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Nutritional status of Tunisian adolescents: associated gender, environmental and socio-economic factors

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Abstract

Objective: To assess the nutritional status of Tunisian adolescents and associated factors.

Design: A cross-sectional study based on a national stratified random cluster sample.

Subjects and methods: In all, 1295 boys and 1577 girls aged 15–19 years, of whom 28·4% had already left school. Socio-economic characteristics of the parents, anthropometric measurements, food behaviours and physical activity of the adolescents were recorded during home visits.

Results: Prevalence of underweight, overweight and obesity (WHO/National Center for Health Statistics reference) were, respectively, 8·1%, 17·4% and 4·1% among boys and 1·3%, 20·7% and 4·4% among girls; abdominal obesity was highly prevalent among both sexes. Prevalence of overweight differed by region (from 11·5% to 22·2%) and was higher in urban *v.* rural areas for males (21·7% *v.* 10·4%) but not for females (21·7% *v.* 19·2%). These differences were partially mediated by socio-economic and lifestyle factors for males. For females, influence of cultural factors is hypothesised. In rural areas, overweight was more prevalent among boys of higher economic level households, having a working mother or a sedentary lifestyle; for girls, prevalence increased with the level of education of the mother. In urban areas, prevalence of overweight was related to eating habits: it was higher for boys with irregular snacking habits and for girls skipping daily meals. Urban girls having left school were also more overweight.

Conclusion: Overweight and abdominal obesity in late adolescence have become a true public health problem in Tunisia with the combined effects of cultural tradition for girls in rural areas, and of rapid economic development for boys and girls in cities.

Keywords
Youth
Underweight
Overweight
Obesity
Health behaviour
North Africa

The worldwide progression of obesity ranks it now as a major public health concern in developed countries and also in many developing countries[1]. Tunisia, a middle-income developing country that has undergone significant socio-economic changes, is no exception, as more than half (51%) of the adult women were already classified as overweight in the last nationwide survey in 1997[2].

After a variable time lag, overweight and obesity are also significantly affecting children and adolescents, sometimes faster than adults[3]. A recent review indicates that 10% of the world's school-aged children have excess body fat; among these, 25% are obese, with a significant likelihood of some developing type 2 diabetes or heart disease during adulthood[4]. According to surveys done since 1990, the Middle Eastern Mediterranean region ranks third after the American continent and Europe for the prevalence of overweight and obesity among school-aged children, as defined by criteria of the International Obesity Taskforce (IOTF). While specific data are scarce for North Africa[4], various surveys conducted in the past in Tunisia or Morocco indicated a progression of obesity in pre-school children and in adults over 20 years[2,5,6]; this probably implies a progression at all ages, including school-aged children and adolescents. However, until recently more attention was paid to undernutrition, which

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is still a significant problem in many pre-school and even school-aged children in various countries[7–9]. In Tunisia, while one study showed that overweight was prevalent in an urban sample of school-aged children and adolescents[10], there has been no regional or national review of the extent of the problem. As in any country undergoing rapid nutrition transition, the pace and extent of changes may vary according to the region depending on the level of urbanisation and of the social and economic transformation[11]. Thus, the aim of the present study was to assess the nutritional status of 15–19-year-old adolescents and to identify associated factors at the national and regional levels, to help target preventive actions. Among these factors, we studied the association with physical activity for which there is growing evidence of its important role, and eating behaviours. While studies on energy intake are conflicting, eating behaviours (e.g. greater away from home consumption, increasing prevalence of snacking or decline in breakfast consumption) have been shown elsewhere to be associated with overweight in children or adolescents[12,13]. Also, as most studies refer only to schooled adolescents, while up to one-third drop out of school at these ages[14], we paid specific attention to those no longer attending school.

Methodology

Study area

Tunisia is a North African country with a population of about ten million and a middle-income developing country economy (gross domestic product per capita: 8800 (purchasing power parity; US$) in 2006). It has a long Mediterranean coastline in the north and the east. Geographical contrasts, inland on the west *v.* coastal regions in the east, as well as a marked climatic and agricultural gradient from Mediterranean in the north to desert in the south, result in pronounced economic differences between the seven administrative regions of the country (see Fig. 1). The main cities and prosperous industrial and tourist activities are concentrated along the eastern regions, with the District of Tunis (the capital) in the north east being the most developed. By contrast, the western inland parts, especially the North West and Centre West regions, often hilly or mountainous, have not reached the same level of economic and social development. Thus, in the present study, for analysis purposes the regions were grouped as coastal (North East, District of Tunis, Centre East, South East) *v.* inland (North West, Centre West, South West), the coastal group being labelled 'more developed' (MD) and the inland group 'less developed' (LD).

Study design and subjects

The target population was all Tunisian adolescents aged 15–19 years. The survey was a cross-sectional, nationally representative, stratified two-stage clustered sample of households, based on the last census of the population in 2004. It was carried out from April to September 2005. Stratification was done according to the seven administrative regions of Tunisia. Then forty-seven census districts were selected, in each region, with a probability proportional to size in number of households. At the second stage, twenty households were sampled randomly for each district selected and all the 15–19-year-olds living in the 6580 households at the time of the survey were included.

The study was approved by the Tunisian Ministry of Health and by the Home Office (Visa no. 5/2005) and was conducted by uniformly trained researchers under the direction of H.A.-S., with a supervision ensured by the regional health directions staff. Verbal consent was obtained from the adolescents and their parents before inclusion in the study. The subjects were informed of their right to refuse and of the strict respect of the confidentiality of their answers.

Variables and measurement methods

To adapt questionnaires issued from previous international studies, a translation–back-translation procedure has been followed to ensure good language accuracy and understanding.

The economic level of the household was assessed by an index constructed from correspondence analysis of the matrix of binary variables coding for type of house, number of people per room, type of drinking water supply, type of sanitation and possessions such as car, refrigerator, television, computer and satellite dish antenna[15,16]. For a given household, the coordinate on the first axis of the correspondence analysis is interpreted as a summary indicator of the economic level of the household. This index was then divided into tertiles of increasing economic level.

Information on the level of education of the parents was recoded as 'secondary or higher' *v.* others (primary or less). Their professional occupation was also assessed and recoded as 'not working' (the majority) *v.* 'working' for the mother and 'upper or intermediate', 'employee/worker' or 'not working' (retired, unemployed) for the father. Adolescents were categorised according to whether they were registered at a school or not at the time of the survey.

Concerning eating behaviours, the subjects were asked about their usual weekly eating habits, i.e. whether they ate breakfast, lunch and dinner or a morning, afternoon or after dinner snack; 'snacks' were defined as other eating episodes apart from meals. The subjects were considered as eating daily meals if they ate all three main meals every day of the week. Regular snacking was defined as eating at least one snack daily. They were also asked about their preference for street food over home cooking as well as whether they considered that they

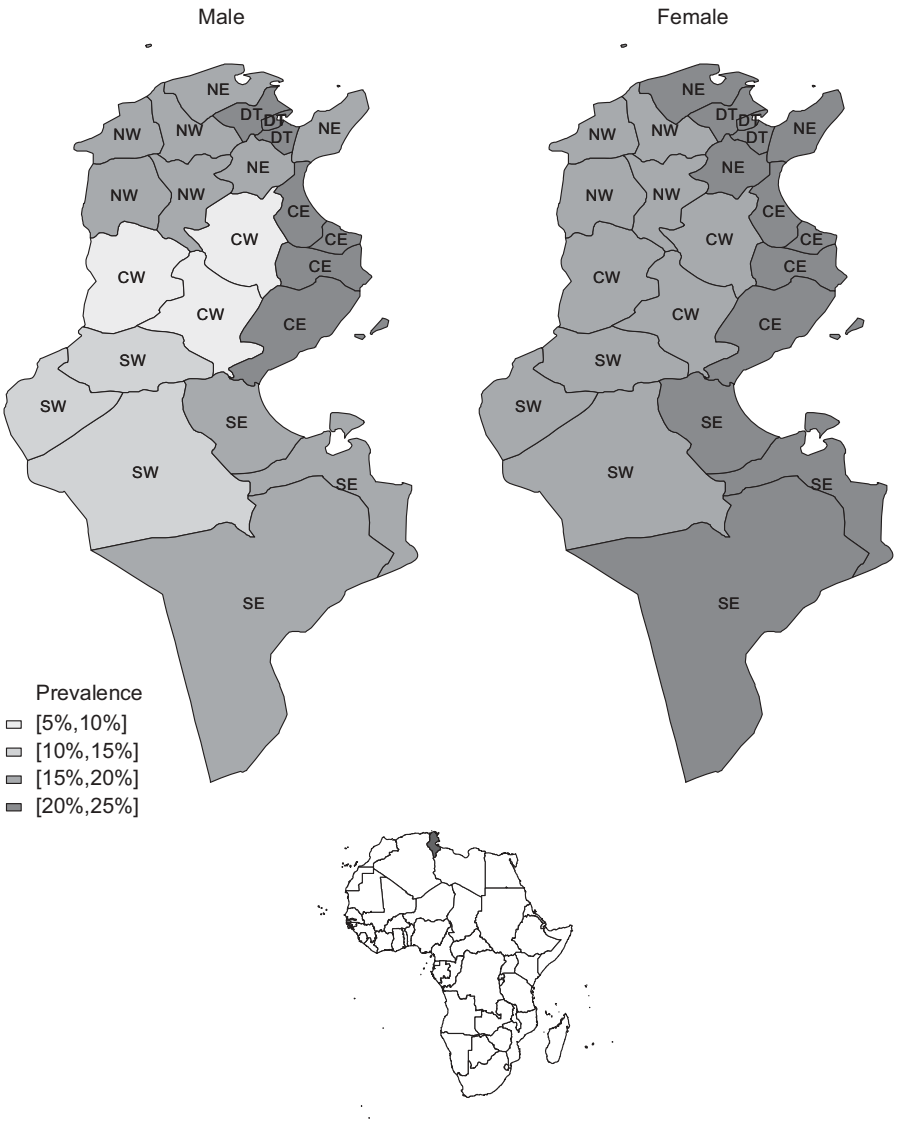

Fig. 1 Prevalence of overweight (including obesity) by region and sex (DT, District of Tunis; NW, North West region; NE, North East region; CW, Centre West region; CE, Centre East region; SW, South West region; SE, South East region)

themselves controlled their dietary intake to promote their health.

Physical activity during the month preceding the survey was assessed using a frequency questionnaire that had previously been validated for Tunisian adults[17] and adapted for young people by adding more detailed questions about sport and leisure activities[18]. We also added an indicator of sports activities (whether the subject had done any exercise, excluding walking, at least once during the previous week). Sedentary lifestyle was assessed by time spent watching television or surfing the Internet daily. The metabolic equivalent (MET) of daily activities was calculated using an international compendium of physical activity[19], and intensities were classified as light, moderate or vigorous (respectively, <3, 3–6 and ≥6 MET; 1 MET = 3·5 ml O_2/kg) using the Centers for Disease Control and Prevention/American College of Sports Medicine classification. Low level of physical activity was defined by the subject being over the 75th percentile of the observed distribution of percentages of daily time with light physical activity.

Weight was measured to the nearest 100 g by trained health personnel using electronic scales that were regularly checked for accuracy and precision (Teraillon, France). Height was measured to the nearest millimetre using portable gauges (Seca, Germany), in a standing position, without shoes. Overweight and obesity were based on the age- and sex-specific BMI reference distributions of the WHO/National Center for Health Statistics (NCHS) data according to WHO recommendations[20]. Underweight was defined as BMI for age and sex <5th percentile, overweight (therefore including obesity) as BMI ≥ 85th percentile and obesity as BMI ≥ 95th percentile. For the purpose of comparison, the IOTF definition

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for child overweight and obesity was also sometimes used[21]. Waist circumference was measured to the nearest 0·1 cm with a non-elastic metric measuring tape with subjects standing in underclothes. Abdominal obesity was defined as waist circumference ≥75th percentile of the observed distribution by age and sex.

Data management and statistical analysis

Data were entered with Epidata software, version 3·1[22] and were validated by double entry and standard quality check procedures.

Sampling weights were computed to account for the differential probabilities of selection in each stratum and also included a post-stratification on sex and urban *v.* rural. Comparisons of means were done through ANOVA and χ^2 tests were used for the comparison of percentages. Associations between underweight, overweight (including obesity) or obesity and relevant factors were assessed by prevalence OR. Thus logistic regression models with underweight, overweight (including obesity) or obesity alone as the response variable were used to assess the effect of the different factors, including relevant confounders and/or interactions, and to estimate adjusted ORs. Analyses of factors associated with overweight were disaggregated by sex and area (urban/rural). The type I error risk was set at 0·05. Data management and analysis were performed using Stata 9[23], and all analyses took the sampling design into account (stratification, clustering and sampling weights).

Results

Characteristics of the sample

From the 6580 households initially selected, according to the average 0·48 ratio of 15–19-year-olds per household (2004 Tunisian census), about 3138 subjects were to be included. Finally 2928 adolescents belonging to 2261 households were included and the final sample analysed comprised 2872 subjects (response rate: 91·5%). The main characteristics of adolescents, after taking sampling weights into account, are presented in Table 1. The mean age was 17·4 (SE 0·03) years. As expected, the proportion of urban households differed markedly between regions. About a third of the fathers had reached at least a secondary level of education, and 20% of mothers, but only 12·7% of mothers were working. The economic level of the households, as well as the level of education and occupational categories of the parents, varied significantly across regions and areas. The percentage of adolescent schooling also varied markedly between areas and between regions, the highest rate being found, as expected, in the cities, more specifically in the capital city.

Nutritional status

Overall, 4·8% (CI 3·8, 5·9) of adolescents were underweight, males more frequently than females (8·1% *v.* 1·3%, $P < 10^{-4}$). The prevalence of underweight was the same in urban and rural areas, but males were more underweight than females in both areas (Fig. 2), thus with no interaction between sex and area ($P = 0·61$). There were no overall differences by groups of regions, males being however more underweight in each group (LD or MD).

Based on the WHO/NCHS reference, 19% of adolescents were overweight (including obesity) (CI 17·2, 21·0), and 4·3% (CI 3·3, 5·4) were obese, with no difference by sex. Based on the IOTF reference (data not shown), the overall prevalence of overweight (15%) and obesity (2·6%) was lower and also differed by sex, being 12·9% for males and 17·3% for females for overweight ($P = 0·014$), and, respectively, 1·9% *v.* 3·2% for obesity ($P = 0·15$).

Urban and rural areas did not differ with respect to the prevalence of obesity, but prevalence of overweight was higher in urban *v.* rural areas (21·7% *v.* 14·7%, $P < 0·001$), specifically for males (Fig. 2), but not for females (sex × area interaction $P < 0·01$). The effect of area on the prevalence of overweight among males was partially mediated by socio-economic factors, as the urban *v.* rural OR varied from 2·38 (CI 1·56, 3·64; $P < 0·001$) unadjusted, to 1·74 (CI 1·07, 2·83; $P = 0·026$) after adjustment for socio-economic factors (schooling, education level and occupation of the parents and economic level of the household) and lifestyle (physical activity, frequency of meals and snacking). On the contrary, there were no urban *v.* rural differences for females, either before adjustment: OR=1·16 (CI 0·85, 1·57; $P = 0·34$) or after: OR = 1·11 (CI 0·75, 21·66; $P = 0·59$).

Prevalence of overweight differed between the seven regions from 11·5% in the Centre West to 22·2% in the Tunis region ($P = 0·0083$). Differences were gender specific (Fig. 1), as no effect was observed for females ($P = 0·52$), while sharp regional contrasts did appear for males (from 22·8% in the Centre East to 6·9% in the Centre West). When grouping regions according to the level of development, for males overweight was more prevalent in MD *v.* LD regions ($P < 0·001$), but only marginally so for females ($P = 0·054$). For males, the difference in prevalence of overweight between groups of regions was partly explained by socio-economic and lifestyle factors as the MD *v.* LD OR varied from 1·96 (CI 1·31, 2·92; $P = 0·001$) unadjusted, to 1·70 (CI 1·08, 2·65; $P = 0·021$) after adjustment. These MD *v.* LD OR in the female group were, respectively, 1·33 (CI 1·00, 1·78; $P = 0·054$) and 1·28 (CI 0·91, 1·80; $P = 0·15$). No MD *v.* LD contrasts were observed for obesity by gender, in spite of a slight overall difference between MD and LD (4·9% *v.* 3·1%; $P = 0·046$).

There was no difference between genders for abdominal obesity. The percentage was significantly higher in urban *v.* rural areas and was mainly due to the observed difference in the male group (sex × area interaction,

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Table 1 Socio-economic characteristics and nutritional status (sample weighted results)

			Areas			Regions		
						Grouped by level of development		
	n	National (2872)	Urban (1533)	Rural (1339)	*P*	More developed (1509)	Less developed (1363)	*P*
Socio-economic features								
Age (years), mean (SE)	2872	17·38 (0·03)	17·40 (0·04)	17·34 (0·04)	0·22	17·39 (0·04)	17·36 (0·04)	0·61
Male/female (%)	2872	51·1/48·9	51·0/49·0	51·2/48·8	0·92	51·0/49·0	51·2/48·8	0·94
Schooling (%)	2866	71·6	79·0	59·4	$<10^{-4}$	73·9	67·2	0·014
Urban (%)	2872	62·3	–	–	–	73·5	40·6	$<10^{-4}$
HH economic level (%)	2734							
Low	1172	37·9	20·4	66·1	$<10^{-4}$	28·5	55·7	$<10^{-4}$
Intermediate	980	34·0	37·7	28·1		34·8	32·6	
High	582	28·1	41·9	5·8		36·7	11·7	
Education level (% >primary school)								
Father	2842	32·6	42·2	16·9	$<10^{-4}$	39·8	18·8	$<10^{-4}$
Mother	2844	20·0	27·1	8·5	$<10^{-4}$	26·7	7·2	$<10^{-4}$
Father's occupation (%)	2838							
Upper	632	24·5	27·8	19·3	0·0019	27·2	19·3	0·0054
Intermediate	1763	59·9	56·1	66·0		57·1	65·2	
Not working	443	15·6	16·2	14·7		15·7	15·5	
Working mother (%)	2856	12·7	16·7	6·1	$<10^{-4}$	16·3	5·9	$<10^{-4}$
Nutritional status								
Underweight (%)								
All	2872	4·8	4·8	4·8	0·97	4·6	5·2	0·54
Male	1295	8·1	8·2	7·8	0·84	7·5	9·1	0·41
Female	1577	1·3	1·2	1·5	0·65	1·5	1·1	0·54
Overweight (%)								
All	2872	19·0	21·7	14·7	$<10^{-3}$	21·3	14·6	$<10^{-3}$
Male	1295	17·4	21·7	10·4	$<10^{-3}$	20·4	11·6	$<10^{-3}$
Female	1577	20·7	21·7	19·2	0·34	22·3	17·7	0·054
Obesity (%)								
All	2872	4·3	4·7	3·5	0·19	4·9	3·1	0·046
Male	1295	4·1	4·8	2·8	0·15	4·6	3·1	0·25
Female	1577	4·4	4·6	4·2	0·78	5·1	3·1	0·10
Abdominal obesity (%)								
All	2860	28·0	30·9	23·2	0·0020	33·0	18·2	$<10^{-4}$
Male	1288	28·4	33·9	19·4	$<10^{-4}$	34·2	17·2	$<10^{-4}$
Female	1572	27·6	27·9	27·2	0·82	31·9	19·2	$<10^{-4}$

HH, household.
Underweight, <5th reference percentile; overweight, ≥85th percentile; obesity, ≥95th percentile.

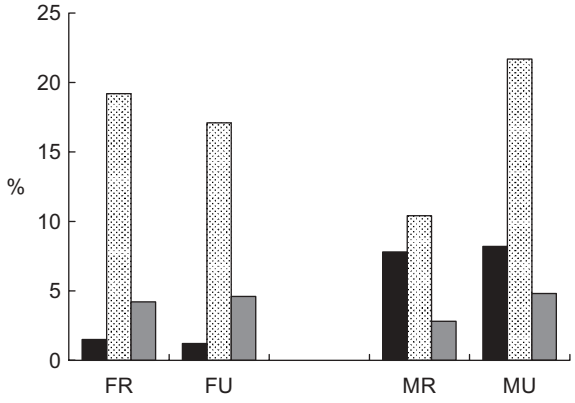

Fig. 2 Prevalence of underweight (■), overweight including obesity (▨) and obesity (▩) by area and sex. For underweight: MR *v.* FR, $P<10^{-4}$; MU *v.* FU, $P<10^{-4}$. For overweight: MU *v.* MR, $P<10^{-3}$; MR *v.* FR, $P<10^{-3}$ (MR, male–rural; FR, female–rural; MU, male–urban; FU, female–urban)

$P<0{\cdot}001$). For males, the urban *v.* rural OR decreased after adjustment for socio-economic and lifestyle factors from 2·14 (CI 1·52, 3·00; $P<10^{-4}$) to 1·46 (CI 0·98, 2·18; $P=0{\cdot}063$), but not for females, from 1·03 (CI 0·78, 1·37; $P=0{\cdot}82$) to 1·14 (CI 0·79, 1·64; $P=0{\cdot}49$). Prevalence of abdominal obesity was different between the two groups of regions, with no significant interaction between sex and region ($P=0{\cdot}23$). The difference between regions (MD *v.* LD) was not mediated by family socio-economic and lifestyle factors as OR varied for males, from 2·49 (CI 1·79, 3·45; $P<0{\cdot}001$) unadjusted, to 2·40 (CI 1·65, 3·49; $P<0{\cdot}001$) after adjustment, and for females, it varied from 1·97 (CI 1·49, 2·60; $P<0{\cdot}0001$) to 2·22 (CI 1·60, 3·08; $P<0{\cdot}001$).

Eating behaviour and physical activity

Skipping meals was frequent (29·5%), especially among females (Table 2). Breakfast and dinner were the most frequently skipped. No difference was observed between areas either for males or for females. Around 40% of adolescents snacked regularly between meals; snacking in the afternoon and after dinner was significantly higher in urban areas for both sexes, but more frequent for males than for females. The percentage of adolescents who declared they preferred street food was 17% with no difference between sexes. This proportion was higher in urban areas for both sexes. Regional differences were observed, but only for females (higher proportion in the MD group of regions). Almost half of the adolescents, and slightly more females than males, declared that they controlled their dietary behaviour. The prevalence of sport was significantly higher for males, as could be expected. It was slightly higher in urban *v.* rural areas (71·1% *v.* 65·4%, $P=0{\cdot}028$), the difference being significant only in the female group. Sedentary behaviour was general and significantly more prevalent among females. The mean duration of watching television or surfing the Internet was higher for females (95·2 (SE 3·4) *v.* 87·0 (SE 3·6) min/d) and was generally higher in urban *v.* rural areas and in the MD *v.* LD group of regions, with a significant difference found mainly for females. The proportion of adolescents who reported a low level of physical activity was significantly higher for females independently of the area or region.

Adolescents not attending school

Among the 28·4% of adolescents not attending school, 40·8% (of whom 65·8% were male and 34·2% female) had a salaried job while the others stayed at home. Among those not attending school, for both sexes the economic level of the household was higher ($P<0{\cdot}001$) for the 'salaried' *v.* the 'stay at home' group (data not shown). Salaried adolescents were more frequent in urban *v.* rural areas (53·0% *v.* 30·4%, $P<10^{-4}$). Prevalence of overweight was 19·9% in adolescents not attending school, similar to the prevalence in the overall sample (19·1%), but was higher for salaried adolescents *v.* those staying at home (respectively, 23·8% and 16·7%, $P=0{\cdot}048$). By sex, the salaried males were more overweight than those staying at home (18·8% *v.* 9·4%, $P=0{\cdot}022$), but less significantly so for females (respectively, 35·0% *v.* 23·0%, $P=0{\cdot}073$).

Factors associated with overweight

As factors associated with overweight differed for males *v.* females as well as for urban *v.* rural areas, separate analyses are presented. For males in urban areas (Table 3), overweight was associated with irregular snacking habits (OR = 1·76, $P=0{\cdot}016$) and marginally significantly so with skipping daily meals (OR = 1·5, $P=0{\cdot}077$). For males in rural areas, overweight was associated with the mother working outside the home (OR = 4·9, $P<0{\cdot}001$) and low physical activity (OR = 2·7, $P=0{\cdot}009$). Overweight also increased with socio-economic level of the household (OR = 3·8 and 2·5, respectively, for high and intermediate *v.* low, $P=0{\cdot}055$). For females in urban areas (Table 4), overweight was associated with not attending school (OR = 2·9, $P<0{\cdot}001$) and skipping daily meals (OR = 1·6, $P=0{\cdot}047$). For females in rural areas, the only association found was with level of education of the mother (primary or less *v.* other, OR = 2·4, $P=0{\cdot}026$).

Discussion

Our study aimed at updating the prevalence and factors associated with nutritional status of Tunisian adolescents. Associations should of course not be interpreted further than the cross-sectional design permits. Also, the study does not feature direct assessment of dietary intake, although in many cases it has been difficult to relate it to

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Table 2 Factors related to food behaviour and physical activity by sex, area or region

	Areas					Regions		
						Grouped by level of development		
	National	*P* (M/F)	Urban	Rural	*P* (U/R)	More developed	Less developed	*P*
Food behaviour								
Eating daily meals (%)	70·5		69·7	71·7	0·38	71·8	67·8	0·074
Male	78·8		78·6	79·1	0·87	79·9	76·6	0·25
Female	61·9	$<10^{-4}$	60·6	63·95	0·30	63·5	58·7	0·13
Breakfast	77·8		77·1	79·1	0·29	79·3	75·1	0·033
Male	84·5		83·9	85·4	0·56	85·3	82·9	0·31
Female	71·0	$<10^{-4}$	70·0	72·6	0·36	73·0	66·9	0·031
Lunch	94·9		95·1	94·7	0·73	95·1	94·7	0·67
Male	95·7		96·0	95·2	0·59	95·9	95·3	0·65
Female	94·1	0·098	94·1	94·1	0·97	94·2	94·0	0·87
Dinner	86·6		86·2	87·2	0·55	86·6	86·6	0·98
Male	91·8		91·9	91·4	0·78	91·7	91·8	0·94
Female	81·2	$<10^{-4}$	80·3	82·7	0·32	81·3	81·0	0·92
Regular snacking* (%)	39·4		43·0	33·6	0·0010	40·3	37·8	0·35
Male	41·0		43·9	36·4	0·044	42·2	38·7	0·32
Female	37·8	0·15	42·1	30·6	$<10^{-3}$	38·3	36·8	0·65
Morning snack	18·7		19·2	17·8	0·49	18·4	19·3	0·67
Male	21·3		21·9	20·4	0·59	21·2	21·5	0·92
Female	16·0	0·0022	16·5	15·1	0·58	15·5	16·9	0·55
Afternoon snack	28·2		31·5	22·9	0·0012	29·3	26·1	0·22
Male	28·6		32·2	23·0	0·0083	29·8	26·4	0·33
Female	27·7	0·66	30·7	22·8	0·012	28·7	25·9	0·34
After dinner snack	11·6		14·0	7·9	$<10^{-3}$	12·7	9·7	0·046
Male	13·5		16·7	8·4	$<10^{-3}$	15·3	10·1	0·018
Female	9·7	0·012	11·2	7·3	0·034	10·0	9·2	0·68
Prefer street foods (%)	17·1		19·7	12·9	$<10^{-3}$	18·2	15·0	0·087
Male	17·3		19·2	14·2	0·047	17·2	17·5	0·89
Female	16·9	0·84	20·2	11·6	$<10^{-3}$	19·3	12·4	0·0039
Food behaviour control (%)	50·9		46·4	49·8	0·21	47·6	48·0	0·86
Male	44·6		43·0	47·2	0·24	44·2	45·4	0·75
Female	50·9	0·0035	49·9	52·4	0·41	51·0	50·7	0·94
Physical activity								
Practice of sport (%)	68·9		71·1	65·4	0·028	70·2	66·6	0·16
Male	82·9		84·5	80·3	0·13	83·9	80·9	0·25
Female	54·2	$<10^{-4}$	57·0	49·6	0·040	55·6	51·5	0·25
TV† min/24 h, mean (SE)	91·1 (2·9)		95·8 (4·2)	83·3 (2·9)	0·016	95·8 (4·1)	81·9 (3·1)	0·0069
Male	87·0 (3·6)		91·1 (5·3)	80·2 (3·8)	0·0983	91·2 (5·1)	79·0 (4·1)	0·063
Female	95·2 (3·4)	0·041	100·6 (4·8)	86·4 (3·8)	0·0228	100·6 (4·6)	85·0 (4·4)	0·015
Low physical activity (%)	22·2		20·7	24·6	0·064	21·8	22·9	0·59
Male	15·4		13·9	17·9	0·065	15·3	15·7	0·83
Female	29·2	$<10^{-4}$	27·7	31·6	0·23	28·6	30·4	0·54

M, male; F, female; U, urban; R, rural.
*At least once daily.
†Watching television and/or Internet.

overweight in adolescents contrary to food-related behaviours[12], which our study does assess.

Nutritional status

With reference to a national nutrition survey conducted in 1996–97[24], which gave limited data for the 15–19-year age class, in 2005 underweight had decreased from 14·4% to 8·1% for males and from 3·3% to 1·3% for females. During the same period overweight had increased markedly from 2·9% to 17·4% for males and from 13·5% to 20·7% for females. A similar trend has been observed in developing countries which underwent a rapid socio-economic transition[8] as did Tunisia, whose Human Development Index rose from 0·515/1·0 in 1975 to 0·765/1·0 in 2005[25]. Thus, the overall prevalence of overweight in adolescents aged 15–19 years is currently high in Tunisia. However, it is still lower than in other Arab countries with prevalence in this age class being around or over 30%[26–28]. Rather, the situation is similar to that of most European countries, where the prevalence of overweight ranges from 20% to 12%[29,30]. Analogous results for overweight were also observed recently in a city from eastern Algeria[31], indicating that this rapid increase in prevalence may concern other North African countries as well, in spite of the lack of nationally representative data. Moreover, our study shows that the increase is not limited to BMI, but also affects waist circumference, an overall marker for higher risks to develop

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Table 3 Correlates of overweight (including obesity): males

	Urban								Rural							
			Unadjusted OR			Adjusted OR*					Unadjusted OR			Adjusted OR*		
	n	OW (%)	OR	CI	*P*	OR	CI	*P*	*n*	OW (%)	OR	CI	*P*	OR	CI	*P*
Schooling																
Yes	543	22·2	1·00	–	0·61	1·00	–	0·60	351	11·5	1·00	–	0·35	1·00	–	0·84
No	162	20·0	0·87	0·52, 1·48		0·84	0·44, 1·61		237	8·8	0·74	0·40, 1·38		0·93	0·44, 1·95	
Economic level of household																
Low	156	15·3	1·00	–	0·22	1·00	–	0·18	371	7·8	1·00	–	0·060	1·00	–	0·055
Intermediate	261	21·8	1·54	0·74, 3·23		1·98	0·85, 4·59		166	15·2	2·13	1·02, 4·45		2·51	1·09, 5·80	
High	252	24·4	1·79	0·92, 3·48		2·16	0·95, 4·91		31	18·1	2·62	0·88, 7·76		3·75	0·74, 18·98	
Father's occupational category																
Upper	180	25·8	1·00	–	0·37	1·00	–	0·46	106	7·6	1·00	–	0·65	1·00	–	0·64
Intermediate	398	20·7	0·75	0·45, 1·26		0·90	0·46, 1·75		380	10·5	1·43	0·64, 3·23		1·48	0·65, 3·36	
Not working	119	17·8	0·62	0·31, 1·26		0·61	0·28, 1·37		98	11·0	1·51	0·55, 4·16		1·35	0·49, 3·73	
Mother's occupational category																
Not working	603	21·0	1·00	–	0·33	1·00	–	0·55	554	9·0	1·00	–	$<10^{-3}$	1·00	–	$<10^{-3}$
Working	101	25·4	1·28	0·77, 2·13		0·82	0·42, 1·59		33	31·9	4·74	2·23, 10·06		4·88	2·14, 11·14	
Father's education level																
Primary or less	422	20·8	1·00	–	0·61	1·00	–	0·34	502	10·6	1·00	–	0·75	1·00	–	0·29
Secondary or higher	271	22·5	1·11	0·75, 1·63		0·78	0·46, 1·31		84	9·5	0·88	0·40, 1·95		0.53	0.17–1.71	
Mother's education level																
Primary or less	522	19·4	1·00	–	0·088	1·00	–	0·29	540	10·4	1·00	–	0·90	1·00	–	0·68
Secondary or higher	172	26·4	1·50	0·94, 2·38		1·41	0·75, 2·64		46	11·0	1·06	0·42, 2·67		0·72	0·17, 3·16	
Eating daily meals																
Yes	551	20·6	1·00	–	0·088	1·00	–	0·077	463	9·0	1·00	–	0·073	1·00	–	0·16
No	147	27·2	1·44	0·95, 2·20		1·50	0·96, 2·36		125	15·9	1·92	0·94, 3·90		1·67	0·81, 3·46	
Regular snacking†																
Yes	291	17·2	1·00	–	0·035	1·00	–	0·016	209	9·3	1·00	–	0·49	1·00	–	0·10
No	388	24·6	1·57	1·03, 2·39		1·76	1·11, 2·80		369	11·3	1·25	0·67, 2·35		1·89	0·88, 4·06	
Low physical activity																
No	601	21·7	1·00	–	0·98	1·00	–	0·60	477	8·7	1·00	–	0·005	1·00	–	0·009
Yes	106	21·8	1·01	0·59, 1·73		0·84	0·43, 1·64		111	18·2	2·33	1·29, 4·23		2·68	1·29, 5·56	

OW, overweight (including obesity).
*Adjusted for age.
†Snacking at least once daily.

Table 4 Correlates of overweight (including obesity): females

	Urban								Rural							
			Unadjusted OR			Adjusted OR*					Unadjusted OR			Adjusted OR*		
	n	OW (%)	OR	CI	*P*	OR	CI	*P*	*n*	OW (%)	OR	CI	*P*	OR	CI	*P*
Attending school																
Yes	681	19·4	1·00	–	0·004	1·00	–	$<10^{-3}$	471	17·3	1·00	–	0·12	1·00	–	0·25
No	141	33·3	2·08	1·26, 3·41		2·89	1·62, 5·13		280	22·3	1·37	0·92, 2·04		1·35	0·81, 2·24	
Economic level of household																
Low	177	16·9	1·00	–	0·54	1·00	–	0·51	468	17·5	1·00	–	0·42	1·00	–	0·44
Intermediate	340	21·1	1·32	0·77, 2·24		1·49	0·76, 2·92		213	21·3	1·27	0·75, 2·15		1·38	0·76, 2·52	
High	259	21·5	1·35	0·73, 2·48		1·39	0·62, 3·12		40	25·9	1·65	0·73, 3·71		1·60	0·67, 3·78	
Father's occupational category																
Upper	189	22·0	1·00	–	0·55	1·00	–		157	24·2	1·00	–	0·092	1·00	–	0·28
Intermediate	493	20·5	0·91	0·56, 1·48		0·88	0·51, 1·52	0·56	492	16·9	0·64	0·40, 1·03		0·79	0·49, 1·29	
Not working	126	26·1	1·25	0·65, 2·38		1·21	0·57, 2·57		100	23·6	0·97	0·54, 1·76		1·19	0·63, 2·24	
Mother's occupational category																
Not working	700	22·1	1·00	–	0·46	1·00	–	0·35	707	19·6	1·00	–	0·25	1·00	–	0·11
Working	117	18·8	0·82	0·48, 1·40		0·74	0·39, 1·40		41	12·1	0·57	0·21, 1·50		0·44	0·16, 1·20	
Father's education level																
Primary or less	517	19·8	1·00	–	0·24	1·00	–	0·45	616	19·9	1·00	–	0·28	1·00	–	0·28
Secondary or higher	299	24·7	1·33	0·83, 2·14		1·24	0·72, 2·13		131	16·3	0·78	0·50, 1·22		0·70	0·37, 1·33	
Mother's education level																
Primary or less	649	20·6	1·00	–	0·31	1·00	–	0·38	686	18·6	1·00	–	0·23	1·00	–	0·026
Secondary or higher	168	25·6	1·32	0·77, 2·27		1·30	0·72, 2·35		61	25·7	1·52	0·77, 2·99		2·38	1·11, 5·08	
Eating daily meals																
Yes	501	19·5	1·00	–	0·092	1·00	–	0·047	472	18·0	1·00	–	0·37	1·00	–	0·35
No	321	25·2	1·40	0·95, 2·06		1·57	1·01, 2·45		278	21·1	1·22	0·79, 1·89		1·25	0·78, 2·02	
Regular snacking†																
Yes	316	21·9	1·00	–	0·80	1·00	–	0·71	221	15·2	1·00	–	0·086	1·00	–	0·10
No	482	21·0	0·95	0·62, 1·45		0·91	0·57, 1·46		509	21·4	1·52	0·94, 2·45		1·54	0·92, 2·58	
Low physical activity																
No	566	20·6	1·00	–	0·26	1·00	–	0·30	510	18·6	1·00	–	0·52	1·00	–	0·65
Yes	260	24·4	1·25	0·85, 1·83		1·27	0·81, 1·98		241	20·7	1·15	0·76, 1·74		1·11	0·70, 1·80	

OW, overweight (including obesity).
*Adjusted for age.
†Snacking at least once daily.

later chronic diseases. This confirms an observation made in the coastal city of Sousse, which showed a clustering of cardiovascular risk factors among obese urban schoolchildren[10].

Influence of living area

Surprisingly, no straightforward differences were observed for the prevalence of underweight between groups of regions according to the level of development, nor between urban and rural areas. A more detailed analysis revealed though that underweight was observed predominantly in the richest (District of Tunis) and in the poorest (Centre West) of the seven administrative regions. The regular rural exodus of rather poor families towards the capital, and also the context of intra-urban economic inequalities[32], may explain this unexpected situation.

On the contrary, for overweight, there were sharp contrasts between regions according to their level of development, and also between rural and urban areas, only for males though, in both cases. Indeed, one of the most significant results was the strong differential effect of sex on regional or urban *v.* rural differences regarding overweight: urban boys and girls appeared to be equally overweight and abdominal obesity prone, but in rural areas boys appeared to be relatively protected. For females, for which no urban *v.* rural difference was observed, whether or not taking into account socio-economic and lifestyle factors, possible inverse confounding effect of marital status on overweight[33] was not assessed in our study because of the rarity of marriage now in this age bracket in Tunisia (around 12‰). For males, adjusted analyses indicated that the differences observed were partly mediated by socio-economic and lifestyle factors. But the residual associations also showed that these differences might be linked to other factors, and this was further emphasised by the large difference in abdominal obesity between regions or areas that had no link with any of the socio-economic or lifestyle factors measured here. Such differences between regions[28,33] and higher prevalence in urban *v.* rural areas[8,34–36] are frequently reported as a consequence of a different level of exposure to genetic influences[37] and particularly to environmental factors[38], and also to traditions, psychological and cultural factors that influence eating behaviours[38–40]. The higher prevalence of overweight and obesity in females *v.* males observed here in rural areas has been reported for other African countries[30], and may also be partly linked to cultural factors. Indeed, a positive perception of overweight is often reported in Arab countries, especially for females, as it is considered to be a sign of high social status, beauty, fertility and prosperity[26]. Although the dominant model in Western countries of a thin body may gain new consideration in countries of the Mediterranean region[7,27], women in Mauritania, for instance[41], or more recently Moroccan Sahraoui women[42,43], have been shown to still value body weight and to undergo social pressure in order to maintain their overweight. With respect to our results, why would these factors result in gender-specific urban *v.* rural differences? It could be that in the urban area, the more obesity-prone socio-economic context is somewhat counterbalanced by the Western model of a thin body.

Gender/area-specific factors of nutritional status

In rural settings, for boys, overweight was associated with increased economic level of the household, with a less available working mother and sedentariness, a classic pattern described by Sobal and Stunkard in 1989[44]. For rural girls, no direct association with the economic level of the household was observed, but only with a high level of education of the mother (which is also somewhat indicative of a higher socio-economic level, though it concerns a relative minority of mothers, as less than 9% of mothers had reached the secondary level). Nutrition transition is generally fuelled by urbanisation so that urban/rural disparities are the rule in the first phase, while the phenomenon evolves at a different pace in different parts of the country, and obesity is usually associated with a better economic status[45,46]. A difference in prevalence of overweight between rural and urban areas as observed here for boys as well as the observed association with socio-economic factors in rural areas fit well with this view of a first stage of the nutrition transition. It is less clear however as to why overweight is no longer associated with the socio-economic level in urban areas. It may mean that cities would be entering another step of the transition phenomenon where overweight spreads from higher to lower socio-economic layers of the society[45].

In rural boys, low physical activity is less frequent than in girls and it appears as an important factor for overweight. A likely explanation would be a close adjustment of energy intake to energy needs of active rural boys so that any reduction in intake would lead to underweight while any reduction in activity would lead to overweight. This is not the case for rural girls as they expend generally less activity than boys and may therefore meet more easily their energy needs but are also prone to becoming more often overweight. In urban settings, regulation of energy expenditure may less be an issue, and for both sexes overweight was no longer associated with physical activity but mainly associated with eating behaviours. Although correlates of overweight may vary largely across studies, a greater number of eating episodes each day for a given total intake, and their regularity, has been classically related to a lower risk of obesity in adolescents and in adults[12]. Finally, while overweight prevalence was similar overall whether or not adolescents were attending school at these ages, a higher risk of overweight was observed in urban girls who had left school, after adjustment for all other factors. It may be related to the higher personal economic status linked with a salaried job, though this has been partly taken into account here

(as analyses are adjusted for whether or not the subject is attending school). Alternatively, when they abandon school, girls are likely to undergo sudden changes in food and physical activity practices; although a minority, they certainly are a group at risk, which should be studied further.

Conclusion

The present study showed an overall persistence of underweight, especially for males, and a sizeable prevalence of overweight for females in rural or less economically developed regions and for both genders in urban parts. Differential factors of overweight may suggest that rural *v.* urban areas are at different stages of nutrition transition. But overall, there are serious reasons to consider overweight in adolescents as a true public health problem in Tunisia, particularly as abdominal obesity appears as a significant feature in most overweight adolescents. Educational programmes to reduce sedentary behaviour and to encourage control of dietary behaviours can be promoted in schools; however, ways should also be found to address the sizeable minority of adolescents who no longer attend school, notably working girls who appeared to be at particular risk of overweight.

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