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ORIGINAL ARTICLE

Prevalence of Double Burden of Malnutrition and Associated Factors of Weight Gain among Schoolchildren in Taza, Eastern Morocco

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ABSTRACT:

Background: Obesity and overweight are characterized by an excessive accumulation of fat present in the body. Worldwide more than 340 million children between the ages of five and nineteen were overweight or obese in 2016. Very few studies have focused on the prevalence of the double burden of malnutrition, namely obesity, and underweight, in the Moroccan context.
Methods: The research was a cross-sectional study based on a self-administered questionnaire which distributed to 462 adolescents in the presence of a dietician who was also responsible for anthropometric measurements and clinical examination.
Results: The prevalence of underweight was 11.4%, overweight was estimated at 7.3%, and obesity at 1.7%. The Odds ratio analysis revealed that the number of people sharing the same household has a strong influence on weight gain, as adolescents who share their home with only 2 people are 61 times more likely to gain weight than adolescents who live with 3 or more people in the same household (OR 61.11 CI 18.96;196.97). Type of residence was also found to be a risk factor for weight gain; adolescents living in urban areas were 6 times more likely to gain weight than those living in rural areas (OR= 6.11 CI: 1.39; 26.82). Adolescents who do not consume fast food are less likely to gain weight (Odds Ration less than 1 (OR=0.014 CI: 0.003;0.063). Regular strenuous physical activity was also a protective factor against weight gain (OR=0.278 CI: 0.080;0.969).
Conclusion: The double burden of malnutrition characterized by the coexistence of obesity and underweight is a reality in Taza. It is therefore urgent to take community action, such as promoting healthy food choices by taxing unhealthy foods, implementing obligatory standards for meals in canteens and school catering, increasing daily physical activity in schools, as well as fighting against obesogenic environments. Early intervention is necessary because moderate overweight in childhood is associated with a significant increase in the risk of type 2 diabetes and cardiovascular disease in later adulthood.

KEYWORDS: obesity, schoolchildren, adolescent, malnutrition, prevalence

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Introduction:

Obesity and overweight are defined by an excessive or abnormal accumulation of fat present in the body. A recent study from 2017 reported the change in prevalence of BMI categories in children and adolescents aged 5-19 years from 21 major regions of the world or 200 countries, that the increase in body mass index (BMI) in some parts of the world has been rapidly increased, according to the same source statistics refer to more than 340 million children and adolescents between the ages of 5 and 19 years were overweight or obese in 2016. This global prevalence was around 4% in 1975 and remarkably increased in 2016 until it reached 18% (Bentham et al., 2017). In 2004 overweight and obesity were the fifth leading risk factor for death worldwide such that in 2019 ischemic heart disease was the leading cause of death worldwide with at least a 23% burden attributable to overweight and obesity (WHO,2009). The risk that an obese child will remain obese in adulthood has been demonstrated by numerous studies, with a probability of persistence of obesity into adulthood of up to 70% (Heude & Charles, 2001; Vanhala et al., 1998; Whitaker et al., 1997). Numerous etiological studies have investigated the risk factors associated with obesity. A study in Afghanistan found that age, gender, education, smoking, type of job, and dietary habits were significantly associated with obesity (Saeed, 2015). Another evidence from research conducted in Turkey reported that the student's school level, the father's education level, and the geographical location of the school were determined as factors associated with overweight and obesity (Meydanlioglu et al., 2022). In a literature review of published works on risk factors associated with obesity, Susann Weihrauch-Blühe, in addition to the above-mentioned factors, indicates the lack of physical activity, sedentary behavior, socioeconomic status, duration and quality of sleep, obesogenic environment, marketing and advertising of energy-dense foods, as factors leading to overweight (Weihrauch-Blüher & Wiegand, 2018). local data report the same risk factors associated with obesity but different prevalence rates (Azekour et al., 2020; el Kabbaoui et al., 2018a; Nouayti et al., 2020a; Sebbani et al., 2013a). Hence the need to identify obese children or children at risk of becoming obese from an early age so that they can be managed as early as possible. The present study aims to remedy this situation by estimating the prevalence of the double burden of malnutrition, mainly overnutrition and undernutrition, and highlighting the factors associated with it

in a population of adolescents attending public and private schools in a city in eastern Morocco (Taza). Our study is a pioneer in this city.

Methods:

Type of study and characteristics of the population:

The present study is a cross-sectional study based on a face-to-face survey. The survey was conducted from May 13, 2019, to October 21, 2019. Eight public and three private schools were sampled at random, and then classes were randomly selected from each school. The number of subjects needed (NSN) was calculated using the Schwartz formula $n = (1.96)^2 \times (0.5)\ (1-0.5) / (0.05)^2 = 384.16$ which was rounded to 385 to this number 20% was added to compensate for the missing value questionnaires i.e. NSN=462 The questionnaire was anonymous and was distributed to 462 adolescents by a previously trained team and was filled in individually by the students in the presence of a dietician who was also responsible for anthropometric measurements and clinical examination. In addition to socio-demographic information, our items included eating and sleeping habits as well as physical activity.

Inclusion and exclusion criteria:

After the questionnaires were examined, the following were excluded from the analysis:

- Forms that contained missing or unreadable data.

- Subjects who did not meet our age criteria (10-20 years).

- Subjects with edema during the clinical examination by the dietician.

- Subjects who completed the questionnaire and did not want their weight and/or height taken.

Otherwise, all students who came to the classroom for the questionnaire and anthropometric measurements and whose parents or guardians agreed to participate in the survey were included in the study.

Variables measured during the interview:

The respondent's weight was measured with an electronic scale (Beurer PS160) with an accuracy of 100g. The choice of the survey period is justified by the weather conditions (spring-summer) of this period of the year when the subjects were lightly dressed. The weight is expressed in kilograms. Height was measured with a wall-mounted height gauge (Seca 206) that could be read to the nearest 220 cm in the standing position and was expressed in centimeters.

Body mass index (BMI) for age was calculated for all respondents, which was determined by a Z-score calculated by WHO AnthroPlus software, based on height, weight, sex, date of birth, and date of measurement. The new WHO growth standards were used to assess the rate of obesity and overweight in children (Overweight: >+1 z (equivalent to BMI of 25 kg/m2) and Obesity: >+2 z (equivalent to BMI of 30 kg/m2)) (WHO, 2007).

Ethical considerations:

All precautions according to the Declaration of Helsinki (Finland, June 1964) were taken to protect the privacy and confidentiality of the personal information of those involved in the research [13]. Informed consent was obtained from the guardians, who were properly informed of the objectives, methods, and institutional affiliations of the researchers. Authorization to conduct the survey in public schools in the province of Taza was obtained from the provincial delegation of the Ministry of National Education. The directors of the institutions were informed one week before the visit. The interview took place during a Day-Off for students.

Statistical analysis:

Analysis of the data was carried out using SPSS version 25 software and WHO Anthroplus version 1.04 software. Quantitative variables were expressed as means and standard deviations, and qualitative variables were expressed as frequencies and percentages. Based on the reference standards established by the WHO in 2007 according to gender and age. Adolescents were classified into 4 categories: underweight (Z Score < -2 standard deviation: SD), normal weight (-2 SD < Z Score < +1 SD), overweight (> +1 SD and < 2 SD), and obese (> +2 SD) (WHO, 2007). An association test was used to highlight possible risk factors controlling for weight gain.

Results:

Characteristics of the studied population:

A total of 411 students were interviewed. The average age was 16.23±1.82 years. The ratio of boys to girls was approximately 1.12:1. The mean height was 165.26 ± 9.86 cm. The mean weight was 55.47±11.3 kg. The age group (15-19 years) was the most represented with 81% of the subjects (N=337) against 19% for the age group (10-14 years). The characteristics of the sample are given in Table 1.

Table 1: Characteristics of respondents by gender.

	Means ± Standard deviations		
	Female	Male	Combined
Age (Years)	16±1	17±2	16.23±1.82
Height (cm)	162.34±6.70	167.85±11.39	165.27±9.86
Weight (Kg)	53.25±9.86	57.44±12.13	55.47±11.30
BMI (Kg/m^2)	20.13±2.92	20.21±2.75	20.17±2.83

Weight status assessment:

The prevalence of underweight, overweight, and obesity was assessed based on the new 2007 World Health Organization references. The underweight prevalence was 11.4% (95% CI [6.9%; 16%]), the overweight prevalence was 7.3% (95% CI [4.7%; 9.9%]), and the obesity prevalence was 1.7% (95% CI [0.2%; 3.5%]). The distribution of the different BMI categories by sex revealed an increase in the proportions of *overweight and obesity in women (Table 2).*

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Table 2*:* Distribution of different BMI categories by gender

		BMI/age (%)			
Age groups	**Sample size N**	**Underweight Z Score < - 2 SD**	**Normal weight -2 SD < Z Score < + 1 SD**	**Overweight +1 SD < Z Score < +2 SD**	**Obesity Z Score > +2 SD**
(10-14)	74	0	78.3	14.9	6.8
(15-19)	337	14	79.8	5.6	0.6

The classification of these categories into two age groups, 10-14 and 15-19 years, revealed a higher prevalence of overweight and obesity among younger subjects, 14.9% and 6.8%, respectively, compared with only 5.6% and 0.6% among older subjects (Table 3)

Table 3: Distribution of different BMI categories by age group

	BMI categories			
	Underweight	Normal weight	Overweight	Obesity
Total (%) N=411	11.4	79.6	7.3	1.7
boys (%) N=193	12.9	77 .8	8.3	1
Girls (%) N=218	10.1	81.2	6.4	2.3

Weight gain and associated factors:

The World Health Organization has reported that most of the world's population lives in countries where overweight and obesity kill more people than underweight. To identify the risk factors associated with weight gain among the adolescents in our study, we performed a Pearson Chi-square test, the results obtained are listed in Table 4 .

After checking the relationship between the dependent variable which is weight gain and the other independent variables: Gender, age class, smoking, number of family members sharing the same home, sleep disturbance, consumption of fast food, type of residence, type of education sector, physical activity, the Odds ratio was calculated for the variables that presented a significant association with the

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dependent variable. Odds ratio analysis revealed that the number of people sharing the same household has a strong influence on weight gain, as adolescents who share their home with only 2 people are 61 times more likely to gain weight than adolescents who live with 3 or more people in the same household (OR 61.11 CI 18.96;196.97). Type of residence was also found to be a risk factor for weight gain; adolescents living in urban areas were 6 times more likely to gain weight than those living in rural areas (OR= 6.11 CI: 1.39; 26.82). Adolescents who do not consume fast food are less likely to gain weight (Odds Ration less than 1 (OR=0.014 CI: 0.003;0.063). Regular strenuous physical activity was also a protective factor against weight gain (OR=0.278 CI: 0.080;0.969).

Table 4: Chi-square test for the dependent variable (weight gain) and possible risk factors for weight gain

Variables		**Overweight**		**Pearson Chi-square Risk alpha =0.05**		
		Yes	**No**	**X^2**	**df**	**p-value**
Gender	Female	5.2%	94.8%	0.257	1	0.612
	Male	4.1%	95.9%			
Age range	10 to 14 years	1.5%	98.5%	1.836	1	0.175
	15 to 19 years	5.2%	94.8%			
Smoking	Yes	5.7%	94.3%	0.228	1	0.633
	No	4.4%	95.6%			
Family members in the same home	Maximum of 2 persons	58.8%	41.2%	118.154	1	0.000
	More than 2 persons	2.3%	97.7%			
Sleep disturbance	Yes	0.0%	100.0%	4.593	1	0.032
	No	5.7%	94.3%			
Fast-Food consumption	At least once per week	28.8%	71.2%	91.431	1	0.000
	Never	0.6%	99.4%			
Location of residence	Rural areas	1.2%	98.8%	7.379	1	0.007
	Urban areas	6.9%	93.1%			
Educational sector	Private	8.1%	91.9%	1.120	1	0.290
	Public	4.3%	95.7%			
The practice of intense physical activity	Yes	1.9%	98.1%	4.571	1	0.033
	No	6.4%	93.6%			

Table 5: Results of binary logistic regression regarding possible risk factors of weight gain among our sample (N=411)

	Odds Ratio		
	Value	**confidence interval**	
		Lower	**Higher**
Family members in the same home	61.111	18.960	196.970
Sleep disturbance	1.060	1.033	1.089
Fast-Food consumption	0.014	0.003	0.063
Location of residence	6.114	1.393	26.828
The practice of intense physical activity	0.278	0.080	0.969

Discussion :

The present study revealed a prevalence of overweight at about 7.3% and 1.7% of obesity. Our results are in line with those found at the Moroccan level, El Kabbaoui M. et al. in a sample of 1818 adolescents aged 12 to 18 years found a prevalence of overweight and obesity respectively of 7.29% and 3.41% (el Kabbaoui et al., 2018b). M. Sebbani reported respective prevalences of overweight and obesity of 8% and 3% among 1418 school children in the city of Marrakech (Sebbani et al., 2013b). In a context similar to ours in the eastern region of Morocco, the authors reported values of 12.2% of overweight and 3% of obesity according to the references of the International Obesity Task Force (IOTF) (Nouayti et al., 2020b). At the regional level, a recent study (2016) in Tunisia conducted on a sample of 715 college students revealed slightly higher proportions of obesity and overweight compared to our study respectively 17.4% and 6.1% (Badr et al., 2018). In Algeria Mesli, F. reported a prevalence of 10% overweight and 3% obesity (Mesli & Raiah, 2013). The prevalence of underweight, overweight, and obesity in Palestinian school-aged children was approximately 7.3%, 14.5%, and 15.7%, respectively (Al-Lahham et al., 2019). At the international level, in a literature review conducted by Juan Ángel Rivera in 2014 that involved school-age adolescent populations in Latin America, the proportions were alarming ranging from 12.9% to 24.4% for overweight and 3.4% to 34.8% for obesity between the years 2002 and 2012 (Rivera et al., 2014). In all the above studies including our study, the percentage of obese girls is higher than that of boys. These results are consistent with the work of Hoffman (Hoffman et al.,

2006) and Economos et al (Economos et al., 2008). On the other hand, this finding is not consistent with the results of Shuhan Jiang (Jiang et al., 2018) and Cluskey M. (Cluskey & Grobe, 2009). The difference observed according to sex in our context can be explained by the differences in growth and hormonal secretions during this period of life which follows puberty as well as by socio-cultural factors. Moreover, the movement outside the home and therefore more physical activity and energy expenditure to do the shopping is much more granted to boys than to girls, boys are more dynamic in their games than girls whether in the school environment or on the days of vacation. The search for risk factors controlling weight gain in our population allowed us to inventory the number of family members in the same residence as a risk factor, in fact; adolescents who live only with their parents and have no more siblings have 61 times more risk of developing obesity, this same result was found by a study conducted in Turkey which showed that the risk of becoming obese among children who have only 1 or two brothers/sisters is 69.2% and decreases to 18. 2% for those who have more than three siblings (Ayyildiz et al., 2014), this association may be explained by the food ratio which is largely sufficient in the first case (co-residence with 2 people at most), and the effect of sharing food when the number of family members exceeds 2 people. In our study, the association between physical activity and weight gain was weak (p=0.032) with an Odds ratio lower than 1 (OR= 0.278 CI: 0.080;0.969) which means that physical activity is a protective factor against weight gain. Recent studies confirm this result found, Juozas R. 2016 and Patrick Ip. 2017 reveal a reduction in the risk of obesity associated with the number of physical activity programs as well as obese and overweight children were less physically active (Ip et al., 2017; Raistenskis et al., 2016). The impact of another factor has been highlighted, that is the type of place of residence; indeed, urban adolescents are more exposed to weight gain, this same result was reported in a meta-analysis including 204,597 students from 42 Californian departments by Strochlic R. (Strochlic et al., 2017). However, our result is not consistent with that of Lewis et al. who found that students residing in rural settings are 23% more likely to gain weight compared to those residing in urban settings (Lewis et al., 2006). The mode of action of this risk factor is not well known, since many studies have affirmed the absence of a significant difference in terms of physical activity practice between rural and urban areas (Bathrellou et al., 2007; Tognarelli et al., 2004), so apart from physical activity, other mechanisms could come into play such as the time spent outside the home, which in our

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context is very reduced in disadvantaged rural areas due to the absence of electricity and public lighting, and therefore, less physical activity, which explains the result found regarding physical activity practice. The availability of food differs in terms of quantity and quality between urban and rural areas; the urban area is characterized by the abundance of ultra-processed foods which, although rich in energy, have a very low nutritional value. Many studies have emphasized the association between the consumption of ultra-processed foods and weight gain (de Deus Mendonça et al., 2016; Juul et al., 2018)Our study confirms this finding, the chi-square test showed a strong association between fast food consumption and weight gain, however the Odds Ratio shows an advantage in favor of non-consumers of fast food (OR=0.014 CI: 0.03; 0.063). The abundance of grocery stores that offer ultra-processed foods near schools in the urban environment seems to explain the increased prevalence of overweight among urban adolescents. Sleep disturbance is no longer a risk factor in our study although the chi-square test showed a significant relationship, the odds ratio was in the order of 1 this means that the two groups that have good sleep quality and poor sleep quality have the same risk of gaining weight, this contradicts the result of Guieu, J.- D who established a causal link between sleep deprivation and weight gain (Chaput et al., 2011). Chi-square analysis did not show a significant association between gender, age, smoking, and education sector on the one hand and weight gain on the other. From this observation, the study of a few risk factors in isolation, i.e., the absence of synergy or antagonism between these different factors, seems to be both a limitation of our study and a research perspective. Another limitation of the study was the random cluster sampling method, as the clusters were not of equal size due to the application of exclusion criteria. However, all strata were represented: the rural, urban, female, male, public, and private sector. The early age (10 years) of some subjects in our sample was a limiting factor for the use of appropriate questionnaires for the assessment of dietary habits such as the FFQ (Food Frequency Questionnaire) or the assessment of physical activity such as the IPAQ (International Physical Activity Questionnaire). These limitations may provide insights for future duplications of this study in other regions. Anthropometric measurements and clinical examination by a nurse dietician using daily calibrated equipment are the strong points of this study.

Conclusion

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The double burden of malnutrition characterized by the coexistence of obesity and underweight is a reality in Taza. The identification of other risk factors related to this public health problem and the elucidation of their mechanisms of action is strongly recommended for their prevention and treatment. It is therefore urgent to take community action, such as promoting healthy food choices by taxing unhealthy foods, implementing obligatory standards for meals in canteens and school catering, increasing daily physical activity in schools, as well as banning the advertising of unhealthy foods to children. To achieve lasting success and end the obesity epidemic, it is imperative to restructure obesity interventions by fighting against obesogenic environments. There is a need for immediate intervention because moderate overweight in childhood is associated with a significantly increased risk of type 2 diabetes and cardiovascular disease in adulthood.

List of abbreviations:

BMI: Body mass index

CI: Confidence interval

IOTF: International Obesity Task Force

NSN: Number of subjects needed

OR: Odds ratio

WHO: World Health Organization

SD: Standard deviation

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References:

Al-Lahham, S., Jaradat, N., Altamimi, M., Anabtawi, O., Irshid, A., Alqub, M., Dwikat, M., Nafaa, F., Badran, L., Mohareb, R., Haji, R., Aqqad, T., Jayyab, S., Ghosh, B. A., Taher, R., & al Zabadi, H. (2019). Prevalence of underweight, overweight and obesity among Palestinian school-age children and the associated risk factors: a cross sectional study. *BMC Pediatrics*, *19*(1). https://doi.org/10.1186/S12887-019-1842-7

Ayyildiz, T. K., Kurtuncu, M., Kulakci, H., & Celik, S. (2014). Factors Affecting the Prevalence of Obesity Among Primary School Students in Turkey. *Iranian Red Crescent Medical Journal*, *16*(12), 17785. https://doi.org/10.5812/IRCMJ.17785

Azekour, K., Idir, I., Lahrach, N., & Bouhali, B. el. (2020). [Prevalence of obesity and overweight within the school environment in Tafilalet oasis, south-east of Morocco]. *The Pan African Medical Journal*, *35*. https://doi.org/10.11604/PAMJ.2020.35.40.17650

Badr, W., Ghammam, R., Maatoug, J., Ammar, A., ben Fredj, S., & Ghannem, H. (2018). Prévalence de l'obésité et du surpoids chez les adolescents et association avec les facteurs de risques comportementaux Sousse, Tunisie 2016. *Annales d'Endocrinologie*, *79*(4), 504–505. https://doi.org/10.1016/J.ANDO.2018.06.1028

Bathrellou, E., Lazarou, C., Panagiotakos, D. B., & Sidossis, L. S. (2007). Physical activity patterns and sedentary behaviors of children from urban and rural areas of Cyprus. *Central European Journal of Public Health*, *15*(2), 66–70. https://doi.org/10.21101/CEJPH.A3414

Bentham, J., di Cesare, M., Bilano, V., Bixby, H., Zhou, B., Stevens, G. A., Riley, L. M., Taddei, C., Hajifathalian, K., Lu, Y., Savin, S., Cowan, M. J., Paciorek, C. J., Chirita-Emandi, A., Hayes, A. J., Katz, J., Kelishadi, R., Kengne, A. P., Khang, Y. H., … Cisneros, J. Z. (2017). Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults. *The Lancet*, *390*(10113), 2627–2642. https://doi.org/10.1016/S0140-6736(17)32129-3

Chaput, J. P., Lambert, M., Gray-Donald, K., McGrath, J. J., Tremblay, M. S., O'Loughlin, J., & Tremblay, A. (2011). Short sleep duration is independently associated with overweight and obesity in Quebec children. *Canadian Journal of Public Health = Revue Canadienne de Sante Publique*, *102*(5), 369–374. https://doi.org/10.1007/BF03404179

Cluskey, M., & Grobe, D. (2009). College weight gain and behavior transitions: male and female differences. *Journal of the American Dietetic Association*, *109*(2), 325–329. https://doi.org/10.1016/J.JADA.2008.10.045

Déclaration d'Helsinki de L'AMM – Principes éthiques applicables à la recherche médicale impliquant des êtres humains – WMA – The World Medical Association. (1964). Retrieved June 17, 2022, from https://www.wma.net/fr/policies-post/declaration-dhelsinki-de-lamm-principes-ethiques-applicables-a-la-recherche-medicale-impliquant-des-etres-humains/

de Deus Mendonça, R., Pimenta, A. M., Gea, A., de La Fuente-Arrillaga, C., Martinez-Gonzalez, M. A., Lopes, A. C. S., & Bes-Rastrollo, M. (2016). Ultraprocessed food consumption and risk of overweight and obesity: the University of Navarra Follow-Up (SUN) cohort study. *The American Journal of Clinical Nutrition*, *104*(5), 1433–1440. https://doi.org/10.3945/AJCN.116.135004

Economos, C. D., Lise Hildebrandt, M., & Hyatt, R. R. (2008). College freshman stress and weight change: differences by gender. *American Journal of Health Behavior*, *32*(1), 16–25. https://doi.org/10.5555/AJHB.2008.32.1.16

El Kabbaoui, M., Chda, A., Bousfiha, A., Aarab, L., Bencheikh, R., & Tazi, A. (2018b). Prevalence of and risk factors for overweight and obesity among adolescents in Morocco. *Eastern Mediterranean Health Journal = La Revue de Sante de La Mediterranee Orientale = Al-Majallah al-Sihhiyah Li-Sharq al-Mutawassit*, *24*(6), 512–521. https://doi.org/10.26719/2018.24.6.512

Global health risks : mortality and burden of disease attributable to selected major risks. (2009). Retrieved June 16, 2022, from https://apps.who.int/iris/handle/10665/44203

Heude, B., & Charles, M. A. (2001). le devenir à l'âge adulte de l'obésité de l'enfant. *Journal de Pédiatrie et de Puériculture*, *14*(8), 474–479. https://doi.org/10.1016/S0987-7983(01)80129-8

Hoffman, D. J., Policastro, P., Quick, V., & Lee, S. K. (2006). Changes in body weight and fat mass of men and women in the first year of college: A study of the "freshman 15." *Journal of American College Health : J of ACH*, *55*(1), 41–46. https://doi.org/10.3200/JACH.55.1.41-46

Ip, P., Ho, F. K. W., Louie, L. H. T., Chung, T. W. H., Cheung, Y. F., Lee, S. L., Hui, S. S. C., Ho, W. K. Y., Ho, D. S. Y., Wong, W. H. S., & Jiang, F. (2017). Childhood Obesity and Physical Activity-Friendly School Environments. *The Journal of Pediatrics*, *191*, 110–116. https://doi.org/10.1016/J.JPEDS.2017.08.017

Jiang, S., Peng, S., Yang, T., Cottrell, R. R., & Li, L. (2018). Overweight and Obesity Among Chinese College Students: An Exploration of Gender as Related to External Environmental Influences. *American Journal of Men's Health*, *12*(4), 926. https://doi.org/10.1177/1557988317750990

Juul, F., Martinez-Steele, E., Parekh, N., Monteiro, C. A., & Chang, V. W. (2018). Ultra-processed food consumption and excess weight among US adults. *The British Journal of Nutrition*, *120*(1), 90–100. https://doi.org/10.1017/S0007114518001046

Lewis, R. D., Meyer, M. C., Lehman, S. C., Trowbridge, F. L., Bason, J. J., Yurman, K. H., & Yin, Z. (2006). Prevalence and Degree of Childhood and Adolescent Overweight in Rural, Urban, and Suburban Georgia. *Journal of School Health*, *76*(4), 126–132. https://doi.org/10.1111/J.1746-1561.2006.00080.X

Mesli, F., & Raiah, M. (2013). Surpoids et obésité des enfants âgés de six à 11ans : prévalence et facteurs associés, Oran, Algérie. *Revue d'Épidémiologie et de Santé Publique*, *61*, S240–S241. https://doi.org/10.1016/J.RESPE.2013.07.126

Meydanlioglu, A., Akcan, A., Oncel, S., Adibelli, D., Cicek Gumus, E., Sarvan, S., & Kavla, I. (2022). Prevalence of obesity and hypertension in children and determination of associated factors by CHAID analysis. *Archives de Pédiatrie*, *29*(1), 30–35. https://doi.org/10.1016/J.ARCPED.2020.10.017

Nouayti, H., Bouanani, N. H., Hammoudi, J., Mekhfi, H., Legssyer, A., Bnouham, M., & Ziyyat, A. (2020b). Overweight and obesity in Eastern Morocco: Prevalence and associated risk factors among high school students. *Revue D'epidemiologie et de Sante Publique*, *68*(5), 295–301. https://doi.org/10.1016/J.RESPE.2020.06.007

Raistenskis, J., Sidlauskiene, A., Strukcinskiene, B., Uğur Baysal, S., & Buckus, R. (2016). Physical activity and physical fitness in obese, overweight, and normal-weight children. *Turkish Journal of Medical Sciences*, *46*(2), 443–450. https://doi.org/10.3906/SAG-1411-119

Rivera, J. Á., de Cossío, T. G., Pedraza, L. S., Aburto, T. C., Sánchez, T. G., & Martorell, R. (2014). Childhood and adolescent overweight and obesity in Latin America: a systematic review. *The Lancet. Diabetes & Endocrinology*, *2*(4), 321–332. https://doi.org/10.1016/S2213-8587(13)70173-6

Saeed, K. M. I. (2015). Prevalence and associated risk factors for obesity in Jalalabad city – Afghanistan. *Alexandria Journal of Medicine*, *51*(4), 347–352. https://doi.org/10.1016/j.ajme.2014.12.004

Sebbani, M., Elbouchti, I., Adarmouch, L., & Amine, M. (2013a). [Prevalence of obesity and overweight among children in primary schools in Marrakech, Morocco]. *Revue d'epidemiologie et de Sante Publique*, *61*(6), 545–549. https://doi.org/10.1016/J.RESPE.2013.08.002

Strochlic, R., Au, L., & Ritchie, L. (2017). Is urban-rural location associated with weight status in school children? An examination of 42 small and rural Californian counties. *Rural and Remote Health*, *17*(2). https://doi.org/10.22605/RRH3966

Tognarelli, M., Picciolli, P., Vezzosi, S., Isola, A., Moretti, F., Tommassetto, E., Fantuzzi, A. L., & Bedogni, G. (2004). Nutritional status of 8-year-old rural and urban Italian children: a study in Pistoia, Tuscany. *International Journal of Food Sciences and Nutrition*, *55*(5), 381–387. https://doi.org/10.1080/09637480400002966

Vanhala, M., Vanhala, P., Kumpusalo, E., Halonen, P., & Takala, J. (1998). Relation between obesity from childhood to adulthood and the metabolic syndrome: population based study. *BMJ (Clinical Research Ed.)*, *317*(7154), 319. https://doi.org/10.1136/BMJ.317.7154.319

Weihrauch-Blüher, S., & Wiegand, S. (2018). Risk Factors and Implications of Childhood Obesity. *Current Obesity Reports*, *7*(4), 254–259. https://doi.org/10.1007/S13679-018-0320-0

Whitaker, R. C., Wright, J. A., Pepe, M. S., Sedel, K. D., & Dietz, W. H. (1997). PREDICTING OBESITY IN YOUNG ADULTHOOD FROM CHILDHOOD AND PARENTAL OBESITY A BSTRACT Background Childhood Obesity Increases the Risk. *N Engl J Med*, *337*(13), 869–873. https://www.nejm.org/doi/pdf/10.1056/NEJM199709253371301 *(Accessed on June 17, 2022)*

WHO (World Health Organization). (2007). Growth reference data for 5-19 years - Indicators. Retrieved June 17, 2022, from https://www.who.int/tools/growth-reference-data-for-5to19-years/indicators