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School-Based Body Mass Index Survey: A national study of Obesity Prevalence among School Students in Saudi Arabia, 2018

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Abstract

Introduction: Childhood obesity is a major public health problem and associated with higher incidence of non-communicable diseases and significant impact on healthcare expenditure. To date, there is no national baseline information on overweight and obesity of school students in Saudi Arabia.

Objective: This study aims to determine the prevalence of obesity and its associated risk factors among school students in Saudi Arabia.

Methods: A school-based, national survey was carried out on 50% of students in third grade of both elementary and intermediate schools in all Saudi Arabia regions with a sample of 174,340 and 190,825 respectively. Weight and height of school students and body mass index (BMI) was calculated using the sex specific-BMI growth charts for Saudi children and adolescents.

Results: Overall prevalence of overweight and obesity was 18.6 %, (overweight was 11.0% and obesity was 7.6%). While underweight was 28.4%. The reported risk factors for obesity and overweight were, age group 10-19 years old (OR: 2.08, 95% CI: 2.05-2.12, P < 0.001), male gender (OR: 1.03, 95% CI: 1.01-1.05, P < 0.001), intermediate grade (OR: 2.1, 95% CI: 2.12–2.2, P < 0.001) and private schools (OR: 1.14, 95% CI: 1.06-1.22, P < 0.001).

Conclusion: Overweight and obesity among school students in Saudi Arabia are still high and continues to be a major public health concern. Policies at the national, community and individual levels are needed to be effectively implemented to control this problem. Notably, underweight also showed a high prevalence and this problem is needed to be highlighted as well.

Keywords: School Students; Obesity; Saudi Arabia; BMI; Adolescents; Overweight.

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1. Introduction

Childhood obesity and overweight have become critical public health problem. Globally, the number of obese children was 107.7 million with a greater increase in the rate of childhood obesity than that of adult obesity in many countries [1, 2].

Childhood obesity has a negative impact on health and may be a risk factor for non-communicable diseases (NCDs) later in life like high cholesterol levels, hypertension, fatty liver, diabetes, sleep apnea, and cancer [3]. Moreover, obesity could adversely affect the psychological and social wellbeing of the children leading to low self-esteem, depression, social isolation, and poor body image. These ultimately have a negative impact on the child's performance and increase school absenteeism [3].

One of the most important international studies on the measurement of body mass index (BMI) among school students is Arkansas's Act1220, which addressed childhood obesity by the annual screening of all students for BMI and tracking childhood obesity. Data were used to formulate policies for promoting physical activity and healthy eating [4].

Several regional studies were conducted in the Gulf Cooperation Council (GCC) countries (Kuwait, Kingdom of Saudi Arabia, United Arab Emirates), to evaluate the BMI among school students. Al-Isa et al. studied the factors associated with overweight and obesity among Kuwaiti elementary school students' males aged 6-10 years and recorded the prevalence of overweight and obesity to be 20.2% and 16.8% respectively. In addition, they reported several risk factors for overweight and obesity including having one or more obese brothers, jobless fathers, or a high crowding index (>11 persons living at home), increased age, school level, and having a chronic disease [5].

Al-hammadi and Reily conducted a systematic review on the prevalence of obesity among school-age children and adolescents in GCC and reported an alarming increase in the obesity level indicating several main deficiencies and limitations in obesity surveillance systems in the GCC states [6].

In Saudi Arabia, the westernization of lifestyle, rising of socioeconomic standards, and other cultural and behavioral issues contribute to making the Saudi population have one of the highest prevalence of obesity as it is estimated that seven out of each 10 people have obesity. The high total obesity and overweight cost represent a relative economic burden on the gross domestic product (GDP). Aside from days of life lost due to obesity-related disabilities, maybe productivity loss due to overweight and obesity, and the cost of health care for cardiovascular disease, diabetes mellitus, and cancer and rehabilitation programs are increasing. These costs are avoidable by preventing the age-related progression of overweight and obesity from early childhood [7].

As previously mentioned data, overweight and obesity are highly prevalent among Saudi Arabian

school students. However, national baseline information pertaining to overweight, and obesity of school students is not well established yet.

To achieve the Saudi Vision by 2030, the health authorities in the kingdom, led by the Ministry of Health, aim to fulfill multiple objectives that promote the health status and support efforts toward an efficient disease-free society. Among the objectives of the strategy, strategic objective 13, ministry of health is intending to improve the public health services by focusing on the obesity target by 2020 to lower the obesity by 1% from the baseline [8]. The first step to prevent and control increasing levels of childhood obesity is to assess accurately its prevalence and the associated risk factors to tailor evidence-based effective intervention programs. Thereby, BMI screening and reporting programs can help to increase public awareness and professional understanding of children's weight issues. In turn, it can be an important tool for engaging with children and their families about healthy lifestyles and weight problems [9].

This study aimed to determine the prevalence of obesity, overweight, and its associated risk factors among both elementary and intermediate school students in Saudi Arabia.

2. Subjects and Methods

2.1 Study design and setting:

A school-based national survey was carried out among elementary and intermediate schools in all the twenty regions of Saudi Arabia during the academic year 2017/2018.

2.2 Study Population:

Students of 3rd grade in elementary and intermediate schools, both males and females, in all Saudi Arabia's regions.

2.3 Inclusion criteria:

Public and private schools, 3rd grade of both elementary and intermediate schools**,** Saudi and non-Saudi were eligible to be included in the study.

2.4 Exclusion criteria:

International schools, evening schools, and the schools that serve students with special needs were excluded from the study.

2.5 Sampling technique:

Fifty percent of students in each selected grade from each region were included in the study. In Kingdom of Saudi Arabia (KSA), there are a total of 348,690 students in 3rd elementary grade and 381,650 in 3rd intermediate grade in the selected schools, yielding a sample size of 174,340 and 190,825 respectively.

We selected the sample based on a multistage, stratified, cluster random sampling procedure. The schools in all Saudi Arabia regions were stratified according to; gender (males and females); education level (elementary and intermediate); management level (governmental and private). Through this stratification, we ensured a good weight representation of students in each region.

Primary Health Care Centers (PHCC) under each regional health affair randomly selected the schools that are connected to their catchment area. From each school, all students of the target group (3rd elementary or 3rd intermediate grades) were taken as a cluster till cover 50% of them in each region.

2.6 Training of fieldwork team:

Local field coordinators (male and female physicians) were assigned in each of the 20 regions. They were responsible for the data collection at male and female schools respectively. Prior to the commencement of the study, each coordinator had standardized and structured training and received the necessary handouts and additional material to facilitate successful data collection.

Each region had one or two regional coordinators who were responsible for liaising with the research team in Riyadh city. The regional coordinator was nominated from the School Health Department at the Ministry of Health. Each coordinator was responsible for coordinating with the local schools to arrange a time to visit the school, introducing the study to the school managers and students. All materials and equipment's necessary for data collection were prepared, packaged, and sent by the research team in Riyadh via courier to each of the respective regional teams.

2.7 Tools of data collection:

Anthropometric measurements (weight and height) of students were used to calculate BMI. Students were weighed lightly dressed and without shoes. Weight was measured to the nearest 0.1 kilograms (kg) using an electronic scale and height was measured to the nearest 0.5-centimeter (cm) using wall mounted height chart. The scale was calibrated before use. Upon entering data into database, BMI was calculated using the equation: BMI= weight (kg)/[height (m)]^2 and plotted on the BMI growth charts for Saudi children and adolescents [10] to determine the BMI status of students which interpreted to be underweight if BMI for age <5th percentiles, healthy weight between 5th – 85th percentiles, overweight between 85th – 95th percentiles and obese equal or greater than 95th percentiles respectively [11]. Data were electronically entered to the School Health, MOH website by the regional coordinators.

2.8 Data Analysis:

We coded the data, entered, cleaned and analyzed by statistical package for social sciences (SPSS) version 25 [SPSS Inc., Chicago, IL, USA]. Data were represented as frequencies and percentages; Chi - Square test ($\chi 2$) was used for testing the association between data frequencies. Odds ratio and 95%

confidence interval was calculated. All p values are two-tailed, and the test results were considered significant when p-value < 0.05 and highly significant when p-value <0.01.

2.9 Ethical statements:

The Central Institutional Review Board of MOH, national registration number NCBE-KACST, KSA, approved this study: (2019-091M) and the Ministry of Education in Saudi Arabia.

All the legal guardians of the study participants provided an informed written consent prior to study enrollment after explaining the importance of the study and assuring their confidentiality and privacy.

3. Results

A total of 395, 969 school students participated in this study. Table (1) shows socio-demographic characteristics and BMI results among school students. More than half of them were adolescents (age group 10-19) years old, females and students in intermediate educational level (55.8%, 56.3% and 52.5%) respectively. The majority were of Saudi nationality and attended governmental schools (87.6% and 98%) respectively. The overall prevalence of overweight and obesity were (18.6%), overweight was 11% and obesity was 7.6% respectively (Fig. 1). The distribution of overweight and obesity were higher among adolescent (14.2%, 10.1%) and private school students (15.9, 13%) respectively. However, overweight was higher among females and non-Saudi students (11.7% and 11.6%) respectively while obesity was higher among males and Saudi students (8.2% and 7.3%) respectively (Table 1).

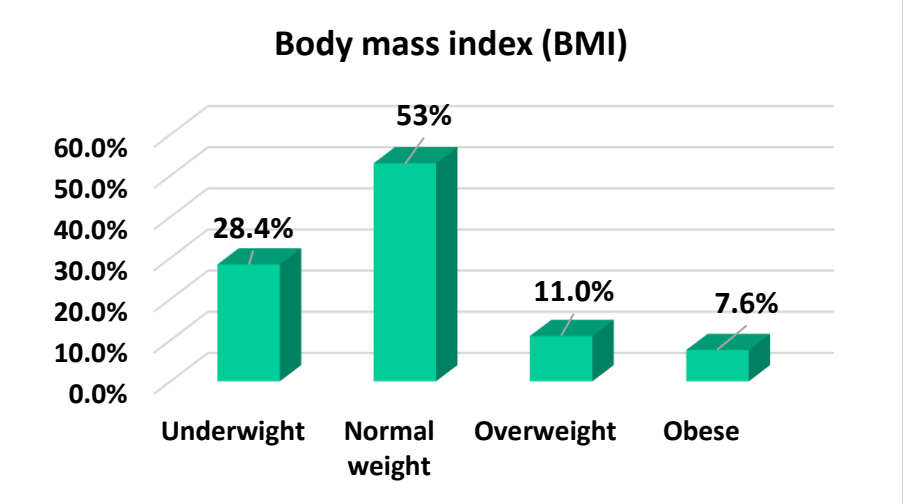

Figure (1): Prevalence of overweight and obesity among school students in Saudi Arabia (N= 395969).

Table (1) Some socio-demographic characteristics and BMI results among school students, Saudi Arabia.

Characteristics	BMI								Total (N.= 395969)	
	Underweight <5th percentile (N=112385)		Normal Weight 5th – <85th Percentile (N= 209774)		Overweight 85th – <95th Percentile (N= 43806)		Obesity ≥ 95th percentile (N= 30004)			
	N	%	N	%	N	%	N	%	N	%
Age (years):										
< 10	62963	36.0	92037	52.6	12433	7.1	7694	4.4	175127	44.2
≥ 10 – 19	49422	22.4	117737	53.3	31373	14.2	22310	10.1	220842	55.8
Gender:										
Males	51659	29.8	89420	51.7	17766	10.3	14270	8.2	173115	43.7
Females	60726	27.2	120354	54.0	26040	11.7	5734	7.1	222854	56.3
Educational Level:										
Primary	68107	36.2	98442	52.4	13286	7.1	8147	4.3	187982	47.5
intermediate	44278	21.3	111332	53.5	30520	14.7	21857	10.5	207987	52.5
School type									***204989**	
Governmental	42854	21.3	107641	53.6	29432	14.6	21032	10.5	200959	98.0
Private	685	17.0	2181	54.1	639	15.9	525	13.0	4030	2.0
Nationality										
Saudi	98470	28.4	183930	53.0	38124	11.0	26431	7.6	346955	87.6
Non-Saudi	13915	28.4	25844	52.7	5682	11.6	3573	7.3	49014	12.4

*** Total number of school type = 204989** **BMI:** body mass index **N:** number

The higher prevalence of overall obesity and overweight in KSA were in Eastren province, Aseer, Al-Ahsa, Jeddah and Tabuk (33.8%, 31.3%, 30%, 29.8% and 28.4%) respectively. Obesity prevalence were higher in Eastren province, Al-Ahsa, Aseer, Jeddah and Tabuk regions (16.6%, 15.4%, 13.3% 12.4% and 11.6%) respectively. Overweight was more prevalent in Aseer, Jeddah, Eastren province, Al-Qassim and Tabuk regions (18%, 17.4%, 17.2%, 17.1% and 16.8%) respectively (Fig. 2).

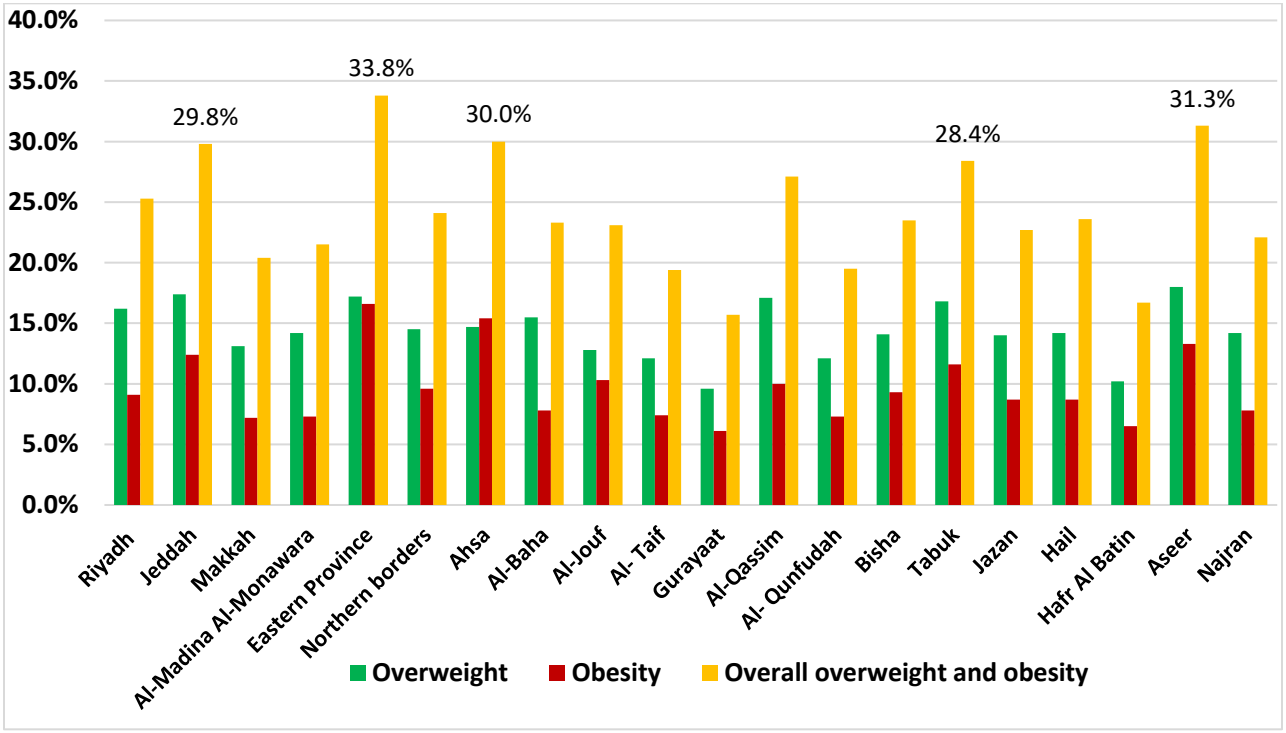

Figure (2): Prevalence of overweight and obesity among school students in different region in Saudi Arabia.

Table (2): Odds Ratio of overall obesity and overweight among studied school students relative to their background variables.

Sociodemographic characteristics	Normal Weight 5th – <85th percentile (N= 209774)		Overweight and Obesity >85thpercentile (N= 73810)		χ2 P value	OR 95% CI
	N	%	N	%		
Age (years):						
< 10	92037	82.1	20127	17.9	**<0.0001****	2.08
≥ 10 – 19	117737	68.7	53683	31.3		52.05-2.12
Gender:						
Males	89420	73.6	32036	26.4	**<0.0001****	1.03
Females	120354	74.2	41774	25.8		1.01 – 1.05
Educational Level:						
Primary	98442	82.1	21433	17.9	**<0.0001****	2.16
intermediate	111332	68.0	52377	32.0		2.12 – 2.2
School type	**N=109822**		**N=51628**			
Governmental	107641	68.0	50464	32.0	**<0.0001****	1.14
Private	2181	65.2	1164	34.8		1.06 – 1.22
Nationality						
Saudi	183930	74.0	64555	26.0	0.12	1.02
Non-Saudi	25844	73.6	9255	26.4		0.99– 1.05

χ2: Chi square test; **OR:** Odds Ratio**;** **CI:** Confidence Interval; ****: High statistical significant (p<0.001)**

Table (2) explains the relationship and odds ratio of overall obesity and overweight among studied school students relative to their background variables. Age group (10-19), males, intermediate grade and private schools were all significant risk factors for overall obesity and overweight while nationality was not a significant factor (OR 1.02, 95% CI 0.99–1.05, P = 0.12). Age and educational level increase the risk for obesity and overweight by about two folds (OR 2.08, 95% CI 2.05-2.12, P< 0.001 and OR 2.1, 95% CI 2.12–2.2, P< 0.001 respectively). While gender and school type increase the risk by about one-fold (OR 1.03, 95% CI 1.01-1.05, P< 0.001 and OR 1.14, 95% CI 1.06-1.22, P< 0.001 respectively).

4. Discussion

This large representative school-based survey was carried out among all the twenty regions of Saudi Arabia to assess the prevalence of overweight and obesity among school students. The current study showed that the overall prevalence of overweight and obesity was (18.6%), 7.6% for obesity and 11.0% for overweight. The highest overall obesity and overweight prevalence was in Eastern province, Aseer, Al-Ahsa, Jeddah and Tabuk regions. A statistically significant association was found between overall obesity and overweight levels and being an adolescent (10-19 years), a male, attending intermediate level of education and going to a private school.

To date, several epidemiological studies on obesity and overweight among school students were performed in Saudi Arabia, however, these studies were conducted on a single region or city [12-14]. El Mouzan et al, 2005 [12] recorded higher prevalence relative to our results for obesity (23.1%) and overweight (11.3%) among children and adolescents in KSA. In addition, Al-Nuaim et al. reported that the overall prevalence of overweight and obesity among male school students in Al-Ahsa to be 11.7% and 15.8% respectively which is consistent with the variation in the prevalence of overweight 14.7% and obesity 15.4% in Al-Ahsa region in our study [13]. However, Alenazi et al. study showed higher prevalence of obesity and overweight among children in Arar city (17.2% and 30.4% respectively) [14]. This study contradicts with our findings in northern borders, as the frequency of overweight (14.5%) was higher than that of obesity (9.6%). This could be because of restriction of Alenazi et al. study to male adolescent schools only, which may have specific different cultural and behavioral factors.

The decreased prevalence of overweight and obesity reported in the present study compared with previous studies that were conducted in KSA could be attributed to several interventions programs and initiatives implemented to change lifestyle of school students including health education about healthy diet and physical activity practice in schools specifically and for the whole population in general.

This study showed that the prevalence of overweight and obesity in children increases significantly with age, a finding consistent with other studies in Saudi Arabia [12, 15-17]. A study that was conducted in the city of Jeddah, reported that BMI were increasing in all age groups. It consistent with our findings,

the study authors also demonstrated highest prevalence of overall obesity and overweight was among males aged between 10 - 16 years old [18]. This observation may be attributable to many factors including hormonal changes associated with the adolescence period and persistence of pediatric obesity during adolescence, as a large proportion of the Saudi preschool students are physically inactive [19].

Gender discrepancy regarding obesity was documented by El Mouzan et al. [12] Similarly, we recorded the predominance of overweight in females and obesity in males during childhood (overweight was 10.3% vs 11.7% among males and females and obesity was 8.2% vs 7.1% among them respectively). In addition, consistent results were found in a study conducted in Riyadh city, where the prevalence of overweight was 13.4% (14.2% for females vs 12% for males) and obesity was 18.2% (18% for females vs 18.4% for males), respectively [17]. It was postulated that adolescent females at this age are more concerned with body image and tend to reduce their weight [20].

The present study was in agreement with a study conducted in Al-Ahsa that included 1270 volunteered adolescents living in different urban and rural areas. The study showed that the prevalence of overweight was 16.8% and 18.8% for males and females, respectively and for obesity was 19.1% and 17.7% respectively. This equates to a total of 35.9% of males and 36.5% of females being overweight or obese [13]. It is worth mentioning that difference in prevalence between genders could be due to the culture in KSA where female school students have very limited extracurricular or curricular sports activities in their schools, a concern that has led to a recent change in the policy of education, with its results upon application yet to be seen. It is important to note that this difference among gender is in contrast with some studies conducted in Europe. These, studies showed higher prevalence of overweight and obesity among school males in Denmark (15.2%, 14.1% compared to 12.9% and 8.2% among females, respectively), [21] in France (15.2%, 14.1% compared to 10.1% and 1.4%) [22], ending Greece (30.0%, 15.0% compared to 27.0% and 10.0%) among males and females, respectively [23]. These differences in the prevalence of overweight and obesity between these European studies and our study could be explained by cultural and lifestyle differences could be issues around the definition of overweight and obesity employed in these studies.

In the present study, attendance of a private school is another significant factor associated with high prevalence of overweight and obesity which was in consistent with Farsi et al., study from KSA [24] and also with other international studies conducted in; Ghana [25] in Kenya [26] and India [27]. Furthermore, attending a private school could be correlated to a higher family income that had been found to have a significant association with childhood obesity. Families with high income have more access to and can afford processed, fatty, and/or sugary foods and beverages compared to poorer households. Socio-

economic status may also predict access to technology (e.g., television, cars, computers, and video games) which is likely to contribute to a more sedentary lifestyle with significant association with childhood obesity [28].

4.1 Limitation

This study has a notable strength; it is the first nationwide survey that includes a huge randomly selected sample, serving effectively as a representative sample of all school aged children and adolescents in all KSA regions. However, there are a number of limitations mostly inherent to the cross-sectional study design that cannot establish causal association; also, further studies are needed to assess several lifestyle factors and dietary habits of the participants.

5. Conclusions and recommendations:

Based on the findings of the current study, the prevalence of overweight and obesity among school students in Saudi Arabia are still high, although correlating with the international levels and continues to be a major public health concern. Attending a private school, being a male, and an adolescent were significantly associated with a higher prevalence of obesity and overweight. Policies at a national, community and individual levels are need to be effectively implemented to prevent and control this problem. Our study also showed high prevalence of underweight and under nutrition and this problem is needed to be highlighted as well.

6. Declarations

6.1 Conflict of Interest Statement

The authors have no conflict of interests to declare.

6.2 Funding Disclosure

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. Publication fully paid by authors.

6.3 Author Contributions:

Ibrahim MH, methodology IRP approval, data cleaning, analysis and writing results, drafting and reviewing; Albwardi SA, follow up and training of data collection and introduction; Althagafi WA, discussion writing; Alzaher AA discussion, drafting and reviewing; Nahhas MA final reviewing; and Alabdulkareem KI, Final reviewing. All the co-authors have seen and approved the final version of the manuscript.

6.4 Data Availability Statement:

The data that support the findings of this study are not publicly available as it is national data need official permission from higher authority at MOH of KSA to share it.

6.5 Acknowledgements

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7. References

1. The GBD 2015 Obesity Collaborators. Health effects of overweight and obesity in 195 countries over 25 years. N Engl J Med. 2017;377(1):13–27.doi: 10.1056/NEJMoa1614362.

2. Nahhas MA, Asamoah F, Mullen S, Nwaru BI, Nurmatov U. Epidemiology of overweight and obesity in early childhood in the Gulf Cooperation Council countries: a systematic review and meta-analysis protocol. BMJ Open. 2018;8(6):e019363.

3. Al Eid A, Alahmed Z, Al-Omary S, Alharbi S. RASHAKA Program: A collaborative initiative between Ministry of Health and Ministry of Education to control childhood obesity in Saudi Arabia. Saudi J Obesity. 2017;5(1):22–7. Available from: https://www.saudijobesity.com/text.asp?2017/5/1/22/210589

4. Raczynski JM, Thompson JW, Phillips MM, Ryan KW, Cleveland HW. Arkansas Act 1220 of 2003 to reduce childhood obesity: its implementation and impact on child and adolescent body mass index. J Public Health Policy. 2009;30 Suppl 1:S124-40. doi: 10.1057/jphp.2008.54. PMID: 19190569.

5. Al-Isa AN, Campbell J, Desapriya E. Factors Associated with Overweight and Obesity among Kuwaiti Elementary Male School students Aged 6-10 Years. Int J Pediatr. 2010;2010:1-6. doi: 10.1155/2010/459261.

6. Al Hammadi H, Reilly J. Prevalence of obesity among school-age children and adolescents in the Gulf cooperation council (GCC) states: a systematic review. BMC Obes. 2019;6(1):3. doi: 10.1186/s40608-018-0221-5.

7. M Alqarni SS. A review of prevalence of obesity in Saudi Arabia. J obes eat disord [Internet]. 2016;02(02). Available from: http://dx.doi.org/10.21767/2471-8203.100025

8. Kingdom of Saudi Arabia. National transformation program 2020. Saudi Vis 2030. 2016; 1–57. [Accessible at 2020 Jan 15]. Available from: http://vision2030.gov.sa/sites/default/files/NTP_En.pdf%0Awww.vision2030.gov.sa

9. Nihiser AJ, Lee SM, Wechsler H, McKenna M, Odom E, Reinold C, et al. Body mass index measurement in schools. J Sch Health. 2007;77(10):651-71; quiz 722-4. doi: 10.1111/j.1746-1561.2007.00249.x.

10. El Mouzan MI, Al Salloum AA, Al Herbish AS, Foster PJ, Qurashi MM, Al Omar AA. The 2005 Growth Charts for Saudi Children and Adolescents (No. AR-20-63). King Abdulaziz City for Science and Technology Riyadh, KSA. 2009. Available from: https://www.moh.gov.sa/HealthAwareness/EducationalContent/BabyHealth/Documents/Intermediate%202%20Compatibility%20Mode.pdf

11. Growth Charts [Internet]. CDC.gov. 2017 [Accessed at 2019 September 10]. Available from: http://www.cdc.gov/growthcharts
12. El Mouzan MI, Foster PJ, Al Herbish AS, Al Salloum AA, Al Omer AA, Qurachi MM, et al. Prevalence of overweight and obesity in Saudi children and adolescents. Ann Saudi Med 2010;30(3):203-8.
13. Al-Nuaim AA, Al-Nakeeb Y, Lyons M, Al-Hazzaa HM, Nevill A, Collins P, et al. The prevalence of physical activity and sedentary behaviors relative to obesity among adolescents from Al-Ahsa, Saudi Arabia: rural versus urban variations. J Nutr Metab. 2012;2012: 417589. doi: 10.1155/2012/417589.
14. Alenazi SA, Koura HM, Zaki SM, Mohamed AH. Prevalence of obesity among male adolescents in Arar Saudi Arabia: Future risk of cardiovascular disease. Indian J Community Med. 2015;40:182–7.
15. Al Alwan I, Al Fattani A, Longford N. The effect of parental socioeconomic class on children's body mass indices. J Clin Res Pediatr Endocrinol. 2013;5(2):110 5. doi:10.4274/Jcrpe.898
16. Al Muhaimeed AA, Dandash K, Ismail MS, Saquib N. Prevalence and correlates of overweight status among Saudi schoolchildren. Ann Saudi Med 2015;35(4):275 81. doi: 10.5144/0256-4947.2015.275.
17. Al-Hussaini A, Bashir MS, Khormi M, Al Turaiki M, Al khamis W, Al rajhi M, et al. Overweight and obesity among Saudi children and adolescents: Where do we stand today? Saudi J Gastroenterol. 2019;25(4):229–35.
18. Abalkhail B. Overweight and obesity among Saudi Arabian children and adolescents between 1994 and 2000. East Mediterr Health J.2002;8(4-5):470-9.PMID: 15603027.
19. Al-Hazzaa HM. Prevalence and trends in obesity among school males in Central Saudi Arabia between 1988 and 2005. Saudi Med J. 2007;28(10):1569–74.PMID: 17914521.
20. Voelker DK, Reel JJ, Greenleaf C. Weight status and body image perceptions in adolescents: current perspectives. Adolesc Health Med Ther. 2015;6:149-58. doi:10.2147/AHMT.S68344
21. Krue S, Coolidge J. The prevalence of overweight and obesity among Danish school children. Obes Rev. 2010;11(7):489-91. doi: 10.1111/j.1467-789X.2010.00732.x.
22. Thibault H, Contrand B, Saubusse E, Baine M, Maurice-Tison S. Risk factors for overweight and obesity in French adolescents: physical activity, sedentary behavior and parental characteristics. Nutrition. 2010;26(2):192–200.doi: 10.1016/j.nut.2009.03.015.
23. Manios Y, Angelopoulos PD, Kourlaba G, Kolotourou M, Grammatikaki E, Cook TL, et al. Prevalence of obesity and body mass index correlates in a representative sample of Cretan schoolchildren. Int J Pediatr Obes. 2011;6(2):135-41. doi: 10.3109/17477161003792572.

24. Farsi DJ, Elkhodary HM, Merdad LA, Farsi NM, Alaki SM, Alamoudi NM, et al. Prevalence of obesity in elementary school children and its association with dental caries. Saudi Med J. 2016;37(12):1387-94. doi: 10.15537/smj.2016.12.15904.
25. Adom T, De Villiers A, Puoane T, Kengne AP. Prevalence and correlates of overweight and obesity among schoolchildren in an urban district in Ghana. BMC Obes [internet]. 2019;6(1):14. Available from: http://dx.doi.org/10.1186/s40608-019-0234-8
26. Kyallo F, Makokha A, Mwangi AM. Overweight and obesity among public and private primary school students in Nairobi, Kenya. Health. 2013;05(08):85-90. doi: 10.4236/health.2013.58A3012.
27. Jagadesan S, Harish R, Miranda P, Unnikrishnan R, Anjana RM, Mohan V. Prevalence of overweight and obesity among school children and adolescents in Chennai. Indian Pediatr. 2014;51(7):544-9. doi: 10.1007/s13312-014-0444-6.
28. Alqahtani N, Scott J, Alshahrani S, Ullah S. Socio-economic Determinants Factors of Overweight and Obesity among Saudi Children. J Obes Weight Loss Ther. 2014;04(04):241. doi:10.4172/2165-7904.1000241