ORIGINAL ARTICLE

Comparison of energy intake and requirement of young students in Isfahan, Iran

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Background: Estimation of energy intakes is required for understanding of growth and disease in young students. This study was conducted to estimate the energy intake of young students and compare with their energy requirements. **Materials and Methods:** In this cross-sectional study, using simple random sampling, 400 students, aged 14–18 years, were selected in 2010. Hariss–Benedict equations were used to estimate the energy requirement of each group. **Results:** Mean and standard error of energy intake and requirements of males was 2155 ± 30 and 1670 ± 18, respectively, and of females was 2700 ± 21, 2300 ± 4 kcal, respectively. Differences of means, energy intake, and requirement in both sexes were significant ($P < 0.001$). **Conclusion:** Because of their age (14–18 years), which is called growth age, energy intake was lower than their needs

Key words: Energy intake, energy requirements, estimation, physical activity

INTRODUCTION

Energy balance is the biological homeostasis of energy in living systems, which is given as energy intake = internal heat produced + external work + storage. It generally uses the energy unit calorie, which equals the energy needed to increase the temperature of 1 kg of water by 1°C. This is about 4.184 kJ. Energy intake is mainly regulated by hunger and food energy of what is consumed. Energy expenditure is the sum of internal heat produced and external work. The internal heat is produced by basal metabolic rate (BMR) and the thermic effect of food (TEF). External work is estimated by physical activity level (PAL). Gaining energy imbalance is a result of energy intake being higher than what is consumed in external work and other bodily means of energy expenditure. The main preventable causes of overeating, are resulting in increased energy intake, resulting in decreased energy expenditure through external work. Gaining imbalance causes weight gain. In time, overweight and obesity may develop the resultant complications. Normal energy requirement, and intake, depends on age, sex, and PAL. One fairly accurate method is the Harris–Benedict equation.[1,2] The BMR is the minimal rate of energy consumption necessary to support all cellular functions and accounts for 50–70% of total energy expenditure (TEE) in humans. BMR is used routinely by clinicians for estimation of energy requirements (EER) in patient care as well as by governmental agencies and health organizations in defining population energy requirements.

Wong *et al*.[3] measured BMR by indirect calorimetric method after their subject rested motionless in a supine position for about 12 h. It takes about 20–30 min in a thermally neutral environment. Many clinicians derive a measurement of heat production in a metabolic chamber and also regression equations were used to predict energy needs in elderly measurement of relatively young, healthy Caucasian population .[4] Several authors have generated simple equations to estimate BMR in humans based on age, body weight, height, and gender. They recognized the significance of BMR in defining energy requirements.[5,4,11,3] These equations were formulated based on BMR. Many clinicians and health organizations applied BMR to estimate human energy requirements during 1919 and 1952.[5] They compared BMR values based on prediction.

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MATERIALS AND METHODS

Total energy expenditure

Traditionally recommendations of energy requirements were based on self-recorded estimate (e.g. 24-h recalls) of food intake. However, it is now well accepted that these methods do not provide

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accurate or unbiased estimate of person's energy intake and the underestimation of food intake is pervasive.[9] Since the proportion of malnutrition was unknown, using sample size formula for estimating proportions with confidence coefficient of 95% and error of 0.049, sample size was derived to be about 400. Since the prevalence of obesity in high-school students aged 14–16 is about 6%, this special group was selected.

Collection of data

In this cross-sectional study, the sample size needed for each sex group was determined. Simple random sampling was applied. A questionnaire was distributed to obtain the energy intake of 14-18 year old students from Isfahan's high school in 2010 to collect information on their food consumption. The number of students was 200 males and 200 females, who completed the 24-h dietary recall questionnaire, for which the test retest reliability was r = 0.59[12] and validity was calculated following the method of Greger.[7] The amount of food consumed per week, such as milk, fruit, vegetable, meat, bread, sugar, fat, chocolate, and junk foods, was found. The height and body weight of participants in both genders were measured. Mean energy requirements of each sex group were estimated by multiplying specific coefficients (allocated to each group). The individual dietary assessment was made and total energy intake (TEI) was calculated. The level of TEI was confirmed by studies using the doubly labeled water technique which measures TEE to assess the accuracy of estimated energy intake.[12] TEE was calculated based on three important factors including BMR or resting energy expenditure (REE), physical activity (PA), and the TEF, which is the energy spent on digestion and metabolism of food.[10]

Estimated energy requirement

The National Academy of Sciences, Institute of Medicine, and Food and Nutrition Board in partnership with Health Canada, developed the EER for males, females, children, infants, and for pregnant and lactating women.[7] The EER is defined as an average dietary energy intake which is predicted to maintain energy balance in a healthy adult of a defined age, gender, weight, height, and level of PA consistent with good health.[10]

PAL was defined in terms of three levels of PA – light, moderate, and high levels. The minimal activity level was set at 1.55 ´ BMR and 1.56 ´ BMR for males and females, respectively.[2] On the other hand, the highest activity level was defined as 2.10 ´ BMR for males and 1.82 ´ BMR for females. Usually the Hariss–Benedict equation was used to estimate BMR and finally estimate EER, but here directly, modified Hariss–Benedict equations were used to find EER for males and females, which are:

$$EER_{male} = 662 - 9.53 \times age_{(years)} + PAL \times (15.91 \times weight_{(kg)} + 539.6 \times height_{(m)})$$

and

$$EER_{female} = 354 - 6.91 \times age_{(years)} + PAL \times (9.36 \times weight_{(kg)} + 726 \times height_{(m)}),$$

respectively. PAL was defined as sedentary (PAL = 1), low active (PAL = 1.11), active (PAL = 1.25), and very active (PAL = 1.48).[2] Also, EER was reported for adults based on ideal weight of WHO/FAO and body mass index (BMI).[9]

Statistical analysis

At first, we used a descriptive statistics of important variables, such as age, height, weight, and BMI, and also we used an independent *t*-test to compare EER, TEI, BMR, and TEE in each sex group. Secondly the difference of TEE and EER in males and females was tested. Results were expressed as means ± standard error and testing hypothesis of equality of means. Data analysis was performed with the Statistical Package for Social Sciences (SPSS, version 16) software.

RESULTS

Age, body weight, and height of our respondents are summarized in Table 1. The mean age of females was higher than that of males ($P < 0.001$). Also, the mean weight of males was significantly different from that of females ($P < 0.001$). The results of study showed that males were significantly taller than females ($P < 0.001$).

Table 2 shows the descriptive statistics of EER, TEI, BMR, and TEE, and also comparison of each item among males and females. Table 3 shows the estimated energy intake, energy requirement, and comparisons of its difference in men and women ($P < 0.001$).

Table 1: Mean and standard error of age, weight, height and sample size of men and women

Variable	Men (*n*=200)	Women (*n*=200)	*P* value*
Age	15.5 ± 0.49	16.5 ± 0.28	<0.001
Weight	53.8 ± 0.93	52.6 ± 0.29	<0.001
Height	165.6 ± 0.66	159.8 ± 0.21	<0.001

*t-test

Table 2: Mean and standard error of EER, TEI, BMR, TEE and TEE-EER

Variable	Men (*n*=200)	Women (*n*=200)	*P* value
EER	2700 ± 21.36	2300 ± 4.63	<0.001
TEI	2155 ± 30.7	1670 ± 18.7	<0.001
BMR	1532 ± 14.9	1363 ± 2.9	<0.001
TEE	2864.3 ± 85.7	2548 ± 18.7	<0.001
TEE-EER	164.3 ± 30.2	248 ± 19.26	<0.001

EER: Estimated energy requirement; TEI: Total energy intake; BMR: Basal metabolism requirement; TEE: Total energy expenditure

Table 3: Mean and standard error of TEI and TEE in men and women

Sex	TEI ± SE	TEE ± SE	95% C.I. of difference	*P* value
Men	2157.5 ± 30.3	2698.5 ± 42.5	(−613.01, −471.21)	*P*<0.001
Women	1682.2 ± 42.1	2293.1 ± 9.9	(−699.1, −552.1)	*P*<0.001

DISCUSSION

Average calorie intake was provided by Institute of Medicine in three categories: sedentary, moderately active, and active, for boys and girls aged 14–18 years. The approximate calorie based on EER has been reported by Institute of Medicine. The present study compared TEE as estimated by traditional recommendations made for energy requirements based on self-reported data.[8] These estimates are calculated by Hariss–Benedict equations.[6,7,2] One of the main findings of the present study was statistically significant differences obtained between TEE and EER in the participants of both sexes. The equations only consider body weight, age, and gender to predict EER and exclude other important factors such as body composition (FAO/WHO/UNU).[2] It is also important to consider that the PAL has been used to determine the EER in the Canadian population. In accordance with the Canadian population, their results are not adapted to real level of PA in the Canadian population, especially in active Canadian females. In their context, PA proposed by the FAO/WHO/UNU procedures (PAL = 1.25) leads them to a false estimation of active Canadian subjects because of errors in the estimation of PAL. On the other hand, as described above, they used PAL = 1.25 for Canadian population subjects, and it is possible that EER is overestimated by equations.[2]

It is concluded from Table 3 that energy intake of a young student is much lower than their requirement, and it seems to be because of being in the growing age of 14–18 years. Probably if we do similar research in adults, it would be vice versa.

Limitations

This study has several limitations. Firstly, TEE was not measured directly. Secondly, EEI was approximate. Since it was estimated based on self-report of food intake based on their memory, it might be a lower estimate or a higher estimate than the actual value.

Implications

This study has one implication for calcinations and nutrition therapist to predict EER based on weight and height of subject easily and predict EER and compare these with TEI.

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