remove carbon dioxide from blood. These tests also measure pathology in lungs if any present and hence used as diagnostic tests for lung diseases. There are a number of diagnostic tests such as Residual volume, Inhalation challenge tests, Body plethysmography, Gas diffusion tests, and exercise stress tests, which help in defining status of lung functions. But spirometry being the most commonly performed lung function test, is considered as first choice in diagnosis of lung pathology. Spirometry is a technique used to measure amount and flow of air inhaled and exhaled and the lung function. It measures amount of air that can be moved in and out of one’s lungs (McNab BK 1997).

Most measured entity of lung function is Vital Capacity; Change in volume of lung after taking maximal inhalation followed by maximal exhalation is called Vital Capacity of lungs. It is the sum of tidal volume, inspiratory reserve volume and expiratory reserve volume. Vital capacity of normal adults ranges between 3 to 5 litres. A number of physiological factors like age, gender, height and ethnicity show variations in pulmonary functions.

1.2. STATEMENT OF PROBLEM

Obesity is a leading cause of mortality. Its prevalence has been on the increase worldwide. Because of the direct influence on metabolic rate, measurement of how obese subjects expend energy is important for estimation of their energy need and weight control interventions.

1.3. AIM OF STUDY

The aim of this study is to investigate the effect of obesity on lung function test and also to investigate the effect of BMR on lung function test.

1.4. OBJECTIVES OF STUDY

The objectives of this study include:
- To determine the FEV1, FVC, VC and TV of obese and non-obese subjects.
- To estimate BMR between obese and non-obese female subjects.
- To estimate BMR between obese and non-obese male subjects.

1.5. SIGNIFICANCE OF STUDY

There will better understanding of physiological lung function test on obese patients and the possibility of using BMR to maintain body weight.

2.1. OVERVIEW OF BASAL METABOLIC RATE

Basal metabolic rate (BMR) or basal energy expenditure (BEE) represents the amount of energy utilized by a body in physical and psychological resting state, after a night sleep, awake, without any previous physical activity, in postabsorptive state (more than 10 hours after last meal) and neutral environment. Resting energy expenditure (REE) is defined as basal metabolic rate, in which one of the conditions excepting the resting state is not fulfilled: less than 10 hours after meal intake, after a low intensity physical activity; other small modification from basal conditions. It is very similar with resting metabolic rate (RMR) which necessitate only 2–4 hours of fasting and is 10% higher than BMR. BMR is not the lowest level of energy required for maintaining life. Lower levels of energy could be found during sleep, coma, hyperthermia, under nutrition. Total energy expenditure includes BMR (which represent 35–70% of total energy expenditure), dietarilyinduced thermogenesis (which represent about 10% of BMR) and energy used in volitional or non-volitional physical activity. Regularly the BMR is measured by indirect calorimetry, but can be also computed using some predictive equations. Predictive equations are a necessity in clinical practice secondary to difficulties and resources in calorimetry devices. For their computation, different variables as individual organ BMR, free fat mass (FFM) BMR, fat body mass, fat body surface, age, gender, height, weight, various biomarkers are used. Predictive equations diversity is the result of the attempt of obtaining accurate data in different physiological and pathological conditions (Elia, M.1992).

The internal organs (liver, heart, brain, kidney), which have 7% on body weight, are responsible for 60% of BMR in comparison with muscle mass, which has 40% of body weight and is responsible for 18% of BMR (Lazzer, et al., 2010). Energy processes involved are mitochondrial proton leak (Jastroch, M.2010 et al) protein synthesis and degradation, ion pumps as Na K ATPase, biochemical reaction. BMR is increased in young age, males with increasing of body weight and free fat mass (Johnstone, et al., 2005). BMR is modified by genetic factors, ethnicity, normal physiological state or co morbidities, nutritional factor, sympathetic activity and stress (Gora et al., 1994). BMR increases with the development of body mass from early childhood to maturity, remains almost stable between 20 an 40 years of age and then decreases with age. BMR decreases with 23% per decade after 50 years of age. (Roberts, S. D., D.E., 2001). The mechanisms incriminated for decreasing of BMR with age were reduction in mass and function of internal organs and muscle mass (Roubenoff et al., 2000). Decreasing of organ mass is between 10–20% at 80 years in comparison with 20 years, excepting for heart. Heart mass increases with age in a similar proportion (He and Heshka,2009). Because BMR is mainly composed by internal organ metabolic rate, an organ reduced activity as in brain neural degenerative disorders, significantly decreases the BMR (Poehlman et al., 1997). Reduction of muscle skeletal mass is also an aging feature.

BMR remained different for older people in comparison with young people (Kremet al., 2005). Renal failure and malnutrition are associated with decrease BMR. Chronic brohopneumopathy, diabetes and lung cancer are associated with increased BMR. In humans, BMR declines with age, especially after 30 years, with ~0.69Mj/day/decade for man and with 0.43 Mj/day/decade for woman26. The decline in BMR with age has been related to the progressive lost of the fat free mass (sarcopenia), heat producing tissues and the decrease in fitness level (Kenney and Buskirk, 1997). The BMR increase with higher level of plasma norephrinefline concentration found in highly fit, physically active adult subjects but not in sedentary elderly persons (Poehlman, E. T.; Horton, E. S1990). The relation of BMR with gender even after free fat mass correction is not very well sustained by latest data. The difference between male and female using Harris Benedict initial calculation was 8%
required to maintain body temperature. This is most obvious from the fact that it is only at the lower critical temperature that BMR represents the heat required to maintain body temperature. At ambient temperatures greater than the lower critical temperature for a particular species, the heat produced from BMR is greater than that required for maintenance of an animal’s body temperature, and this excess heat must be removed from the body by vasomotor-mediated increases in the thermal conductance. In 1895, Magnus-Levy showed that secretions from the thyroid gland stimulated the metabolic rate of humans. Until the development of radioimmunoassays in the 1960s for the measurement of blood thyroid hormone concentrations, the measurement of BMR was an important clinical measurement used to assess thyroid status of individual humans. This clinical context was a major influence on the development of strict conditions for the measurement of metabolic rate and the refinement of the BMR concept during the twentieth century. During this period, BMR was also increasingly used to compare metabolic activity among various mammals and birds. However, the detailed conditions prescribed for the correct measurement of BMR of humans were not easily translated to the measurement of BMR in animals. Indeed, as pointed out by Blaxter (1989), in practice it is often easier to define the precise conditions for measurement of an animal’s BMR than to achieve them. The concept of standard metabolic rate (SMR) was also developed to analyze the bioenergetics of ectotherms. It is related to BMR and includes the specification of the temperature at which metabolic rate is measured, which is important information when comparing the metabolic rate of ectothermic animal.

2.3. PHYSIOLOGY OF BASAL METABOLIC RATE

The early work of the scientists J. Arthur Harris and Francis G. Benedict showed that approximate values for BMR could be derived using body surface area (computed from height and weight), age, and sex, along with the oxygen and carbon dioxide measures taken from calorimetry. Studies also showed that by eliminating the sex differences that occur with the accumulation of adipose tissue by expressing metabolic rate per unit of “fat-free” or lean body mass, the values between sexes for basal metabolism are essentially the same. Exercise physiology textbooks have tables to show the conversion of height and body surface area as they relate to weight and basal metabolic values.

The primary organ responsible for regulating metabolism is the hypothalamus. The hypothalamus is located on the diencephalon and forms the floor and part of the lateral walls of the third ventricle of the cerebrum. The chief functions of the hypothalamus are:

1. control and integration of activities of the autonomic nervous system (ANS)
   - The ANS regulates contraction of smooth muscle and cardiac muscle, along with secretions of many endocrine organs such as the thyroid gland (associated with many metabolic disorders).
   - Through the ANS, the hypothalamus is the main regulator of visceral activities, such as heart rate, movement of food through the gastrointestinal tract, and contraction of the urinary bladder.

2. production and regulation of feelings of rage and aggression
3. regulation of body temperature
4. regulation of food intake, through two centers:

- The feeding center or hunger center is responsible for the sensations that cause us to seek food. When sufficient food or substrates have been received and leptin is high, then the satiety center is stimulated and sends impulses that inhibit the feeding center. When insufficient food is present in the stomach and ghrelin levels are high, receptors in the hypothalamus initiate the sense of hunger.
- The thirst center operates similarly when certain cells in the hypothalamus are stimulated by the rising osmotic pressure of the extracellular fluid. If thirst is satisfied, osmotic pressure decreases.

All of these functions taken together form a survival mechanism that causes us to sustain the body processes that BMR measures.

2.4. FACTORS THAT INFLUENCE BASAL METABOLIC RATE

- Body size: Metabolic rate increases as weight, height, and surface area increase.
- Body composition: Fat tissue has a lower metabolic activity than muscle tissue. As lean muscle mass increases, metabolic rate increases.
- Gender: The basal metabolic rate (BMR) averages 5 to 10 percent lower in women than in men. This is largely because women generally possess more body fat and less muscle mass than men of similar size.
- Age: A decrease in lean muscle mass during adulthood results in a slow, steady decline of roughly 0.3 percent per year in BMR after the age of about 30. This can be largely avoided by strength training throughout adulthood.
- Climate and body temperature: The BMR of people in tropical climates is generally 5 to 20 percent higher than their counterparts living in more temperate areas because it takes energy to keep the body cool. Exercise performed in hot weather also imposes an additional metabolic load. Body fat content and effectiveness of clothing determine the magnitude of increase in energy metabolism in cold environments; it takes energy to keep the body warm if you work or exercise in very cold weather.
- Hormonal levels: Thyroxine (T4), the key hormone released by the thyroid glands has a significant effect upon metabolic rate. Hypothyroidism is relatively common, especially in women near or after menopause. Everyone with a weight problem should have their thyroid function checked by their doctor and treated appropriately if it turns out to be low.
- Health: Fever, illness, or injury may increase resting metabolic rate two-fold.

2.5. BMR IN METABOLIC DISORDER

BMR IN OBESITY

Obesity is a state defined by a BMI over 30 and consists of accumulation of fat in subcutaneous and visceral region. The accumulation of fat in internal organ is a feature which reduces their caloric consumption of internal organs decreases the number of metabolic active cells. The adipose tissue has a lower energetic expenditure than lean mass: 4.5kcal/kg/day in adipose tissue in comparison with 13 kcal/kg/day in skeletal muscle. Secondary to fat accumulation BMR augments in absolute value, but energy consumption per kilogram of body weight is reduced compared with energy consumption per free fat mass kilogram which is normal. However, BMR adjusted per weight is not similar to all obese patients. In morbid obesity, lower level of BMR/kg total weight were found in higher BMI and heavier subgroup. These patients are more energetically efficient and accumulate more adipose tissue.

In nutritional intervention with low caloric diets or in fasting, BMR is reduced, the patients did not lose the expected weight and are frequently suspected of non compliance. BMR reduction in fasting state is about 15% and explain weight preserving in these conditions. Leptin level modulates BMR, increases BMR in obesity and decrease it in fasting condition. Obese patients with higher BMR adjusted to weight are considered hypermetabolizer patients. These patients are considered to support metabolic adaptation for reduction of further gain weight. This category was often associated with more diabetes, but it could be also associated with different increased blood glucose levels, but below the values diagnostic for diabetes (Rosales-Velderrain et al., 2014). The leptin resistant state with dysfunctional satiety and BMR reduction could be a cause of obesity. Leptin resistant state is produced by a defective regulator expression of leptin receptor gene (Sahu and Minireview, 2004).

BMR IN METABOLIC SYNDROME Metabolic syndrome with obesity has a lower energetic requirement in comparison with diabetes with associated obesity. BMR adjusted for free mass is decreased in metabolic syndrome (Buscemi et al., 2007). That induces the idea that more efficient energetically, metabolic syndrome is a particular state prone to accumulation of fat tissue. Some of the mechanisms considered involved are genetic modification for uncoupling proteins (UCP) with decreased mitochondrial function and lipotoxic mechanism.

BMR IN DIABETES MELLITUS

BMR in diabetes is increased and correlate with the level of glycemic imbalance. It is considered that BMR is increased in Caucasian diabetic patient with 6% (Fontvieille et al., 1992; Bitz et al., 2004). There are many mechanism implicated in increasing BMR in diabetes, such the increased oxidation’s level for carbohydrates, augmentation of neoglucogenesis and hepatic glucose output, increased sympathetic activity and decreased capacity of glycogen synthesis.

2.6. OBESITY

Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have a negative effect on health (WHO, 2015). People are generally considered obese when their body mass index (BMI), a measurement obtained by dividing a person’s weight by the square of the person’s height, is over 30 kg/m², with the range 25–30 kg/m² defined as overweight (WHO, 2015). Some East Asian countries use lower values (Kanazawa et al., 2005). Obesity increases the likelihood of various diseases and conditions, particularly cardiovascular diseases, type 2 diabetes, obstructive sleep
apnea, certain types of cancer, osteoarthritis and depression (Haslam and James, 2005; Luppino et al., 2010).

Obesity is most commonly caused by a combination of excessive food intake, lack of physical activity, and genetic susceptibility (WHO, 2015; Yazdi, Clee and Meyre, 2015). A few cases are caused primarily by genes, endocrine disorders, medications, or mental disorder (Bleich et al., 2008). The view that obese people eat little yet gain weight due to a slow metabolism is not medically supported. On average, obese people have greater energy expenditure than their normal counterparts due to the energy required to maintain an increased body mass (Kushner, 2007).

Obesity is mostly preventable through a combination of social changes and personal choices (WHO, 2015). Changes to diet and exercising are the main treatments (Haslam and James, 2005). Diet quality can be improved by reducing the consumption of energy-dense foods, such as those high in fat or sugars, and by increasing the intake of dietary fiber (WHO, 2015). Medications can be used, along with a suitable diet, to reduce appetite or decrease fat absorption (Yanovski and Yanovski, 2014). If diet, exercise, and medication are not effective, a gastric balloon or surgery may be performed to reduce stomach volume or length of the intestines, leading to feeling full earlier or a reduced ability to absorb nutrients from food (Calquitt et al., 2014).

Obesity is a leading preventable cause of death worldwide, with increasing rates in adults and children (Imaz et al., 2008). In 2015, 600 million adults (12%) and 100 million children were obese in 195 countries. Obesity is more common in women than men (WHO, 2015). Authorities view it as one of the most serious public health problems of the 21st century (Dibaise and Foxx-Orenstein, 2013). Obesity is stigmatized in much of the modern world (particularly in the Western world), though it was seen as a symbol of wealth and fertility at other times in history and still is in some parts of the world (Woodhouse, 2008).

Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have an adverse effect on health (Sweeting, 2007). It is defined by body mass index (BMI) and further evaluated in terms of fat distribution via the waist-hip ratio and total cardiovascular risk factors (Gray and Fujioka, 1991). BMI is closely related to both percentage body fat and total body fat (Flegal et al., 2001). In children, a healthy weight varies with age and sex. Obesity in children and adolescents is defined not as an absolute number but in relation to a historical normal group, such that obesity is a BMI greater than the 95th percentile (Nikcevic, Kuczmierczyk and Bruch, 2009). The reference data on which these percentiles were based date from 1963 to 1994, and thus have not been affected by the recent increases in weight (Bei-Fan, 2002). BMI is defined as the subject’s weight divided by the square of their height. BMI is usually expressed in kilograms of weight per metre squared of height. To convert from pounds per inch squared multiply by 703 (kg/m2)/(lb/sq in) (Nikcevic, Kuczmierczyk and Bruch, 2009).

Effects of obesity on health
Excessive body weight is associated with various diseases and conditions, particularly cardiovascular diseases, diabetes mellitus type 2, obstructive sleep apnea, certain types of cancer, osteoarthritis, and asthma (Haslam and James, 2005). As a result, obesity has been found to reduce life expectancy.

2.7. Lung Function Test
Lung function tests (LFTs) are a group of tests that measure how well your lungs work. This includes how well you’re able to breathe and how effective your lungs are able to bring oxygen to the rest of your body.

It helps to test the following:
if you are having symptoms of lung problems, if you are regularly exposed to certain substances in the environment or workplace to monitor the course of chronic lung disease, such as asthma or chronic obstructive pulmonary disease (COPD) to assess how well your lungs are working before you have surgery. LFTs are also known as lung function tests.

LUNG VOLUME AND CAPACITY
Lung volumes and lung capacities refer to the volume of air associated with different phases of the respiratory cycle. The average total lung capacity of an adult human male is about 6 litres of air. A lung’s capacity consists of two or more lung volumes.

Total lung capacity (TLC): the volume in the lungs at maximal inflation, the sum of VC and RV. Tidal volume: that volume of air moved into or out of the lungs during quiet breathing (TV indicates a subdivision of the lung; when tidal volume is precisely measured, as in gas exchange calculation, the symbol TV or VT is used.) Residual volume (RV): the volume of air remaining in the lungs after a maximal exhalation. Expiratory reserve volume (ERV): the maximal volume of air that can be exhaled from the end-expiratory position. Inspiratory reserve volume (IRV): the maximal volume that can be inhaled from the end-inspiratory level. Inspiratory capacity (IC): the sum of IRV and TV. Inspiratory vital capacity (IVC): the maximum volume of air inhaled from the point of maximum expiration. Vital capacity (VC): the volume of air breathed out after the deepest inhalation. Tidal volume: that volume of air moved into or out of the lungs during quiet breathing (VT indicates a subdivision of the lung; when tidal volume is precisely measured, as in gas exchange calculation, the symbol TV or VT is used.) Functional residual capacity: the volume in the lungs at the end-expiratory position. Forced vital capacity (FVC): the determination of the vital capacity from a maximally forced expiratory effort. FEV1Forced expiratory volume (time): a generic term indicating the volume of air exhaled under forced conditions in the first t seconds.FEV1 Volume that has been exhaled at the end of the first second of forced expiration.

Maximal voluntary ventilation (MVV): volume of air expired in a specified period during repetitive maximal effort.

Measurements
Lung function test is measured using spirometry. Spirometry includes tests of pulmonary mechanics –
measurements of FVC, FEV1, FEF values, forced inspiratory flow rates (FFIs), and MVV. Measuring pulmonary mechanics assesses the ability of the lungs to move huge volumes of air quickly through the airways to identify airway obstruction. The spirometry device is used to generate a pneumotachograph that can help to assess lung conditions such as: asthma, pulmonary fibrosis, cystic fibrosis, and chronic obstructive pulmonary disease. Physicians may also use the test results to diagnose bronchial hyper responsiveness to exercise, cold air, or pharmaceutical agents (McMurray et al., 2015).

Lung volumes and capacity
There are four lung volumes and four lung capacities. A lung’s capacity consists of two or more lung volumes. The lung volumes are tidal volume (VT), inspiratory reserve volume (IRV), expiratory reserve volume (ERV), and residual volume (RV). The four lung capacities are total lung capacity (TLC), inspiratory capacity (IC), functional residual capacity (FRC) and vital capacity (VC).

Factors affecting volumes
Several factors affect lung volumes; some can be controlled and some cannot be controlled. Lung volumes vary with different people as follows: Taller people, people who live at higher altitudes have larger lung volume, while shorter people, people who live at lower altitudes, people who are obese have smaller lung volume (Jones and Nzekwu, 2006).

A person who is born and lives at sea level will develop a slightly smaller lung capacity than a person who spends their life at a high altitude. This is because the partial pressure of oxygen is lower at higher altitude which, as a result means that oxygen less readily diffuses into the bloodstream. In response to higher altitude, the body's diffusing capacity increases in order to process more air. Also, due to the lower environmental air pressure at higher altitudes, the air pressure within the breathing system must be lower in order to inhale; in order to meet this requirement, the thoracic diaphragm has a tendency to lower to a greater extent during inhalation, which in turn causes an increase in lung volume.

MATERIALS AND METHOD
3.1. MATERIALS
Spirometer
Stadiometer
Cotton wool
Spirit

SPIROMETER:
A spirometer is an apparatus used for measuring the volume of air inspired and expired by the lungs. A spirometer measures ventilation, the movement of air into and out of the lungs. It is the main piece of equipment used for basic Pulmonary Function Tests (PFTs). The spirometer used for this study was gotten from the Department of Human Physiology, NnamdiAzikiwe University.

STANDIOMETER: A stadiometer is an apparatus or equipment used for measuring height and weight at the same time. It is used in routine medical examinations and also clinical tests and experiments. The stadiometer was gotten from the department of physiology NnamdiAzikiwe University.

COTTON WOOL: Cotton wool is a soft mass of cotton, used especially for applying liquids to the skin. It is soaked in spirit to form swab.

SPIRIT: is a volatile liquid (alcohol) used in sterilizing or disinfecting surfaces or parts.

3.2. METHOD
3.2.1. Research design
This research is a cross sectional study conducted in college of Health Science NnamdiAzikiwe University Nnewi campus.

3.2.2. Area of study
This study took place at the Old Physiology laboratory of the Department of Human Physiology, NnamdiAzikiwe University, Nnewi campus. This study involved ninety (90) students.

3.2.3. Population of study
The study population was made up of ninety (90) students (52 male and 38 female) which included both males and females from different departments.

3.2.4. Determination of sample size
The sample size for this study was determined by simple random selection. A total number of 90 Students (52 male and 38 female) participated in the study. Inclusion criteria were healthy student, and age 20-26 years old. Exclusion criteria were age <20 or >26 years old, presence of skeletal deformity, current history of acute respiratory illness, and a history of a chronic disease.

3.2.5. Ethical consideration
Ethical clearance was obtained from the Faculty of Basic Medical Sciences before the commencement of this study. The students’ consent was gotten before data collection.

3.3. Experimental procedure for collection of data
The subjects used for this study were 90 in number. Each of the subjects was given detailed explanation of the procedures involved and why the experiment is done. Those who agreed were recruited for the experiment.

The subjects’ weight and height were measured using a stadiometer. Before climbing the stadiometer the subject was asked to remove any weighty thing from their pockets and also their shoes or sandals so as to get their exact weight and height. After measuring their weight and height, each of the subjects was asked to put the mouth piece of the spirometer on the mouth and was asked to
inhale maximally and exhale maximally. The reading on the spirometer was taken. After use by each subject, the mouthpiece of spirometer was cleaned with swap and the spirometer was reset so as to take another reading. This was done for each and every one of the subjects.

The body mass index (BMI) was calculated for each student as weight (in kilograms) divided by square of height (in meters). BMI less than 25.00 was classified as “non-obese” and 25.00 or higher as “overweight/obese”. A portable All-flow spirometer was used for measurement of FVC, FEV1, VT and VC for each subject.

Spirometry measurements were carried out according to the guidelines of the American Thoracic Society (ATS). Four predictive equations were used for estimation of basal metabolic rate for all participants in the study as follows:

1. Harris and Benedict equation: BMR (kcal/day) for men = (13.7516 wt/1 kg + 5.0033 ht/1 cm - 6.7550 age/1 year + 66.4730) and for women = (9.5634 wt/1 kg + 1.8496 ht/1 cm - 4.6756 age/1 year + 655.0955) (Frankenfield, Roth-Yousey and Compher, 2005).
2. Henry and Rees equation (Henry and Rees, 1991): BMR (kcal/day) for men (18–30 years old) = (0.0560 wt + 2.800) × 238.85, and for women (18–38 years old) = (0.0480wt + 2.562) × 238.85.

3.3.1. Parameters used

Weight: the standiometer was used measure subjects' weight. The measurement of subjects' weight were in kilogram.

Height: standiometer was also used to measure subjects' height. Height is measured alongside weight using a standiometer.

FEV1: is the volume that has been exhaled at the end of the first second of forced expiration.

FVC: force vital capacity (FVC) is the determination of the vital capacity from maximally forced expiratory effort.

VT: Tidal volume (VT) is the volume of air moved into and out of the lungs during quiet breathing.

VC: vital capacity (VC) is the volume of air breathed out after the deepest inhalation.

3.4. Statistical analysis

The data collected were entered into Microsoft Excel and analyzed using statistical package for social sciences (SPSS) Version 20.0. The student's t-test was used for testing the statistical difference between the groups of male and female, and between the groups of ‘overweight/obese’ and ‘non-obese’ in relation to the demographic details, the spirometric indicators, and the predicted values of BMR for each equation. P value <0.05.

RESULT

| Table 4.1 Characteristics of male and female in the study group |
|-----------------|--------|------|----------|
| **SEX** | N  | **Mean** | **P-VALUE** |
| **AGE (YEAR)** | | | |
| MALE | 50 | 22.98±1.51 | |
| FEMALE | 40 | 21.88±1.44 | 0.001* |
| **WEIGHT (Kg)** | | | |
| MALE | 50 | 69.87±7.53 | |
| FEMALE | 40 | 62.39±8.45 | 0.00* |
| **HEIGHT (CM)** | | | |
| MALE | 50 | 176.32±15.45 | |
| FEMALE | 40 | 164.05±12.09 | 0.00* |
| **H(m)** | | | |
| MALE | 50 | 1.76±0.16 | |
| FEMALE | 40 | 1.64±0.12 | 0.00* |
| **H2** | | | |
| MALE | 50 | 3.13±0.64 | |
| FEMALE | 40 | 2.71±0.38 | 0.00* |
| **BMR** | | | |
| MALE | 50 | 1722.59. ±121.47 | |
| FEMALE | 40 | 16270.81±2094.94 | 0.00* |
| **VC** | | | |
| MALE | 50 | 1.22±0.50 | |
| FEMALE | 40 | 1.16±0.35 | 0.47 |
| **MVV** | | | |
| MALE | 49 | 1.35±0.53 | |
| FEMALE | 40 | 1.27±0.49 | 0.48 |
| **FEVI** | | | |
| MALE | 49 | 1.39±0.49 | |
| FEMALE | 40 | 1.23±0.36 | 0.07 |
| **VT** | | | |
| MALE | 49 | 1.45±0.52 | |
| FEMALE | 40 | 1.42±0.48 | 0.82 |
| **BMI** | | | |
| MALE | 49 | 22.78±3.75 | |
| FEMALE | 40 | 23.55±5.11 | 0.43 |

Table 4.1 shows characteristics of males and females in the study group. Males were significantly taller (p < 0.05) and heavier (p < 0.05) than females. Lung function test indicators were significantly higher (p < 0.05) among males compared to Mean BMR values predicted with the two equations were significantly higher in males compared to females (p < 0.05).
Table 4.2 shows insignificant statistical difference in age, height and lung function indicators (but not in weight and BMI) between overweight/obese and non-obese males and females of the study population.

Table 4.3 showing comparison between Non-obese and obese in male and female subjects

<table>
<thead>
<tr>
<th>Nutritional Status</th>
<th>Mean ± Std. deviation</th>
<th>N</th>
<th>P-value</th>
<th>Mean ± Std. deviation</th>
<th>N</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NON OBESO</td>
<td>15762.75±2214.45</td>
<td>27</td>
<td>0.004*</td>
<td>1711.02±127.33</td>
<td>39</td>
<td>0.316</td>
</tr>
<tr>
<td>OBESE</td>
<td>10949.51±7911.278</td>
<td>22</td>
<td></td>
<td>1754.55±90.76</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13601.70±5990.79</td>
<td>49</td>
<td></td>
<td>1719.90±121.22</td>
<td>49</td>
<td></td>
</tr>
</tbody>
</table>

Mean BMR values for overweight/obese and non-obese subjects were presented in Table 4.3. A Significant statistical difference was found between the two groups for each equation (p < 0.05).

Table 4.4 The estimated basal metabolic rate among obese and non-obese male and female subjects using the two different predictive equations.

<table>
<thead>
<tr>
<th>BMR Equations</th>
<th>NUTRITIONAL STATUS</th>
<th>Mean±SD</th>
<th>P-value</th>
<th>NUTRITIONAL STATUS</th>
<th>Mean±SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HARRIS AND BENEDIT</td>
<td>NON OBESO</td>
<td>15762.75±2214.45</td>
<td>0.009</td>
<td>OVER WEIGHT</td>
<td>1711.02±127.32</td>
<td>0.14</td>
</tr>
<tr>
<td>HENRY AND REES</td>
<td>NON OBESO</td>
<td>1303.01±102.15</td>
<td>0.007</td>
<td>OVER WEIGHT</td>
<td>1578.84±96.07</td>
<td>0.00*</td>
</tr>
</tbody>
</table>

Tables 4.4 show the relation between mean BMR values and LFT indicators among males and females respectively. Although the majority of BMR values were lower among those who have low values of LFT, statistical analysis showed insignificant relation (p > 0.05).

**DISCUSSION**

Measurement of basal metabolic rate is needed for nutritional assessment, weight loss planning and care for various medical conditions. Because of the increasing awareness about its importance worldwide, a free metabolic rate calculator, based on Harris and Benedict's equation, was recently released as a new application for smart mobile phones (Merghani et al., 2015). In this study, I chose two commonly used predictive equations for estimation of BMR in my study. In general, predictive equations tend to overestimate the actual energy expenditure (Frankenfield, Roth-Yousey and Compher, 2005).

The finding that lung function test are significantly among the males compared to the females is a normal physiological finding. Other factors known to affect lung volumes and capacities are age, height and weight. The age range of the students who participated in our study is relatively narrow (from 20 to 26 years old). This decreases variation in their expected values of lung function test however, the range of height is wide. The negative effects of excessive weight gain on the respiratory system are well known (Koenig, 2001; Chinn, Jarvis and Burney, 2002; Weiss and Shore, 2004). Accordingly, I divided my subjects into overweight/obese and non-obese subjects. In the absence of extreme values, presentation of lung function test in the form of (mean ± SD) is representative for my findings in the study population. My finding that, there was an insignificant difference in lung ventilatory function between overweight/obese and non-obese subjects was similar to results of a study recently conducted in king Abdulaziz medical city in Riyadh, Saudi Arabia and researchers
recommended searching for another diagnosis to explain abnormal lung function findings in obese subjects (Ghobain, 2012; Merghani et al., 2015). Basal metabolic rate is relatively constant but varies greatly between individuals depending on their age, gender, and free fat mass. Gender is a significant determinant of BMR, with men having a greater rate than women (Lazzer et al., 2010). However, this difference might be attributed to higher free fat mass in males compared to females. Since the estimation of BMR in this study was based on predictive equations, results were significantly higher among males compared to females. Higher BMR values among males were reported by Arciero and his colleagues in 1993 who conducted their study in the United States across a broad spectrum of age (Arciero, Goran and Poehlman, 1993). In Arciero study, the lower values in females persisted even after controlling for differences in body composition and aerobic fitness.

It is well known that patients who consume low amount of oxygen have lower rate of metabolism than those who consume higher amounts; however, patients with impaired lung function, have still higher BMR compared to those with normal lung function, due to the increased activity of their respiratory muscles as a compensation for the impaired lung function. A recent study has shown that patients with COPD and bronchial asthma have increased metabolic rate that is directly correlated to severity of the diseases (Agha and ElWahsh, 2013). On the other hand, the negative effect of abnormal metabolism on lung function was confirmed in many previous studies. For example, diabetic patients had FEV1 values lower than those without diabetes, and this effect is even greater in those with poorly controlled diabetes (McKeever et al., 2005). In contradistinction to these results, I found insignificant association between predicted BMR and abnormal values of lung function tests. However, a significant difference in predicted BMR between overweight/obese and non-obese subjects is an expected finding since BMR calculations are directly based on weights of the participants. It is worth noting that accurate BMR calculations should rely on free fat mass rather than total body weight; that is why many studies found that the predictive equations overestimate the BMR, especially in obese subjects (Foster and McGuckin, 2001).

CONCLUSION

In conclusion, this study showed that the relation between predicted basal metabolic rate and indicators of lung function tests was statistically insignificant. A practical estimation of BMR based on direct measurement of oxygen consumption is recommended to confirm the absence of this association.

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