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Overweight and Obesity Related Factors among Lebanese Adolescents: An Explanation for Gender and Socioeconomic Differences

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Abstract

Background: The obesity-related factors in adolescents differ from one country to another. In Lebanon, those factors are still undetermined. Therefore, our purpose is to investigate the main determinants of overweight and obesity in Lebanese adolescents and to assess gender-specific differences.

Methods: In this cross-sectional epidemiological study, 1000 Lebanese adolescents were recruited to determine obesity-related factors: birth weight, weight at 5 and 10-year-old children, feeding pattern, only child or first born status, puberty characteristics, lifestyle [nutrition, sedentary behaviors, and physical activity], school grades, family obesity, obesity-related diseases, place of residence, and socio-economic and professional status of parents.

Results: Multiple regressions show that puberty obesity, lifestyle, family obesity and family status, and childhood feeding pattern are consecutively the major factors to adolescents' obesity. Contrary to Western countries, overweight and obese Lebanese adolescents belong to a high socioeconomic class, and they do practice more physical and leisure activities. This paradox is more obvious in boys (having a higher socio-economic status compared to girls, boys are more affected by overweight and obesity caused by behavioral problems and this despite their more frequent physical leisure activities). On the contrary, girls' obesity is more associated with family obesity rather than behavior disorders.

Conclusion: Lebanese adolescents' obesity is related to many behavior disorders especially in boys. Moreover, their physical practice is not sufficient to overcome their excessive sedentary behaviors and nutritional mistakes.

Keywords: Obesity; Obesity-related factors; Adolescent; Gender difference; Socio-economic factors

Introduction

Obesity and overweight epidemic in adolescents have reached important proportions worldwide. Indeed, it is well-known that 70-80% of obese adolescents will remain obese at adult age, increasing morbidity risk [1]. Moreover, adolescence is a vulnerable period including puberty, where many metabolic, hormonal, psychological and behavior disorders promote weight and fat gain [2].

The causes and effects of adolescents' obesity have been largely discussed [2-4]. Certainly, it is well-known that obesity is mainly affected by behavior determinants including a decrease in physical activity (especially in girls) [5-7], and alimentary disorders [8,9]. Besides this imbalance between energy intake and expenditure, several parameters can contribute to adolescents' obesity, such as disorders related to the puberty period and sedentary behaviors [3,4,10], familial factors (familial obesity, first born or only child status) [11,12], childhood characteristics (birth weight and feeding patterns) [11-13], and socio-economic status (parents' educational level, economic status, or socio-professional level) [13-15].

The adolescents' obesity epidemic is not restricted to Western countries, but it is also increasing at an alarming pace in many developing countries [16] such as Lebanon [17-21]. The few studies conducted found that overweight and obesity prevalence is higher in boys than in girls [17,18,20,21]. However, no studies have investigated obesity-related factors. The purposes of this study are first to identify and to rank the major obesity-related factors in Lebanese adolescents, and then to explain the gender differences in Lebanese adolescents' obesity. We hypothesize that the prevalence of overweight and obesity is increasing in Lebanon especially in boys compared to girls and this could be associated with the expansion of sedentary lifestyle that is increasingly found in this country and worldwide.

Material and Methods

Subjects

One thousand Lebanese adolescents (14-18 years old, 569 girls and 431 boys) were randomly recruited from nine different representative public and private schools across most regions in the country. This population represented 0.55% of the total number of adolescents that went to school in the country, which counted approximately 180000 adolescents (57.1% girls and 42.9% boys). The schools were randomly drawn among the most important schools that teach the French as second language. One school was taken from each region. Subjects with chronic physical disabilities and those with incomplete data were not included in the study. All procedures used in this research were approved by the Ethics Committee of the University of Balamand in North Lebanon.

Study design

As adolescents were francophone, we used a questionnaire in French language. It was submitted to the participants for one week. This questionnaire consists of two-part survey enabling us to collect information in two fields concerning obesity-related parameters and estimation of physical activity, in addition to general information about the participants and their parents.

The first part of the questionnaire concerns obesity-related parameters where parents' support was requested regarding some information about themselves. Those parameters are: childhood and puberty characteristics (weight at birth, weight at ages 5 and 10, baby's feeding patterns, childhood activity, pubescence or not, menarche age and regularity of menstrual cycle in girls, estimated weight gain at puberty: where adolescents were asked to estimate the weight they took during puberty, physical activity cessation at puberty), health (obesity-related diseases), family obesity and status (parents' BMI and obesity-related chronic diseases, having obese siblings, the number of children in the family, being a first born or an only child), lifestyle (imbalanced diet [breakfast and fast-food consumption frequencies], hours of watching TV, presence of TV in bedroom, hours of computer-using, owning a personal computer, hours of sleeping and sitting, owning a personal car), activities (physical activity in school and leisure activity), place of residence (urban or rural), socio-economic status (number of cars owned by family, parents' salaries, education level and socio-professional level). The parents' socio-professional level was established using classification (1-6) of INSEE (Institut National de la Statistique et des Études Économiques, France), 1 being the highest socio-professional level.

The second part of the survey was the validated questionnaire of physical activity [22] filled by the adolescents themselves and proposed in its original language since all participants were Francophone. The score for physical activity was calculated as MET (Metabolic Equivalent Task) expressed in kj kg^{-1} wk^{-1}, based on the data of Ainsworth et al. [23]. The questionnaire was then validated by a rereading with a member of our team.

Statistical analysis

After determining BMI, participants were stratified into three groups (depending on age and gender)(normal-weight, overweight, and obese) based on the criteria of Cole et al. [24]. Data entry and analysis were performed on SPSS statistical software, version 16.0. Values were expressed in mean ± SD or in prevalence rates (%). Anova one way and Chi-squared (χ^2) tests were used to compare the prevalence and frequencies within age and category groups, between boys and girls. Pearson correlations were used to correlate adolescents' BMI to the different obesity-related parameters. Linear and multiple regressions were used to estimate the factors of different obesity-related factors to adolescents' BMI variation.

Results

Some questionnaires were not included in the study due to incomplete data. Subjects older than 18 years of age and those with chronic physical disabilities were exempted from participation. In all, a total of 18 subjects were excluded from the analysis.

Obesity prevalence

The prevalence of overweight and obesity subdivided by sex and age is reported in Table 1. In the total population, 17.1% were overweight and 4.5 % were obese.

	Girls		Boys		Chi-square p-value	Total	
	%OV (CI)	%OB (CI)	%OV (CI)	%OB (CI)	%OV (CI)	%OB (CI)	
14 years	14 (12-16)	1.3 (0.6-2.0)	17.5 (15.3-19.6)	1.9 (1.0-2.8)	0.79	15.4 (13.3-17.5)	1.5 (0.7-2.2)
15 years	12.2 (10.3-14.1)	0.8 (0.2-1.4)	22.6 (20.3-24.9)	10.4 (8.6-12.2)	>0.001*	17 (14.8-19.1)	5.2 (3.8-6.5)
16 years	15.3 (13.2-17.4)	0.6 (0.1-1.1)	26 (23.6-28.4)	7.8 (6.2-9.4)	>0.001*	20.5 (18.2-22.7)	4.1 (2.8-6.5)
17 years	12.8 (10.8-14.7)	2.7 (1.7-3.7)	20.3 (18.0-22.5)	10.1 (8.3-11.9)	0.01*	15.2 (13.1-17.3)	5.1 (3.7-6.4)
18 years	6.4 (4.9-7.8)	2.1 (1.2-3.0)	23.8 (21.5-26.1)	7.1 (5.5-8.6)	0.07*	12.3 (10.3-14.2)	6.7 (5.2-8.2)
Total	12.7 (10.7-14.6)	1.8 (0.9-2.6)	23 (20.7-25.3)	8.1 (6.4-9.7)	>0.001*	17.1 (14.9-19.2)	4.5 (3.2-5.7)

Values are expressed in percentage. Confidence interval at 95%. Chi-square are relative to categories x gender x age differences.*Significativity is fixed for p=0.05

Table 1: Prevalence of overweight and obesity related to age and gender. OV: overweight; OB: obese.

In the overall population and in both genders, no difference was detected in the prevalence of overweight and obesity with increase in age. However, for all ages except for 14 years old (p=0.79), the prevalence of overweight and obesity was higher in boys compared to girls (23 *vs.* 12.7 % and 8.1 *vs.* 1.8 % respectively) (χ^2=44.5, df=2, p<10-4) [at 15 years old (χ^2=16.52, df=2, p<10-4) at 16 years old (χ^2=17.65, df=2, p<10-4), at 17 years old (χ^2=8.17, df=2, p=0.01), and at 18 years old (χ^2=9.83, df=2, p=0.007)].

Obesity-related factors

Childhood and puberty characteristics: Concerning childhood characteristics, at birth, at age 5, and at age 10, overweight and obese adolescents were heavier compared with normal-weight adolescents. Moreover, adolescents' BMI was correlated to birth, 5-year-olds' and 10-year-olds' weights (r=0.2, 0.4 and 0.5 respectively, p<0.01). Thus, the gaps of the mean weight between weight categories increased with age (Table 2).

Variables	Normal weight	Overweight	Obese	p value
Childhood Weight (mean, SD) (kg)				
Birth	3.2 ± 0.7	3.38 ± 0.8	3.4 ± 0.7	0.002*-a
5 years old	19.1 ± 4.9	21.5 ± 6.2	25.4 ± 14.3	0.001*-a
10 years old	33.1 ± 7.2	38.6 ± 9.9	44.7 ± 18.3	0.001*-a
Baby's feeding patterns				
Breast-feeding (%) (CI)	81.9 (80.8-83.0)	90.4 (89.8-90.9)	95.0 (94.6-95.3)	0.005*-b
Bottle-feeding (%) (CI)	18.1 (15.9-20.3)	9.6 (7.8-11.3)	5.0 (3.6-6.3)	
Breast feeding months (mean, SD)	5.8 ± 6.4	6.5 ± 5,3	9.1 ± 8.2	0.013*-a
9 months (%) (CI)	21.1 (18.8-23.3)	29.1 (26.7-31.5)	40.6 (38.2-42.9)	0.005*-b
12 months (%) (CI)	17.3 (15.1-19.4)	24.6 (22.2-26.9)	37.5 (35.1-39.9)	0.003*-b
Childhood activity				
Slightly active % (CI)	7.2 (5.6-8.7)	13.8 (11.8-15.8)	4.9 (3.5-6.2)	0.086-b
Moderately active % (CI)	41.3 (41.5-46.2)	36.9 (34.5-39.2)	43.9 (41.5-46.2)	
Very active % (CI)	51.4 (49.2-53.6)	49.4 (47.1-51.6)	51.2 (46.0-53.4)	
Puberty status				
Pubescent (%) (CI)	91.5 (90.0-92.0)	88.6 (87.9-89.2)	84.1 (83.1-85.0)	0.15-b
Not pubescent (%) (CI)	8.5 (6.8-10.1)	11.4 (9.5-13.3)	15.9 (13.8-17.9)	
Menarche age in girls (years) (mean, SD)	12.2 ± 1.1	11.8 ± 1.3	11.6 ± 1.1	0.004*-a
Irregular menstrual cycle (girls) (%) (CI)	28.7 (26.3-31.1)	30.4 (28.0-32.8)	40.0 (37.6-42.4)	0.7-b
Puberty weight gain (%) (CI)	45.3 (43.0-47.6)	63.3 (61.4-65.1)	74.4 (73.0-75.8)	0.001*-a
Puberty weight gain (kg) (mean, SD)	2.3 ± 3.8	4.8 ± 6.4	9.0 ± 10.2	0.001*-a
Ceasing physical activity at puberty (%) (CI)	13.2 (11.2-15.2)	17.1 (14.9-21.2)	19.0 (16.8-21.2)	0.29-b

Values are expressed in mean ± SD or in percentage (%). Confidence interval in 95%. *Significativity is fixed for p=0.05. a: p values for one way ANOVA test. b: p values for χ^2 test.

Table 2: Childhood and puberty characteristics in normal-weight, overweight and obese adolescents.

The percentage of breastfed adolescents was higher in overweight and obese participants compared with those of normal weight (χ^2=10.74, df=2, p=0.005) (linear trend test, LLA=10.5, p=0.001). Moreover, the percentage of adolescents who were breastfed for a period exceeding 9 months (χ^2=14.78, df=4, p=0.005) (linear trend test, LLA=14.5, p<0.10-4) and 12 months (χ^2=16.07, df=4, p=0.003) (linear trend test, LLA= 15.5, p<0.10-4) was also higher in overweight and obese adolescents compared with normal-weight adolescents. However, no difference was shown between boys and girls [percentage of breastfed adolescents (84.3% *vs.* 83.4%) (χ^2=0.14, df=1, p=0.7), percentage of breastfed adolescents for a period exceeding 9 months (22.1 % *vs.* 24.2 %) (χ^2=0.88, df=2, p=0.6), and percentage of breastfed adolescents for a period exceeding 12 months (18.4 % *vs.* 20.1 %) (χ^2=0.86, df=2, p=0.6)].

In addition, childhood activity was not different among various weight categories (table 2) or genders [very active: 50.2 % in girls *vs.* 52.4 % in boys (χ^2=0.75, df=2, p=0.68)].

Concerning puberty characteristics, the puberty status for the overall population was not different among categories (χ^2=3.8, df=2, p=0.15) (linear trend test, LLA=3.7, p=0.05) whereas the percentage of pubescent girls was significantly higher compared with boys (98% *vs.* 79.7%), (χ^2=104.2, df=1, p<0.10-4) specifically in normal-weight and overweight categories (p<0.001). Additionally, overweight and obese adolescent girls had an earlier menarche compared with normal-weight adolescents (p=0.004), but the regularity of the menstrual cycle was not different among weight categories (χ^2=0.67, df=2, p=0.71) (linear trend test, LLA=0.48, p=0.5).

The percentage of participants who estimated that they had gained weight during puberty increased with weight categories (χ^2=25.64, df=2, p<0.001) (linear trend test, LLA=25.2, p<10-4). Also, this estimated weight gain (kg) increased with the weight categories (p<0.001). This weight gain was correlated to the adolescents' BMI (r=0.32, p<0.05). Moreover, boys estimate that they had gained more fat during puberty than girls (3.6 ± 6.5 *vs.* 2.5 ± 3.8 kg) (p=0.02).

The percentage of adolescents ceasing physical activity at puberty tended to be higher in obese compared with normal-weight participants (19% *vs.* 13.2%) (χ^2=2.4, df=2, p=0.29) (linear trend test, LLA=2.9, p=0.08) and in boys compared with girls (15.3% vs 12%) (χ^2=1.2, df=1, p=0.1), but these differences were not significant. Family obesity and family status, place of residence and socio-economic status and socio-professional level (Table 3).

Variables	Normal weight	Overweight	Obese	p value
Family obesity				
Father's BMI (mean, SD)	27.1 ± 3.7	28.2 ± 3.5	29.3 ± 5.3	0.001*-a
Mother's BMI (mean, SD)	24.3 ± 4.1	26.2 ± 4.3	28.4 ± 6.3	0.001*-a
Parents BMI>25 kg/m² (%) (CI)	26.0 (23.6-28.3)	49.7 (47.5-1.9)	58.3 (56.3-60.3)	0.001*-b
Parents BMI>30 kg/m² (%)(CI)	3.9 (2.7-5.1)	9.4 (7.6-11.1)	19.4 (19.1-21.6)	0.001*-b
Parents suffering from obesity related diseases (%) (CI)	25.1 (22.7-27.4)	32.9 (30.5-35.3)	31.0 (28.6-33.4)	0.09-b
Overweight brothers or sisters (%) (CI)	21.9 (19.6-24.1)	39.1 (36.6-41.5)	56.1 (54.0-58.1)	0.001*-b
Family status				
First born (%) (CI)	38.1 (35.7-40.5)	35.9 (33.5-38.3)	31.8 (29.4-34.2)	0.6-b
Only child (%) (CI)	4.2 (2.9-5.4)	4.2 (2.9-5.4)	4.5 (3.2-5.8)	0.99-b
Birth order				
First (%) (CI)	37.0 (34.6-39.1)	33.1 (30.7-35.5)	30.2 (27.8-32.6)	0.75-b
Last (%)(CI)	36.7 (34.3-39.1)	38.1 (35.7-40.5)	44.2 (41.9-46.5)	
Number of family children (mean, SD)	3.6 ± 1.5	3.5 ± 1.4	3.6 ± 1.3	0.82-a
Place of residence				
Urban (%) (CI)	57.9 (55.9-59.9)	57.5 (55.5-59.5)	65.9 (64.1-67.6)	0.56-b
Rural (%) (CI)	42.1 (39.7-44.5)	42.5 (40.1-44.8)	34.1 (31.7-36.5)	
Socio-economic status				
Parent's salary ($)(mean, SD)	1449 ± 1211.0	1878 ± 2711.0	2306 ± 424.6	0.01*-a
Parents possessing a university degree (%) (CI)	24.0 (21.6-26.3)	17.6 (15.4-19.7)	37.5 (35.1-39.9)	0.02*-a
Number of family children (mean, SD)	1.7 ± 1.0	1.5 ± 1.8	1.9 ± 1.1	0.002*-a
Father's socio-professional level (%) (CI)				
1	0.9 (0.3-1.5)	2.0 (1.1-2.9)	2.4 (1.4-3.3)	0.001*-b
2	11.6 (9.7-13.5)	15.8 (13.7-17.9)	19.5 (17.2-21.7)	
3	13.2 (11.2-15.2)	32.2 (29.8-34.6)	26.8 (24.4-29.2)	
4	22.1 (19.8-24.4)	28.9 (26.5-31.3)	34.1 (31.7-36.5)	
5	38.4 (36.0-40.8)	18.4 (16.2-20.6)	7.3 (5.7-8.8)	
6	13.9 (11.9-15.9)	2.6 (1.6-3.5)	9.8 (8.0-11.6)	
*Significativity is fixed for p=0.05. a: p values for one way ANOVA test. b: p values for χ^2 test. Confidence interval is 95%.				

Table 3: Family obesity and status, place of residence, socio-economic status and professional level in normal-weight, overweight and obese adolescents.

Concerning family obesity, the fathers' BMI was higher in obese (p=0.001) and overweight adolescents (p=0.002) compared with normal-weight adolescents and the mothers' BMI increased with the adolescents' weight categories (p<0.001). Moreover, the percentages of adolescents having overweight or obese parents were higher in overweight (χ^2=43.63, df=2, p<0.001) and obese (χ^2=16.65, df=2, p<0.001) participants compared with normal weight participants. And a linear trend test showed that the percentage of adolescents having

overweight and obese parents increased with weight categories (value= 39.2, p<10-4). The adolescents' BMI was correlated to the fathers' and mothers' BMI (r=0.22 and 0.22 respectively, p<0.01). Gender comparison reveals that in overweight and obese adolescents, the mothers' BMI was higher in girls compared with boys (in overweight adolescents: 27.85 ± 4.60 *vs.* 25.04 ± 3.86 and in obese adolescents: 31.12 ± 4.68 *vs.* 27.40 ± 6.45). Overweight and obese adolescents had parents who suffer from some obesity-related diseases, but the difference among groups was not significant (χ^2=0.3, df=2, p=0.8) (linear trend test, LLA=0.3, p=0.6). However, the percentage of adolescents that had an overweight sibling increased with weight categories (χ^2=32.29, df=2, p<0.001) (linear trend test, LLA=39.2, p< 10-4). Gender comparison showed that 70% of obese girls' parents versus only 18.8% of obese boys' parents suffered from obesity-related diseases (χ^2=9.364, df=1, p=0.002) and 51.5% of overweight girls versus 29.5% of overweight boys have overweight siblings (χ^2=7.74, df=1, p=0.005).

Family status, like being the firstborn (χ^2=0.9, df=2, p=0.6) (linear trend test, LLA= 0.8, p=0.3), or the only child (χ^2=0.14, df=2, p=0.9) (linear trend test, LLA=0.08, p=0.9), the birth order (first, middle and last) (χ^2=01.9, df=4, p=0.7) (linear trend test, LLA=1.4, p=0.2), and the number of children in the family (χ^2=8.3, df=20, p=0.9) (linear trend test, LLA=0.01, p=0.9) were not different among weight categories. The only difference between genders concerned the number of children in one family, which was higher in obese girls than in obese boys (mean: 4.66 ± 1.32 *vs.* 3.29 ± 1.20; p=0.01).

The prevalence of obesity was not different between the place of residence (urban and rural) and the region of residence (North Lebanon, Beirut, Mount Lebanon) (data not shown).

Concerning the socio-economic status, the parents' salary (US dollars) was higher in overweight and obese adolescents compared with those of normal weight (p=0.01). Furthermore, the obese adolescents' families possessed significantly more cars than overweight (p=0.001) and normal-weight adolescents (p=0.001). With respect to the educational level, the percentage of parents having a university degree was also higher in obese adolescents compared with normal-weight and overweight adolescents (χ^2=7.53, df=2, p=0.02).

Concerning gender comparison, the parents' salary was higher in overweight boys than overweight girls (2192 ± 2639 *vs.* 1337 ± 871.35; p=0.04). Also, overweight boys' families possessed more cars than the girls' (1.8 ± 1.1 *vs.* 1.4 ± 0.9; p=0.003). Moreover, the percentage of parents having a university degree was higher in obese boys (46.7%) compared with obese girls (10%) (χ^2=4.30, df=1, p=0.03).

Concerning the fathers' socio-professional level, the percentage of obese and overweight adolescents was higher in the first four levels (1-4) and lower in the last 2 levels (5 and 6) compared with the normal-weight adolescents (χ^2=75.99, df=10, p<0.001). Only 39.1% of mothers versus 97% of fathers were working. Similarly to fathers, significant intergroup differences existed in mothers' socio-professional levels (χ^2=54.12, df=10, p<0.001) (data not shown). In addition, increasing adolescents' BMI was correlated to the increase in both the fathers' and the mothers' socio-professional levels (r=0.2 and 0.3 respectively, p<0.01).

Life style (Nutrition, sedentary behaviors and physical activity): Concerning nutritional habits, 8.3% and 11.4% of overweight and obese adolescents versus 7.2% of normal-weight adolescents skiped breakfast every day, but this difference was not significant (χ^2=10.1, df=6, p=0.12) (linear trend test, LLA=0.67, p=0.2). However, overweight and obese adolescents consumed fast-food more frequently (time/week) compared with normal-weight adolescents (p=0.03). Moreover, there were more overweight and obese adolescents who estimated they have an imbalanced diet compared with normal-weight adolescents (χ^2=53.08, df=2, p<0.001). And a linear trend test showed that the percentage of adolescents who estimated having an imbalanced diet increased with adolescent weight categories (LLA=48.5, p<10-4) (Table 4).

Variables	Normal weight	Overweight	Obese	P value
Nutritional habits				
Breakfast				
Never (%) (CI)	7.2 (5.6-8.7)	8.3 (6.6-9.9)	11.4 (9.5-13.2)	0.50-b
Rarely (1 or 2 times/week) (%)(CI)	50.0 (47.8-52.2)	55.4 (53.3-57.3)	50.0 (47.8-52.2)	
Always (%) (CI)	42.8 (40.4-45.1)	36.3 (33.9-38.7)	38.6 (36.2-41.0)	
Fast-food (time/week) (mean, SD)	1.9 ± 1.4	2.2 ± 1.6	2.4 ± 1.9	0.03*-a
Estimated imbalanced diet (%)(CI)	49.9 (47.7-52.1)	77.2 (75.9-78.4)	81.4 (80.3-82.4)	0.001*-b
Sedentary behaviors				
TV viewing (h/day) (mean, SD)	4.0 ± 1.97	4.17 ± 1.87	4.25 ± 2.02	0.37-a
Bedroom TV (%) (CI)	31.5 (29.1-33.9)	37.3 (34.9-39.7)	40.9 (38.5-43.2)	0.17-b
Computer using (h/day) (mean, SD)	1.7 ± 1.5	1.7 ± 1.5	2.2 ± 1.8	0.04*-a
Personal computer (%)(CI)	80.6 (79.5-81.7)	78 (76.7-79.2)	88.6 (87.9-89.3)	0.001*-b
Sleeping (h/day) (mean, SD)	8.4 ± 1.3	8.2 ± 1.3	8.1 ± 1.3	0.05*-a
Sitting (h/day) (mean, SD)	8.3 ± 1.9	8.3 ± 2.0	8.8 ± 2.1	0.21-a

Personal car (Own car) (%) (CI)	4.3 (3.1-5.5)	4.2 (2.9-5.4)	6.8 (5.2-8.3)	0.7-b
Physical activity				
Practicing to physical activity session in school (physical education class in school) (%)(CI)	75.3 (73.9-76.6)	71.3 (69.7-72.8)	74.8 (73.4-76.1)	0.42-b
Practicing leisure activity (physical activity out of school for pleasure) (%) (CI)	43.6 (41.2-45.9)	33.9 (31.5-36.3)	48.8 (46.6-51.0)	0.05*-b
Total Physical activity (kj kg^{-1} wk^{-1}) (kcal kg^{-1} wk^{-1}) (mean, SD)	147.1 ± 155.1	143.8 ± 170.9	136.3 ± 142.9	0.66-a
	(35.8 ± 37.1)	(34.4 ± 40.9)	(32.6 ± 34.2)	
Club organized activities (kj kg^{-1} wk^{-1}) (kcal kg^{-1} wk^{-1}) (mean, SD)	35.9 ± 93.2	29.7 ± 78.6	28.9 ± 91.5	0.67-a
	(8.6 ± 22.3)	(7.1 ± 18.8)	(6.9 ± 21.9)	
*Significativity is fixed for p=0.05. Confidence interval is 95%. a: p values for one way ANOVA test. b: p values for χ^2 test.				

Table 4: life style: nutrition, physical inactivity and activity in normal-weight, overweight and obese adolescents. Values are expressed in mean ± SD or in percentage (%).

Concerning gender comparison, the percentage of adolescents who do not eat breakfast was higher in boys compared with girls (9.6% *vs.* 6.4%) (χ^2=19.24, df=2, p<0.001). Boys also consumed fast-food more frequently compared with girls (2.77 ± 1.53 *vs.* 1.79 ± 1.35 time/week) (p<0.001). However, the percentage of adolescents who estimated they have an imbalanced diet was higher in girls compared with boys (58.7% *vs.* 52.2%) (χ^2=4.36, df=1, p=0.03).

Concerning sedentary behaviors, obese adolescents spent more time using the computer (p=0.042) and slept less than normal-weight adolescents (p=0.05). Other parameters, which include television (χ^2=3.4, df=2, p=0.17) (linear trend test, LLA=3.4, p=0.06), cars (χ^2=0.6, df=2, p=0.7) (linear trend test, LLA=0.26, p=0.6), and sitting hours per day (p=0.21), were not different among categories. Gender comparison revealed that the percentage of boys who possessed a television in their room (41.8% vs 26.7%; χ^2=25.13, df=1, p<0.001), a personal computer (88.6% *vs.* 74.1%; χ^2=32.34, df=1, p<0.001), and a personal car specifically allocated to adolescents (7.1% *vs.* 2.5%; χ^2= 2.20, df=1, p<0.001) was higher than girls. Moreover, boys spent more time watching television (hour/day) (4.20 ± 1.98 *vs.* 3.78 ± 1.99; p=0.001) and using the computer (hour/day) (2.3 ± 1.6 *vs.* 1.4 ± 1.4; p<0.001) compared with girls.

Regarding physical activity, overweight participants practiced fewer leisure activities compared with normal-weight and obese adolescents (χ^2=5.91, df=2, p=0.05). However, neither the percentage of participants participating in their schools' physical education session, nor the total weekly score of physical activity or club-organized activities (evaluated by the validated questionnaire) was different among groups.

The percentage of boys who practiced leisure activities was higher than in girls (51.2% *vs.* 35.7%; χ^2=23.44, df=1, p<0.001). Moreover, boys had a higher score of total physical activity (kcal kg^{-1} wk^{-1}) (43.9 ± 45.3 *vs.* 30.9 ± 30.0; p<0.001) and of club-organized activities (kcal kg^{-1} wk^{-1}) (13.9 ± 29.1 *vs.* 4.1 ± 11.8; p<0.001) compared with girls.

Regression analysis

Table 5 reported the linear and multiple regressions for several parameters' contribution to adolescents' obesity using the BMI as an independent factor. Based on linear regression, childhood and puberty characteristics contribute 22% of obesity (R^2=0.22, F=24.40, p<0.001), family obesity and family status, place of residence, socio-economic status, and professional level encompassed 30% of obesity (R^2=0.30, F=10.14. p<0.001). Finally, lifestyle characteristics accounted for 8.9% of obesity (R^2=0.089, F=13.16. p<0.001).

Variables	β	R^2	P value
Linear regression			
Childhood and puberty			
Birth weight	0.028	0.22	0.51
10 years old weight	0.3		<0.001*
Physical activity sports cessation	0.088		0.04*
Puberty weight gain (kg)	0.258		0.001*
Breast-feeding	0.086		0.04*
Family obesity and status, residence and socio-economic and professional status			

Father BMI	0.168		0.01*
Mother BMI	0.205		0.07*
Number of family children	0.083		0.22
Overweight brothers or sisters	0.282	0.3	<0.001*
Parent's salary	0.072		0.32
Father's socio-professional level	-0.029		0.69
Mother's socio-professional level	-0.255		0.001*
Life style characteristics			
Total Physical activity (kcal kg^{-1} wk^{-1})	0.053		0.24
Club organized activities (kcal kg^{-1} wk^{-1})	-0.08		0.07*
Computer using (h/day)	0.087	0.089	0.01*
Sleeping (h/day)	0.102		0.006*
Estimated balanced diet	0.246		<0.001*
Multiple regression			
10 years old weight	0.362		<0.001*
Physical activity cessation	0.135		0.09
Breast-feeding	0.194		0.014*
Puberty weight gain (kg)	0.391		<0.001*
Club organized activities	-0.077		0.332
Computer using (h/day)	0.123		0.122
Sleeping (h/day)	0.022	0.4	0.785
Estimate having balanced diet	0.328		<0.001*
Father BMI	0.13		0.101
Mother BMI	0.297		< 0.001*
Overweight brothers and sisters	-0.238		0.002*
Mother's socio-professional level	-0.308		<0.001*
*Donate a significant contributor to the model.			

Table 5: Linear and multiple regression analysis for obesity-related parameters.

When all the parameters are arranged together in a multiple regression, the listed parameters contributed to 41.1% of obesity (R^2=0.411, F=8.54, p<0.001). In order of importance, the major factors of adolescents' obesity were: puberty (puberty weight gain, 10-year-olds' weight), lifestyle (imbalanced diet), family status (mothers' professional level, mothers' BMI, overweight brothers and sisters) and childhood feeding patterns (breast-feeding).

Table 6 reported the linear regressions stratified on gender. Accordantly to the results mentioned before, the linear regressions showed that childhood and puberty characteristics, as weight at 10 years old and puberty weight gain, contributed approximately the same in both girls' (24%) and boys' obesity (19%), (Girls: R^2=0.24, F=18.5, p<10-4 *vs.* boys: R^2=0.19, F=6.9, p<10-4). And that the family-related parameters, as obesity in parents and/or siblings, contributed more in girls' obesity (40%) compared to boys' obesity (25%) (Girls: R^2=0.4, F=4.7, p<10-4 *vs.* boys: R^2=0.25, F=2.7, p=0.05). Whereas, the life style, as sedentary and alimentary behaviors, contributed more in boys' obesity (13.3%) compared to girls' obesity (6%) (Girls: R^2=0.06, F=3.0, p=0.01 *vs.* boys: R^2=0.13, F=5.2, p=0.008).

Variables	Girls			Boys		
	β	R^2	P value	β	R^2	P value
Childhood and puberty						
Birth weight	0.015	0.24	0.7	-0.018	0.19	0.8
10 years old weight	0.36		10-4*	0.21		0.005*
Physical activity sports cessation	-0.18		0.001*	0.023		0.7
Puberty weight gain (kg)	0.19		0.001*	0.3		10-4*
Breast-feeding	0.053		0.06	-0.06		0.3
Family obesity and status, residence and socio-economic and professional status						
Father BMI	0.22	0.4	0.008*	0.11	0.25	0.3
Mother BMI	0.21		0.32	0.32		0.01*
Number of family children	-0.71		0.5	0.009		0.9
Overweight brothers or sisters	-0.24		0.04*	-0.29		0.07
Parent's salary	-0.3		0.1	0.09		0.5
Father's socio-professional level	-0.02		0.3	-0.05		0.7
Mother's socio-professional level	0.1		0.04*	0.5		0.01*
Life style characteristics						
Total Physical activity (kcal kg^{-1} wk^{-1})	0.012	0.06	0.8	-0.06	0.13	0.8
Club organized activities (kcal kg^{-1} wk^{-1})	-0.03		0.2	0.04		0.1
Computer using (h/day)	0.08		0.07	0.11		0.04*
Sleeping (h/day)	0.06		0.2	0.003		0.9
Estimated balanced diet	0.23		10-4*	0.35		10-4*

Table 6: Linear analysis stratified by gender for obesity-related parameters.

Discussion

This epidemiological study is the first to explore the obesity-related factors in Lebanese adolescents and to explain the gender differences in the prevalence of overweight and obesity. The main results are: 1) The main factors influencing overweight and obesity are: a) the weight at age 10 and at puberty, b) lifestyle (nutritional mistakes [skipping breakfast and eating fast food frequently] and sedentary behavior), c) family obesity and socioeconomic status, and d) baby's feeding patterns; 2) Despite a greater leisure-time physical activity, boys are more affected by obesity compared to girls due to more obesity-related parameters (in order of importance: puberty obesity, nutritional mistakes, family obesity, family status, and childhood feeding pattern); 3) Obesity is more frequent in families with high socioeconomic and professional statuses.

Obesity-related parameters

Concerning weight at 10 years old and at puberty, it is well-known that the control of babies' and children's weights is of fundamental importance in order to avoid overweight at adolescence and in adulthood. The later obesity appears, the more it persists. In fact, as in other studies [11-13], we found that childhood characteristics (the weight at birth, at age 5, and at age 10) contribute significantly to adolescents' overweight and obesity. However, the effect of obesity at puberty is more obvious, since this period is associated with many metabolic and hormonal changes that promote fat gain [2] and the risk of obesity and its related disorders [1]. Indeed, 70 to 80% of obese at this age remain obese at adult age which increases morbidity risks [1].

Even if puberty constitutes a risk of obesity in adolescents, lifestyle (nutrition and sedentary behaviors) remains the main determinant of onset of obesity. With reference to unhealthy nutrition, fast food is well known to be directly related to obesity because of its high content in saturated fat and sugar. Regardless of socioeconomic status, other nutritional mistakes, such as skipping meals (never having breakfast) are more frequent in obese adolescents compared with those of normal weight. Other studies show that these alimentary disorders (committing nutritional mistakes), such as frequently consuming fast food [25] or never eating breakfast [26] are often found in the adolescent population. In our study, overweight and obese adolescents are aware of having alimentary disorders since they admitted to having a more imbalanced diet compared with normal weight adolescents.

It is clear that obesity is aggravated when alimentary disorders are coupled with an increase in sedentary behaviors and a decrease in physical activity practice [3]. Actually, the increase in watching television or having a personal television in the bedroom [27], computer use [4] and the decrease in leisure activity [3] are positively associated with adolescents' obesity. All these behavior changes at adolescence are partially responsible for the decrease in the amount of sleep [28], which in itself decreases energetic expenditure. In our study, obese adolescents who belong to high socioeconomic family status are more likely to possess a personal car, a television in their room, a personal computer, and to use their computers considerably more often when compared with adolescents of normal weight. Those sedentary behaviors, added to alimentary disorders, contribute to 8.9% of the adolescents' BMI variation. In addition, these two parameters are significantly correlated to BMI.

In Lebanon, adolescents' obesity is associated with high socio-economic statuses and socio-professional levels of parents while in Western countries obesity increases when the socioeconomic status decreases. In developing countries such as Lebanon [15,17], it seems that the population is not sufficiently aware of obesity risks.

In Western countries, sedentary behaviors are associated with a decrease in physical practice [3], which apparently is not the case in Lebanon. In reality, many obese adolescents who belong to affluent families are enrolled in a costly leisure sport compared with those of normal weight. However, their score of physical activity estimated by the Deheeger et al. [22] questionnaire, which includes numerous items concerning physical activity, is not different from the score of the normal-weight adolescents. These results show that the occasional physical practice performed in leisure clubs, are not enough to compensate their daily inactivity.

Another parameter concerning the impact of parents' behavior on children's ponderal status is the babies' feeding patterns. Concerning this point, our results obviously differ from several previous studies which concluded that breast-feeding, for more than 4 or 6 months, is associated with lower rates of obesity [13,29], and with a leaner body shape during childhood (5 years old) [11,30]. Indeed, we found more overweight and obese adolescents who were breastfed for a long period (exceeding 9 or 12 months) compared with those of normal weight. This could be caused by the introduction of solid nutrients after the age of 9 to 12 months, added to the breastfed milk, which greatly increases the child's caloric intake and increases their risk of obesity during this period. Which in turn increases the risk of remaining obese during childhood and adolescence.

Therefore, the relationship between long-term breast-feeding and obesity seems to be complex [30], and we suggest that long-term breast-feeding can also reflect the psychological difficulties of weaning. This relation is complex because it goes both ways depending on the period of breastfeeding. In their meta-analysis review, Cope and Allison [30] couldn't warranty a protective effect of breastfeeding against obesity. They concluded, that while breastfeeding may have benefits beyond any putative protection against obesity, and benefits of breastfeeding most likely outweigh any harms, any statement that a strong, clear or consistent body of evidence shows that breastfeeding causally reduces the risk of overweight or obesity is unwarranted at this time.

Thus, we hypothesize that in Lebanon; the parents with the higher socio-economic and socio-professional levels may not have sufficient knowledge about physical activity, inactivity, and nutritional education. Indeed, they allow their children to engage in unhealthy nutrition and sedentary habits although they granted more access to physical, leisure activities. This led us to conclude that physical practice cannot counteract the deleterious effects of sedentary behaviors and alimentary disorders. As a public health goal for adolescents, it would be important to encourage daily physical practice (walking, taking the stairs) while struggling against sedentary behavior.

Gender difference

The paradox, which consists in having greater sedentary behaviors and nutritional disorders despite more physical, leisure activity in obese adolescents compared with non-obese ones, is more obvious in boys than girls. Indeed, sedentary behaviors (indirect: possessing a television in the bedroom, a personal computer, or a car and direct: spending more time watching television and using a computer) and unhealthy dietary behaviors (skipping breakfast frequently and consuming fast food more often) are more commonly found in boys. However, boys reported practicing more physical activity (more leisure activities and higher score of total physical activity (kcal kg^{-1} wk^{-1})) when compared with girls. Here again, occasional physical activity does not compensate for the detrimental effects of excessive sedentary behaviors and alimentary disorders in boys.

The previously cited factors and the linear regression allow us to explain the higher prevalence of obesity among boys compared with girls. Similar to Lebanon, recent studies in Western (the USA, France) [31,32], Asian (China) [33] and Middle Eastern (Qatar and Kuwait) [34,35] countries have shown a higher prevalence of overweight and obesity in boys compared with girls due to a worse lifestyle [36,37] with the same paradoxical physical activity practice [28,38]. However, the underlying mechanisms could be different; the cultural parameters are certainly playing a determinant role. Moreover, during adolescence, girls are more sensitive to their body shape and image. They spend more time on personal care [38], and consequently decrease their physical activity, as opposed to boys [5-7] who spend their free time practicing some leisure activities [38]. We also found that boys' obesity is more related to deteriorative alimentary habits and sedentary behaviors; whereas, girls' obesity seems to be associated with family-related parameters (obese parents and/or siblings).

The present study has some limitations, such as the use of an indirect measure to assess physical activity, the fact that the questionnaires are all self-reported by the children and their parents, and that the questionnaire was in French and not in native language knowing that a big part of Lebanese population is French educated. However, the study also has several strengths; it is the first to provide data on obesity-related factors in Lebanese adolescents and to explain the gender differences in the prevalence of overweight and obesity. In addition, the number of participants is important considering the number of residents of the country. This issue needs, however, to be more extensively investigated in future studies.

Implications and contribution

By identifying obesity-related factors in Lebanese adolescents (which differ according to the gender), our study provides Middle Eastern countries and Lebanon's neighboring countries with specific observations to this epidemic, which predominantly affects boys. As it is the first study concerning obesity-related factors in Lebanon, this could be a reference to new studies. Plus, detecting the factors associated to obesity in our country and publishing them, help us

create our own prevention or treatment. And the gender difference implies different treatments because we do not treat girls' and boys' obesity the same way.

Conclusion

Our study underlines the importance of behavior disorders in obesity's onset. Contrary to developed countries where such disorders are found in low socio-economic levels, in Lebanon disorders are found in high socio-economic classes, where people have an unhealthy food intake and are more sedentary though they practice more leisure activities. Furthermore, gender difference reveals that boys' obesity is more related to behavioral factors (deteriorative alimentary habits and sedentary behaviors); whereas, girls' obesity is linked to family-related parameters (obese parents and/or siblings).

These results indicate the need 1) For a nutritional education program for parents and 2) For arising raise awareness concerning the importance of daily physical activity in order to overcome weight gain.

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