International Journal of Physiotherapy and Research,
Int J Physiother Res 2015, Vol 3(4):1111-16. ISSN 2321-1822
DOI: http://dx.doi.org/10.16965/ijpr.2015.152

Original Article

EVALUATION OF COMPONENTS OF ENERGY EXPENDITURE IN INDIAN PHYSIOTHERAPY STUDENTS: A CROSS-SECTIONAL STUDY

Renu B. Pattanshetty *, Ceona Chopde.

Department of Cardio-Pulmonary Physiotherapy, KLEU Institute Of Physiotherapy, Jn Medical College Campus Belagavi, Karnataka, India

ABSTRACT

Background and Objectives: Energy expenditure (EE) is the total energy cost of maintaining homeostasis. Therefore, it is important to adjust the individual's nutritional supply and physical activities. Numerous studies suggest evaluation of energy expenditure in various Caucasian and few studies in Asian population. However there is dearth of literature relating to evaluation of components of energy expenditure in Indian physiotherapy student population. Hence, the present study was taken up to evaluate EE in terms of basal metabolic rate, resting metabolic rate, thermic effect of exercise, total daily calorie expenditure in Indian physiotherapy students and to find the correlation between anthropometric measurements and components of EE.

Materials and methodology: A total of 100 Physiotherapy students who participated were subjected to anthropometric measurements (BMI, waist-hip ratio). Energy expenditure was calculated using Harris-Benedict's and Mifflin's equation. RMR and TEE were also calculated as per FAO guidelines.

Results: Miffin's equation demonstrated statistically significant differences (p<0.001) between normal, overweight and obese students. However, using Harris Benedict equation showed no statistically difference (p=0.164) between overweight and obese group. Also when compared Miffin to gold standard equation (i.e Harris Benedict),it was found that Miffin was more accurate among nonobese students. RMR, TEE and TDCE (r=0.677, r=0.512, r=0.609) respectively were highly significant (pd"0.05) when compared between normal BMI, overweight and obese students. There was a positive correlation between the components of EE and the anthropometric measurements

Conclusion: This pilot study concludes that Miffin's equation demonstrated a strong positive correlation among all the three groups as compared to Harris Benedict equation and may be considered as an accurate equation among all the three groups in Indian physiotherapy student population.

KEY WORDS: Energy expenditure, Harris-Benedict, Miffin's equation, Thermic effect of exercise (TEE), Body mass index, Waist-hip ratio, Obesity.

Address for correspondence: Dr.Renu B. Pattanshetty MPT; Ph.D., Department of Cardio-Pulmonary Physiotherapy, KLEU Institute Of Physiotherapy, JN Medical College Campus, Belagavi-590010, Karnataka, India. Mob. No: +91-9448482564 **E-Mail:** renu_kori@rediffmail.com

Access this Article online

Quick Response code	International Journal of Physiotherapy and Research	
	ISSN 2321- 1822	
	www.ijmhr.org/ijpr.html	
	Received: 27-05-2015	Accepted: 15-06-2015
	Peer Review: 27-05-2015	Published (O): 07-07-2015
DOI: 10.16965/ijpr.2015.152	Revised: None	Published (P): 11-08-2015

INTRODUCTION

The amount of energy requires for a human body to maintain its organic and vital functions is obtained by the oxidation of macronutrients from foods [1]. Energy expenditure may be considered as a process of energy production from energy substrates (carbohydrates, lipids, proteins and alcohol) combustion, in which there is an oxygen consumption and carbon dioxide production. Some part of the chemical energy is lost as heat and in urine, and the remaining energy is stored in high energy molecules known as adenosine triphosphates (ATPs) [2]. Energy expenditure is the total energy cost to maintain the homeostasis including the nutritional status and the physical activity. Therefore it is important to adjust the individual's nutritional supply and physical activities. Obesity is a chronic metabolic disorder affecting approximately 5% of the Indian population [3] and characterized by an increase in body fat mass and predisposition to numerous obesity related illnesses which includes hypertension, type II diabetes mellitus, cardiovascular and pulmonary disease, gallbladder disease, some forms of cancer, and other disorders [4-6]. The exact aetiology of obesity is unknown. However, an obesity result from positive energy balance, i.e., energy intake exceeds energy expenditure [7].

The amount of energy that is required by an individual depends on age and physiological status. Adults need nutrients for maintaining constant body weight and ensuring proper body function. The factors which influence energy needs are age, size and altered physiological status such as pregnancy and lactation. Total quantity of food intake is a measure of the total energy expenditure. However, the precision of the dietary assessment at the individual level is reported to be poor as per FAO/WHO/UNU Expert consultation on energy and protein requirements emphasized the importance of relying on measures of energy expenditure rather than energy intake as a basis for arriving at possible estimates of energy requirements of individuals[8]. There are various components of total energy expenditure like Basal energy expenditure (BEE), Resting energy expenditure (REE), Thermic effect of food or diet induced thermogenesis (DIT), and physical activity (PA).

Basal energy expenditure is the amount of calories spent per minute or per hour which can be extrapolated to 24 hours, it also represents the minimal energy required for body vital function maintenance. The BEE contributes for 60% to 70% of daily energy requirement for most sedentary individuals and nearly 50% for those physically active [9,10] Resting energy expenditure (REE) is a component of energy expenditure that is also measured by indirect calorimetry. It can be 3-10% higher than BEE due to diet induced themogenesis and the influence of most recent physical activity [11]. Thermal effect of food (TEF) or diet induced thermogenesis (DIT) is also an component of energy expenditure which is related to energy required for digestion, absorption, uses and storage of nutrients after food intake. The DIT represents 5-15% of total energy expenditure and plays an important role in regulation of energy balance and of body weight [12-14]. Physical activity represents the thermal effect of any movement that exceeds basal energy expenditure. It also have a great variability inter and intra individual. In active individual the energy required for physical activity can correspond as 1-2 times the BEE, while in sedentary individuals it can represent less than half of BEE. There are several methods for energy expenditure measurement such as direct calorimetry and indirect calorimetry, bioelectrical impedance, doubly labelled water and others. Difficulty involved in measuring these methods have motivated several investigators in generating simple equations for the estimation of basal metabolic rate based on age, body weight, height and gender. Most of the energy measurements equations like Harris Benedict equation, Fredix equation, Miffin equation, etc. are generated for the estimation of basal metabolic rate (BMR) are applicable for the temperate climate.

Numerous studies have been done to suggest evaluation of energy expenditure in various Caucasian and few studies in Asian population especially the adolescents. However, there is hardly any literature to evaluate of components of energy expenditure in India physiotherapy students population. Hence, the objectives of the study were to evaluate EE in terms of BMR, RMR, TEE, TDCE in Indian physiotherapy students and also to find the correlation between anthropometric measurements and components of EE.

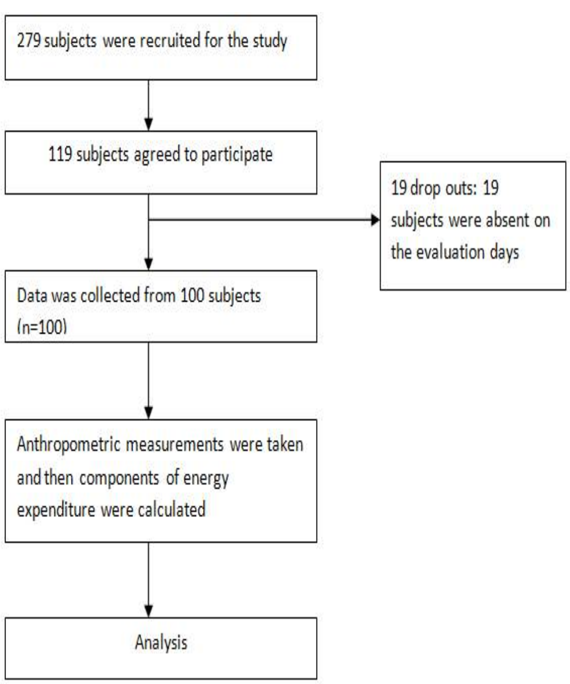
METHODOLOGY

Subjects: A total of 100 subjects were included in the study. The subjects included for the study group were all the students of KLEU Institute of Physiotherapy, Belagavi aged between 17-31 years. Subjects were excluded if they were absent on evaluation days, Students suffering from fever or any other illness and/or not willing to participate. Ethical approval for the study was obtained by the Institutional Ethical Committee prior to the conduction of the study.

Study design: This study was an observational study of cross-sectional type with a convenient sampling and a sample size of 100 Students above the age of 17years who were pursuing Physiotherapy course at KLE Institute of Physiotherapy, Belagavi, Karnataka, India.

Procedure: The purpose of the study was explained and a written informed consent was obtained from all the study subjects. All the participants were screened based on the inclusion and exclusion criteria prior to their enrolment into the study. Demographic data including the anthropometric measurement of the participants such as BMI, waist-circumference, hip-circumference and waist-to-hip ratio were measured, then the components of energy expenditure i.e. Basal metabolic rate was calculated using Harris-Benedict and Miffin's equations along with Resting Metabolic Rate, Thermic effect of exercise and Total Daily Calorie Expenditure.

Fig. 1: Flowchart of the study participant's recruitment process.



Outcome measures: Anthropometric measurements such as BMI, waist circumference, hip circumference and waist-to-hip ratio along with components of energy expenditure such as Basal metabolic rate using Harris-Benedict (RDEE) and Miffin's equation, Resting Metabolic Rate, Thermic effect of exercise and Total daily calorie expenditure were included in the study.

Statistical analysis: Data was analysed using SPSS windows version 16.0. Descriptive statistics including numbers, proportions, mean and standard deviations were used to analyse the data. Chi-square test and ANOVA followed by Bonferroni multiple comparison test was used to compare mean of all groups. Correlation co-efficient was used to find the strength of association between numerical variables (i.e Anthropometric measurements and components of energy expenditure).

RESULTS AND TABLES

A total of 100 subjects were included in the present cross-sectional study after the initial recruitment process. The study population of 100 students was divided into normal, overweight and obese as per their BMI. Age group ranged between 18-31 years. The mean age was 20.3±2.40 and the gender distribution was categorized according to BMI grades under normal, overweight and obese subjects. The study demonstrated positive correlation between BMI, Waist-hip ratio and Components of Energy Expenditure respectively ($p<0.001$). Association between Miffin's equation and Harris-Benedict equation among normal, overweight and obese subjects showed that Miffin's equation had statistically significant differences in all the 3 groups($p=0.002$, $p<0.001$, $p=0.034$ respectively) whereas Harris-Benedict equation has significant differences in normal and overweight, normal and obese groups ($p=0.002$, $p=0.001$, $p=0.164$ respectively). Correlation between Harris-Benedict equation and Components of Energy Expenditure suggested Miffin's equation had a stronger positive correlation as compared to Harris-Benedict equation.

There was a strong positive correlation between Miffin equation and TEE (0.953) compared to RDEE and TEE (0.888). Also when compared Miffin to gold standard equation (i.e Harris Benedict), it was found that Miffin is more accurate among nonobese students.

Table 1: Age and Gender distribution.

Sr no.	Variables	Study group N=100	
		Males	Females
1	Normal	8(50%)	42(50.6%)
	Overweight	6(31.2%)	32(38.6%)
	Obese	3(18.8%)	9(16.8%)
2	Age	20.6±2.40	

Table 2: Correlation between BMI and Components of Energy Expenditure.

Sr no.	Variables	Correlation (r value)	Level of significance
1	Harris-Benedict (RDEE)	0.447	P<0.001
2	Miffin's equation	0.522	P<0.001
3	RMR	0.677	P<0.001
4	TEE	0.512	P<0.001
5	TDCE	0.609	P<0.001

Table 3: Correlation between waist-hip-ratio and Components of Energy Expenditure.

Sr no.	Variables	Correlation (r value)	Level of significance
1	Harris-Benedict (RDEE)	0.423	P<0.001
2	Miffin's equation	0.469	P<0.001
3	RMR	0.45	P<0.001
4	TEE	0.431	P<0.001
5	TDCE	0.475	P<0.001

Table 4: Association between Miffin's and Harris-Benedict equations among normal, overweight and obese individuals.

Variables	Miffin's equation (P value)	Harris-Benedict equation (P value)
Normal and Overweight	P=0.002	P=0.002
Normal and Obese	P<0.001	P=0.001
Overweight and Obese	P=0.034	P=0.164

Table 5: Correlation between Harris-Benedict equation and components of energy expenditure.

	Variables	Correlation (r value)	Level of significance (P value)
Harris-Benedict equation (RDEE)	Miffin's	0.896	P<0.001
	RMR	0.892	P<0.001
	TEE	0.888	P<0.001
	TDCE	0.897	P<0.001

Table 6: Correlation between Miffin's equation and components of energy expenditure.

	Variables	Correlation (r value)	Level of significance (P value)
Miffin's equation	RMR	0.984	P<0.001
	TEE	0.953	P<0.001
	TDCE	0.977	P<0.001

DISCUSSION

The present study tried to evaluate the components of energy expenditure using Miffin's, and Harris-Benedict equation with all the 3 groups. The present study suggested a strong positive correlation among all the 3 groups with Miffin's equation as compared to Harris-Benedict equation.

Stephen Welle et al suggested that most overweight subjects must consume more energy than lean subjects to maintain their excess weight and also stated that some may maintain their obesity without eating more than lean subjects [15]. The change in energy expenditure associated with a weight change provides a buffer against further weight change. If one of the normal-weight women started to gain weight because of an increase in food intake or a reduction in physical activity of 400kJ/d, and would predict that her weight gain would not continue indefinitely but would eventually stop after approximately 5kg. The half-time to achieve this weight gain would be approximately 9 mo, assuming that the energy cost of weight gains 33kJ/g. however there could be considerable variability between subjects in the degree to which weight gains or losses after energy expenditure because of individual differences in the effect of diet or weight changes on metabolic efficiency or physical activity [16-17]. However, present study only evaluated the energy expenditure but did not attempt to study the reasons for weight gain and weight loss.

Other studies have evaluated the possible role of low energy expenditure in the development of obesity by studying reduced obese subjects, assuming that their metabolic rate reverts to its preobese condition when weight is normalized. Obese individuals have higher energy expenditures than lean individuals [18] and energy expenditure declines during weight loss in obese patients [19-31]. Rao et al measured resting energy expenditure in Chinese young healthy normal weight adults using five predictive equations and found Harris-Benedict and WHO equations cannot be used to predict REE due to low accuracy rates as compared to Lius, Owen and Miffin's equations that had had higher accuracy rates and lower bias in estimating REE [32].

Study of RMR in Iranian women evaluated the validity of predictive equations for estimating RMR in normal and obese subjects and suggested that Harris-Benedict formula provided more valid estimation of RMR at the group level in a range of normal weight to morbidly obese Iranian women [33].

Several studies have suggested that weight gain in obesity-prone women may be due to maladaptive responses to the environment, such as physical inactivity or excess energy intake, rather than to reduced energy requirements.

According to Peter JM Weijs, Resting Energy Expenditure (REE) for U.S. overweight and obese class I and II adults can best be predicted with the Miffin's equation [34]. It was also suggested that for Dutch overweight adults, the FAO/WHO/UNU weight equations [35] may be used with reasonable accuracy upto a BMI of 30. However, for Dutch obese adults a BMI of 30-40, the Lazzer equation [36,37] provides improved accuracy, whereas the Miffin's equation provides almost 80% accurate equation for U.S. adults. There are limited data to support the use of Miffin's equation in overweight and obese subjects but a recent review by expert panel [38] advised that the Miffin's equation be used for overweight and obese subjects.

In the present pilot study, the accuracy of Miffin's equation has shown to be more accurate than Harris-Benedict among non-obese Indian Physiotherapy students.

CONCLUSION

This pilot study suggested that Miffin's equation demonstrated a strong positive correlation among all the three groups as compared to Harris Benedict equation. It may also be considered as an better equation among all the three groups in Indian physiotherapy student population.The higher TEE, RMR, TDEE in overweight and obese individuals may be explained by high body fat since Physical activity levels (PALS) of all the individuals in the study were lightly active. Further studies are needed to re-examine the relationship between PAL and EE as a predisposing factor leading to obesity.

Acknowledgement: The authors would like to thank all the physiotherapy students who voluntarily participated in this study.

Conflicts of interest: None

REFERENCES

[1]. Diener JRC. Calorimetria indireta. Rev Assoc Med Bras 1997;43(3):245-253.

[2]. Labayen I, Lopes-M arques J, Msrtinez JA. Metodos de medida del gasto energetico. Nutr Clin 1997;6(16):203.

[3]. Keith N. Frayn. Metabolic Regulation: A Human Perspective. John Wiley and Sons (2013). 3rd edition.

[4]. Van Itallie, T.B. Health implications of overweight and obesity in the United States. Ann. Intern. Med.1985;103:983-988.

[5]. Bray, G.A. Complications of obesity. Ann. Intern. Med.1985; 103:1052-1062.

[6]. Grundy, S.M., and J.P. Barnett. Metabolic and health complications of obesity. Disease-a-Month 1990;36:644-696.

[7]. Bouchard, C. Current understanding of the etiology of obesity: genetic and nongenetic factors. Am. J. Clin. Nutr.1991;53:1561-1565.

[8]. WHO, Energy and protein requirements, Report of a Joint FAO/WHO/UNU Expert consultation. (Technical Report Series 724), Geneva, World Health Organisation, 1985.

[9]. Guyton A, Hall J. Energetica e metabolismo. In: Guyton A, Hall J, Eds. Tratado de fisiologia mrdica. 10ed: Editora ABP-DEA 2002:762-768.

[10]. Oliveira FCE, Cruz ACM, Oliveira CG, Cruz ACRF, Nakajima VM, Bressan J. Gasto energetico de adultos brasilenos saludables:una comparacion de metodos. Nutr Hosp2008;23(6):554-561.

[11]. Rodrigues AE, Marostegan PF, Mancini MC et al. Analise da taxa metabolica de repouso avaliada por calorimetria indireta em mulheres obesas com baixa e alta ingestao caloric. Arq Bras Endocrinol Metabol 2008;52(1):76-84.

[12]. Tappy L. Thermic effect of food and sympathetic nervous system activity in humans. Reprod Nutr Dev 1996;36(4):391-397.

[13]. Prat- Larquemin L, Oppert JM, Bellisle F, Guy-Grand B. Sweet taste of aspartame and sucrose: effects on diet-induced thermogenesis. Appetite 2000; 34(3):245-251.

[14]. Rocha EEM. A determinacao do gasto energetico em pacientes criticos. In: Ferro HC, Azevedo JRA, Loss SH, Eds. Nutricao parenteral e enteral em UTI: Editora Atheneu 2001:1-23.

[15]. Stephen Welle, Gilbert B Forbes, Marcia Statt, R Roger Barnard, John M Amatruda. Energy expenditure under free-living conditions in normal-weight and overweight women. Am J Clin Nutr 1992;55:14-21.

[16]. Sims EAH. Experimental obesity dietary-induced thermogenesis, and their clinical implications. Clin Endocrinol Metab 1976;5:377-395.

[17].Bouchard C, Tremblay A, Despres J-P, et al. The response to long-term overfeeding in identical twins. N Engl J Med 1990;322:1477-1482.

[18]. Welle, S., G.B. Forbes, M. Statt, R.R. Barnard, and J.M. Amatruda. Energy expenditure under free-living conditions in normal-weight and overweight women. Am. J. Clin. Nutr. 1992;55:14-21.

[19].Ravussin, E., B. Burnand, and Y. Schultz. Energy expenditure before and during energy restriction in obese patients. Am. J. Clin. Nutr. 1985;41:753-759.

[20]. Weigle, D. S., K. J. Sande, P.-H. Iverius, E. R. Monsen, and J. D. Brunzell. Weight loss leads to a marked decrease in nonresting energy expenditure in ambulatory human subjects. Metab. Clin. Exp. 1988;37:930-936.

[21]. Leibel, R. L., and J. Hirsch. . Diminished energy requirements in reduced-obese patients. Metab. Clin. Exp.1984;33:164-170.

[22]. Miller, D. S., and S. Parsonage. Resistance to slimming adaptation or illusion? Lancet. 1975;1:773-775.

[23]. Geissler, C. A., D. S. Miller, and M. Shah. The daily metabolic rate of the post-obese and the lean. Am. J. Clin. Nutr. 1987;45:914-920.

[24]. Elliot, D. L., L. Goldberg, K. S. Kuehl, and W. M. Bennett. Sustained depression of the resting metabolic rate after massive weight loss. Am. J. Clin. Nutr. 1989;49:93-96.

[25]. Shah, M., D. S. Miller, and C. A. Geissler. Lower metabolic rates of post-obese versus lean women: thermogenesis, basal metabolic rate and genetics.Eur. J. Clin. Nutr. 1988;42:741-752.

[26]. McNeill, G., S. G. F. Bukkens, D. C. Morrison, and J. S. Smith. Energy intake and energy expenditure in post-obese women and weight-matched controls. Proc. Nutr. Soc. 1990;49:14. (Abstr.)

[27]. Welle, S. L., J. M. Amatruda, G. B. Forbes, and D. H. Lockwood.. Resting metabolic rates of obese women after rapid weight loss. J. Clin. Endocrinol.& Metab. 1984;59:41-44.

[28]. De Grott, L., A. J. H. van Es, J. M. A. van Raaij, J. E. Vogt, and J. G. A. J. Hautvast. Energy metabolism of overweight women I mo and 1 y after an 8-wk slimming period. Am. J. Clin. Nutr. 1990;51:578-583.

[29]. James, W. P., M. E. J. Lean, and G. McNeill. Dietary recommendations after weight loss: how to avoid relapse of obesity. Am. J. Clin. Nutr. 1987;45:1135-1141.

[30].Bessard, T., Y. Schutz, and E. Jequier. Energy expenditure and postprandial thermogenesis in obese women before and after weight loss. Am. J. Clin. Nutr. 1983; 38:680-693.

[31]. Dore, C., R. Hesp, D. Wilkins, and J. S. Garrow. Prediction of energy requirements of obese patients after massive weight loss. Hum. Nutr. Clin. Nutr. 1982;36C:41-48.

[32]. Zhi-yong Rao, Xiao-ting Wu, Bin-miao Liang, Mao-yun Wang and Wen Hu. Comparison of five equations for estimating resting energy expenditure in Chinese young, normal weight healthy adults. European Journal Of Medical Research. 2012;17(26):1-9

[33]. Mahboubeh Shaneshin, Arezoo Rezazadeh, Mahsa Jessri, Tirang Neyestani, Bahram Rashidkhani. Validity of predictive equations for resting energy expenditure among Iranian women. Asia Pac J. Clin. Nutr. 2011;20(4):646-653.

[34]. Mifflin MD, St Jeor ST, Hill LA, Scott BJ, Daugherty SA, Koh YO. A new predictive equation for resting energy expenditure in healthy individuals. Am J Clin Nutr 1990;51:241–7.

[35]. FAO/WHO/UNU. Energy and protein requirements. Geneva, Switzerland: World Health Organ Tech Rep Ser, 1985.

[36]. Lazzer S, Agosti F, Silvestri P, Derumeaux-Burel H, Sartorio A. Prediction of resting energy expenditure in severely obese Italian women. J Endocrinol Invest 2007;30(1):20 –7.

[37]. Lazzer S, Agosti F, Resnik M, Marazzi N, Mornati D, Sartorio A. Prediction of resting energy expenditure in severely obese Italian males. J Endocrinol Invest 2007 Oct;30(9):754 –61.

[38]. Frankenfield D, Roth-Yousey L, Compher C. Comparison of predictive equations for resting metabolic rate in healthy nonobese and obese adults: a systematic review. J Am Diet Assoc 2005;105:775–89.

How to cite this article:

Renu B. Pattanshetty, Ceona Chopde. EVALUATION OF COMPONENTS OF ENERGY EXPENDITURE IN INDIAN PHYSIOTHERAPY STUDENTS: A CROSS-SECTIONAL STUDY. Int J Physiother Res 2015;3(4):1111-1116. **DOI:** 10.16965/ijpr.2015.152