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Dietary Fat Intake, Micronutritient and Obesity among Adolescent in Tlemcen (Western Algeria)

Meryem Allioua[1], Rabah Djaziri[2], Moustafa Yassine Mahdad[3], Semir Bechir Suheil Gaouar[3], Harek Derradji[4], Boumediene Moussa Boudjemaa[1], Slimane Belbraouet[5]

[1]Laboratory of Applied Microbiology in Food in Biomedical and Environmental (LAMAABE), Department of Biology, Faculty of Natural Science and Life, University of Tlemcen, Tlemcen, Algeria
[2]Laboratory of Antibiotic and Antifungal Physico-Chemistry, Synthesis and Biological Activity (LAPSAB), Department of Biology, Faculty of Natural Science and Life, University of Tlemcen, Tlemcen, Algeria
[3]Laboratory of Pathophysiology and Biochemistry of Nutrition (PPABIONUT), Department of Biology, Faculty of Natural Science and Life, University of Tlemcen, Tlemcen, Algeria
[4]National Institute of Agronomic Research (INRA) Algiers, Algiers, Algeria
[5]Ecole de Nutrition, Université de Moncton, Moncton, Canada
Email: slimane.belbraouet@umoncton.ca

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Abstract

Background: A number of epidemiological studies around the world have shown that the occurred and the high prevalence of some chronic diseases such as diabetes, obesity, cardiovascular disease, etc. are mainly caused by a high calorie and unbalanced diet associate with reduced physical activity. In Algeria, as in many emerging countries to improve the standard of living of the population and changes in lifestyle, more westernized characterized by abundant food and sedentary lifestyle especially among young people contribute to the increased incidence of these chronic diseases. Objectives: This work consists of a dietary survey conducted among adolescent boys and girls in Tlemcen (Algeria). Subject and Methods: This is a descriptive cross-sectional study of dietary intake of adolescent aged 10 - 17 years and anthropometric parameters: weight, height, body mass index. Results: Increased fat intake was associated with increased body mass index in both sexes, increased obesity and abdominal obesity in girls, boys are more active than girls and we observed decreased intake of sugar, the nutritient adequacy ratio of folate, niacin, vitamin B6, iron, magnesium. Conclusion: The early prevention of obesity in children and adolescents is essential in the prevention of chronic diseases in adults. We recommended adolescent by healthy diets towards helps regulate their body weight and reduces the risk of cardiovascular disease and some types of cancer and especially the girls by lifestyle more active.

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Keywords

Adolescents, Fat Intake, Micronutrient, Body Mass Index, Obesity

1. Introduction

Human food preferences tend to favor foods with both fats and sugar [1], high energy dense diets could increase the prevalence of obesity and abdominal obesity [2] and low energy dense diets could reduce weight and waist circumference [3]. An elevated body mass index in adolescence—one that is well within the range currently considered to be normal—constitutes a substantial risk factor for obesity-related disorders in midlife [4] and diet in this period is an important modifiable risk factor in the prevention of obesity and the development of chronic diseases such as cardiovascular disease and cancer in adulthood [5] [6]; early prevention of childhood and adolescent obesity is critical in prevention of adult coronary vascular disease [7] [8]. In Algeria, in 2012 the proportion of deaths (% of all deaths, all ages, both sexes) is 41% of cardiovascular diseases, 10% cancers, 7% diabetes, which obesity includes (22.4% women and 9.6% men) of risk factors [9]. The dietary fat intake of children and adolescents plays an important role in their growth and development, and also has a long-term effect on adult health. For this reason, both quantity and quality of dietary fat are important [10], since the 1980s many bodies and organizations have published recommendations regarding fat intake [11], Lipids should provide 30% - 35% of total energy intake with less than 10% of saturated fatty acids, Cholesterol ≤ 300 mg [12]. Fat is the most energy dense macronutrient and has a less satiating effect than protein or carbohydrates [13], and overconsumption has been linked to obesity, cardiovascular disease, non-insulin dependent diabetes [14]. Obese people prefer foods high in fat [15], obese adolescents tend to move towards a high-energy food, sweet-fatty or salty-fatty; and absorb excessive sodas which unbalance torque hunger/satiety [12]. Childhood obesity has more than doubled in children and quadrupled in adolescents in the past 30 years in USA [16]. In Algeria, Overweight reached 13.7% and obesity 3.2% in adolescents 13 to 15 years [17].

Dietary practices established during adolescence can be difficult to change in future years [18], recognizing the pattern of food consumption in adolescents is one of the most important in designing appropriate programs of research priorities and implementing effective approaches to improve the health status [19]. In Algeria, the information is limited on diet and health status of adolescents compared to children [20]; for this reason, we conducted this study to examine the relationship between nutritional intake based on fat intake and obesity in adolescents and to suggest recommendations to improve adolescent health and then to prevent disease in adulthood.

2. Subjects and Methods

2.1. Subjects

This is a descriptive cross-sectional study of the qualitative and quantitative variables. The research was conducted from December 2011 and June 2012. The target population was adolescents (boys and girls) from 10 to 17 years the intermediate cycle, in the public schools of Tlemcen. In advance, adolescents and their parents were informed about the objectives and methods. Written informed consent was taken from each student and a parent, it was finally selected 718 (52% girls and 48% boys); in this study we randomly selected some regions from among all the regions of Tlemcen. We tried to include different regions with different socio-economic status. Then, some schools were randomly chosen from selective regions. The list of student records was obtained from each school and the students were randomly selected. All students aged 10 to 17 years were eligible to participate in the study unless they were on a specific diet.

2.2. Anthropometric Assessment

Measured by school nurse, body weight was measured to a precision of 100 g, with minimal clothing and without shoes, using a calibrated portable scale. Height was measured by a stem cell calibrated measurement with a precision of 1cm; the subject was standing without shoes. The body mass index BMI was calculated by the formula: body weight (kg) divided by height square in meters. The classification of nutritional status was determined according to the IOTF international criteria [21]. Adolescents were defined as obese if they had a percen-

tile BMI-25, and adolescents with BMI-30 percentile were defined as overweight. Waist circumference was measured by a inextensible tape with a precision of 0.1 cm (with arms hanging relaxed along the body), waist circumference was measured halfway with a measuring tape between the edge of the lower rib margin and the iliac crest. Waist circumference is classified by the criteria of HD Mc Charthy *et al.* 2001 [22]. Waist circumference with moderate risk ≥ 90th percentile and waist circumference with high risk ≥ 95th percentile.

2.3. The Assessment of Dietary Intakes

The dietary assessment was based on the 24-hour recall (3 days including a weekend day) assisted by food records. We asked participants to specify certain type or brand of food, for example: type of milk (whole, low fat or skim), type of meat consumed (boiled, fried, or grilled). There were open questions for some food products, such as type of fruit, vegetables and snack. Nutrients adequacy ratio was calculated by dividing daily individual intake to dietary recommended intake [23] for each nutrient. The P/S is calculated by dividing the polyunsaturated fatty acids/saturated fatty acids.

2.4. Determination of Physical Activity

Data collected from the global physical activity questioner GPAQ analysis guide and WHO steps instruments for chronic disease risk surveillance [24].

3. Statistical Analysis

We used USDA's nutritient database for Nutrinux® program to analyze dietary intake. GenStat discovery 03 was used to conduct the statistical analysis. Groups were formed according to the quartile of total fat as percentage of energy intake. Cut points for quartiles were: 1st: Q1 < 30%, 2nd: 30% ≤ Q2 ≤ 35%, 3rd: Q3 > 35%. Chi-square test was used for evaluating the prevalence of overweight, obesity, and abdominal obesity across de consumption of lipids quartiles. To compare the variations of continuous variables across quartiles of fat intake, we used analysis of variance ANOVA, and comparison of means was performed by using Duncan's test for significance level $\alpha = 0.05$.

1-There are only one *P* value: There is one factor of comparison which is the increased percentage in the consumption of fat and the comparison is done between the three groups Q1 Q2 Q3 and its relationship with:

Table 1: anthropometric characteristics,

Table 2: Mean energy, macronutrient and fatty acids intake

Table 3: Mean nutrient adequacy ratio

2-The significant difference among each group was presented using different superscript characters (a, b) was well explained:

a, a, a: there is no difference

a, b, c: all the parameters are different

a, a, b: there is some rapprochement between parameters 1 and 2 and the parameter 3 are different, and so on…

4. Results

Anthropometric characteristics of adolescents across quartiles of percentage energy from total fat intake are presented in **Table 1**. A significant increase in age, weight, obesity and abdominal obesity in the higher quartiles in girls ($P = 0.004$, $P = 0.008$, $P = 0.002$, $P = 0.010$) was observed respectively. On the contrary, it was not a difference in boys. BMI increased significantly in the higher quartiles in both sexes. The frequency of the girls who walk at least 30 min/day decreased in the upper quartiles with a significant difference ($P = 0.04$), boys are more active than girls, although the intensity of physical activity did not differ in quartiles. **Table 2** shows the distribution of energy and nutrient intakes across the quartiles of dietary fat. We observed higher consumption of SFA, LA, ratio n-6/n-3 that exceeds the recommendations [12] in the different quartiles of fat in both sexes, the increase in total fat intake is associated with decreased intake of sugars and increased energy intake, protein, saturated fatty acids SFA, monounsaturated fatty acids MUFA, PUFA and P/S in both sexes. For boys, there is an increase Cholesterol, ALA (18:3n3) and decrease in the ratio n6/n3, Cholesterol remains in recommendations ≤ 300 mg/day [12].

Table 1. Anthropometric characteristics according to the quartiles of fat intake in both sexes.

Variables	Girls (n = 374, 52%)			[2]*P*	Boys (n = 344, 48%)			[2]*P*
	Q1 < 30% (n = 176)	30% ≤ Q2 ≤ 35% (n = 156)	Q3 > 35% (n = 42)		Q1 < 30% (n = 99)	30% ≤ Q2 ≤ 35% (n = 194)	Q3 > 35% (n = 51)	
Age (year)	12.05a ± 0.141	12.06a ± 0.15	13.19b ± 0.36	0.002	13.18a ± 0.26	12.85a ± 0.19	13.56a ± 0.33	0.167
Weight (kg)	40.66a ± 0.94	40.08a ± 0.94	46.95b ± 20	0.004	42.80a ± 1.37	42.11a ± 1.04	45a ± 1.97	0.415
BMI (kg/m^2)	17.94a ± 0.25	18.06a ± 0.29	20.07b ± 0.69	0.002	18.18a ± 0.40	18.28a ± 0.20	19.45b ± 0.05	0.047
BMI-25 (%)	12	11.5	21.4	0.21	8	8	9.8	0.89
BMI-30 (%)	0.5	1.3	7.2	0.008	2	1	5.9	0.09
$W_C \geq$ 90th (%)	10.8	12.8	23.8	0.08	7	11.4	13.8	0.38
$W_C \geq$ 95th (%)	1.2	5.8	9.5	0.01	2	2.6	7.8	0.12
Walking at least 30 min/day (%)	68	67	48	0.04	74.75	83.5	76.47	0.17
Vigorous Intensity sport (%) (≥1 h ≥3 days/week)	5.68	5.13	14.3	0.11	23.23	14	19.6	0.13
Moderate Intensity sport (%) (≥1 h ≥3 days/week)	23	19.23	19	0.66	28	20.5	21.57	0.33

[1]Values are mean ± SE unless indicated; [a,b,c]The different letters indicate significant differences between means according to Duncan's test $\alpha = 0.05$; [2]*P* Values resulted from ANOVA from analysis of variance for quantitative variables and χ^2 from qualitative variables. BMI: body mass index; W_C: waist circumference.

Table 2. Mean energy, macronutrient and fatty acids intake according to quartiles of fat intake.

Variables	Girls (n = 374)			[2]*P*	Boys (n = 344)			[2]*P*
	Q1 < 30% (n = 176)	30% ≤ Q2 ≤ 35% (n = 156)	Q3 > 35% (n = 42)		Q1 < 30% (n = 99)	30% ≤ Q2 ≤ 35% (n = 194)	Q3 > 35% (n = 51)	
Energy (kcal/d)	1636.1a ± 5.85	1696.9b ± 6.31	1706b ± 16.38	<0.001	1615.2a ± 0.26	1655.1b ± 0.19	1775c ± 0.33	<0.001
Protein (g/d)	49.59b ± 1.96	54.48a ± 0.49	53.39a ± 0.64	0.003	52.77a ± 0.64	55.06b ± 0.36	57.94c ± 0.99	<0.001
Carbohydrate (g/d)	195.9a ± 2.73	197.7a ± 1.89	189.8a ± 2.87	0.31	184.64a ± 1.81	182.15a ± 0.96	185.28a ± 3.11	0.306
Fiber (g/d)	27.85a ± 0.47	28.14a ± 0.50	26.12a ± 1.06	0.177	30.54a ± 0.53	30.90a ± 0.36	31.91a ± 0.76	0.298
Sugar (g/d)	72.22a ± 0.70	69.57ab ± 0.65	70.17b ± 1.74	0.02	70.49a ± 1.42	69.32ab ± 1.98	66.58b ± 0.78	0.03
Cholesterol (mg/d)	157.3a ± 1.74	162.5a ± 1.78	161.4a ± 3.58	0.107	164.3ab ± 3.77	157.5a ± 2.78	178.3b ± 8.99	0.008
SFA (g/d)	14.42a ± 0.18	15.04b ± 0.18	15.39b ± 0.51	0.018	12.43a ± 0.28	14.25b ± 0.20	14.60b ± 0.32	<0.001
MUFA (g/d)	11.71a ± 0.09	13.134b ± 0.11	14.076c ± 0.24	<0.001	10.89a ± 0.33	13.85b ± 0.20	13.63b ± 0.36	<0.001
PUFA (g/d)	7.99a ± 0.23	10.37b ± 0.28	10.60b ± 0.52	<0.001	6.81a ± 0.23	7.69b ± 0.21	6.07b ± 0.40	<0.001
P/S	0.52a ± 0.02	0.69b ± 0.02	0.68b ± 0.04	<0.001	0.55a ± 0.02	0.54a ± 0.02	0.42b ± 0.04	0.002
LA (18:2n-6)	11.605a ± 0.07	11.404a ± 0.07	11.402a ± 0.12	0.094	11.54a ± 0.09	11.52a ± 0.07	11.43a ± 0.12	0.766
ALA (18:3n-3)	1.16a ± 0.01	1.17b ± 0.01	1.18c ± 0.02	0.597	1.08a ± 0.02	1.16b ± 0.01	1.21b ± 0.02	<0.001
ratio n-6/n-3	10.19a ± 0.12	10.03b ± 0.11	9.89c ± 0.20	0.392	10.91a ± 0.19	10.16b ± 0.12	9.64b ± 0.20	<0.001

[1]Values are mean ± SE unless indicated, [2]*P* Values resulted from ANOVA from analysis of variance for quantitative variables; [a,b,c]The different letters indicate significant differences between means according to Duncan's test $\alpha = 0.05$; SFA: Saturated fatty acid, PUFA: Polyunsaturated fatty acid, MUFA: Monounsaturated fatty acid, P/S: PUFA/ SFA, LA (18:2n-6): linoleic acid, ALA (18:3n-3): alpha linolenic acid, Ratio n-6/n-3: LA (18:2n-6)/ ALA (18:3n-3).

Table 3 shows the nutritient adequacy ratio according to quartiles of dietary fat. The increase in fat intake is associated with a decrease of the nutritient adequacy ratio of folate, niacin, vitamin B6, iron, magnesium in both sexes, the nutritient adequacy ratio of vitamin C, riboflavin reduced only in girls ($P = 0.043$, $P = 0029$) respectively. The *NARs* of vitamin E, phosphorus, thiamin increase in both sexes with increasing fat intake, the *NARs* of calcium, retinol and vitamin D increase only in boys ($P < 0.001$, $P = 0.010$, $P = 0.010$), respectively.

5. Discussion

The results of this study showed a significant association between increased consumption of fat and body mass index in both sexes and obesity and abdominal obesity in girls. There was a significant increase in age, weight, obesity in the upper quartiles in girls; the age of girls affects their fat intake, when age of girls increased, their fat intake increased affects their weight, body mass index and obesity. Some studies also show the higher tendency of girls toward consuming fats at post-puberty stage, which can be a response to the changes of steroids level of the gonads [25]. We did not find a difference in boys despite increasing body mass index ($P = 0.047$). The increase in fat consumption is associated with a decrease in the frequency of walking in girls; boys are more active than girls despite that we did not find a difference in the intensity of sports activity (vigorous or moderate) in the different quartiles in both sexes. Physical activity provides fundamental health benefits for children and youth and appropriate levels of physical activity contribute to facilitate maintenance of a healthy body weight [26]. Children and youth aged 5 - 17 should accumulate at least 60 minutes of moderate—to vigorous—intensity physical activity daily. Vigorous-intensity activities should be incorporated at least 3 times per week [26].

Excessive consumption, especially of lipids, and the imbalance of fatty acids in foods for humans are a cause of the development of obesity [27], and the higher intake of carbohydrates from sweetened beverages, sugary

Table 3. Mean nutrient adequacy ratio across quartile of fat intake.

Variables	Girls (n = 374)			[2]*P*	Boys (n = 344)			[2]*P*
	Q1 < 30% (n = 176)	30% ≤ Q2 ≤ 35% (n = 156)	Q3 > 35% (n = 42)		Q1 < 30% (n = 99)	30% ≤ Q2 ≤ 35% (n = 194)	Q3 > 35% (n = 51)	
Calcium/DRI‡	0.311a ± 0.05	0.327a ± 0.01	0.308a ± 0.01	0.154	0.321a ± 0.01	0.320a ± 0.01	0.352b ± 0,01	<0.001
Phosphorus/DRI‡	0.632a ± 0.01	0.679b ± 0.01	0.689b ± 0.01	<0.001	0.619a ± 0.01	0.692b ± 0.01	0.772c ± 0.01	<0.001
Iron/DRI†	0.980a ± 0.05	1.120b ± 0.02	1.030a ± 0.02	0.007	1.017a ± 0.03	1.173b ± 0.04	1.117c ± 0.02	<0.001
Magnesium/DRI†	0.920a ± 0.02	1.160b ± 0.07	1.100b ± 0.02	<0.001	0.823a ± 0.03	1.132b ± 0.05	1.036b ± 0.02	<0.001
Sodium/DRI†	1.298a ± 0.01	1.326a ± 0.01	1.310a ± 0.02	0.091	1.278a ± 0.01	1.276a ± 0.01	1.307a ± 0.02	0.128
Potassium/DRI‡	0.505a ± 0.01	0.529a ± 0.01	0.491a ± 0.01	0.118	0.504a ± 0.01	0.592a ± 0.04	0.540a ± 0.01	0.248
Vitamin B12/DRI†	0.744a ± 0.01	0.713a ± 0.01	0.720a ± 0.02	0.077	0.823a ± 0.03	0.747a ± 0.01	0.747a ± 0.03	0.199
Vitamin B6/DRI†	1.053a ± 0.01	1.149b ± 0.01	1.088a ± 0.03	<0.001	0.936a ± 0.02	1.094b ± 0.03	1.055b ± 0.02	0.01
Vitamin C/DRI‡	0.917a ± 0.02	0.898a ± 0.02	0.804b ± 0.05	0.0430	0.796a ± 0.03	0.805a ± 0.02	0.734a ± 0.03	0.199
Vitamin E/DRI†	0.740a ± 0.03	1.261b ± 0.06	1.417b ± 0.21	0.001	0.569a ± 0.04	0.739b ± 0.02	0.897c ± 0.04	<0.001
Vitamin D/DRI†	1.584a ± 0.03	1.588a ± 0.01	1.591a ± 0.01	0.706	1.577a ± 0.01	1.585a ± 0.01	1.628b ± 0.01	0.01
Folate/DRI‡	0.562a ± 0.01	0.634b ± 0.01	0.601ab ± 0.02	<0.001	0.528a ± 0.02	0.674b ± 0.02	0.644b ± 0.01	<0.001
Niacin/DRI†	0.923a ± 0.01	1.142a ± 0.09	0.912ab ± 0.02	0.020	0.825a ± 0.02	0.898b ± 0.02	0.885b ± 0.01	0.01
Rétinol/DRI ‡	0.267a ± 0.01	0.260a ± 0.01	0.251a ± 0.01	0.052	0.825a ± 0.01	0.885b ± 0.01	0.898b ± 0.01	0.01
Riboflavin/DRI†	0.915a ± 0.02	0.879b ± 0.01	0.846ab ± 0.02	0.029	0.248a ± 0.02	0.241a ± 0.01	0.253a ± 0.03	0.432
Thiamin/DRI†	0.823a ± 0.02	1.051b ± 0.02	1.108ab ± 0.03	<0.001	0.680a ± 0.03	0.984b ± 0.02	1.163c ± 0.04	<0.001

[1]Values are mean ± SE unless indicated, [2]*P* Values resulted from ANOVA from analysis of variance for quantitative variables; [a,b,c]The different letters indicate significant differences between means according to Duncan's test $\alpha = 0.05$; †Adequate intake is considered as DRI, ‡Recommended dietary allowance is considered as DRI.

cereals and industrial snacks, especially consumed and preferred, has been associated with overweight and obesity in school-age children [28]. Sweetened beverage consumption has also been linked to obesity and type 2 diabetes [29] and coronary heart disease [30].

A lower total fat consumption leads to low but durable significant reduction (statistically and clinically) body weight in adults, the evidence supports a similar effect in children and young people [31], The percentage of the population that is obese and coronary heart disease rates across countries [32]. Populations with relatively high intakes of saturated fat, especially animal fat and cholesterol, have relatively high serum cholesterol levels and high incidence of coronary heart disease compared to people with low intakes of fat [33]. Evidence from cohort studies reported conflicting results on total fat intake and the positive association with type 2diabetes [34].

Different types of fatty acids display different metabolic behaviors such as oxidation and deposition rate differences that may contribute to weight change [35]. Although monounsaturated fatty acids and polyunsaturated fatty acids were not associated with changes in weight, animal fat, saturated fatty acids and Trans fatty acids have shown a positive association with 8 years of weight gain [36]. Contrary to the findings of the Swedish study, that reports some weak associations only in women, between the type of fatty acids and weight change: weight gain was inversely associated with saturated fatty acids consumption and positively associated au P/S ratio [37]. High consumption of saturated and Trans fats are associated with chronic diseases linked to obesity [38]. The majority of this population of adolescents needs to improve their intakes of calcium, the proportion did not differ by quartile of fat intake, inadequate intake of calcium would lead to increased appetite and overconsumption of fat [39], a small amount of calcium is associated with increased adiposity. Different studies support an inverse relationship between calcium intake and the development of body fat [40]. Calcium was also required for an effective weight reduction program [35]. Davies *et al.* 2000 [41] noted a negative association between calcium intake and weight in young, middle-aged and older women and calculated that 1g calcium intake difference was associated with an 8kg difference in body weight [35]. Vitamin C may affect weight reduction [35]. Few studies have reported a significant inverse relationship between plasma vitamin C concentrations and degree of obesity [42]. Insufficient intake of fruits and vegetables often results in increased consumption of higher calorie foods [43], adequate intake of fruits and vegetables reduces the risk of cardiovascular disease and certain types of cancer and it helps regulate body weight [44].

6. Conclusion

Higher dietary fat intake was associated with poor diet quality and higher body mass index in both sexes and high prevalence of obesity and abdominal obesity among adolescent's girls in Tlemcen. We recommended adolescent by healthy diets towards helps regulate their body weight and reduces the risk of cardiovascular disease and some types of cancer and especially the girls by lifestyle more active.

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Abbreviations

BMI: body mass index
Wc: waist circumference
IOTF: International Obesity Task Force
USDA: United States Department of Agriculture
SFA: saturated fatty acid
MUFA: monounsaturated fatty acid
PUFA: polyunsaturated fatty acid, ratio
P/S: PUFA/SFA
LA(18:2n-6): linoleic acid
ALA(18:3n-3): alpha linolenic acid
ratio n-6/n-3: LA(18:2n-6)/ALA(18:3n-3)
NAR: nutrient adequacy ratio
DRI: dietary recommended intake
GPAQ: global physical activity questioner