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Version: 3

Description: Table I

File format: application/msword

4): Tables 2

Version: 2

Description: Table II

File format: application/msword

5): Tables 3

Version: 2

Description: Table III

File format: application/msword

6): Tables 4

Version: 1

Description: Table IV

File format: application/msword

7): Tables 5

Version: 1

Description: Table V

File format: application/msword

8): Tables 6

Version: 2

Description: Supplementary material

File format: application/msword

9): Tables 7

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Decision on manuscript

Final decision: Manuscript accepted pending revision

Comment 1

General comment (originality, scientific accuracy, strengths and/or weaknesses): The focus about the background and the impact of obesity with its complications in pediatrics, suggested in the last review, is still incomplete and insufficient.

Response:

We would like to thank all the effort invested by the reviewer to improve the quality of our manuscript. We agree that in the previous versions the introduction was succinct. Now, we have expanded the introduction with new sentences about the background and the medical complications caused by obesity in children.

CHANGES INTRODUCED IN THE LAST VERSION ARE HIGHLIGHTED IN **YELLOW**

Abstract

BACKGROUND: Kuwait is one of the Arab countries with the highest prevalence of overweight or obesity. However, few studies have described the prevalence of obesity in this country. Aim: To describe the prevalence of overweight and obesity among Kuwaiti adolescents; and to examine the association of overweight and obesity status with familial socioeconomic status (SES).

METHODS: Cross-sectional data from 591 adolescent students (47% boys, median age: 16 years) from the Study of Health and Activity among Adolescents in Kuwait in 2012 and 2013. Body weight status was determined using the *International Obesity Task Force* (IOTF) body mass index standards. SES was based on parental education. Odds ratio for overweight and obesity were calculated using multiple logistic regression.

RESULTS: In our study, over half of the adolescents were overweight or obese 54.3% (95% CI: 49.9-58.4). The prevalence of overweight (including obesity) was higher in boys (59.8%, 54.3-66.3) than girls (49.2%, 43.5-54.8). No association between parental education and the risk of overweight/obesity was found.

CONCLUSIONS: There is an alarmingly high rate of overweight/obesity among Kuwaiti adolescents, but we did not find evidence of a social gradient in obesity risk. Urgent actions are needed to reverse this epidemic across all social groups.

Keywords: Social class; Overweight; Obesity; Adolescents; Middle East.

Introduction

In the last three decades the prevalence of childhood obesity has risen substantially worldwide.¹ For the World Obesity Federation (updated data in November 2015) the area with the highest prevalence of overweight (including obesity) in 10-17 years olds was America (~30%), followed by Europe (~18%) and Eastern Mediterranean region, which covers 22 countries including the Arab peninsula (~17%).² The Arab peninsula is one of most vulnerable worldwide regions affected by the obesity epidemic due to the adoption of Westernized dietary patterns³. In Kuwait, recent data indicates that more than half of adult population is affected by overweight or obesity⁴. The high prevalence of obesity in adolescents is projected to place excessive demands on health services because the numerous medical complications associated with obesity. Obesity persisting through adulthood is associated with a higher incidence cardiovascular disease, type 2 diabetes mellitus, cancer, osteoarthritis, work disability, and sleep apnea.¹ In addition, emerging evidence suggests that there may be direct medical complications caused by excess adiposity in children. For example, a recent study found that high adiposity in children is a risk factor for retinal ganglion cell damage⁵. Other medical and psychological comorbidities caused by obesity in adolescents are polycystic ovary syndrome, gastro-oesophageal reflux disease, weight-related joint disease, depression, poor self-esteem and eating disorders⁶.

Nonetheless, the burden of obesity is not equally distributed in the population. For example, a review focused in children and adolescents found evidence of a social gradient in the obesity risk. The higher the parental income or parental occupation or education level, the lower the risk of overweight/obesity.⁷ Although several factors may explain why children living in worse off families are at higher risk of overweight or obesity, inappropriate food environments are well established causal factors of weight problems.¹

To our knowledge, few studies have examined the prevalence of overweight (and obesity) in children and adolescents in the Arab countries.⁸⁻¹⁶ From these, three studies have been conducted in Kuwait.⁸⁻¹⁰ In 2006, in a large sample of adolescents (10-14 years) (n=5402) the prevalence of overweight (including obesity) was 45.6%, of which remarkably 90% of obese adolescents belonged to high-income families.⁸ In 2008-2009, the prevalence of overweight (including obesity) in 9-18 years (boys: n=206; girls=180) ranged from 48% to 53% for boys and from 39% to 40% for girls.⁹ Finally in 2010-2011 data from a seven Arab countries study the highest prevalence of overweight (including obesity) in Kuwaiti adolescents (15-18 years), 60.4% (boys) and 41.4% (girls).¹⁰ However, it is worth noting that only one¹⁰ of the three previously mentioned studies defined overweight and obesity according to international standards (Cole cut-off points). Due to the scarcity of well-designed epidemiological studies and the alarming high prevalence of overweight observed in Kuwait further surveillance studies in adolescents are needed.

The aim of this study was to examine the prevalence of overweight and obesity among Kuwaiti adolescents who participated in the Study of Health and Activity among Adolescents in Kuwait (SHAAK), and also, determine the association of weight status with demographic and socioeconomic (SES) indicators.

Materials and Methods

The SHAAK was a cross-sectional study targeting Kuwaiti adolescent students, between 2012 and 2013. A multistage stratified sampling design with proportionate sampling was used. The original sampling frame included all the governmental (intermediate and secondary) schools in Kuwait. One percent of the total student population (N= 128,948) constituted a target sample size of 1,289 participants. They were stratified by governorate (Hawalli, Asimah, Jahra, Farwaniya, Ahmadi and Mubarak), gender and the school grades (7 to 12). In a first stage, researchers randomly selected (using a box with folded papers) two intermediate schools for each sex and governorate by a serial number assigned to each school. For example, the Jahra governorate has 17 and 18 intermediate schools for boys and girls respectively. This process was repeated for the secondary schools. In a second stage, using a similar allocation process, one class was selected from each grade (that is, three classes from each intermediate school and three from each secondary one). Due to resource and time constraints, data were collected from only three (Hawalli, Asimah and Jahra) of Kuwait's six governorates. Data collection took place from October 2012 through June 2013, following the protocols that are described below.

Socioeconomic and demographic measures

A self-reported questionnaire was used to collect participants' sociodemographic information (date of birth, gender, school grade, birth order, family size, owned or rented house/flat, number of cars and number of bedrooms). A proxy of parental SES was based on parental education

(response categories: illiterate, read and write, intermediate, secondary, university or higher).

The questionnaire is shown in a supplementary file.

Physical examination

Trained nurses measured weight and height of participants. Weight was measured (light clothing, emptied pockets and without shoes), to the nearest 0.1 kg using a SECA electronic scale, model 813 (Hamburg, Germany). Height was measured in a standing upright position (without shoes) to the nearest 0.1cm using a SECA portable stadiometer, model 217 (Hamburg, Germany). Overweight and obesity were defined based on BMI cut-off points according to the International Obesity Task Force (IOTF) reference for children and adolescents.¹⁷

Participants received a detailed explanation of the aim of the study and its methods. Both students and their parents were free to agree or refuse to participate and/or withdraw from the study at any time, without any obligation. Written consent was obtained for each participant. Ethical approval for all study procedures and instruments was obtained by Kuwait Institute for Medical Specialization (Reference number: VQR/JC/505. Date: April 8, 2012).

Data handling and statistical analysis

For descriptive purposes, median and inter-quartile range or mean and 95% confidence interval were used for continuous variables. Percentages for categorical variables (BMI) were reported in the total sample, by sex and age (using two age-groups divided at the median age). Statistical significant differences between BMI categories and sex were examined using Chi-square test. A multivariate logistic regression was used to estimate the association between parental education

and BMI categories. Separate logistic regression models were run for overweight (including obesity) and obesity as outcomes. Exposure variables in the main analysis included maternal and paternal education, (recoded into two levels: High, if parents achieved at least university; Low, below university studies). The reason for recoding into binary categories (rather than including three categories) was made to maximise statistical power. Each logistic regression analysis was performed in two stages, Model 1: unadjusted; Model 2: adjusted for student age and governorate. Null hypothesis significance testing was two sided and P values at the 5% level were used in all analyses. The data management and analysis were carried out using SPSS version 24.0[®] (IBM Corp, Armonk, NY, USA).

Results

From 594 students invited to participate, 591 gave written informed consent (99%) and were included in this study.

Sample characteristics and obesity/overweight prevalence

Table 1 shows the descriptive characteristics of participants, N=591 (279 boys (median age: 16.1 years), 310 girls (median age: 16.0)). As shown in Table 2 (using IOTF criteria) over half of participants were overweight (including obesity): 54.3% (95% CI: 49.9-58.4). The prevalence of overweight and obesity was higher in boys than girls (boys: 59.8% (54.3-66.3) and girls: 49.2% (43.5-54.8) ($p \leq 0.01$)). By categories of weight status, the sex-specific prevalence of overweight was higher in girls, 31.1% (26.1-36.5) than boys, 25.4% (20.7-30.4) ($p > 0.05$). However, the sex-specific prevalence of obesity was patterned in the opposite way, being higher in boys: 34.4% (28.6-40.2) than girls 18.1% (13.7-22.7) ($p \leq 0.01$). When data were additionally split into two age

categories (11-16 years or 16.1-22 years), the prevalence of obesity was higher in boys in both strata (for example, in 11-16 years: 37.6% (29.6-46.5) versus 15.9% (10-21.5) for boys and girls respectively).

Obesity/overweight prevalence by parental education

As shown in Table 3, the prevalence of overweight was higher in adolescents (both sexes) with higher parental education level, whilst for obesity, the prevalence was slightly higher in adolescents with a low/medium educational level.

Associations between overweight/obesity and SES status

Table 4 shows the results of the multivariate logistic regression analyses. There were no associations between parental education and overweight (including obesity) risk or just obesity risk. Additional analysis, by sex, using a mutually adjusted model with several multiple sociodemographic indicators showed no associations among variables (Table 5).

Discussion

This is one of the few studies published in Kuwaiti adolescents examining the prevalence of overweight plus obesity and their associations with a proxy of SES (parental education). Due to the scarcity of well-designed obesity related epidemiological studies in Kuwait, and the lack of studies addressing the association between socioeconomic status indicators and adiposity further studies in adolescents are warranted. We found that in 2012-2013 over half of adolescents were overweight or obese. This worrisome finding is line with a previous study conducted in seven Arab countries in 2010-2011,¹⁰ in which Kuwaiti adolescents (15-18 years) ranked first in

overweight plus obesity problems (60.4% of boys and 41.4% of girls) using Cole cut-off points.¹⁷ Despite there have been two additional studies carried out in Kuwait,^{8,9} they used different adiposity cut-off points (percentiles from USA⁸ and BMI Z-scores⁹) that limit the comparability among studies. We also found a higher prevalence of obesity in boys than girls (34.4% vs 18.1%), in full agreement with the literature⁸⁻¹⁰. For example in 2010-2011, 35% of obese boys and 21% of obese girls was reported¹⁰. The causes of this marked differences in the rate of obesity among sexes are unknown.

While our multivariate sex-specific analyses offer no evidence for a social patterning of BMI (Table 3), analysis using total participants showed a borderline statistical significant association with maternal education. Contrary to the findings in other rich countries,⁷ adolescents whose mother achieved lower education levels had lower odds ratio (95% CI) of overweight (including obesity) 0.73 (0.49-1.09). Similarly, El-Bayoumy et al.⁸ found a higher prevalence of obesity in high social class adolescents assessed by income. The reasons why the socioeconomic health gradient in relation with weight status has been eroded in Kuwait should be studied in the future. Gulf countries have adopted a Westernized diet in the last decades. The traditional Kuwaiti diet consisted mainly in rice, dates, seafood, sheep, camel milk and goat meat has been replaced by energy-dense, nutrient-poor foods (snacks, sugar-sweetened beverages and increased portion sizes).⁹ Imported foods comprise most of the Kuwaiti food market.³ In fact, a recent report from the Food and Agricultural Organization (FAO)³ concluded that Kuwait has one of the highest energy intake (per capita) among all Arab countries (3471 kcal/day in 2011). Furthermore, the epidemic of physical inactivity may exacerbate the medical problems caused by poor diets. In Kuwait some parents do not allow their children to join the residential sports clubs. Parental concerns include the risk of injury during sports, unsuitable weather conditions and the loss of

academic performance.¹⁸ Furthermore, young Kuwaiti male adolescents often gather at a friend's room to watch TV or play with videogames,¹⁹ all of which are to some extent implicated in obesity aetiology²⁰ as they are associated with a higher consumption of snacks and sugar-sweetened beverages.

This study provides an update of the prevalence of obesity in Kuwaiti adolescents. Strengths were the high response rate obtained as well as the collection of socio-demographic information of participants. Limitations were the lack of information about maturation status (Tanner stage), waist circumference and the reliance on an indirect method to assess adiposity (BMI), instead of more sophisticated methods such as air displacement plethysmography or dual-energy X-ray absorptiometry.²¹ In addition, this study included data of three out of six governorates in Kuwait. Although the sample is not fully representative of the whole population of adolescents in Kuwait, we provide a partial picture of how is affecting the obesity epidemic in this Arab country.

From a public health perspective, Arab countries are experiencing a continued deterioration in health indicators. For example, between 1980 and 2014, the age-standardised adult diabetes prevalence in Middle East grew around 15% (one of the largest increases observed in world).²² Our concerning findings reinforce the importance of promoting healthy food environments and active lifestyles in Kuwaiti children to achieve an optimal cardio-metabolic health in adulthood.²³ Health policies in Kuwait should prioritise promoting upstream interventions with broad population reach to halt the rising trajectory to poor health in the current generation of adolescents.

Conclusions

We found that over half of school age Kuwait adolescents were overweight or obese. Contrary to the findings observed in other rich Westernized countries, no evidence of associations between parental education and BMI was found. Urgent actions are needed to reverse the obesity epidemic in Kuwait across all socioeconomic groups.

Acknowledgements

This work was supported by the Kuwait Institute For Medical Specializations and the Ministry of Health Kuwait. JPRL is supported by University of Sydney, Sydney (Australia) (Project Code: U2334). ES is supported by the National Health and Medical Research Council through a Senior Research Fellowship. All authors declare that they have no conflict of interest. All procedures performed in studies involving human participants were in accordance with the ethical standards of the Kuwait Institute for Medical Specialization (Reference number: VDR/JC/505. Date: April 8, 2012) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors. Informed consent was obtained from all individual participants included in the study. Author's contribution: RH and ES conceived the study design. RH contributed in the fieldwork. MH, AM, PHW, CGO and ES advised about statistical issues. JPRL and RH performed statistical analysis. All authors were involved in writing the paper and the critical revision of multiple drafts.

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Tables captions

Table 1. Characteristics of participants in the Study of Health and Activity among Adolescents in Kuwait (SHAAK study). Continuous variables are shown as median (interquartile range) or mean§ (95% CI) according to their distribution. n= number of participants. For categorical variables, number of subjects and percentages are depicted. Education level: ¹Low, read and write, intermediate (Grades 7-9); ²Medium, secondary (Grades 10-12); ³High, at least University degree. Number of cars: [#]Low, up to 2 cars. [§]High, at least 3 cars. Number of bedrooms: [^]Low, up to 2 bedrooms. [□] High, at least 3 bedrooms.

Table 2. Prevalence of overweight, obesity and overweight plus obesity in adolescents by age: the Study of Health and Activity among Adolescents in Kuwait (SHAAK study). Data are percentage and 95% confidence intervals. Weight categories based on IOTF criteria (ref.).

*p≤0.01 between sexes using Chi-square tests.

Table 3. Prevalence of overweight and obesity in adolescents by maternal education and paternal education: the Study of Health and Activity among Adolescents in Kuwait (SHAAK study). Data are percentage and 95% confidence intervals. Weight categories based on IOTF criteria (ref.).

#Low/Medium education level: read and write, intermediate, secondary level; §High education level as having at least University studies. * $p \leq 0.01$ between sexes using Chi-square tests.

Table 4. Odds ratio (OR) and 95% confidence intervals for overweight, obesity and overweight/obesity by paternal and maternal education in adolescents: the Study of Health and Activity among Adolescents in Kuwait (SHAAK study). Weight categories based on IOTF criteria (ref.). #Low/Medium education level: read and write, intermediate, secondary level; §High education as having at least University studies. Model 1: crude; Model 2: Adjusted by age, sex (only in total participants) and governorate. OR, odds ratio, CI, confidence interval.

Table 5. Odds ratio (OR) and 95% confidence intervals for overweight/obesity by paternal and maternal education: the Study of Health and Activity among Adolescents in Kuwait (SHAAK study). Fully adjusted model by age, governorate, parental education, number of cars, number of bedrooms and home ownership. Weight categories based on IOTF criteria (ref.). #Low/Medium education level: read and write, intermediate, secondary level; §High education as having at least University studies. Model 1: crude; Model 2: Adjusted by age and governorate. Number of cars: ¶Low, up to 2 cars. ◻ High, at least 3 cars. Number of bedrooms: ^Low, up to 2 bedrooms. ◻ High, at least 3 bedrooms. OR, odds ratio, CI, confidence interval.

Prevalence of overweight and obesity among Kuwaiti adolescents and associations with socioeconomic indicators: the study of health and activity among adolescents in Kuwait.

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Abstract

BACKGROUND: Kuwait is one of the Arab countries with the highest prevalence of overweight or obesity. However, few studies have described the prevalence of obesity in this country. **Aim:** To describe the prevalence of overweight and obesity among Kuwaiti adolescents; and to examine the association of overweight and obesity status with familial socioeconomic status (SES).

METHODS: Cross-sectional data from 591 adolescent students (47% boys, median age: 16 years) from the Study of Health and Activity among Adolescents in Kuwait in 2012 and 2013. Body weight status was determined using the *International Obesity Task Force* (IOTF) body mass index standards. SES was based on parental education. Odds ratio for overweight and obesity were calculated using multiple logistic regression.

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Introduction

In the last three decades the prevalence of childhood obesity has risen substantially worldwide.¹ For the World Obesity Federation (updated data in November 2015) the area with the highest prevalence of overweight (including obesity) in 10-17 years olds was America (~30%), followed by Europe (~18%) and Eastern Mediterranean region, which covers 22 countries including the Arab peninsula (~17%).² The Arab peninsula is one of most vulnerable worldwide regions affected by the obesity epidemic due to the adoption of Westernized dietary patterns³. In Kuwait, recent data indicates that more than half of adult population is affected by overweight or obesity⁴. The high prevalence of obesity in adolescents is projected to place excessive demands on health services because the numerous medical complications associated with obesity. Obesity persisting through adulthood is associated with a higher incidence cardiovascular disease, type 2 diabetes mellitus, cancer, osteoarthritis, work disability, and sleep apnea.¹ In addition, emerging evidence suggests that there may be direct medical complications caused by excess adiposity in children. For example, a recent study found that high adiposity in children is a risk factor for retinal ganglion cell damage⁵. Other medical and psychological comorbidities caused by obesity in adolescents are polycystic ovary syndrome, gastro-oesophageal reflux disease, weight-related joint disease, depression, poor self-esteem and eating disorders⁶.

Nonetheless, the burden of obesity is not equally distributed in the population. For example, a review focused in children and adolescents found evidence of a social gradient in the obesity risk. The higher the parental income or parental occupation or education level, the lower the risk of overweight/obesity.⁷ Although several factors may explain why children living in worse off families are at higher risk of overweight or obesity, inappropriate food environments are well established causal factors of weight problems.¹

To our knowledge, few studies have examined the prevalence of overweight (and obesity) in children and adolescents in the Arab countries.⁸⁻¹⁶ From these, three studies have been conducted in Kuwait.⁸⁻¹⁰ In 2006, in a large sample of adolescents (10-14 years) (n=5402) the prevalence of overweight (including obesity) was 45.6%, of which remarkably 90% of obese adolescents belonged to high-income families.⁸ In 2008-2009, the prevalence of overweight (including obesity) in 9-18 years (boys: n=206; girls=180) ranged from 48% to 53% for boys and from 39% to 40% for girls.⁹ Finally in 2010-2011 data from a seven Arab countries study the highest prevalence of overweight (including obesity) in Kuwaiti adolescents (15-18 years), 60.4% (boys) and 41.4% (girls).¹⁰ However, it is worth noting that only one¹⁰ of the three previously mentioned studies defined overweight and obesity according to international standards (Cole cut-off points). Due to the scarcity of well-designed epidemiological studies and the alarming high prevalence of overweight observed in Kuwait further surveillance studies in adolescents are needed.

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The questionnaire is shown in a supplementary file.

Physical examination

Trained nurses measured weight and height of participants. Weight was measured (light clothing, emptied pockets and without shoes), to the nearest 0.1 kg using a SECA electronic scale, model 813 (Hamburg, Germany). Height was measured in a standing upright position (without shoes) to the nearest 0.1cm using a SECA portable stadiometer, model 217 (Hamburg, Germany). Overweight and obesity were defined based on BMI cut-off points according to the International Obesity Task Force (IOTF) reference for children and adolescents.¹⁷

Participants received a detailed explanation of the aim of the study and its methods. Both students and their parents were free to agree or refuse to participate and/or withdraw from the study at any time, without any obligation. Written consent was obtained for each participant. Ethical approval for all study procedures and instruments was obtained by Kuwait Institute for Medical Specialization (Reference number: VQR/JC/505. Date: April 8, 2012).

Data handling and statistical analysis

For descriptive purposes, median and inter-quartile range or mean and 95% confidence interval were used for continuous variables. Percentages for categorical variables (BMI) were reported in the total sample, by sex and age (using two age-groups divided at the median age). Statistical significant differences between BMI categories and sex were examined using Chi-square test. A multivariate logistic regression was used to estimate the association between parental education

and BMI categories. Separate logistic regression models were run for overweight (including obesity) and obesity as outcomes. Exposure variables in the main analysis included maternal and paternal education, (recoded into two levels: High, if parents achieved at least university; Low, below university studies). The reason for recoding into binary categories (rather than including three categories) was made to maximise statistical power. Each logistic regression analysis was performed in two stages, Model 1: unadjusted; Model 2: adjusted for student age and governorate. Null hypothesis significance testing was two sided and P values at the 5% level were used in all analyses. The data management and analysis were carried out using SPSS version 24.0[®] (IBM Corp, Armonk, NY, USA).

Results

From 594 students invited to participate, 591 gave written informed consent (99%) and were included in this study.

Sample characteristics and obesity/overweight prevalence

Table 1 shows the descriptive characteristics of participants, N=591 (279 boys (median age: 16.1 years), 310 girls (median age: 16.0)). As shown in Table 2 (using IOTF criteria) over half of participants were overweight (including obesity): 54.3% (95% CI: 49.9-58.4). The prevalence of overweight and obesity was higher in boys than girls (boys: 59.8% (54.3-66.3) and girls: 49.2% (43.5-54.8) ($p \leq 0.01$)). By categories of weight status, the sex-specific prevalence of overweight was higher in girls, 31.1% (26.1-36.5) than boys, 25.4% (20.7-30.4) ($p > 0.05$). However, the sex-specific prevalence of obesity was patterned in the opposite way, being higher in boys: 34.4% (28.6-40.2) than girls 18.1% (13.7-22.7) ($p \leq 0.01$). When data were additionally split into two age

categories (11-16 years or 16.1-22 years), the prevalence of obesity was higher in boys in both strata (for example, in 11-16 years: 37.6% (29.6-46.5) versus 15.9% (10-21.5) for boys and girls respectively).

Obesity/overweight prevalence by parental education

As shown in Table 3, the prevalence of overweight was higher in adolescents (both sexes) with higher parental education level, whilst for obesity, the prevalence was slightly higher in adolescents with a low/medium educational level.

Associations between overweight/obesity and SES status

Table 4 shows the results of the multivariate logistic regression analyses. There were no associations between parental education and overweight (including obesity) risk or just obesity risk. Additional analysis, by sex, using a mutually adjusted model with several multiple sociodemographic indicators showed no associations among variables (Table 5).

Discussion

This is one of the few studies published in Kuwaiti adolescents examining the prevalence of overweight plus obesity and their associations with a proxy of SES (parental education). Due to the scarcity of well-designed obesity related epidemiological studies in Kuwait, and the lack of studies addressing the association between socioeconomic status indicators and adiposity further studies in adolescents are warranted. We found that in 2012-2013 over half of adolescents were overweight or obese. This worrisome finding is line with a previous study conducted in seven Arab countries in 2010-2011,¹⁰ in which Kuwaiti adolescents (15-18 years) ranked first in

overweight plus obesity problems (60.4% of boys and 41.4% of girls) using Cole cut-off points.¹⁷ Despite there have been two additional studies carried out in Kuwait,^{8,9} they used different adiposity cut-off points (percentiles from USA⁸ and BMI Z-scores⁹) that limit the comparability among studies. We also found a higher prevalence of obesity in boys than girls (34.4% vs 18.1%), in full agreement with the literature⁸⁻¹⁰. For example in 2010-2011, 35% of obese boys and 21% of obese girls was reported¹⁰. The causes of this marked differences in the rate of obesity among sexes are unknown.

While our multivariate sex-specific analyses offer no evidence for a social patterning of BMI (Table 3), analysis using total participants showed a borderline statistical significant association with maternal education. Contrary to the findings in other rich countries,⁷ adolescents whose mother achieved lower education levels had lower odds ratio (95% CI) of overweight (including obesity) 0.73 (0.49-1.09). Similarly, El-Bayoumy et al.⁸ found a higher prevalence of obesity in high social class adolescents assessed by income. The reasons why the socioeconomic health gradient in relation with weight status has been eroded in Kuwait should be studied in the future. Gulf countries have adopted a Westernized diet in the last decades. The traditional Kuwaiti diet consisted mainly in rice, dates, seafood, sheep, camel milk and goat meat has been replaced by energy-dense, nutrient-poor foods (snacks, sugar-sweetened beverages and increased portion sizes).⁹ Imported foods comprise most of the Kuwaiti food market.³ In fact, a recent report from the Food and Agricultural Organization (FAO)³ concluded that Kuwait has one of the highest energy intake (per capita) among all Arab countries (3471 kcal/day in 2011). Furthermore, the epidemic of physical inactivity may exacerbate the medical problems caused by poor diets. In Kuwait some parents do not allow their children to join the residential sports clubs. Parental concerns include the risk of injury during sports, unsuitable weather conditions and the loss of

academic performance.¹⁸ Furthermore, young Kuwaiti male adolescents often gather at a friend's room to watch TV or play with videogames,¹⁹ all of which are to some extent implicated in obesity aetiology²⁰ as they are associated with a higher consumption of snacks and sugar-sweetened beverages.

This study provides an update of the prevalence of obesity in Kuwaiti adolescents. Strengths were the high response rate obtained as well as the collection of socio-demographic information of participants. Limitations were the lack of information about maturation status (Tanner stage), waist circumference and the reliance on an indirect method to assess adiposity (BMI), instead of more sophisticated methods such as air displacement plethysmography or dual-energy X-ray absorptiometry.²¹ In addition, this study included data of three out of six governorates in Kuwait. Although the sample is not fully representative of the whole population of adolescents in Kuwait, we provide a partial picture of how is affecting the obesity epidemic in this Arab country.

From a public health perspective, Arab countries are experiencing a continued deterioration in health indicators. For example, between 1980 and 2014, the age-standardised adult diabetes prevalence in Middle East grew around 15% (one of the largest increases observed in world).²² Our concerning findings reinforce the importance of promoting healthy food environments and active lifestyles in Kuwaiti children to achieve an optimal cardio-metabolic health in adulthood.²³ Health policies in Kuwait should prioritise promoting upstream interventions with broad population reach to halt the rising trajectory to poor health in the current generation of adolescents.

Conclusions

We found that over half of school age Kuwait adolescents were overweight or obese. Contrary to the findings observed in other rich Westernized countries, no evidence of associations between parental education and BMI was found. Urgent actions are needed to reverse the obesity epidemic in Kuwait across all socioeconomic groups.

Acknowledgements

This work was supported by the Kuwait Institute For Medical Specializations and the Ministry of Health Kuwait. JPRL is supported by University of Sydney, Sydney (Australia) (Project Code: U2334). ES is supported by the National Health and Medical Research Council through a Senior Research Fellowship. All authors declare that they have no conflict of interest. All procedures performed in studies involving human participants were in accordance with the ethical standards of the Kuwait Institute for Medical Specialization (Reference number: VDR/JC/505. Date: April 8, 2012) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors. Informed consent was obtained from all individual participants included in the study. Author's contribution: RH and ES conceived the study design. RH contributed in the fieldwork. MH, AM, PHW, CGO and ES advised about statistical issues. JPRL and RH performed statistical analysis. All authors were involved in writing the paper and the critical revision of multiple drafts.

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Tables captions

Table 1. Characteristics of participants in the Study of Health and Activity among Adolescents in Kuwait (SHAAK study). Continuous variables are shown as median (interquartile range) or mean§ (95% CI) according to their distribution. n= number of participants. For categorical variables, number of subjects and percentages are depicted. Education level: ¹Low, read and write, intermediate (Grades 7-9); ²Medium, secondary (Grades 10-12); ³High, at least University degree. Number of cars: [#]Low, up to 2 cars. [§]High, at least 3 cars. Number of bedrooms: [^]Low, up to 2 bedrooms. [□] High, at least 3 bedrooms.

Table 2. Prevalence of overweight, obesity and overweight plus obesity in adolescents by age: the Study of Health and Activity among Adolescents in Kuwait (SHAAK study). Data are percentage and 95% confidence intervals. Weight categories based on IOTF criteria (ref.).

*p≤0.01 between sexes using Chi-square tests.

Table 3. Prevalence of overweight and obesity in adolescents by maternal education and paternal education: the Study of Health and Activity among Adolescents in Kuwait (SHAAK study). Data are percentage and 95% confidence intervals. Weight categories based on IOTF criteria (ref.).

#Low/Medium education level: read and write, intermediate, secondary level; §High education level as having at least University studies. * $p \leq 0.01$ between sexes using Chi-square tests.

Table 4. Odds ratio (OR) and 95% confidence intervals for overweight, obesity and overweight/obesity by paternal and maternal education in adolescents: the Study of Health and Activity among Adolescents in Kuwait (SHAAK study). Weight categories based on IOTF criteria (ref.). #Low/Medium education level: read and write, intermediate, secondary level; §High education as having at least University studies. Model 1: crude; Model 2: Adjusted by age, sex (only in total participants) and governorate. OR, odds ratio, CI, confidence interval.

Table 5. Odds ratio (OR) and 95% confidence intervals for overweight/obesity by paternal and maternal education: the Study of Health and Activity among Adolescents in Kuwait (SHAAK study). Fully adjusted model by age, governorate, parental education, number of cars, number of bedrooms and home ownership. Weight categories based on IOTF criteria (ref.). #Low/Medium education level: read and write, intermediate, secondary level; §High education as having at least University studies. Model 1: crude; Model 2: Adjusted by age and governorate. Number of cars: ¶Low, up to 2 cars. ◻ High, at least 3 cars. Number of bedrooms: ^Low, up to 2 bedrooms. ◻ High, at least 3 bedrooms. OR, odds ratio, CI, confidence interval.

Table 1. Characteristics of participants in the Study of Health and Activity among 589 Adolescents in Kuwait (SHAAK study)

	Boys (n=279)	Girls (n=310)
Age (year)	16.1 (14.8-17.4)	16.0 (14.6-17.5)
Height§ (cm)	169.0 (168.0-171.0)	156.0 (155.0-157.0)
Weight (kg)	70.7 (58.9-90.0)	58.1 (46.6-68.2)
BMI (kg m ⁻²)	24.5 (20.4-30.6)	23.4 (19.5-26.9)
	Boys (n=239)	Girls (n=270)
Maternal education level n (%)	Low ¹	26.0 (10.0)
	Medium ²	39.0 (14.4)
	High ³	205.0 (75.9)
Paternal education level n (%)	Low ¹	27.0 (10.9)
	Medium ²	47.0 (19.0)
	High ³	173.0 (70.0)
Number of cars n (%)	Low [#]	52.0 (19.3)
	High [§]	218.0 (80.7)
Home ownership n (%)	Owned	227.0 (84.1)
	Rented	43.0 (15.9)
Number of bedrooms n (%)	Low [^]	184.0 (68.1)
	High [□]	86.0 (31.9)

Continuous variables are shown as median (interquartile range) or mean§ (95% CI) according to their distribution. n= number of participants. For categorical variables, number of subjects and percentages are depicted. Education level: ¹Low, read and write, intermediate (Grades 7-9); ²Medium, secondary (Grades 10-12); ³High, at least University degree. Number of cars: [#]Low, up to 2 cars. [§]High, at least 3 cars. Number of bedrooms: [^]Low, up to 2 bedrooms. [□] High, at least 3 bedroom

Table 2. Prevalence of overweight, obesity and overweight plus obesity in adolescents by age: the Study of Health and Activity among Adolescents in Kuwait (SHAAC study)

	<i>Overweight</i> % (95% CI)		<i>Obesity</i> % (95% CI)		<i>Overweight + Obesity</i> % (95% CI)	
	Boys n	Girls n	Boys n	Girls n	Boys n	Girls n
<i>11-16 years</i>	27.8 (20.3-35.9) n=37	32.5 (25.1-39.3) n=49	37.6 (29.6-46.5)* n=50	15.9 (10-21.5) n=24	65.4 (57.3-73)* n=87	48.3 (40.7-56.5) n=73
<i>16.1-22 years</i>	23.7 (17-30.9) n=33	29.7 (21.5-37.1) n=43	30.9 (23.2-38.6)* n=43	20.7 (14.5-27.9) n=30	54.7 (46.4-63.3) n=76	50.3 (42.2-58.6) n=73
<i>Total sample by sex</i>	25.4 (20.7-30.4) n=70	31.1 (26.1-36.5) n=92	34.4 (28.6-40.2)* n=93	18.1 (13.7-22.7) n=54	59.8 (54.3-66.3)* n=163	49.2 (43.5-54.8) n=146
	n=162		n=147		n=309	
<i>Total sample</i>	28.3 (24.5-32.0)		25.9 (22.3-29.7)		54.3 (49.9-58.4)	

Data are percentage and 95% confidence intervals. Weight categories based on IOTF criteria (ref.). *Statistically significant differences $p \leq 0.01$ between sexes using Chi-square tests.

Table 3. Prevalence of overweight and obesity in adolescents by maternal education and paternal education: the Study of Health and Activity among Adolescents in Kuwait (SHAAK study)

	<i>Overweight</i> % (95% CI)		<i>Obesity</i> % (95% CI)		<i>Overweight + Obesity</i> % (95% CI)	
	Boys n=59	Girls n=83	Boys n=82	Girls n=47	Boys n=141	Girls n=130
<i>Maternal Education</i>						
Low/Medium [#]	n=12 17.9 (9.0-28.0)	n=17 26.6 (15.8-38.2)	n=25 37.3 (25.0-49.2)*	n=10 15.6 (7.2-24.6)	n=37 55.2 (43.4-67.2)	n=27 42.2 (30.0-54.7)
High [§]	n=47 27.8 (21.3-34.5)	n=66 33.7 (27.2-40.5)	n=57 34.0 (26.4-41.1)*	n=37 18.9 (13.2-24.5)	n=104 61.5 (54.4-69)	n=103 52.6 (45.9-59.4)
<i>Paternal Education</i>						
Low/Medium [#]	n=21 22.6 (14.9-32.5)	n=20 25.6 (16.0-35.8)	n=33 35.5 (26.3-45.1)*	n=18 23.1 (13.6-32.9)	n=54 58.1 (48.1-68.5)	n=38 48.7 (37.7-59.7)
High [§]	n=38 26.0 (19.2-33.6)	n=58 33.7 (26.5-40.7)	n=48 32.9 (25.3-41.1)*	n=28 16.3 (10.9-22.3)	n=86 58.9 (51.1-66.9)	n=86 50.0 (42.6-57.6)

Data are percentage and 95% confidence intervals. Weight categories based on IOTF criteria (ref.). [#]Low/Medium education level: read and write, intermediate, secondary level; [§]High education level as having at least University studies. *Statistically significant differences $p \leq 0.01$ between sexes using Chi-square tests.

Table 4. Odds ratio (OR) and 95% confidence intervals for overweight, obesity and overweight/obesity by paternal and maternal education in adolescents: the Study of Health and Activity among Adolescents in Kuwait (SHAAK study)

	<i>Overweight (including obesity)</i>					
	Model 1		Model 2		Model 1	Model 2
	Boys (n=239)	Girls (n=270)	Boys (n=239)	Girls (n=270)	Total (n=509)	Total (n=509)
Maternal education	OR 95% CI	OR 95% CI	OR 95% CI	OR 95% CI	OR 95% CI	OR 95% CI
High [§]	1	1	1	1	1	1
Low/Medium [#]	0.77 (0.43-1.37)	0.66 (0.37-1.16)	0.92 (0.51-1.68)	0.68 (0.38-1.22)	0.73 (0.49-1.09)	0.74 (0.49-1.11)
Paternal education						
High [§]	1	1	1	1	1	1
Low/Medium [#]	0.97 (0.57-1.64)	0.95 (0.56-1.62)	1.06 (0.62-1.81)	1.02 (0.57-1.82)	0.99 (0.68-1.43)	0.98 (0.67-1.43)
	<i>Obesity</i>					
	Boys (n=180)	Girls (n=172)	Boys (n=180)	Girls (n=172)	Total (n=352)	
Maternal education	OR 95% CI	OR 95% CI	OR 95% CI	OR 95% CI	OR 95% CI	OR 95% CI
High [§]	1	1	1	1	1	1
Low/Medium [#]	0.95 (0.50-1.80)	0.68 (0.34-1.50)	1.17 (0.60-2.29)	0.75 (0.33-1.70)	0.88 (0.54-1.42)	0.91 (0.56-1.47)
Paternal education						
High [§]	1	1	1	1	1	1
Low/Medium [#]	1.06 (0.58-1.93)	1.38 (0.69-2.79)	1.16 (0.62-2.14)	1.71 (0.77-3.78)	1.24 (0.79-1.94)	1.26 (0.80-1.98)

Weight categories based on IOTF criteria (ref.). [#]Low/Medium education level: read and write, intermediate, secondary level; [§]High education as having at least University studies. Model 1: crude; Model 2: Adjusted by age, sex (only in total participants) and governorate. OR, odds ratio, CI, confidence interval.

Table 5. Odds ratio (OR) and 95% confidence intervals for overweight/obesity by paternal and maternal education: the Study of Health and Activity among Adolescents in Kuwait (SHAAK study)

	Mutually adjusted model	
	Boys (n=239)	Girls (n=270)
	OR	95% CI
Maternal education		
High [§]	1	1
Low [#]	0.92 (0.50-1.67)	0.63 (0.34-1.14)
Paternal education		
High [§]	1	1
Low [#]	1.06 (0.61-1.81)	1.05 (0.58-1.88)
Number of cars		
High [□]	1	1
Low [†]	1.01 (0.36-3.23)	0.58 (0.28-1.21)
Home ownership		
Owned	1	1
Rented	1.27 (0.50-1.59)	0.77 (0.37-1.59)
Number of bedrooms		
High [□]	1	1
Low [^]	1.63 (0.91-2.90)	1.34 (0.76-2.34)

Fully adjusted model by age, governorate, parental education, number of cars, number of bedrooms and home ownership. Weight categories based on IOTF criteria (ref.). [#]Low/Medium education level: read and write, intermediate, secondary level; [§]High education as having at least University studies. Model 1: crude; Model 2: Adjusted by age and governorate. Number of cars: [†]Low, up to 2 cars. [□]High, at least 3 cars. Number of bedrooms: [^]Low, up to 2 bedrooms. [□]High, at least 3 bedrooms. OR, odds ratio, CI, confidence interval

-Supplementary Material-**Socioeconomic Questionnaire*****Study Of Health And Activity Among Adolescents In Kuwait*****Please answer the following questions:****I want to ask you some questions about yourself:**

2) School Grade:

-7 () -8 () -9 () -10 () -11 () -12 ()

3) Date of birth:/...../.....

4) Gender:

Male () Female ()

I want to ask you some questions about your family:

5) What is your rank among brothers and sisters?

Firstborn () Middle () Youngest () Only child ()

6) How many people live in your home including you? (not including domestic maid/s)

7) How many bedrooms does your home have altogether?

8) Do you share your bedroom with a sibling or a family member? Yes () No ()

9) In your home do you live with?

Parents and siblings only () More than one family together eg. grandparents () Father only or mother only ()

10) Is your home?

Rented () Owned ()

11) How many cars does your family own?

12) How many people work in your home (including maids, driver, gardener, and cook) ?.....

13) Father education:

Illiterate () Read and write () Primary () intermediate () secondary () university () higher ()

14) What is your fathers job?.....

15) Mother education:

Illiterate () Read and write () Primary () intermediate () secondary () university () higher ()

16) What is your mothers job?.....

I want to ask you some question about your health:

17) Do you have allergies in your chest or asthma? Yes () No () Do not know ()

18) Do you use an inhaler or nebulizer? Yes () No () Do not know ()

19) Do you have high blood sugar or Diabetes ? Yes () No () Do not know ()

20) Do you suffer from any other health related problem ? Yes () No () Do not know ()

If yes mention the problem.....

21) Did you suffer from any condition that has limited your physical activity the past week:.....

22) Are you currently on a diet? Yes () No ()

23) Did you ever go on a diet? Yes () No () If yes, mention why you stopped.....

11/01/2018

Dear Editor of the *Minerva Pediatrica*,

We are re-submitting the manuscript "*Prevalence of overweight and obesity among Kuwaiti adolescents and associations with socioeconomic indicators: the study of health and activity among adolescents in Kuwait*" for your consideration.

We have addressed the last comment expressed by one reviewer (see changes in the introduction section). We hope that the submitted version has reached the scientific quality to meet the requirements wanted.

All authors declare that they have no conflicts of interest.

On behalf of the authors,

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