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ORIGINAL ARTICLE

FOOD QUALITY AND NUTRITIONAL STATUS OF SCHOOL-GOING ADOLESCENTS IN THE PROVINCE OF EL JADIDA IN MOROCCO

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ABSTRACT

Background. Dietary diversity and variety scores represent tools for measuring the overall quality of diets. In children, they are good indicators of their nutritional status and growth.

Objective. The aim of this study was to assess the consumption and eating habits as well as the lifestyle of Moroccan adolescents attending school in the city of El Jadida.

Methodology. A sample of 463 children of both sexes, aged 9 to 17, attending four schools in the city of El Jadida was studied. Eating habits and information on socioeconomic level are assessed using questionnaires and weight and height were measured on participants.

Results. According to the dietary diversity score (DDS) classes, 2.4% of the children surveyed were with low DDS, 55.7% moderate and 41.9%, with high DDS. The mean DDS was 5.67 ± 1.03 in underweight children and 5.53 ± 1.5 in those with overweight (obesity included) and the food variety scores (DVS) were of 12.94±3.24 food items and 10.81±3.25 in the 2 groups respectively. In addition, data analyzes show that children from parents with a low level of education had higher averages of DDS and DVS (DDS: 5.54 ± 0.84; SVA: 10.65 ± 2.32) compared to those of parents with medium education level (DDS: 5.31±0.96; DVS: 9.72±2.62) or high level (DDS: 5.17±0.93; DVS: 9.36 ±2.42). In addition, children from parents of high economic level had a lower averages of DDS and DVS (DDS: 5.24 ± 0.88; DVS: 8.84 ± 2.10) compared to those of parents of low economic level (DDS: 5.36±1.00; DVS: 10.14±2.85). The sugary products were consumed by 56.3% of underweiht children, 75% of normal-weight children and 67% of overweight children (including obese).

The estimated total energy intake (TEI) was higher than the Recommended Daily Allowances (RDA) in underweight 2933 Kcal/d and in overweight (including obese) children 3061.75 Kcal/d, while the mean daily intakes of folate, calcium, iron, potassium and zinc were lower than the (RDA). The food groups consumed by the majority of children were cereals (98.5%), fruits and vegetables (87.7%), and sweet products (69.8%) while oilseed products and fat were less consumed (9.7% and 7.8% respectively).

Conclusion. The study data show that the adolescents diet were moderately diverse, little varied and poor in certain nutrients essential for their nutritional status and growth. The study draws attention to the need for parents to be aware of the benefits of improving the diet quality and weight status of adolescents.

Keywords: *Dietary Diversity Score, Dietary Variety Score, eating behavior, eating habits, malnutrition, teenagers*

INTRODUCTION

Despite the efforts of governments, people in developing countries still face malnutrition in all its forms. The situation has worsened with the increase in food insecurity and the economic crisis caused by the advent of the COVID-19 pandemic showing an increase in the problems of both undernutrition and overnutrition or double burden of malnutrition in more people of all ages [1]. In children and adolescents, malnutrition is less likely to be linked to insufficient nutrition but rather to unhealthy diets. Indeed, overnutrition has been considered a problem of industrialized countries. But this scourge is increasing more and more with the nutritional transition or the rapid evolution of diets and lifestyles. These have been linked to industrialization, urbanization, economic development and market globalization over the past decade [2].

In the developing world, one in four children under five (27%) or a total of some 146 million children are underweight [3]. The World Health

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Organization (WHO) has estimated the contribution of undernutrition to one third of total child mortality [4]. It can also cause developmental delays in young people during childhood and adolescence and lead to poor academic performance and school dropout. The WHO has also estimated the number of overweight children at 42 million in 2010, of which nearly 35 million (83%) are in developing countries [5]. In Morocco, it is reported that one in ten Moroccan children and adolescents are affected by the scourge of obesity, which corresponds to 10.3% of boys and 9.9% of girls aged 5 to 19 [6]. Due to profound changes such as those in lifestyle and unhealthy eating habits, this problem is a major determinant of major chronic diseases, such as cardiovascular disease (CVD), certain cancers, type 2 diabetes and their risk factors [7, 8, 9, 10]. A diet capable of contributing to the prevention of malnutrition must comply with nutritional recommendations and meet criteria of diversity and balance in terms of food quantity and quality.

The objective of this study was therefore to characterize the quality of the diet and the nutritional status of school-going adolescents by evaluating the scores of food diversity and variety.

METERIAL AND METHODS

Study location

The survey was carried out on children attending school in two private secondary schools in the urban area of El Jadida, province of the greater region of Casa-Settat in Morocco, over a period from September 2016 until the end June 2018, during the 2016/2017 and 2017/2018 school years.

Sample and data collection

The study included a sample of 463 adolescents (e), from 9 to 17 years old, with an average age of 14.16 years ± 1.93, of both sexes (58.1% boys and 41.9% girls). Using a structured questionnaire, information on the sociodemographic and socioeconomic characteristics of the participants was collected and the anthropometric parameters measured.

Dietary data was collected using the 24-hour dietary recall to list all foods ingested and determine participants' macronutrient and micronutrient intake using BILNUT software. In addition, a food consumption frequency questionnaire was used to estimate the number of food groups consumed by each adolescent and to calculate the dietary diversity score (DDS) and assess the dietary habits of the sample.

Calculation of the Dietary Diversity Score (DDS)

For the calculation of this score, the diet must be accurately described during a reference period [11], the food groups to be included are defined in such a way as to reflect the eating habits and practices of the population studied [11]. In the present study, the foods consumed belong to the following 8 food groups (vegetables and fruits, cereals, milk/dairy products, meat/fish/eggs, sugar/sweet products, fat, sugary drinks, oilseed products). A simple count of the food groups an adolescent has eaten can be used to calculate the DDS in a period prior to the survey. This number of food groups consumed reflects the degree of diversity of the food intake. DDS was classified into three categories indicating low dietary diversity if DDS is <3; medium if it is [3-5] and high if DDS is >5.

Calculating the Food Variety Score (DVS)

The DVS estimates the number of biologically distinct foods consumed at a threshold of at least 0.1 g by a household or person over a given period ranging from 24, 48 hours or 3 days [12]. In the present study, it is the number of different foods identified from a list of 242 items consumed by the adolescent and belonging to different food groups (cereals, fruits, dairy products, etc.) and within each group: wheat, rice, rye, … for the group of cereals for example [13].

Anthropometric data

The height (Ht) of the children, determined by the length of the skeleton in meters, was measured using a fathom, with the legs straight, the heels together, the arms dangling and the shoulders relaxed [14].

The weight is measured to the nearest 100 g, in the naked child or with light underwear, preferably in the morning and after evacuation of the bladder [14].

Waist circumference (WC), linked to the risk of cardiovascular disease and other forms of chronic disease [15], is measured with a tape measure halfway between the lower costal edge and the iliac spine, antero-superior on the mid-axillary line, at the end of a normal exhalation and without exerting pressure on the skin [16]. The waist circumference (WC) to height or height (WC/Ht or WHTR) ratio is also calculated and the threshold of 0.5 is used to define presence, if WHTR ≥ 0.5 or absence if WHTR < 0.5 of abdominal fat or abdominal obesity in boys and girls [17].

Body mass index or BMI is increasingly used to determine excess weight in children 2 to 17 years old [18, 19]. BMI is calculated by dividing weight (kg) by height (m) squared (Weight (kg) / Height (m^2)). The distribution of BMI values is used to determine BMI Z-scores to obtain a numerical indication of the standard deviation (SD) from the median for sex and age. According to the value of the Z-score obtained, the adolescent's weight status would indicate underweight if "Z Score ≤ -2DS", normal weight if "-2DS <Z Score<+1DS", overweight if "Z Score ≥+1DS" and obesity if "Z Score≥+2DS" [20].

Sociodemographic and socioeconomic characteristics

The collected informations are age, sex, school level, the parents education level (determined by the highest level of one of the parents), the size of the household, the type of habitat and the parents' socioeconomic status (SES) divided into four levels according to monthly income: SES1≤2500MAD, 2500MAD<SES2≤7000MAD, 7000MAD<SES3≤15000MAD and SES4>15000MAD.

Statistics analysis

Data analysis was performed using SPSS (Statistical Package for the Social Sciences) software for Windows version 23.0. Quantitative variables were described by means and standard deviations and qualitative variables by frequencies and percentages. For weight status, the children were classified into 4 categories based on the reference standards established by the WHO according to sex and age and using a macro from the WHO Anthro software for SPSS. The analysis of variance (ANOVA) was used for the comparison of several means. The Student t-test was used for independent samples and the chi-square test to compare categorical variables. Correlation analyzes were performed. All probability values below 0.05 are considered statistically significant.

Ethical considerations

The study on the pupils is carried out after obtaining an authorization from the Regional Academy of Education, the selected schools and after obtaining the oral consent of the parents. All participants were informed about the objectives and the course of the survey as well as their willingness to withdraw from the study at any time if they so wish.

RESULTS

In the Table 1 the average dietary intakes of macronutrients and micronutrients are presented in comparison to the recommended daily intakes in the study population using the Student's t test. The Table shows that the surveyed adolescents had a significantly higher consumption of total lipids (t test =10.755, p-value <0.0001***), DEI (t test (Girls) =3.274, p-value <0.001** ; t test (Boys) =3.429, p-value <0.001**), Phosphorus (t test = 10.461, p-value <0.0001** *), sodium (t test = 7.691, p-value <0.0001***), SFA in % energy (t test = 34.308, p-value <0.0001***), AGM in % energy (t test = 29.717, p-value <0.0001***), AGP in % energy (t test = 7.338, p-value <0.0001* **) than the recommendations.

Conversely, there were lower intakes of vitamin B1 (t test = -10.857, p-value <0.0001***), vitamin C (t test = -14.350, p-value <0 .0001***), vitamin E (t test = -27.040, p-value <0.0001***), calcium (t test = -9.118, p-value <0.0001***), in folates (t test = -7.919, p-value <0.0001***), in magnesium (t test (Girls) = -9.450, p-value <0.0001***; t test (Boys) = -12.151, p-value <0.0001***), iron (t test =-22.869, p-value <0.0001***), zinc (t test (Girls) = -12.159, p- value <0.0001***, t-test (Boys) = -14.374, p-value <0.0001***), potassium (t-test = -30.013, p-value <0.0001***) and fiber (T test (Girls) = -10.939, p-value <0.0001***; t test (Boys) = -26.556, p-value <0.0001***) than the recommendations.

Table 2 presents averages of DDS and DVS according to the socio-demographic and anthropometric characteristics of the study population. The adolescents studied had on average 16.16 ± 1.93 years old, 1.57 ± 0.12 m for height, 50.35 ± 13.43 kg for weight and a corpulence estimated by their BMI 20.03±3.83 kg/m^2 on average. The table results also show that the participants had amean DDS of 5.28±0.93 and DVS of 9.71±2.51. These DDS and DVS scores average were higher (DDS: 5.44±0.96); (DVS: 10.35±2.66)] in the primary school pupils than those in middle school (DDS: 5.31±0 ,89); (DVS: 9.80±2.50) and high school (DDS: 5.20±0.94); (DVS: 9.40±2.41). The study data also show that children from parents with a low education level had an average of DDS (5.54 ± 0.84) and DVS; (10.65±2.32) higher than those with a medium education level (DDS: 5.31±0.96); (DVS: 9.72±2.62) or high education level (DDS: 5.17±0.93); (DVS: 9.36±2.42). In addition, children from parents with a high SES had lower mean DDS (5.24±0.88) and DVS (8.84±2.10) compared to those from low SES parents (DDS: 5.36±1.00); (DVS: 10.14±2.85).

The Table 2 also shows that according to their anthropometrical parameters, adolescents with abdominal fat had a lower average DDS (5.06±1.00) and DVS (9.66±2.52). The same observation is true for overweight children (including obesity) who had a low mean DDS (5.12±1.19) and DVS (8.94±2.66) in comparison with their underweight counterpart (DDS: 5.37±0.93); (DVS: 9.36±2.20). The analysis also highlighted that the differences of the food variety and diversity scores found according to the demographic and anthropometric characteristics, were not significant, except for the BMI categories (p-value = 0.021*) and parent education level (p-value = 0.001**).

The results in Table 3 present the socio-demographic characteristics of the adolescents surveyed according to BMI categories. The use of the chi2 test confirms significant differences between BMI categories according to gender (p-value = 0.004**), age group (p-value = 0.004**), school level (p- value = 0.003**) and to parents' level of education (p-value = 0.009**). The data in this table also shows that overweight children (including obesity) represented 21.60% of the sample of which 33% were boys and 67% girls, while underweight was prevalent in 18.79% of whom 56.3% were boys and 43.7 girls. According to these results, overweight children (including obesity) had

Table 1. Mean energy and nutrients daily intakes compared to the recommended daily allowances (RDA) of the study adolescents

Energy and nutrient	RDA	Means ± SD	p-value	*Student's* t test
Energy (Kcal)				
Girls	2100	2494.46±925.38	<0.001**	3.274
Boys	2240	2640.56±991.07	<0.001**	3.429
Total fat	30-35	68.49±40.96	<0.0001***	10.755
Cholesterol	<300 mg/day	214.02±151.62	<0.0001***	-6.490
SFA (% energy)	8-12	46.06±11.36	<0.0001***	34.308
MUFA (% energy)	>12	40.25±10.88	<0.0001***	29.717
PUFA (%energy)	>8	13.28±8.23	<0.0001***	7.338
Vitamin B1 (mg)	1.2	0.48±0.76	<0.0001***	-10.857
Vitamin C (mg)	110	51.88±46.36	<0.0001***	-14.350
Vitamin E (mg)	12	2.57±3.99	<0.0001***	-27.040
Calcium (mg)	1200	796.89±505.98	<0.0001***	-9.118
Iron (mg)	20.7	9.96±5.37	<0.0001***	-22.869
Magnesium (mg)				
Girls	370	261.17±88.46	<0.0001***	-9.450
Boys	410	247.89±113.21	<0.0001***	-12.151
Phosphorous (mg)	800	1224.50±464.47	<0.0001***	10.461
Zinc (mg)				
Girls	9	4.90±2.59	<0.0001***	-12.159
Boys	11	5.38±3.32	<0.0001***	-14.374
Folates (µg)	200	149.97±72.31	<0.0001***	-7.919
Fiber (g)				
Girls	30	16.24±9.66	<0.0001***	-10.939
Boys	40	13.57±8.45	<0.0001***	-26.556
Potassium (mg)	2500-5000	2348.55±1011.13	<0.0001***	-30.013
Sodium (mg)	500-1600	3161.36±2323.43	<0.0001***	7.691

Legends: the values represent means ± SD (standard deviation); *significant. NS: Not significant ; t: value of the *Student's* t Test; RDA: recommended daily allowances

Table 2. Mean scores for dietary diversity and variety according to the socio-demographic and anthropometric characteristics of the adolescents surveyed

		DDS Mean ± SD	p-value	DVS Mean ± SD	p-value
	Total	5.28±0.93		9.71±2.51	
Sex	Males	5.35±0.93	NS	9.97±2.37	NS
	Females	5.23±0.93		9.53±2.60	
Age category	[9-11]	5.42±0.89	NS	10.02±2.46	NS
	[12-14]	5.40±0.97		10.07±2.66	
	[15-17]	5.19±0.91		9.47±2.42	
School level	Primary	5.44±0.96	NS	10.35±2.66	NS
	Medium school	5.31±0.89		9.80±2.50	
	High school	5.20±0.94		9.40±2.41	

Habitat type	Owner	5.28±0.92	NS	9.68±2.46	NS
	Renter	5.29±0.95		9.76±2.59	
Household size	[3-4]	5.26±0.90	NS	9.68±2.50	NS
	[5-6]	5.31±0.95		9.76±2.55	
	[7-8]	5.23±0.99		9.65±2.43	
Parents education level	Low	5.54±0.84	0.006**	10.65±2.32	0.001**
	Medium	5.31±0.96		9.72±2.62	
	High	5.17±0.93		9.36±2.42	
SES	SES1	5.36±1.00	NS	10.14±2.85	NS
	SES2	5.25±0.97		9.59±2.23	
	SES3	5.24±0.84		9.99±2.35	
	SES4	5.22±0.88		8.84±2.10	
BMI categories	Underweight	5.37±0.93	NS	9.36±2.20	0.021
	Normal weight	5.31±0.82		10.11±2.47	
	Overweight & obesity	5.12±1.19		8.94±2.66	
WHTR : abdominal fat	> 0.5 with	5.06±1.00	NS	9.66±2.52	NS
	> 0.5 without	5.31±0.92		9.72±2.51	

DDS: dietary diversity score; DVS: food variety score; SES: Socioeconomic Status; BMI: Body Mass Index; WHTR: waist-to-height ratio (WC/HT); * significant. NS: Not significant; The statistical test used is the one-factor Anova test.

Table 3. Socio-demographic characteristics of the adolescents surveyed according to BMI categories

		BMI categories N(%)			p-value
		Normal weight 276(59.61)	Overweight & Obesity 100(21.60)	Underweight 87(18.79)	
Sex	Males	112(40.58)	33(33.0)	49(56.3)	P=0.004**
	Females	164(59.42)	67(67.0)	38(43.7)	
Age category	[9_11]	27(9.78)	8(8.0)	18(20.7)	P=0.004**
	[12_14]	75(27.17)	31(31.0)	32(36.8)	
	[15_17]	174(63.04)	61(61.0)	37(42.5)	
School level	Primary	55(19.93)	16(16.0)	29(33.3)	P=0.003**
	Medium school	67(24.28)	29(29.0)	29(33.3)	
	High school	154(55.80)	55(55.0)	29(33.3)	
Habitate type	Owner	152(55.07)	68(68.0)	52(59.8)	NS
	Renter	124(44.93)	32(32.0)	35(40.2)	
Household size	[3-4]	125(45.29)	45(45.0)	33(37.9)	NS
	[5-6]	125(45.29)	46(46.0)	41(47.1)	
	[7-8]	26(9.42)	9(9.0)	13(14.9)	
Parents education level	Low	48(17.39)	10(10.0)	26(29.9)	P=0.009**
	Medium	89(32.25)	38(38.0)	28(32.2)	
	High	139(50.36)	52(52.0)	33(37.9)	
Parents SES	SES1	98(35.51)	31(31.0)	34(39.1)	NS
	SES2	51(18.48)	17(17.0)	17(19.5)	
	SES3	72(26.09)	24(24.0)	16(18.4)	
	SES4	55(19.93)	28(28.0)	20(23.0)	

SES: Socioeconomic status of parents; BMI: Body Mass Index;
* significant. NS: Not significant; Statistical test used is the Chi2 test.

parents with a high level of education (52%) and a high economic level (28%). Similarly, thin children had parents with a high level of education (37.9%) but a low economic level (39.1%).

Table 4 presents dietary diversity according to weight status among adolescents participating in the study. The table shows that overweight including obesity was prevalent in 63.64% of children with low DDS, 20.93% among students with moderate DDS and in 20.10% of children with high DDS while the Underweight was present in 9.09% of children with low DDS, 18.99% among those with moderate DDS and in 19.07% of students with high DDS. The results in the table show also that while high DDS was found in only 19.07% of uner and 20.1% of overweight, the low DDS was found among the majority of overweight (60.82%).

The analyzes also revealed a non-significant negative correlation between the DDS and the BMI and WHTR while a significant negative correlation was found between the DVS and BMI. As shown in Tables 5 and 6, the diversity score categories and BMI classes are characterized by different dietary intakes of energy, macronutrients and micronutrients.

On the other hand, Person correlation analysis showed that energy intake is positively and significantly associated with BMI (r = 0.212*) while a significant but negative association (r = -0.019*) was found between the latter and vitamin C.

Table 6 indeed shows that using the calculated DDS, dietary diversity was low in 2.4%, moderate in 55.7% and high in 41.9% of the children surveyed.

The table 6 shows also that overall adolescents with low DDS had lower energy intake (349.00±142.84) than those with medium DDS (2532.32 ±1039.70) or high DDS (2744.72± 938.82). Similarly, lower intakes of carbohydrates, proteins and lipids were found in adolescents with a low DDS than those with a high

Table 4. Prevalence of DDS classes according to BMI and WHTR categories

		DDS categories N(%)			p-value
		Low 11(2.4)	Moderate 258 (55.7)	High 194 (41.9)	
BMI categories	N(%)				
- Underweight	87 (18.8)	1(9.09)	49(18.99)	37(19.07)	0.019*
- Normal weight	276 (59.61)	3(27.27)	155(60.08)	118(60.82)	
- Overweight &Obesity	100 (21.6)	7(63.64)	54(20.93)	39(20.10)	
WHTR categories					
WHTR ≥0.5	50(10.8)	3(27.3)	28(10.9)	19(9.8)	NS
WHTR <0.5	413 (89.2)	8(72.7)	230(89.1)	175(90.2)	

WHTR: Waist-to-Height ratio; BMI: Body Mass Index;
* significant. NS: Not significant; Statistical test used is the Chi2 test.

Table 5. Daily energy and nutritional intake of adolescents according to their weight status

Énergy & nutrient		BMI Categories			p-value	Person correlation
		Normal weight 81(61.8%)	Overweight & Obesity 32(24.4%)	Underweight 18(13.7%)		
Energy (Kcal)	Girls	2459.20±1120.26	2974.52±660.56	2906.40±286.25	<0.0001***	r = 0.212*
	Boys	2096.77±842.92	3228.27±791.34	2944.23±655.67		
Carbohydrates		153.42±104.41	219.73±74.05	202.32±73.87	0.002**	r = 0.04
Protein (mg)		81.81±26.13	84.80±31.36	86.13±34.50	NS	r = 0.01
Lipids totaux		62.23±36.28	72.41±48.33	89.69±41.06	0.029*	r = -0.09
Vitamin B1 (mg)		0.41±0.70	0.47±0.51	0.83±1.20	NS	r = -0.04
Vitamin C (mg)		52.52±42.11	34.47±24.41	79.94±74.82	0.003**	r = -0.19*
Vitamin E (mg)		1.95±2.13	3.84±6.62	3.11±3.89	NS	r = -0.06
Calcium (mg)		819.48±530.62	743.91±474.65	789.44±462.82	NS	r = 0.03
Iron (mg)		9.30±4.19	10.44±7.18	12.11±6.08	NS	r = -0.03
Magnesium (mg)	Girls	238.35±85.42	273.86±154.32	226.60±145.50	NS	r = -0.07
	Boys	263.66±74.53	225.27±75.16	284.85±124.78	NS	
Phosphore (mg)		1202.11±418.04	1288.25±566.28	1211.94±481.98	NS	r = 0.05

Zinc (mg)	Girls	5.00±2.66	6.29±4.21	5.00±4.64	NS	r = 0.01
	Boys	5.43±2.58	4.27±2.53	4.00±2.48	NS	
Folates (µg)		147.89±65.45	147.91±89.17	163.00±71.57	NS	r = 0.01
Fiber (g)	Girls	13.89±8.57	12.95±7.82	13.20±11.43	NS	r = -0.09
	Boys	17.83±10.97	11.09±5.47	16.31±7.34	NS	
Cholesterol		222.07±155.33	191.41±131.76	217.98±171.21	NS	r = -0.06
Potassium (mg)		2352.01±963.91	2365.00±1036.36	2303.72±1218.43	NS	r = -0.08
Sodium (mg)		3124.68±2598.68	3173.47±1845.19	3304.89±1806.89	NS	r = 0.00

Values are dietary intakes averages+ standard deviation; BMI: Body mass index ; r: correlation coeficient ; ** significant at 0.01; *significant at 0.05 ; NS: Not significant

Table 6: Daily energy and nutritional intake of adolescents according to their dietary diversity

Énergy & nutrient		DDS Categories			p-value	Person correlation
		Low DDS 2(1.5%)	Medium DDS 68(51.9%)	High DDS 61(46.6%)		
Énergy (Kcal)	Girls	-	2788.37±796.70	2246.47±964.93	NS	r= -0.11
	Boys	349.00±142.84	2532.32±1039.70	2744.72±938.82		
Carbohydrates		166.20±55.72	161.97±89.13	192.69±106.76	NS	r= 0.16
Protein (mg)		78.40±27.01	76.84±29.00	90.31±26.70	0.026*	r= 0.27**
Lipids totaux		49.15±25.81	56.50±36.13	82.49±42.34	0.001*	r= 0.36**
Vitamin B1 (mg)		1.00±0.00	0.44±0.76	0.51±0.77	NS	r= 0.02
Vitamin C (mg)		27.50±7.78	46.93±39.56	58.20±53.10	NS	r= -0.01
Vitamin E (mg)		2.00±3.20	1.79±2.15	3.46±5.27	NS	r= 0.19*
Calcium (mg)		772.50±422.14	679.25±529.24	928.84±453.39	0.01*	r= 0.28**
Iron (mg)		6.00±1.41	9.43±5.46	10.69±5.27	NS	r= 0.16
Magnesium (mg)	Girls	-	239.33±79.73	279.59±92.43	0.004**	r= 0.40**
	Boys	209.00±11.31	218.41±88.49	292.24±133.75		
Phosphore (mg)		1197.50±292.04	1100.96±464.84	1363.11±433.42	0.005**	r= 0.38**
Zinc (mg)	Girls	-	5.07±2.59	4.75±2.63	NS	r= 0.05
	Boys	2.50±2.12	5.78±3.65	5.00±2.79		
Folates (µg)		148.00±12.73	141.63±74.39	159.33±70.57	NS	r= 0.16
Fiber (g)	Girls	-	15.30±10.09	17.03±9.38	NS	r= 0.19*
	Boys	7.00±4.24	12.68±8.79	15.28±7.91		
Cholesterol		111.00±115.97	207.29±149.94	224.90±154.77	NS	r= 0.13
Potassium (mg)		2097.00±347.90	2176.03±1026.67	2549.11±979.47	NS	r= 0.23**
Sodium (mg)		3217.50±1820.80	3027.25±2501.92	3309.02±2146.76	NS	r= 0.08

Values are dietary intakes averages ± standard deviation; DDS: dietary diversity score; r: correlation coeficient; *significant; NS:Not significant

DDS (166.20±55.72 vs 192.69±106.76; 90.31±26, 70 vs. 78.40±27.01 and 82.49±42.34 vs. 49.15±25.81 respectively). The use of the ANOVA test shows that these differences by DDS categories were significant for protein and lipid intakes.

The same comparison is found for intakes of certain micronutrients in particular vitamin C and vitamin E and also for certain minerals brought particularly calcium, iron, magnesium, phosphorus, zinc, folates and fibers which were also found lower in participants with low DDS compared to those with high DDS. These differences were found to be significant for calcium, magnesium and phosphorus intakes.

Furthermore, the Person correlation analysis revealed a significant and positive association between DDS and protein (r=0.27**), lipid (r=0.36**), calcium (r =0.28**), vitamin E (r=0.19*), magnesium (r=0.40**), phosphorus (r=0.38**), potassium (r=0 .23**) and dietary fiber (r= 0.19*). Similarly, positive correlations have been noted between the DVS and some nutrients including magnesium, iron, calcium, phosphorus, vitamin E, fiber and lipids.

DISCUSSION

In this study, the evaluation of eating habits and the quality of food was studied in relation to the nutritional status of adolescents attending school in the city of El Jadida. The quality of food consumption was estimated in terms of food diversity and variety.

The results of this study, show the existence of the double burden of malnutrition in this population, as indicated by their weight status manifested by the problem of overweight which affects 21.60% in addition to underweight prevailing in 18, 79% of children surveyed aged 9 to 17. The prevalences found in this study for the two problems of malnutrition are alarming for both underweight and excess weight compared to data from the literature [21, 22, 23]. The presence of overweight and underweight, within the same population, confirms the nutritional transition that Morocco is going through, which is associated with socioeconomic and sociodemographic changes as well as lifestyle changes including those of food. The socio-economic environment in which an individual evolves also influences weight gain. Indeed, *Goyal* et al (2010) found that overweight (obesity included) is higher in high socioeconomic backgrounds [24]. The same is true for poor countries because of several factors including globalization [22] and in other Western Countries, which have considered that the prevalence of obesity is higher in adults and children from a disadvantaged socio-economic background. [25, 26]. In fact, in developing and underdeveloped countries, overweight increases with the improvement of the families socio-economic level, although underweight still persists [27, 28, 29].In this study, the prevalences of the two malnutrition problems, both underweight and overweight with obesity, were more marked among children from families with a very low socio-economic level. These results are in agreement with those of *Renzaho* et al. (2006) who observed that underweight affects more disadvantaged backgrounds [30].

In underprivileged areas, the socio-economic level influences the diet of children by leading to the availability of few healthy foods, such as fresh fruits and vegetables, associated with a high consumption of inexpensive, energy-rich and healthy foods. poor in nutrients [31, 32, 33]. The coexistence of the two problems of malnutrition, underweight and overweight, can thus be the result of an insufficient diet or an unhealthy diet. In addition, the fact that the parents are unemployed or have a low-income job has repercussions on the quality of the children's diet, which is then poor and not very varied with a low consumption of meat, fruit and vegetables, which are expensive food items.

The low dietary variety and diversity scores found in the present study reveal low dietary quality in children of high economic status parents. Several studies have also reported that the level of parental education influences both the eating habits of children and their weight status [26]. Contrary to certain studies which have reported an inverse association of the weight of children with the level of education of their parents [33], the present population of children who are both overweight (including obesity) and those who are underweight have parents with a high level of education. These results, which are in agreement with other studies, bear witness to parents' poor perception of their children's weight problems and a lack of education in terms of nutrition [34].

Determination of food intake among the students surveyed showed that the average energy intake was generally higher than the recommendations [35]. This result is different from that of a study carried out in a country of the same region reporting in normal weight children aged 6 to 12 years, an average energy intake, lower than the recommended intakes [36].

In relation to weight status, both overweight (including obesity) and underweight children had a higher energy intake than normal-weight children. The same is true for protein, lipid and carbohydrate intake, although their quantitative distribution more or less complied with the recommendations for all children. Indeed, these intakes were also higher in children with the two abnormal weight statuses, underweight and overweight, compared to those with normal weight with an even higher intake of these macronutrients in thin children compared to those with overweight (including obesity) as is the case with lipid intake. High energy intake is the expression of energy-dense foods whose consumption is reported to be associated with obesity [37, 38, 39].

In the present study, the foods most consumed by the majority of children studied were bread and sugary products (results not shown) with daily consumption of sugary products (69.8%) and drinks (87%) among children with overweight (obesity included) while fruit and vegetable intake was lower than recommended.

The data reported here also provide information on food quality, judging by the diversity (DDS) and variety (DVS) scores calculated in the study population. The diet of the participants in the present study is considered moderately diverse. Thus, of the 242 foods or varieties divided into 8 food groups which are vegetables and fruits, cereals, milk/dairy products, meat/fish/eggs, sugar/sweet products, fat, sugary drinks, oilseed products, there is an abundance of varieties for the food groups ranging from [Items: 62] for the group [vegetables and fruits] to [Items: 8] for the [oilseed products] group. However, the variety

scores are distributed very unevenly within the diets of the adolescents studied.

A diversified diet allows adequate intake of macro and micronutrients that the body needs and it is a way to assess the quality of food that affects the nutritional status and health of individuals in general [40, 41, 42, 43].

In this study, the intake of energy and macronutrients was increased while a downward trend is observed for micronutrients with increasing body size in the children surveyed. In addition, a less diversified diet estimated by a low DDS was more prevalent in overweight children, while high dietary diversity (high DDS) was less prevalent in underweight and overweight children compared to children normal weight. This less diversified diet observed in both types of malnutrition was also revealed in children with abdominal obesity. In addition, the study also reports that nutrient intakes increase with increasing dietary diversity, as demonstrated by the positive correlations found for the majority of nutrients with increasing dietary diversity and variety scores.

Both the state of health and the nutritional balance in children depend on the socioeconomic status of their parents [26]. The data reported here concerning sociodemographic and economic characteristics reveal the coexistence of the double burden of malnutrition in the population studied, whatever the socioeconomic level. Moreover, the level of education of the parents does not seem to improve either the diversity and variety of the diet or the weight status of their children. These results reveal a need raising awareness on management and education in terms of nutrition and healthy weight among the parents of the adolescents surveyed.

CONCLUSION

The present data report the presence of the double burden of malnutrition with alarming prevalences of both underweight and overweight in the study school children.

The diet of this opulation age group, being characterized by a moderate diversity can be qualified as unhealthy.

The study also shows that increasing parental education was not associated with normal weight status or good dietary diversity. This reveals a poor perception among parents, of both the normal weight and the healthy diet of children. The study draws attention to the need for parents to be aware of the benefits of improving the quality of nutrition and the weight status of adolescents.

Declaration of interest

The authors declare that they have no conflict of interest regarding this article.

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