

Prediction of Percent Body Fat and Energy Requirements of Preparatory School Children in the Gaza Strip.

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Abstract: This study was conducted to describe anthropometric measures of body fat and energy requirements of Prep. School children (PSC) aged 12-14 yrs in three different socioeconomical communities in the Gaza Strip (GS). It was also aimed to test whether body mass index (BMI) values are associated with energy requirements or socioeconomical factors among PSC in these communities.

Study sample was chosen purposively from three different socioeconomical communities in GS. These communities are Jabalia refugee camp (JRC), Gaza city (GC), and Al-Garrara village (GV). It was selected randomly from two largest preparatory schools (one for males and one for females) per each area and totally consisted of 680 PSC (350 males and 330 females). A structural and self-administered questionnaire about socioeconomical factors for each pupil in the sample was recorded. Data were analyzed by SPSS WIN program.

Mean values of BMI and percent body fat (PBF) for the male pupils in GC, JRC, and GV were 19.77 (3.62), 18.92 (3.12), 18.51 (3.41) kg/m² and 18.53 (5.40), 17.26 (4.64), 16.59 (5.04), respectively. On the other hand, mean values of BMI and PBF for female pupils in GC, JRC, and GV were 19.51 (4.00), 19.95 (4.00), 20.10 (2.81) kg/m², and 21.75 (5.97), 22.42 (6.01), 22.59 (4.14), respectively. Moreover, means of predicted total daily energy requirements (TDR) for the males in GC, JRC, and GV were 2540 (357), 2491 (315), 2415 (326) kcal/day and for the female pupils were 2220 (206), 2231 (215), 2225 (160) kcal/day, respectively.

Results also showed statistical significant differences in PBF or energy requirements between both sexes in the three different communities ($p < 0.05$). In contrast, a significant difference was not observed in BMI between both sexes in GC ($p = 0.62$).

The values of BMI of PSC and basal metabolic rate (BMR) of the female pupils lied within the corresponding reference values of WHO. In contrast, BMR for the males are slightly higher than the corresponding reference values. Moreover, BMI was strongly correlated with BMR in the three communities ($p < 0.01$).

The results also showed that there were significant differences ($p < 0.05$) in BMI or PBF or energy requirements among the males in GC and GV. In contrast, these significant differences were not observed with the other communities. Moreover, there were no significant differences in these variables for the female pupils in the three communities. BMI was found to be highly associated with father job in GC ($p = 0.02$).

Key words: Body fat, Energy requirements, Preparatory school-ged children., Socioeconomical factors.

تقدير نسبة الدهون الجسمية ومتطلبات الطاقة المفقودة لطلبة الإعدادية في قطاع غزة

ملخص: يهدف هذا البحث لدراسة بعض القياسات الجسمية التي تقدر من خلالها نسبة الدهون الجسمية ومتطلبات الطاقة المفقودة يومياً لطلبة الإعدادية (12 - 14 سنة) في ثلاث تجمعات اقتصادية مختلفة في قطاع غزة، كما يهدف لدراسة علاقة دليل الوزن بمتطلبات الطاقة المفقودة وبالعوامل الاقتصادية والاجتماعية لدى نفس الفئة من الطلبة.

اختيرت عينة الدراسة من ثلاث تجمعات اقتصادية واجتماعية مختلفة في قطاع غزة وهي مخيم جباليا ومدينة غزة وقرية القرارة، وذلك بطريقة عشوائية من أكبر مدارس إعدادية فيها (طلاب وطالبات)، تتكون العينة الكلية من 680 من الطلبة (350 ذكراً، و330 أنثى). عباً الطلبة نموذج استبانة القياسات الجسمية والعوامل الاقتصادية والاجتماعية، وتحليل بيانات هؤلاء الطلبة تم باستخدام برنامج الحزمة الإحصائية المعروفة باسم SPSS.

أظهرت النتائج أن دليل وزن الطلبة الذكور في مدينة غزة ومخيم جباليا وقرية القرارة هي: 19.77 (3.62)، 18.92 (3.12)، 18.51 (3.41) كيلو جراماً / متر مربع، ونسبة الدهون الجسمية هي: 18.53 (5.40)، 17.26 (4.64)، 16.59 (5.04)، على التوالي. وأظهرت النتائج أن دليل وزن الطلبة الإناث في مدينة غزة ومخيم جباليا وقرية القرارة هي: 19.51 (4.00)، 19.95 (4.00)، 20.10 (2.81) كيلو جراماً / متر مربع، ونسبة الدهون الجسمية هي: 21.75 (5.97)، 22.42 (6.01)، 22.59 (4.14) على التوالي. وأظهرت النتائج أن متوسط متطلبات الطاقة للذكور في مدينة غزة ومخيم جباليا وقرية القرارة هي: 2491 (315)، 2415 (326)، ولالإناث هي: 2220 (206)، 2231 (215)، 2225 (160) سعر حراري/يوم على التوالي. أظهرت الدراسة أيضاً أن هناك فروقاً ذات قيمة معنوية بالنسبة لدليل الوزن ومتطلبات الطاقة اليومية بين الذكور والإناث في التجمعات الثلاث ($p < 0.05$)، ماعدا غزة حيث لا توجد هناك فروق ذات قيمة بين الجنسين بالنسبة لدليل الوزن فقط ($p = 0.62$)، ومتوسط دليل الوزن ومتوسط الطاقة الأساسية للإناث يقع في مدى القيم القياسية لهذه الفئة العمرية على حسب منظمة الصحة العالمية، أما قيمة الطاقة الأساسية للذكور فهي أعلى بقليل من القيم القياسية المعمول بها في نفس المنظمة، وكذلك وجد أنه يوجد علاقة قوية بين متوسط دليل الوزن ومتوسط الطاقة الأساسية لهؤلاء الطلبة في التجمعات الثلاث ($p < 0.01$).

كما أظهرت النتائج أن هناك فروقاً ذات قيمة معنوية بالنسبة لدليل الوزن أو نسبة الدهون الجسمية أو متطلبات الطاقة اليومية بين الطلبة الذكور في مدينة غزة وقرية القرارة ($p < 0.05$)، ولم يلحظ ذلك بين ذكور مدينة غزة، وبين الطالبات في التجمعات الثلاث، ووجد أن دليل الوزن له علاقة قوية بوظيفة الأب في مدينة غزة ($p = 0.02$).

الكلمات المفتاحية: نسبة الدهون الجسمية، الطاقة المفقودة، طلبة الإعدادية، العوامل الاقتصادية والاجتماعية.

Prediction of Percent Body Fat and Energy Requirements

Introduction

The Gaza strip is an over populated area, about 1.5 million live in 365 km² where poverty level in this locality reached more than 70% last year [1]. Bad political conditions continuously characterize the Palestinian population. The socioeconomical conditions and modernization among Palestinian population in the cities differ from those in rural and camps communities. However, about 67% of the Palestinian population are refugees who depend primarily on the helps of UNRWA [1].

Adolescence is a significant period of human growth and maturation. It begins with puberty and includes those children of 10-19 years old. It is characterized by low prevalence of most infection and chronic diseases, but high health risks associated with sexual transmitted disease, drug abuse, pregnancy accidental and intentional injuries in the developed countries [2]. According to the WHO [3], adolescents comprise about 19% of the world's population (approximately 1.2 billion people), yet "adolescents remain a largely neglected, difficult-to-measure, and hard-to-reach population, in which the needs of adolescent girls in particular are often ignored".

Nutrition assessment evaluates a person's health from a nutrition perspective. Many assessment techniques have been developed to detect sign(s) of malnutrition which are dietary data, anthropometric measures, physical examination and biochemical analysis. Anthropometric measures include weight, height, BMI, etc. BMI provides a reliable indicator of body fatness for most people and is used to screen body composition in clinical and epidemiological studies [4-7]. However, 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 [8].

PBF in healthy subjects can be estimated by using numerous techniques such as total body electrical conduction, Bioelectrical impedance analysis, dual energy X-ray absorptiometry etc [9]. These methods are sophisticated and require well equipped research facilities to apply to large number of subjects, especially in developing countries. For routine clinically and epidemiological use, simple and readily available anthropometric measurements such as BMI are preferable variable for predicting body composition including PBF [4,7]. Nevertheless, many formulas, nowadays, are available to predict PBF, based on current BMI, age, and gender [10]. The prediction error of using BMI in estimation of PBF is comparable to prediction error obtained with other methods estimating PBF [11, 12]. The relation between fatness and BMI differs with age and gender. For example, women are more

likely to have higher PBF than men for the same BMI. It should be emphasized that degree of fatness, reflects the number and the size of fat cells-adipocytes-maturing up the adipose tissue. Body fat may account 15-30% of total body weight among males and 20-35% among females. It differs according to age, gender, and exercise [2].

BMR is defined as the rate of energy expenditure at completely rest in the post absorptive state after 12 hours overnight fast. It represents the energy needed to sustain the metabolic activity, plus the energy to maintain blood circulation and respiration in the awake state. BMR comprises 60%-70% of TDR upon sedentary activity. It can be measured by indirect calorimetric method or can be predicted directly on the basis of oxygen consumption or indirectly on the basis of anthropometric measures such as age, body area, weight and height [13-15].

The thermic effect of feeding (TEF) refers to energy expenditure associated with digestion, absorption, and increased sympathetic nervous system activity after eating a meal. This component accounts for approximately 5%-10% of TDR. Thus, for the purpose of rough estimation, TEF can be ignored because its value is less than errors in estimation of energy requirements[16]. Thus, TDR is roughly composed of two different components which are BMR and physical activity level (PAL) [13,14]. PAL is a result of mechanical work, such as exercise, muscle contractions, and maintaining posture; this accounts for 15%-50% of TDR or even more [13-15]. Nevertheless, amount of BAL depends on intensity, duration of activities, and body weight. Thus, it is the most variable component of the body energy expenditure.

There was one study about nutritional status and life style among school adolescents aged 12-15 yrs in the Gaza strip [17]. The study described obesity, stunting and anemia among 942 adolescents attending 10 preparatory schools in GC and the JRC.

Significance and objectives of the study: Although there are annual reports described malnutrition among children and pregnant women [18] as well as some studies about adults in GS and the West Bank [7,19], nutritional assessment of Palestinian adolescents as a group have been largely ignored. They are not only ignored by health care providers but also by health policy makers in spite of they represent about 25% of the Palestinian population [18]. Therefore, this study is aimed to describe BMI, PBF, and energy metabolism (BMR and TDR) of PSC in three different socioeconomical communities in GS. It also conducted to test whether BMI are associated with energy metabolism or socioeconomical variables among PSC in these communities.

Prediction of Percent Body Fat and Energy Requirements

Methods

Design and subjects: Cross sectional study was applied among PSC who aged 12 to 14 years old in GS. The total numbers of population of preparatory school children in GS was estimated to be 121,937 pupils [20].

Settings and Ethical considerations: The study communities (JRC , GC and GV) were selected purposively to match the criteria of differences in socio-economical status which were. Consent forms were obtained from Ministry of Education (MOE), Ministry of Health (MOH), Education Department of UNRWA, from each child and child's parents in the study sample.

Sampling and tools of the study: Two largest prep. schools (one for males and the other for females) were chosen from each community. In each school, the number of pupils was selected randomly from the three grades according to total number of PSC in each community in GS. Importance and nature of this study were explained to a head master of each school who participated in collecting randomly required number of pupils during a mid brake time. Most of the pupils collected were agreed freely to participate in this study and registered in. Then age, height and weight of the pupils were recorded. The same manual stadiometer and an electronic digital weighing scale were used for measuring the height and the weight of the pupils to nearest of 0.5 cm and 0.1 kg, respectively. Moreover, A short structural and self administered questionnaire about socioeconomical factors for each pupil in the sample was recorded by the help of their parents and brought it next day. Socioeconomical factors included parents job, parents education, and income. The final numbers of male and female pupils were 123, 116, 111 and 116, 110, 104 from JRC, GC, and GV, respectively. However, the overall response rate of the PSC was 97% (350 males and 330 females).

Operational definitions

-BMI = Wt in Kg/ Ht in squared meter.

-Predicted PBF of the pupils was calculated from BMI, age and gender according to the Deurenberg et al. [11] equation of adolescents ($PBF = (1.51 \times BMI) - (0.70 \times Age) - (3.6 \times gender) + 1.4$ where male gender = 1, and female = 0).

-BMR based on weight (Wt) and height (Ht) for the pupils were calculated according to Schofield's equations (BMR for the male pupils = $16.2 \times Wt + 137 \times Ht + 516$ and BMR for the female pupils = $8.4 \times Wt + 466 \times Ht + 200$) [21].

-PAL of the PSC was calculated roughly by multiplying BMR by 1.70 factor [15, 21].

-TDR \approx BMR + PAL [13,14].

Data Collection: Estimated energy requirements, BMI, and PBF were calculated according to the above operational definitions for every pupil in the study sample and filled in his/her specific record.

Data analysis: From the PSC anthropometric measures, energy requirements (Kcal/day), BMI, and PBF were calculated using SPSS WIN (Version 13). Student t-test, ANOVA test were carried out at a significance level of less than 5 %, for two and more than two numerical means, respectively. The cross tabulations and the Chi-square tests at a significance level of less than 5% were used to investigate the statistical association between BMI and socioeconomic factors. Pearson correlation coefficient (r) between BMI and BMR was done at 1 % significance level.

Data assessment: Data were assessed by comparing results of the three communities with each others and by comparing results of the total sample of PSC with standard reference values of the same age [22, 23].

Results

Table 1: Mean (SD) BMI, PBF, BMR and TDR among Prep. School children in the Gaza City.

Variable	Males (n=116)	Females (n=110)	P value
BMI(kg/m ²)	19.77 (3.62)	19.51 (4.00)	0.62
PBF	18.53 (5.40)	21.75 (5.97)	0.00
BMR (Kcal/day)	1494 (210)	1306 (121)	0.00
TDR (Kcal/day)	2540 (357)	2220 (206)	0.00

r (BMI and BMR) among the males = 0.87 (p<0.01) and among the females = 0.89 (p<0.01).

Table 1 shows mean and SD values of BMI, PBF and energy requirements in the Gaza City. BMI values for males and females were 19.77(3.62) and 19.51(4.00) kg/m² whereas PBF values were 18.53(5.40) and 21.75(5.97), respectively. Moreover, BMR and TDR were 1494(210), 2540(357) and 1306(121), 2220(206) Kcal/day for males and females, respectively. However, these results showed significant differences in PBF or energy requirement among both sexes (p<0.01). Surprisingly, no significant difference was observed in BMI among them in GC (p= 0.62).

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Table 2: Mean (SD) BMI, PBF, BMR and TDR of Prep. School children in Jabalia refugee camp.

Variable	Males (n=123)	Female (n=116)	P value
BMI(kg/m ²)	18.92 (3.12)	19.95 (4.00)	0.03
PBF	17.26 (4.64)	22.42 (6.01)	0.00
BMR (Kcal/day)	1465 (185)	1312 (126)	0.00
TDR (Kcal/day)	2491 (315)	2231 (215)	0.00

r (BMI and BMR) among the males = 0.87 (p<0.01) and among the females = 0.91 (p<0.01).

Table 2 illustrates that BMI (SD) values for PSC Jabalia refugee camp were 18.92(3.12) and 19.95(4.00) kg/m², whereas PBF means were 17.26 (4.64) and 22.42(6.01) Kg/m² for the males and the females, respectively. It also shows that BMR and TDR for the males were 1465(185) and 2491(315) Kcal/day, whereas they were 1312 (126) and 2231(215) Kcal/day for females in the same community. In contrast to GC, BMI among males and females in JRC was statistically significant (p= 0.03).

Table 3: Mean (SD) BMI, PBF, BMR and TDR of Prep. School children in Al-Garrara village.

Variable	Males (n=111)	Female (n=104)	P value
BMI(kg/m ²)	18.51 (3.41)	20.10 (2.81)	0.00
PBF	16.59 (5.04)	22.59 (4.14)	0.00
BMR (Kcal/day)	1421 (192)	1308(94)	0.00
TDR (Kcal/day)	2415 (326)	2225 (160)	0.00

r (BMI and BMR) among the males = 0.89 (p<0.01) and among the females = 0.90 (p<0.01).

In Al-Garrara village, BMI values were 18.51(3.41) and 20.10(2.81) kg/m² whereas PBF were 16.59(5.04) and 22.59(4.14) for males and females, respectively (table 3). In addition, BMR and TDR values were 1421 (192), 2415(326) and 1308 (94), 2225(160) Kcal/day for males and females, respectively. In contrast to GC, BMI among both sexes was also very statistically significant in this community (p<0.01).

Table 4: Mean (SD) BMI, PBF, BMR and TDR among Prep. School children in the Gaza Strip.

Variable	Males (n=350)	Female (n=330)	P value
BMI (kg/m ²)	19.07 (3.42)	19.85 (3.67)	0.005
PBF	17.47 (5.07)	22.25 (5.47)	0.00
BMR (Kcal/day)	1461 (197)	1309 (115)	0.00
TDR (Kcal/day)	2484 (336)	2226 (196)	0.00

r (BMI and BMR) among the males = 0.87 (p<0.01) and among the females = 0.88 (p<0.01).

Table 4 pointed out that the mean and SD values of BMI and PBF for the study male pupils were 19.07 (3.42) Kg/m², and 17.47 (5.07) whereas for the study female pupils they were 19.85 (3.67) Kg/m² and 22.25 (5.47), respectively. On the other hand, BMR and TDR values for pupils were 1461 (197) and 2484 (336) kcal/day and for the study female pupils were 1309 (115) and 2226 (196) kcal/day, respectively. All these variables were very significantly different between both sexes.

Comparing the BMI values of PSC with very recent reference Z-score values of WHO of the same age and sex [23], it was found that these values lied within the corresponding optimal rang (18.2-20.8 kg/m² in average). On the other hand, BMR values of the study PSC were also compared with those reference BMR values reported by WHO, and other organizations [22] which were 1418 and 1310 Kcal/day for adolescents boys and girls, respectively. It was found that BMR values for males are slightly greater than the corresponding reference value, whereas BMR values for females are identical to the reference value.

Table 5: Mean (SD) BMI, PBF, BMR and TDR among the males in the Gaza Strip

Variable	GC (n=116)	GV (n=111)	JRC (n= 123)	P value
BMI (kg/m ²)	19.77 ^a (3.62)	18.51 ^b (3.41)	18.92 ^{ab} (3.12)	<0.05
PBF	18.53 ^a (5.40)	16.59 ^b (5.04)	17.26 ^{ab} (4.64)	<0.05
BMR (Kcal/day)	1494 ^a (210)	1421 ^b (192)	1465 ^{ab} (185)	<0.05
TDR (Kcal/day)	2540 ^a (357)	2415 ^b (326)	2491 ^{ab} (315)	<0.05

Means of different superscripts differ significantly.

GC: Gaza City, GV: Al-Garrara village, JRC: Jabalia refugee camp.

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Applying ANOVA test (table 5) for measuring the differences between BMI or PBF or BMR and TDR among PSC in the three communities showed that there were significant differences between the males in GC and GV. These differences for males in JRC were not observed with the other communities.

Table 6: Mean (SD) BMI, PBF, BMR and TDR among the females in the Gaza Strip.

Variable	GC (n=110)	GV (n=104)	JRC (n= 116)	P value
BMI(kg/m ²)	19.51 (4.00)	20.10 (2.81)	19.95 (4.00)	>0.05
PBF	21.75 (5.97)	22.58 (4.14)	22.42 (6.01)	>0.05
BMR (Kcal/day)	1306 (121)	1308 (94)	1312 (126)	>0.05
TDR (Kcal/day)	2220 (206)	2225 (160)	2331 (215)	>0.05

GC: Gaza City, GV: Al-Garrara village, JRC: Jabalia refugee camp.

On the other hand, applying of ANOVA test for the adolescent females (table 6), showed that there were no significant differences between these variables in the three communities.

Table 7: BMI correlated with socioeconomical variables among Prep. School children in the three communities in the Gaza Strip.

Variables	GC		JRC		GV	
	F	M	F	M	F	M
F. Job	0.24	0.35	0.61	0.15	0.17	0.43
M. Job	0.43	0.82	0.95	0.08	0.16	0.75
F. Education	0.02*	0.14	0.09	0.11	0.65	0.63
M. Education	0.90	0.67	0.17	0.45	0.17	0.67
Income	0.70	0.22	0.10	0.08	0.20	0.91

***Significant (p< 0.05). GS: Gaza City, JRC: Jabalia refugee camp, GV: Al-Garrara village.**

Table 7 shows there was a strong association between BMI and father education in GC. Further associations were not observed between BMI and father education in other communities or between BMI and other socioeconomical factors among PSC in three communities in GS.

Discussion

Puberty is a period of rapid growth. Average growth rate of females aged 12-14 is more than males in the same age period. During the present study average BMI, BPF, BMR and TDR were estimated in order to describe body fat and energy metabolism of PSC in the Gaza strip. The significant differences in PBF or BMR among both sexes were observed in the three

communities. These findings were also observed among university adult students in the GS [7]. In contrast to the PSC in GV and JRC, no significant difference in BMI among both sexes was observed in the GC that might be explained due to low sample size that required further investigations.

In contrast to these findings, results of a similar study among intermediate school adolescents in Kuwait found that boys had more BMI than girls [24]. Social economical status differences between Kuwait and GS may be the main reason. On the other hand, BMI for the female pupils in GS was nearly similar to the mean of BMI among affluent adolescent school girls in the Bangalore city, India [25]. Moreover, the difference in BMI values in the present study between the male and the female pupils was in agreement with those studies carried out among elementary school aged children in the Tuzla, Bosnia [26], and the North West Province, South Africa [27].

The significant differences in PBF among both sexes were also observed during this study because sexual dimorphism in fat patterning was more observed among females. These findings were in agreement with similar studies carried out among Bahraini adolescents [28] and late primary school aged children in the Ankara, Turkey [29]. The male pupils in the three communities of the GS, in contrast, had significantly higher BMR and TDR than the female pupils. Similar BMR values was reported among both sexes in England [30]. In contrast, similar BMR values determined by indirect calorimetry using different equations including the Schofield's ones and reported higher BMR values among obese children (BMI > 28) for different ethnics [31].

The study findings also showed very strong statistical correlation between BMI and BMR among both sexes. Similar correlations between BMI and BMR were also observed among university adults in GS [7]. Thus, BMI is very related to energy requirements during puberty and adulthood.

There were no significant differences in BMI or PBF or energy requirements between the males in JRC with either GC or GV. The reason for the differences in these variables between the males in the GC and GV might be relate to differences in social-economical status between both communities. Previously, similar results were also observed among the university students in the GS [7]. Surprisingly, measuring the differences between the study anthropometric measures among females of PSC showed that there were no significant differences in BMI or PBF or BMR in the three communities. These final results as well as the effect of socioeconomical variables on BMI among PSC in GS communities required also further investigations.

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In conclusions, BMI was correlated with energy requirements among PSC in the GS. BMI of PSC and BMR values of female pupils lied within the corresponding reference values of WHO. In contrast, BMR values for males are slightly greater than the corresponding reference values. Statistical significant variations in BMI or energy requirements were observed among male pupils in GC and GV. No significant variations in these anthropometric variables were observed among male pupils in JRC with either community or among females in the three communities. Effect of socioeconomical variables on BMI among Palestinian communities required further investigation.

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