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Energy Requirements, Prediction of Body Fat and Weight Status Analysis of Nursing Students in Gaza Strip

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Abstract: This study aimed to assess the total daily energy requirements (TDR), body mass index (BMI) , body fat percentage (PBF), and weight status analysis according to body mass of nursing students in Gaza Strip. Study sample consisted of (93) subjects from college of nursing at Islamic university, Gaza, and (61) subjects from Palestine college of nursing, Khan Younus. Systematic random sample was used in this study to select the subjects from both colleges. Average basal metabolic rate (BMR) and approx. total daily energy requirements (TDR) for male students at Islamic university-Gaza (IUG) were 1700 (SD 252) and 2040 Kcal/day respectively. For the female students BMR and TDR were 1506 (SD 213) Kcal/day and 1807 Kcal/day, respectively. Average body mass index (BMI) of the male students at IUG was 23.85 (SD 4.06) Kg/m^2, and for female students of the same college was 23.97 (SD 4.51) Kg/m^2. Average body fat percentage (PBF) of nursing male students at IUG was 17.21 (SD 4.82) and for females was 27.96 (SD 5.41). About sixty sex (66.1%) percent of male nursing students at IUG had ideal weight whereas, 5.3% and 28.5 % were underweight and overweight respectively. For female students, 73% had normal weight and 27% had overweight. Average BMR and approx. TDR for the male students at Palestine college of nursing (PCN) were 1635 (SD 226) and 1962 Kcal/day respectively. For the female students BMR and TDR were 1470 (SD 152) and 1765 Kcal/day respectively. Average BMI of the male students at PCN was 22.70 (SD 3.25) Kg/m^2, and female students of the same college was 21.80 (SD 2.93) Kg/m^2. Average PBF for males at PCN was 15.64 (SD 3.90) and for females was 26.30 (SD 3.88). About seventy two (72.2) % of male students at PCN had ideal weight whereas, 5.6% and 22.2 % were underweight and overweight respectively. For female students at the same college, 72 %, 4 %,and 24 % had ideal weight, underweight and overweight respectively.

Key words: Basal metabolic rate, total daily energy requirements, anthropometric measures

Introduction

Total daily energy requirements (TDR) is an energy output expended by individual and includes three energy uses which are :Basal metabolic rate (BMR) (basal energy expenditures (BEE)), thermal effect of food (TEF) (diet induced thermo-genesis) and energy of physical activities. BMR is the sum of all energy required by chemical activities that maintain the body at rest, after fasting 12 to 16 hrs and at room temperature. It is the largest component of energy expenditure in humans, constituting about 60 to 70% of the daily energy requirements of light active individuals and is influenced by the state of fitness and the environment (Williams, 1994). Direct and indirect methods of measuring BMR were used (Guyton, 1991). However, Many formulas have been used for indirect determination of BMR (Al-Mokhalalaty, 1997). Kcal/kg/hr is the simplest factor used for determination of BMR of ideal weight adults (Whitney *et al*., 1990). This factor is not valid for obese persons and substituted by the equation, BMR (Kcal/day) = 70X (Wt. In Kg)$^{0.75}$ in order to overcome this disadvantage (Al-Mokhalalaty, 1997).

Food ingestion requires energy to meet multiple activities of digestion, absorption, and transport of nutrients. This metabolic stimulation is called thermal effect of food (TEF). About 10% of total energy in food consumed are used in activities related to metabolism of food ingested (Whitney *et al*., 1990). Thus, for the purpose of rough estimation, TEF can be ignored. However, TEF value is less than errors in estimation of energy during physical activities and energy inputs of food (Whitney *et al*.,1990).

The third component of TDR is energy of voluntary physical activity achieved by use of skeletal muscles. However, the amount of energy required for physical activity, depends on type and duration of work. It can be approximated as a percentage of BMR and varies with the type of physical activity. For light activity (e.g. a student), the energy of physical activity is roughly 20 % of BMR (Williams, 1994). Thus, TDR can be considered approximately as the sum of BMR and energy of physical activity when both TEF and adaptive thermogenesis are ignored (Whitney *et al*., 1990; Williams, 1994).

Body mass index (BMI, Kg/meter square) has been commonly used as an easy index for body composition in clinical and epidemiological studies (Watkins *et al*., 1992; Wellens *et al*., 1996; Clinical guidelines, 1998). The BMI value relates quite closely to the percent of body fat. Thus, differences in BMI between people of the same age and sex are usually due to body fat. The exceptions

to this rule are body builders, pregnant woman, and people with physical disability who are unable to walk, and people with either anorexia nervosa or massive obesity (Nakanishi *et al.*, 2000). However, BMI is still widely used as a tool for indicating weight status for young and middle aged adults (Garrow and Webester, 1985; Nakanishi *et al.*, 2000). Its value falls into one of these categories: below 18.5 corresponds to underweight and possibly malnourished, 18.5-24.9 corresponds to healthy normal weight; 25-29.9 indicates overweight, and 30 or above corresponds to obesity. If an adult is overweight (BMI over 25) and physically inactive he may develop cardiovascular disease (CVD), hypertension, diabetes mellitus, cancer and other chronic diseases (Calle *et al.*, 1999; Dudeja *et al.*, 2001). It should be emphasized that, these cut-off values of the BMI are very applicable for Orientals. A recent report (Dudeja *et al.*, 2001) recommended that people who are shorter e.g. populations of East Asia, the cut-off value of BMI (25 Kg/m^2) for overweight needs to be lower. This is because there is an increased risk of diabetes and CVD, which begins at a BMI as low as 23 in these populations. In taller Caucasian populations, this risk occurs around a BMI of 27.

Nowadays, many formulas are available to predict adult body fat percentage (PBF), based on current BMI, age, and gender (Jackson *et al.*, 2002). One of these formula is: PBF = (1.2x BMI) + (0.23 x age) – (10.8 x gender) -5.4 where, male gender = 1 and female gender = 0 (Deurenberg *et al.*, 1991). This formula gives valid estimates of body fat in adults except obese subjects. In obese subjects, the formula slightly overestimates the PBF. The prediction error is comparable to prediction error obtained with other methods estimating PBF, such as skin fold thickness measurements or bioelectrical impedance analysis (Roubenoff et al, 1995, Deurenberg *et al.*, 1991). The advantage of the BMI over other predictive methods to assess body fat like skin fold thickness or bioelectrical impedance (Roubenoff *et al.*, 1995; Nakanishi *et al.*, 2000) is that, this method requires no other instruments than a weighing scale and a standiometer, and that measurements are easy to perform with no or only minor between observer variance (Nakanishi *et al.*, 2000).

The relation between fatness and BMI differs with age and gender. For example, women are more likely to have higher percent of body fat than men for the same BMI. On average, older people may have more body fat than younger adults with the same BMI (Gallagher *et al.*, 1996).

Significance and objective of the study: Assessment of nutritional status of college students in Gaza strip have not been reported before (Annual Health Report, 2004). Therefore, this study was designed to assess the nutritional status of the students by estimating their energy requirements, predicting percent body fat, and analyzing weight status according to BMI. It also aimed to test whether there is a correlation between BMI and energy requirements of these students.

Materials and Methods

Tools of the study: Structural anthropometrical measurements and daily energy requirements record was used that showed high validity and reliability.

Study design: Non-experimental descriptive correlation design.

Sampling, location and sample size: Two systematic random samples of students were used in this study. One from school of nursing, Islamic university-Gaza (IUG), Gaza, and the other one from Palestine college of nursing (PCN), MOH, Khan Younus. The age range of these students was 18-22 yrs, assuming similarities in physical activities and standard living conditions in order to decrease confounding variables. The importance of this study was explained to the students through an assembly that was held after getting agreement from the dean of each college. All students chosen (96 from IUG, and 70 from PCN) agreed to participate in this study and registered in. At the end of the assembly weight of all registered students was measured to the nearest 0.5 kg using the same weighing scale . It should be mentioned that the major aim of the assembly in each college was to fill food intake record that was used in the other studies (Zabut and Aljeesh, 2005; Zabut and Habiby, 2005a,b) . When the students returned back their food intake records at specific date, their height to the nearest cm by using the same standiometer was also measured. The obtained data of weight, height and age to the nearest year were recorded in a specific record for every student. The response rate was 97% for nursing students at IUG and 87% for students at PCN.

Operational Definitions:

1. BMR based on body weight (Wt.) was calculated according to the equation (BMR = 70 x $Wt^{0.75}$) (Al-Mokhalalaty, 1997)
2. Energy of physical activities of the students was calculated roughly by multiplying BMR by 20% (Williams, 1994; Al-Mokhalalaty, 1997)
3. TDR was approximately as the sum of BMR and energy of physical activities of these students (Whitney *et al.*, 1990)
4. Body mass index from actual weight and height was calculated according to the equation (BMI = actual weight in kg /height in meters squared)
5. Predicted PFB was calculated according to Deurenberg *et al.* (1991) equation (PBF = (1.2x BMI) + (0.23 x age) – (10.8 x gender) -5.4 where, male gender = 1 and female gender = 0.

Table 1: Mean (SD) Body mass index and energy requirements of nursing students at IUG

Sex	BMI (SD)kg/m^2	BMR (SD)$_{(Kcal/day)}$	TDR$_{(Kcal/day)}$	r*
Male (N=56)	23.85 (4.06)	1700 (252)	2040	0.84
Female (N=37)	23.97 (4.51)	1506 (213)	1807	0.87
P-value	>0.05	<0.05		

*Pearson's correlation coefficient between BMI and BMR, P<0.01.

Table 2: Mean (SD) Body mass index and Body fat percentage of nursing students at IUG

Sex	BMI (SD) kg/m^2	PBF (SD)	r*
Male (N=56)	23.85 (4.06)	17.21 (4.82)	0.79
Female (N=37)	23.97 (4.51)	27.96 (5.41)	0.80
P-value	>0.05	< 0.05	

*Pearson's correlation coefficient between BMI and PBF, P<0.01.

6. Weight status of the students according to BMI was analyzed as the following: BMI values below 18.5, 18.5-24.9, 25.0-29.9, and 30.0 and above were considered underweight, normal, overweight, and obese respectively (WHO, 1995; and Calle *et al.*, 1999).

Data collection: BMR, approx. TDR, BMI, predicted PFB, and weight status analysis were calculated by researchers according to the operational definitions for every student and filled in his specific record.

Data analysis: From the student anthropometric measures , the average and standard deviation values of weight , energy requirements (in Kcal/day), BMI, PBF, and analysis of Wt status according to BMI were calculated using SPSS for window.

Student t-test was done in two directions at a significance level of 5 %, and any difference between two means was considered statistically significant if P value < 0.05.

Pearson's correlation coefficient was done at a significance level of 1 %, and any correlation between two ratio scale data was considered statistically significant if P value less than <0.01 .

The Chi-square test was done at a significance level of 5 %, and any difference between two nominal data was considered statistically significant if P value < 0.05 .

Data were assessed by comparing results of the both colleges with each other, by comparing anthropometric measurements with standard reference values and by comparing energy requirements with energy inputs of the students that estimated in the first study (Zabut and Habiby, 2005a,b).

Results

Table 1 shows average energy requirements, BMI, and (r) value between the two variables for nursing students at IUG. The average BMI of the male students was 23.85 (SD 4.06) Kg/m^2, and for female students of the same college was 23.97 (SD 4.51) Kg/m^2. The average BMR and approx. TDR for male students were 1700 (SD 252) Kcal/day and 2040 Kcal/day, and for female students were 1506 (SD 213) Kcal/day and 1807 Kcal/day respectively. Pearson's correlation coefficient between BMI and BMR was estimated to be 0.84, and 0.87 for males and females respectively.

Table 2 shows BMI, PBF, and Pearson's correlation coefficient between the two variables for the same students. Average PBF of males was 17.21 (SD 4.82) and for females was 27.96 (SD 5.41). The (r) values between BMI and PBF were calculated to be 0.79 and 0.80 for males and females respectively .

Moreover, analysis of Wt. status of the same students according to BMI is shown in Table 3. About sixty sex percent (66.1%) of male students had ideal weight whereas, 5.3% and 28.5% were underweight and overweight respectively. Three out of 56 male (5.3%) students were obese. For female students, the same table shows that 73 % had normal weight and 27 % had overweight. Three out of 37 (8.1%) females were obese.

Table 4 shows average energy requirements, BMI, and (r) value between the two variables for PCN in Khan Younus. The average BMI of the male students was 22.70 (SD 3.25) Kg/m^2. For female students of the same college the average BMI was 21.80 (SD 2.93) Kg/m^2. The average BMR and approx. TDR for male students were 1635 (SD 226) Kcal/day and 1962 Kcal/day, and for female students were 1470 (SD 152) and 1765 Kcal/day respectively. The (r) values between BMR and BMI of the same students were 0.82 and 0.90 for males and females respectively.

Table 5 shows BMI, PBF, and (r) between the two variables for the students at PCN. Average PBF for males was 15.64 (SD 3.90) and for females was 26.30 (SD 3.88). The (r) values between BMI and PBF were estimated to be 0.80 for the males and 0.77 for the females.

Analysis of Wt. status of students at PCN according to BMI is shown in Table 6. 72.2% of male students had ideal weight whereas, 5.6% and 22.2% are underweight and overweight respectively. Two out of 36 (5.6%) male students were obese. For female students, Table 6 also shows that 72% of these females had ideal weight, 4% had underweight and 24% are overweight. No obesity was observed between the females.

Student t test showed that there was a significant difference in BMR (Tables 1,4) and PBF (Tables 2, 5)

Table 3: Mean (SD) Weight and weight status analysis according to BMI of nursing students at IUG

Sex	Weight* (SD) (Kg)	Weight Status According to BMI**			
		Under No. (%)	Normal No. (%)	Over No. (%)	Sever No. (%)
Male (N=56)	70.6 (14.2)	3 (5.3)	37 (66.1)	13 (23.2)	3 (5.3)
Female (N=37)	58.9 (9.2)	0 (0.0)	27 (73)	7 (18.9)	3 (8.1)

*t- test (P-value <0.05) , **Chi-square test (P-value >0.05)

Table 4: Mean (SD) Body mass index and energy requirements of Palestine college of nursing

Sex	BMI (SD) kg/m^2	$BMR\ (SD)_{(Kcal/day)}$	$TDR_{(Kcal/day)}$	r*
Male (N=36)	22.70 (3.25)	1635 (226)	1962	0.82
Female (N=56)	21.80 (2.93)	1470 (152)	1765	0.90
P-value	>0.05	<0.05		

*Pearson's correlation coefficient between BMI and BMR, P<0.01.

Table 5: Mean (SD) Body mass index and body fat percentage of Palestine college of nursing

Sex	BMI (SD) kg/m^2	PBF (SD) (%)	r*
Male (N=36)	22.69 (3.25)	15.64 (3.90)	0.80
Female (N=25)	21.81 (2.93)	26.30 (3.88)	0.77
P-value	>0.05	<0.05	

*Pearson's correlation coefficient between BMI and PBF, P<0.01.

between both sexes where P value < 0.05. The test also showed there was no detectable significant difference in BMI values was observed between both sexes where P value > 0.05 (Tables 1, 4).

Applying, Chi-square test at a significance level of 5%, showed that there was independent relationship between sex and analysis of weight status according to BMI in both colleges, where P value > 0.05 (Tables 3, 6). The results also showed that small no. of students were underweight and was not considered a significant value at $\alpha = 0.05$.

Applying t-test for measuring the difference between average Wt, BMI, PBF, and BMR of male students (Table 7) and female students (Table 8) in the two colleges showed that there was only a significant difference between average body mass index for the females at $\alpha = 0.05$

Discussion

In this study average BMR, approx. TDR, BMI, and predicted PBF, were calculated for both male and female students at nursing colleges in Gaza strip . It was also correlated between BMI and energy requirements and between BMI and PBF for the same students. Moreover, during this study weight status of the students according to BMI was analyzed in order to identify percentage of nursing students who had abnormal weights.

Based on BMR, approx. TDR values of nursing students at IUG were 2040 and 1807 Kcal/day for males and females respectively (Table 1). In contrast to the first study (Zabut, and Habiby, 2005a,b) their average energy input values were 2310 kcal/day and 1740 Kcal/day for the males and females respectively.

In comparison with PCN, approx. TDR for the male and female students were 1962 Kcal/day and 1765 Kcal/day respectively (Table 4). In contrast, their average energy input values were 2250 (SD 352) for males and 1545 (SD 278) for females (Zabut, and Habiby, 2005a,b). These differences between energy input and energy output of the students were most probably due to errors in estimation of the energy that normally occur under these conditions (Whitney *et al.*, 1990).

Average BMI values of males and females at IUG were 23.85 (SD 4.06) and 23.97 (SD 4.51) Kg/m^2. Predicted PBF values calculation according to BMI, age, and gender were 17.21 (SD 4.82) and 27.96 (SD 5.41) for males and females respectively (Table 2). These results showed that females had significantly percent body fat more than males for the same BMI in agreement with those results reported before (Gallagher *et al.*, 1996).In contrast, male students in this college had significantly BMR more than female students for the same BMI (Table 1) due to the difference in their body weights.

Table 1 and 2 show a very strong correlation between BMI and BMR and between BMI and PBF ($p < 0.01$). According to the operational definitions these variables are quietly body weight dependent. Analysis of weight status according to BMI (Table 3) showed that 66.1% of male students and 73% of female students had normal weight. The study also showed that 28.5% of males and 27% of females were overweight. These results were consistent with the difference in their BMR, and PBF values. Thus, more than 25% of these students in the college might be at risk of diabetes, hypertension, CVD, and other chronic diseases (Calle *et al.*, 1999; Dudeja *et al.*, 2001).

BMI and predicted PBF for the males and the females students at PCN in Khan Younus were 22.70 (SD 3.25) kg/m^2, 15.64 (SD 3.90) and 21.80 (SD 2.93) kg/m^2, 26.30 (SD 3.88) respectively (Table 5). No significant difference between the BMI values of these students was also observed at $\alpha = 0.05$. The significance difference at the same significance level in the same college was observed between predicted PBF and BMR values (Tables 4, 5), which was consistent with those results

Table 6: Mean (SD) Weight and weight status analysis according to BMI of Palestine college of nursing

Sex	Average Wt* (SD) (Kg)	Weight Status According to BMI**			
		Under No. (%)	Normal No. (%)	Over No. (%)	Sever No. (%)
Male (n=36)	68.5 (10.4)	2 (5.6)	26 (72.2)	6 (16.6)	2 (5.6)
Female (n=25)	58.0 (8.1)	1(4.0)	18 (72.0)	6 (24.0)	0 (0)

*t- test (P-value <0.05) , **Chi-square test (P-value >0.05)

Table 7: Mean (SD) Wt, BMI, PBF, and BMR of nursing male students in Gaza Strip

Variable	Males (N=56) (IUG)	Males (N=36) (PCN)	p-value
Wt (Kg)	70.6 (14.2)	68.5 (10.4)	>0.05
BMI (kg/m)	23.85 (4.06)	22.69 (3.25)	>0.05
PBF (%)	17.21 (4.82)	15.64 (3.90)	>0.05
BMR (Kcal/mole)	1701(252)	1635 (226)	>0.05

Table 8: Mean (SD) Wt, BMI, PBF, and BMR of nursing female students in Gaza Strip

Variable	Females (N=37) (IUG)	Females (N=25) (PCN)	p-value
Wt (Kg)	58.9 (9.2)	58.0 (8.1)	>0.05
BMI(kg/m)	23.97 (4.51)	21.81 (2.93)	<0.05
PBF (%)	27.96 (5.41)	26.31 (3.88)	>0.05
BMR (Kcal/mole)	1506 (213)	1471 (152)	>0.05

obtained at IUG. Tables 4 and 5 show a very strong correlation between BMI and BMR and between BMI and PBF ($p < 0.01$). However, the strong correlation between BMI and with either BMR (Tables 1, 4) or PBF (Tables 2, 5) indicated that BMI is a good predictor of energy metabolism and overweight of the college students . BMI values of these adult students were different from those values of young adults reported in Western (Shetty and James, 1994) and Eastern societies (Ge, 1994).

Moreover, analysis of weight status according to BMI at PCN (Table 6) showed that 72% of students had normal weight and only 22.2% from males and 24% from females had overweight. No obesity was observed between female students in this college (Table 6). Thus, more than 20% of the nursing student at PCN might be at risk of chronic diseases (Calle *et al*., 1999; Dudeja *et al*., 2001).

No significant differences were also observed between average Wt, BMI, PBF, and BMR for the male students (Table 7) and for the female students except in BMI (Table 8). The significant difference in BMI may be due to difference in fat composition, although this difference was not shown by comparison of their PBF. However, analysis of Wt. status according to BMI (Tables 3 and 6) showed that 18.9% and 8.1% of female students of nursing college at IUG were overweight and obese respectively. In comparison with 24% of female students in Khan Youmus was overweight, and no obesity observed. This significance difference in BMI between the female students were consistent with results of the first study (Zabut and Habiby, 2005a,b). The previous study showed that there was a significant difference in fat intake between nursing female students at IUG and PCN. These significant differences in BMI and daily fat intake might be due to the difference in socio-economical conditions between Gaza and Khan Younus regions.

Conclusions: These results indicated that most of nursing students at Gaza Strip had normal energy requirements , BMI, and predicted PBF . Their BMI values were strongly correlated to their energy requirements and PBF values. Thus BMI can be considered a good predictor of energy metabolism and body composition. The results also showed that about 20 to 25% of the nursing students had overweight and thus might be at risk of cancer, cardiovascular disease, hypertension, diabetes, and other chronic diseases.

Recommendations: Assessment of nutritional status for adults in any population is considered a very important predictor of health status of this important group. Gaza Strip is very crowded area, and most people undergo from many social economical and political problems affecting their nutritional status. Accordingly, many adults had high risk of chronic diseases (Annual Health Report, 2004). The present study used representative samples and gave an indication about the risk of such diseases between adults in Gaza Strip. Therefore, It recommends studying the relationship between income, residence, culture, socio-economical conditions with energy requirements, weight status, body composition, and physical activity of all population groups in Gaza Strip.

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