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Original Research Article

Daily food intake in adolescents: Relation to parameters of physical fitness and weight status

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ARTICLE INFO

Article history:
Received 5 February 2013
Accepted 4 June 2013
Available online 14 June 2013

Keywords:
Daily food intake
Physical fitness
Body mass index
Children
Adolescents

ABSTRACT

Introduction: Balanced nutrition and good physical fitness are the essential parts of a healthy growth and development of children and adolescents. Furthermore, these are the key factors in the prevention of overweight and obesity.
Aim: The aim of the study was to examine daily food intake of adolescents aged 11–14 years and to assess the parameters of physical fitness and weight status among different genders.
Material and methods: The study included 65 adolescents aged 11–14. Data were collected by a 24-h diet recall interview, the European physical fitness test battery (Eurofit) and the assessment of body mass index (BMI), based on body height and weight measurements.
Result: In total, in 64.0% of boys and 62.5% of girls daily energy intake was too low. There was a serious calcium and iodine deficiency and a deficiency of some vitamins (vitamin A and vitamin D) in adolescents. The total score of physical fitness ranged from 3.2 to 5.8. The evaluation of body weight indicated that 9.2% of adolescents were underweight, 23.1% were overweight and 3.1% showed obesity.
Discussion: The assessment of energy expenditure needs to be included in studies for more accurate evaluation of energy balance and relation to weight status. Results on physical fitness in relation to weight status are controversial.
Conclusions: Daily food intake of adolescents is not balanced and with sufficient nutrients. Flexibility was the weakest parameter of physical fitness. The remaining parameters of physical fitness were satisfactory. Only 64.6% of adolescents were classified as normal weight.

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1230-8013/$ – see front matter
http://dx.doi.org/10.1016/j.poamed.2013.06.001

1. Introduction

Childhood and adolescence is a period of rapid growth and development. Both are influenced by nutrition and physical activity, which therefore play a particularly important role during this phase of life. It is important for young people to have knowledge on nutrition in relation to physical activity, good health and improved quality of life, and that good habits are deeply embedded. This plays a particularly critical role considering the trends in childhood obesity across Europe.[15]

Obesity is the most frequent type of malnutrition in developed countries. The prevalence of excess body fat has increased enormously over the last few years, both in children and adults. This dramatic rise has reached epidemic proportions in almost all regions of Europe, North America and Australia. Depending on the demographic origin, population characteristics and definition criteria, epidemiological data show the prevalence of overweight/obesity in children and adolescents ranges between 15% and 25%. Furthermore, the risk of becoming obese seems to be currently on the increase.[9]

Obesity results from an imbalance between energy intake and expenditure.[11] A fundamental principle of nutrition and metabolism states: a change in body weight is associated with an imbalance between energy density of diet and energy expended on life-sustaining processes and physical activity.[7]

Obesity is associated with a variety of health problems, as well as physical (cardiorespiratory endurance, flexibility, muscle strength, muscle endurance and body composition) and motor proficiency (fine manual control, manual coordination, body coordination and strength-and-agility).[12]

Cross-sectional studies have documented the relationship between physical activity, physical fitness and health with a number of cardiovascular risk factors present already in childhood and adolescence.[14] Similarly, longitudinal studies have shown that the degree of physical fitness during childhood and adolescence may determine physical fitness of the subject in adulthood. In addition, poor physical fitness during these stages of life seems to be associated with the presence of cardiovascular risk factors such as hyperlipidemia, hypertension and obesity at a later age.[3]

The effectiveness of prevention of obesity and overweight among children and adolescents depends on early diagnosis, which involves screening in elementary, middle and high schools, as well as the implementation of effective prevention programs and education.[2]

2. Aim

The aim of the study was to examine daily food intake of adolescents aged 11–14 years and to assess the parameters of physical fitness and weight status among different genders.

3. Materials and methods

The study included 65 adolescents (25 boys and 40 girls) aged 11–14 (12.7 ± 1.1 years). The study was conducted in May 2012 at Utena Vyturiai Basic School.

3.1. *Daily food intake assessment*

The 24-h dietary recall interview was used to assess daily food intake. The 24-h dietary recall interview provides estimates of the intake of total daily energy, nutrients and no-nutrient dietary components, as well as dietary behaviors regarding type, quantity and time of each food and beverage consumption. In the interview, respondents reported all foods and beverages consumed in a prior 24-h period (midnight to midnight).

Chemical composition of food was analyzed using food composition databases. The collected data were coded and analyzed with a dietary assessment software. The results were compared with the daily nutrient recommendations for the corresponding age and gender of respondents.[10]

3.2. *Physical fitness assessment*

The European physical fitness test battery (Eurofit)[1] was used to assess physical fitness. Five tests that measure various components of fitness were performed: flamingo balance (general balance), sit and reach test (flexibility), standing-broad jump (explosive strength), sit-ups (trunk strength and endurance), and 10×5 m shuttle run (speed and agility). Results were assessed according to the Lithuanian Eurofit reference scales. Different components of physical fitness were analyzed as the number of fitness tests passed (scale ranging from 0 to 10).

3.3. *Weight status assessment*

Weight status was assessed in anthropometric measurements. Body height and weight were measured to calculate body mass index (BMI). Results were interpreted with the use of percentile charts for children.[4]

3.4. *Statistical analysis*

Statistical data analysis was performed with IBM SPSS Statistics for Windows, version 20.0. Results are presented as mean ± SD, minimum to maximum. Differences between groups were tested for statistical significance with Student's t-test. Statistical significance was set at $p < .05$.

4. Results

The analysis of daily food intake in adolescents aged 11–14 years of both genders showed that girls usually consume 1646.7 ± 718.1 kcal/day (recommendations for girls – 2200 kcal/day), boys consume slightly more – 1740.6 ± 770.0 kcal/day (recommendations for boys – 2420 kcal/day) (Table 1). This indicates that daily nutrition does not provide a sufficient amount of energy for adolescents: daily energy intake was too low in 64.0% of boys and 62.5% of girls. However, in 3.0% of boys and 10.0% of girls quantity of food calories consumed was too high.

The analysis of key nutrients in diet revealed that nutrition of most adolescents is not balanced. It was found that fat intake in both genders often exceeded the recommendations: 25% of girls and 20% of boys consume too much fat per day. Although

carbohydrates should be the main source of energy, daily food intake of most adolescents does not provide sufficient amounts of carbohydrates: among boys even 76.0% consume insufficient amounts of carbohydrates, among girls – 67.5%. Protein intake of most adolescents does not meet the requirements as well: in 60% of boys and 75% of girls dietary protein was insufficient.

A lack of some minerals and vitamins in adolescent daily food intake was observed (Table 2). The results revealed a serious deficiency of calcium (435.9±80.9 mg/day, recommended – 800 mg/day) and iodine (41.7±8.8 μg/day, recommended – 150 μg/day) in diet. Intakes of other micronutrients were also estimated to be inadequate, but closer to the recommended amounts.

In addition, adolescent nutrition is low in some vitamins, such as vitamins A and D. Vitamin A intake is particularly low in boys – average consumption of vitamin A was only 133.0±77.0 μg/day, with a recommended amount of 1000 μg/day. Vitamin D deficiency in daily nutrition was observed in both gender groups – vitamin D consumption was only 0.35±0.1 μg/day (recommended – 5 μg/day). Amounts of vitamin C and vitamin E were adequate in adolescent daily food intake.

The assessment of physical fitness showed that the total score of physical fitness ranged from 3.2 to 5.8, which is classified as bad, poor and satisfactory. Results of the Eurofit test battery for both genders were worst in the sit and reach test: girls reached 16.1±3.7 cm, boys – 15.4±3.3 cm, which is classified as 3.6 score (Table 3). Among boys low results were also achieved in the 1×5 m^2 shuttle run test: their speed and agility was estimated at 21.6±1.0 s (4.2 score), while girls achieved – 21.8±1.2 s (5.8 score). The other parameters of physical fitness were classified as satisfactory: general balance – 5.5 score, explosive strength – 5.3 score, trunk strength and endurance – 5.5 score.

Anthropometric measurements demonstrated that girls weight ranges from 31 kg (11 years of age) to 79 kg (14 years of age), height – from 141.0 cm (11 years of age) to 174.0 cm (14 years of age). Boys weight ranges from 31 kg to 69 kg, height – from 139.0 cm to 177.5 cm (Table 4).

The evaluation of weight state with the use of percentile charts for children[4] showed that only 64.6% of adolescents had normal BMI (72.0% of boys and 60.0% of girls), 9.2% of adolescents had insufficient weight (8.0% of boys and 10.0% of girls), 23.1% were overweight (20% of boys and 25% of girls) and 3.1% were obese (0% of boys and 5% of girls).

5. Discussion

Results of the study confirm that adolescent nutrition does not provide sufficient amounts of energy, minerals and vitamins. Furthermore, there are many teenagers with abnormal body weight. Studies also show a growing tendency for replacing

Table 1 – Amounts of nutrients and energy value in daily food intake of adolescents aged 11–14 years.

Nutrients and energy value	Girls			Boys		
	Minimum–maximum	Mean±SD	Recommendations	Minimum–maximum	Mean±SD	Recommendations
Protein, g	13.9–103.7	54.0±23.1	70	21.0–252.4	68.5±46.0	75
Fat, g	9.9–182.6	59.1±35.4	75	27.6–164.8	64.3±33.3	80
Carbohydrate, g	46.0–416.0	219.6±98.2	311	59.0–495.0	219.2±115.8	350
Energy value, kcal	455.5–3689.0	1646.7±718.1	2200	673.2–3734.0	1740.6±770.0	2420

Table 2 – Amounts of minerals and vitamins in daily food intake of adolescents aged 11–14 years.

Minerals and vitamins	Girls		Boys	
	Mean±SD	Recommendations	Mean±SD	Recommendations
Calcium, mg	407.6±107.4	800	481.3±178.5	800
Magnesium, mg	211.4±36.4	300	231.1±75.5	350
Phosphorus, mg	840.7±141.9	1200	974.0±264.1	1200
Iron, mg	14.1±4.7	18	13.4±4.3	12
Iodine, μg	35.3±7.1	150	52.1±21.0	150
Zinc, mg	6.3±0.7	12	7.9±2.5	15
Vitamin A, μg	301.0±294.0	800	133.0±77.0	1000
Vitamin B_1, mg	0.8±0.2	1.1	1.1±0.3	1.4
Vitamin B_2, mg	1.0±0.3	1.3	1.0±0.3	1.6
Vitamin PP, mg	10.0±1.9	13	10.5±3.1	16
Vitamin C, mg	76.1±30.7	50	77.4±64.9	50
Vitamin D, μg	0.3±0.1	5	0.4±0.3	5
Vitamin E, mg	9.0±3.0	8	9.9±2.4	8
Vitamin B_6, mg	1.5±0.3	1.5	1.8±0.5	1.7
Vitamin B_{12}, μg	3.6±2.7	3	2.7±1.1	3

Table 3 – Mean values of physical fitness parameters in adolescents aged 11–14 years in relation to gender.

Gender	General balance		Explosive strength		Trunk strength and endurance		Speed and agility		Flexibility	
	n/min	Score	cm	Score	*n*/30 s	Score	s	Score	cm	Score
Girls	10.3*±2.8	5.8	161.6±13.2	5.4	24.7*±2.5	5.6	21.8±1.2	5.8	16.1±3.7	3.2
Boys	11.6*±2.8	5.2	175.6±23.7	5.2	26.2*±3.6	5.4	21.6±1.0	4.2	15.4±3.3	4.0

* $p<0.05$.

Table 4 – Anthropometric characteristics of adolescents aged 11–14 years in relation to gender.

Age, years	Girls			Boys		
	Weight, kg	Height, cm	BMI, kg/m^2	Weight, kg	Height, cm	BMI, kg/m^2
11	38.5±7.9	150.0±7.0	17.2±4.0	38.0±3.5	150.3±4.2	16.8±1.6
12	45.1±9.6	153.9±8.1	19.0±3.5	38.2±7.1	152.9±7.1	16.3±1.8
13	48.0±11.0	159.8±6.1	18.7±3.8	55.1±5.6	165.1±8.0	20.2±2.1
14	51.1±10.2	164.5±5.9	18.8±3.7	62.2±6.4	168.1±6.4	22.2±3.3

animal fats (mainly milk fat) with vegetable fats, which is a matter of concern.[8]

The study on energy intake, energy expenditure, diet composition and obesity of adolescents in Northern Greece (11–14 years of age) showed that 31% of boys and 21% of girls were overweight. Overweight adolescents of both genders (boys – 2290±930 kcal/day, girls – 1720±689 kcal/day) reported a lower energy intake than the non-overweight subjects (boys – 2465±858 kcal/day, girls – 2062±652 kcal/day). Calculated energy expenditure (kcal/day) was found significantly higher in the overweight subjects. Overweight children had a higher negative energy balance.[6] Therefore, the assessment of energy expenditure needs to be included in studies for more accurate evaluation of energy balance and relation to weight status.

The assessment of physical fitness of adolescents revealed that general balance, explosive strength, trunk strength and endurance were satisfactory, while flexibility of both genders and speed and agility of boys were poor.

Results of the study on the relationship between obesity and motor and physical development in 10–12-year-old South African children demonstrated that the physical fitness variables, cardiorespiratory endurance and muscular strength (particularly leg muscular strength) decreased significantly as BMI increased. A progressive but insignificant decrease was found in muscular endurance with an increase in BMI, while flexibility showed the weakest relationship to BMI. The motor variables strength-and-agility weakened significantly with an increase in BMI, while fine manual control, manual coordination, and body coordination showed the weakest relationships to BMI. Variance analysis showed further significant relationships among BMI, cardiorespiratory endurance, muscular strength, and running speed-and-agility.[13]

In another study, various aspects of physical fitness and physical activity were assessed in obese and non-obese Flemish youth. It was found that obese subjects had poorer performances in weight-bearing tasks, but did not have lower scores in all fitness components.[5]

Results of the studies on the relation of physical fitness to weight status are controversial, therefore further researches are necessary.

6. Conclusions

1. Daily food intake of adolescents aged 11–14 years is not balanced and with sufficient nutrients. Inadequate nutrition was more frequent among girls.
2. Flexibility was the weakest parameter of physical fitness in both genders of adolescents aged 11–14 years. The remaining parameters of physical fitness (general balance, explosive strength, trunk strength and endurance) were satisfactory.
3. Only 64.6% of adolescents had normal weight. Insufficient weight, overweight and obesity were more frequent among girls.

Conflict of interest

The authors have no conflict of interest.

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