Estimation of Total Energy Expenditure among Female Students of TNPESU

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Abstract

The purpose of the study was to assess the Female energy requirements need be balance with total daily energy expenditure (TEE). Therefore, meeting of energy needs for all components of TDEE must be the most important concern for active females. In addition, the study intended to provide an indication of the level of energy requirement for the female student of TNPESU. The predictive equations for RMR used in this study is, equations based on weight and/or height of adolescent, or equations that are the most commonly used in clinical settings although based on adults. Harris and Benedict equationsare commonly used in prediction of BMR in healthy subjects and the WHO/FAO recommended energy requirements for developing countries. In this study involving 26 female students were randomly selected from Department of Exercise Physiology and Nutrition, TNPESU and their age ranged between 18 to 23 years. Physical activity Level was measured by twenty-four hour activity diary and TEE calculated as a product of BMR and PAL. The measured mean and standard deviation of BMI 19.03± 2.54Kg and BSA for female students was 1.41 ± 0.11m^2, the mean and standard deviation of BMR were1264.46 ± 55.96 Kcal/day and mean and standard deviation of TEE was 1652.88 ± 72.42 Kcal/day in female student. It was revealed that total energy expenditure of female student in TNPESU was high with the values being above the mean daily calorie requirement per capita for Indian (2058 Kcal/day) but within the WHO/FAO recommended energy requirements (2,360 Kcal/day) for developing countries. High energy expenditure was attributed to high energy levels spent in sports activities which were physical and effort exhaustive.

Keywords: Body Mass Index (BMI), Body Surface Area (BSA), Basal Metabolic Rate (BMR) and their relationships to Total Energy Expenditure (TEE).

Introduction

Energy is defined as the capacity to do work. Energy requirements are based on the energy needs for optimal growth and development for each individual at their stage in life in order to maximize long-term good health. Energy requirements for humans are not the same as nutritional requirements. In simple terms, energy requirement is the level of energy intake necessary to meet energy expenditure. This definition assumes that energy balance is desirable for optimum health, that is, the individual is of a healthy weight. Therefore for individualswith a weight that is above or below the desirable weight range, the energy requirement for good health would be less than or greater than total energy expenditure respectively, to understand the energy requirement of individuals, knowledge of energy expenditure is necessary.

The level of energy intake from food that will balance energy expenditure when the individual has a body size and composition, and level of physical activity, consistent with long-term good health; and that will allow for the maintenance of economically necessary and socially desirable physical activity (FAO/WHO/UNU, 1985). Total energy expenditure (TEE) is the amount of energy1 (kilojoules or calories) used by the body over a 24-hour period. TEE is often considered in three components: basal metabolism, thermogenesis and physical activity. The contribution of each component to TEE differs among individuals.

The basal metabolic rate (BMR) is ameasure of the minimal amount of energy (kcal)needed to maintain basic and essential physiologicalfunctions such as breathing, blood circulation,and temperature regulation. Basal metabolic ratevaries according to age, gender, body size, and bodycomposition.For assessment of BMR, the individualneeds to be rested and fasted and should be in acontrolled environment. Since this is not alwayspractical, we use the term resting metabolic rate(RMR), or resting energy expenditure (REE), toindicate the energy required to maintain essentialphysiological processes in a relaxed, awake, andreclined state. The RMR is approximately 10% higher than the BMR (Matarese, 1997, Turley, et al, 1993).

Thermogenesis relates to the changes in energy expenditure in response to a variety of factors such as food, cold, medications or hormones (Warwick, 1989). The thermogenic effect of food (TEF) contributes the greatest in healthy individuals, accounting for approximately 10-15% of energy expenditure (Mifflin, et al, 1990, Owen, et al, 1986). TEF refers to the energy associated with the digestion, absorption, transportation and storage of ingested nutrients (Franken field, 1998, Toth, 2001).

Energy expenditure from physical activity varies within individuals from day -to-day and between individuals. In practice, it is difficult to measure energy expended from physical activity. The energy expended when undertaking various levels of physical activity has been measured, and average values published (FAO/WHO/UNU, 1985). Average energy costs of physical activities are expressed as multiples of BMR, as the energy expended in physical activities is related to body weight (FAO/WHO/UNU, 1985, Warwick, 1989). It is likely that modern day leisure activities and occupations require less energy expenditure due to greater advances in technology and less physical work, and more sedentary lives.Therefore, the purposes of this study are to assess the body surface area (BSA), basal metabolic rate (BMR) and their relationships to total energy expenditure (TEE) of healthy young female students.

Methodology

For the purpose of the study twenty six female (N=26)student were selected randomly from Department of Exercise Physiology and Nutrition, Tamilnadu Physical Education and Sports University, Chennai. Their age ranged between 18-23 years were recruited for the study.The standing heights were measured using a stadiometer. Each participant were assessed while in good standing posture on the foot rest of the device with minimal clothing without shoes but with the head facing forward, shoulders relaxed, arms hanging loosely on both sides, palms facing forwards, feet together and knees straight. The subjects stand on the scale looking straight ahead, relaxed, remove shoes and motionless. Weight measurements were taken when the scale stabilized and recorded to the nearest 0.5kg.Body surface area (BSA) was calculated using DuBois equation: BSA (m2) = (Body Height) $^{0.725}$ × (Body Weight) $^{0.425}$ × 0.007184. The predictive equations for BMR used in this study is, equations based on weight and/or height of adolescent, or equations that are the most commonly used in clinical settings although based on adults. Harris and Benedict equationsare commonly used in prediction of BMR in healthy subjects.Females BMR = BMR = 655.1 + (9.563 × weight in kg) + (1.850 × height in cm) – (4.676 × age in years).

Basal metabolic rate (BMR) and their relationships to total energy expenditure (TEE) and physical activity level (PAL). Total Energy Expenditure, which is equal to 24 hours energy expenditure was then expressed as a multiple of BMR and determined PAL values. Physical activity level was determined by a 24-hour activity diary, a method used to record detailed information on how the 24 hours of an average day were spent by each subject. The recording was done for two week days and one weekend day.

Statistical Analysis

The data obtained during the investigation was analyzed using SPSS 16.0 for Windows P.C. The descriptive statistics were expressed as a mean ± SD for each variable. Pearson product moment correlation was carried out to detect the relationship for each parameter: Age, Weight, Height, Body mass index, Body surface area (BSA), basal metabolic rate (BMR) and their relationships to total energy expenditure (TEE). The lower and upper normal limits were determined at 5th and 95th percentiles. A p value < 0.05 was taken as statistically significant.

Results

Descriptive data of Mean and Standard Deviation for the study participants are shown in Table 1.

Table-I

	Age (years)	Weight (kg)	Height (cm)	BMI (kg/m^2)	BSA (m^2)	BMR (kcal/day)	TEE (kcal/day)
Mean	19.31	43.7	151.73	19.03	1.36	1264.46	1652.88
SD	1.64	5.25	7.54	2.54	0.10	55.96	72.42
Min	18	35	132	15.6	1.2	1170	1521
Max	23	52	169	26.8	1.59	1373	1785

The mean age of female student was 19.31± 1.64 years (range 18 - 23 years).The mean height of the females was 151.73± 7.54cm. Similarly the mean weight female student was 43.7± 5.25kg.With regard to the mean BMI female student was 19.03± 2.54 kg.The measuredmean and standard deviation of BSA for Female students was 1.36 ± 0.10m^2, the mean and standard deviation ofBMR were 1264.46 ± 55.96 Kcal/dayand mean and standard deviationof TEE was 1652.88 ± 72.42 Kcal/day in female student. Correlation and coefficient for young female studentsare shown in Table 2

Table-II

Subjects	**Parameters**	**Correlation and Coefficient (r)**	**Remarks**
Female Students	TEE and Age	-0.24	**NS**
	TEE and Weight	0.80	S
	TEE and Height	0.43	S
	TEE and BMI	0.40	S
	TEE and BSA	0.77	S
	TEE and BMR	0.79	S

*Significant Table Value 0.330 with df 24

This table 2 shows that predicted TEE has a negative association with age of young female students (r = 0.24; P< 0.10). It is evident from the table 2 that there is a positive correlation (r = 0.80) between predicted TEE and body weight of the young female students and height of young female students (r =0.43; P> 0.10). The predicted TEE has a positive correlation with BMI and BSA of both (r =0.40) and (r = 0.77) young female students respectively. BMR of the subjects has positive correlation (r = 0.79) with predicted TEE.

Figure-1

Graph Shows their Relationships to Total Energy Expenditure (TEE)

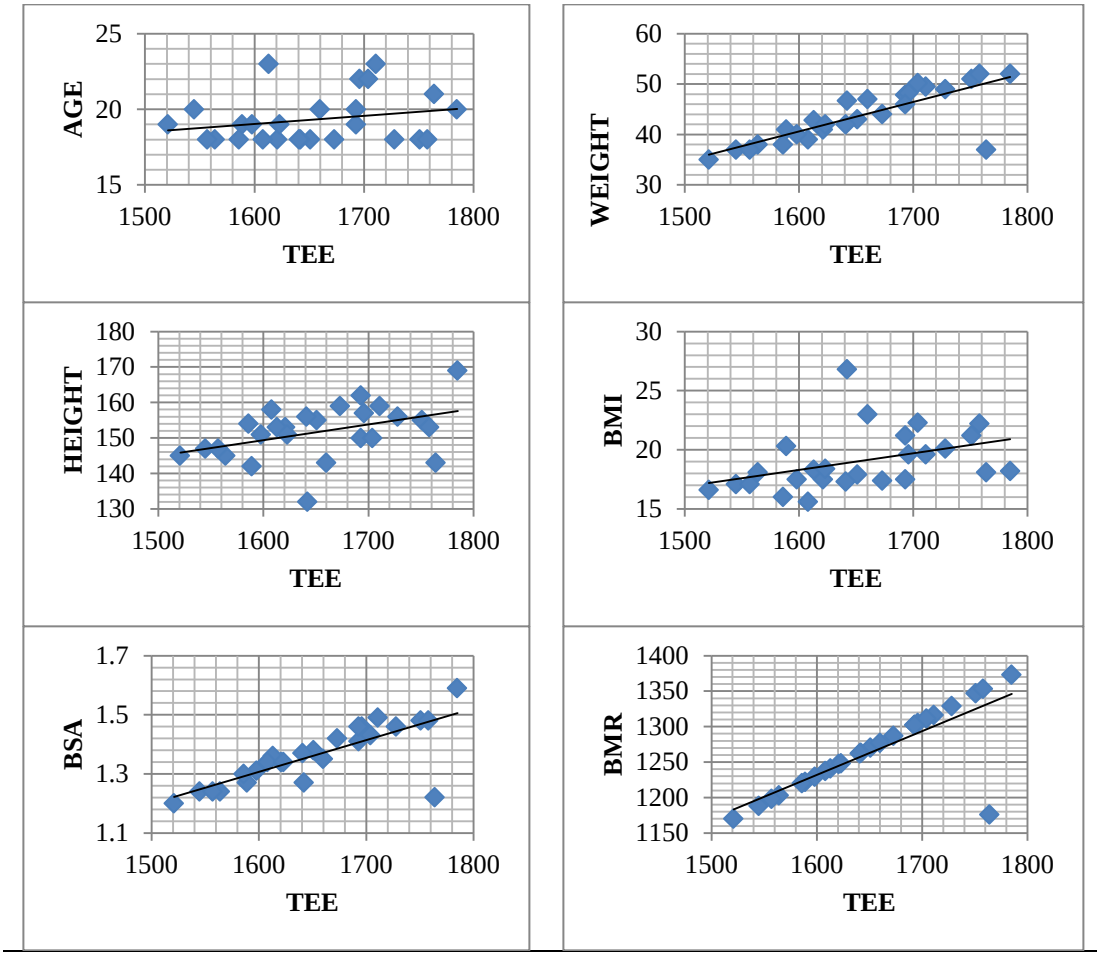
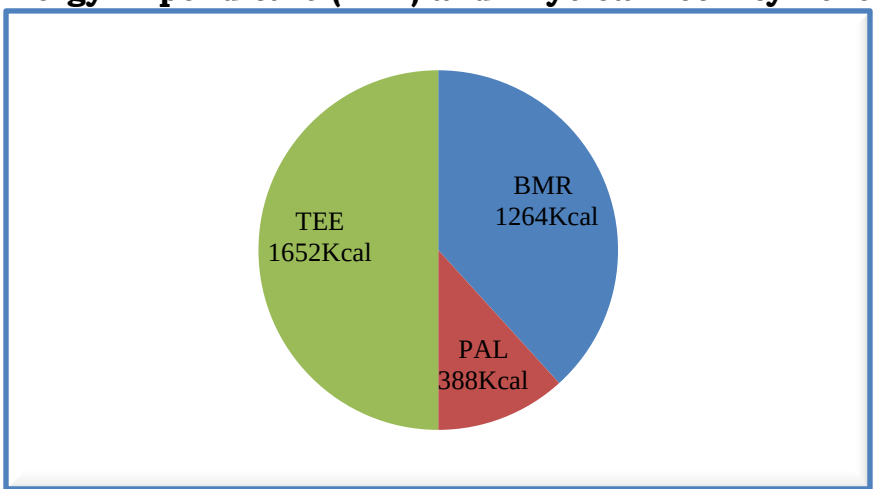


Figure- 2

Pie Chart shows Basal Metabolic Rate (BMR) and their relationships to Total Energy Expenditure (TEE) and Physical Activity Level (PAL)



Discussion

Dietary energy intake of a healthy, well-nourished population should allow for maintaining an adequate BMI at the population's usual level of energy expenditure. At the individual level, a normal range of 18.5 to 24.9 kg/m^2 BMI is generally accepted (WHO 1995 and 2000).When a female has an adequate amount of food, body weight and body energy stores that are within the acceptable range of normality, their health will not be impaired and physiological function will not be compromised.Lack of sufficient energy stores during these period results in the energy deficiency phase taking place, body weight falls and BMRis lowered. Ferro–Luzzi (2000) explained that energy imbalance leads to marked changes in body weight as well as quantity and quality of energy output. Therefore, long standing energy deficiency is reflected by both changes in body weight and activity pattern.The normal range of PAL for light to light active lifestyle is between 1.4 - 1.6.

Determination of TEE using observed BMR and PAL revealed a higher TEE in females above the mean daily calorie per capita ofIndian which is 2058 Kcal/day. However, the TEE was below 2,360 Kcal/day, which is an energy intake level for developing countries. In the present investigation, age was observed to have only insignificant relationship with the TEE in the female students. When correlating each physical parameter with TEE, it was established that body height, body weight, BSA and BMI of the female students have significant correlation with TEE. This study also shows that there is a significant correlation between the predicted BMRof young female students.

Conclusion

The present study results suggest that current mean daily calorie per capita of female in the study area does not meet the energy needs of females. Therefore, there is still a need for recommended energy requirements to be met to complement the energy needs of the students.

Reference

Ferro-Luzzi, (2000), A Seasonality studies in three developing countries: Introduction and background,Eur J ClinNutr, 44(1): S3-S6.

Food and Agriculture Organization (1985), World Health Organization (CH); United Nations University (US). Energy and Protein Requirement. Report of a Joint FAO/WHO/UNU Expert Consultation. WHO Technical Report Series No.724. Geneva (CH): World Health Organization.

Frankenfield DC. Energy Dynamics. In: Matarese LE, Gottschlich MM, (1998), Contemporary Nutrition Support Practice: A Clinical Guide. Philadelphia: W.B. Saunders Company.

Harris J, Benedict F. (1919), A biometric study of basal metabolism in man. Washington D.C. Carnegie Institute of Washington.

Matarese LE. Indirect calorimetry: technical aspects. Journal of the American Dietetic Association 1997;97:S154-160

Mifflin MD, St Jeor ST, Hill LA, Scott BJ, Daugherty SA, Koh YO.(1987), A new predictiveMosteller RD. Simplified calculation of body surface area, N Engl J Med, 317: 1098.

Shetty PS, Henry CJ, Black AE, Prentice AM.(1996), Energy requirements of adults: an update on basal metabolic rates (BMRs) and physical activity levels (PALs). European Journal of Clinical Nutrition, 50:S11-23.

Toth MJ.(2001), Comparing energy expenditure data among individuals differing in body size and composition: statistical and physiological considerations. Current Opinion in Clinical Nutrition and Metabolic Care, 4:391-397.

Turley KR, McBride PJ, Wilmore JH.(1993), Resting metabolic rate measured after subjects spent the night at home vs at a clinic. American Journal Of Clinical Nutrition, 58:141-144.

Wang Z, Heshka S, Gallagher D, Boozer CN, Kotler DP, Heymsfield SB. (2000),Resting energy expenditure-fat-free mass relationship: new insights provided by body composition modelling. American Journal of Physiology - Endocrinology & Metabolism, 279:E539-545.

Warwick PM.(1989), Predicting food energy requirements from estimates of energy expenditure. Australian Journal of Nutrition and Dietetics, 46:S3-S28.

Wong WW, Butte NF, Hergenroeder AC, Hill RB, Stuff JE, Smith EO.(1996), Are basal metabolic rate prediction equations appropriate for female children and adolescents? Journal of Applied Physiology, 81:2407-2414.

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