



# Excess Weight Among Preschool Children in a Lower-Middle-Income Country: Predictors and Perspectives of Prevention

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## Abstract

**Objective:** We aimed to assess the weight status and to determine predicted factors of excess weight among Tunisian preschool children. **Methods:** We conducted a cross-sectional study among preschoolers attending kindergarten during 2016-2017 school-years in Sousse, Tunisia. The children's parents completed the self-administered questionnaire. Anthropometric measures (Weight and height) were taken for the children. Weight status considered body mass index (BMI) and excess weight was defined by the International Obesity Task Force (IOTF) standards. Odds ratios for excess weight were calculated using binary logistic regression analyses. **Results:** A total of 364 preschoolers were included with a mean age  $4.49 \pm 0.9$  years. The ratio boys/girls was 1.05. The prevalence of excess weight was 31.3%; CI95%:[26.7%-36.5%]. Female gender (AOR=1.74; CI95%:[1.07-2.83]), working mother (AOR=1.75; CI95%:[1.04-2.92]), sedentary behavior (AOR=1.87; CI95%:[1.01-3.51]), eating sweets (AOR=1.95; CI95%:[1.19-3.19]), eating while watching television (AOR=2.53; CI95%:[1.23-5.18]) were positively associated with greater risk of excess weight while sleep duration <10h (AOR=0.41; CI95%:[0.24-0.71]) and less educated mother (AOR=0.35; CI95%:[0.12-0.96]) were negatively associated with excess weight. **Conclusion:** Our results show that the prevalence of overweight and obesity among preschoolers was alarming. Prevention of obesity should start early in life through a multisectoral approach.

**Keywords:** Career orientation; Factors; New generation; Turkish human resource.

## 1. Introduction

The world is facing a global epidemic of obesity, which is a serious public health problem [1]. In the past three decades, the prevalence of obesity has dramatically increased and has shifted epidemiologically to younger ages [2]. In 2017, over 38 million preschool children under the age of five across the world were estimated to be overweight; that is the number has increased by 8 million since 2000. Almost half of these overweight children lived in Asia and

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one quarter lived in Africa [3]. Obesity has many associated child's health risks including orthopedic complications, sleep apnea, and psychological disorders [4]. The negative impact of being overweight or obese on the health and development of children can also track into adulthood, which can lead to long-term health issues and disability [5], and create more pressure on healthcare systems. Therefore, the identification of overweight and obesity during childhood period and associated risk factors for preventive measures is expected to provide long-term benefits during later stages of life. Tunisia, a low middle income country in north Africa, is not spared from this health concern whose prevalence is increasing [6, 7] as a result of the ongoing epidemiologic transition in the country [8]. However, there is substantially less published data about obesity, even less for adolescents and school children, and least about preschool children. The aim of this study was to assess the weight status among Tunisian pre-school children and to investigate the predictive factors for excess weight in this age group.

## **2. Methods**

### **2.1. Study Design**

We conducted a cross-sectional study among pre-school children aged 3–5 years attending kindergarten during 2016-2017 school years in Sousse, Tunisia.

### **2.2. Study Population and Sampling**

Our population was composed of children aged 3 to 5 years and their parents who completed and returned the questionnaire. The needed sample size was 255, which was increased to 306 children to accommodate for an estimated none response rate of 20%. We prepared a list of kindergartens in Sousse city along with the total number of children in them. Kindergartens with fewer than 50 children were excluded. We randomly selected 6 kindergartens from 5 delegations in the region of Sousse (Jawhra, Riadh, Hammem-Sousse, Sidi-Abdelhamid, sousse-ville). All children, aged between 3 to 5 years old, enrolled in kindergarten participating in this study were included. Children whose parents were unconsented were excluded.

### **2.3. Data Collection**

The parents of children completed the survey on behalf of selected child. We used self-administered pre-tested anonymous questionnaire to gather socio-demographic data and information on parents feeding style and their children's lifestyle. Sedentary behavior was assessed by the question; "How many hours does your child usually watch of television/video movies, plays video games, plays or talk seated?"

Trained research staff has taken the anthropometric measures for the children. Body weight was recorded to the nearest 0.1 kg using a portable electronic scale. Balances were calibrated in every kindergarten. Preschoolers' Standing height was measured to the nearest 0.5 cm using a portable stadiometer fixed on the wall. The body mass index (BMI) was calculated as weight (Kg)/height (m<sup>2</sup>).

### **2.4. Variables Definition**

We used the International Obesity Task Force (IOTF) [9] standards to classify the children to normal-weight, overweight and obese using BMI cut-offs by age and gender. Weight excess was defined as overweight including obesity. Physical activity was defined as children who accumulate at least 60 minutes of moderate-intensity of activity including playing, movement, leisure activities and physical education. We defined the unhealthy snack as consuming at least one of the following food and beverages: chips, popcorn, chocolate, cake, biscuits, soda and sugary drinks.

### **2.5. Data Analysis**

We used SPSS 10.0 Software for data capture and analysis. Descriptive analysis was carried out with the mean, standard deviation and minimum and maximum values for quantitative variables. The absolute and relative frequencies were given for the qualitative variables. Overweight and obesity prevalence rates with 95% Confidence Intervals (CI) were estimated. For the selection of explanatory variables, the univariate analysis was applied to examine the association between each independent variable and weight excess. Then, Stepwise Multiple logistic regressions analysis was used in order to seek the independent effects of those variables showing significant univariate associations or with  $p\text{-value} \leq 0.2$ . These variables were included as potential confounding variables and the adjusted odds ratios (AOR) and 95% confidence interval (CI<sub>95%</sub>) were calculated. The significance level was pre-set at 0.05.

### **2.6. Ethical Consideration**

The present study was undertaken with caution and with respect for the rights and the integrity of children. Ethical approval for this study was obtained from Ethics Committee of the University Hospital Farhat Hached. An informed written consent was obtained from the parents of each selected child. Data was collected and treated in the department of Epidemiology anonymously. Authorization was requested from the Regional Directorate of Tunisian Ministry of Women and child, the directors of kindergartens and from the parents of selected children. Parents were free to refuse their child's participation. After the end of the study, parents and kindergarten staff were informed by the results.

### 3. Results

The mean age of preschoolers was  $4.49 \pm 0.97$  years. The ratio boys/girls was 1.05. Of 364 children who participated, 20.1% (CI<sub>95%</sub>[15.9%-23.9%]) were overweight and 11.3% (CI<sub>95%</sub>[8%-14.6%]) were obese. Among girls, 24.9 % were overweight and 10.7 % were obese while 15.5% and 11.8% boys were respectively overweight and obese. (Table 1)

**Table-1.** Estimated prevalence of overweight and obesity according to IOTF criteria among preschool children in Sousse, Tunisia (2017)

Weight status	Overweight % [ CI 95%]	Obesity % [CI 95%]	Excess weight % [CI 95%]
All(n=364)	20.1 [15.9-23.9]	11.3 [8-14.6%]	31.4 [26.7-36.5]
<b>Gender</b>			
Boys	15.5 [10.7-20.9]	11.8 [7.5-16.6]	27.3 [21.4-33.7]
Girls	24.9 [18.6-31.1]	10.7 [6.2-15.3]	35.6 [28.2-42.9]
<b>Age group (year)</b>			
3	22.4 [15.2-29.6]	10.4 [4.8-16.0]	32.8 [24.8-40.8]
4	21.1 [13.8-28.4]	10.1 [5.5-16.5]	31.2 [22.9-40.4]
5	16.9 [10.8-23.8]	13.1 [7.7-19.2]	30.0 [22.3-38.4]

Table 2 summarizes the crude association between weight excess and variables related to child and family environment. At individual level, there were no significant differences in the rate of weight excess according to gender ( $p=0.08$ ) or age ( $p=0.89$ ). Greater number of children with excess weight tended insignificantly to be heavy at birth (12.6% weighted at least 4000g at birth) compared with normal weight children (10.5%). At family level, the mothers of a greater rate of normal weight children were unemployed (41.3%) and achieved low educational attainment (21.3%) compared with overweight/obese children (33.9%;  $p=0.18$  and 13.3%;  $p=0.07$  respectively). Approximately, 54% of overweight/obese children had also an overweight father or mother compared with 45.2% of normal weight children ( $p=0.25$ ).

**Table-2.** Socio-demographic factors associated with overweight/obesity among preschool children in Sousse, Tunisia (2017)

Variables	Total(n=364) N (%)	Normal weight N (%)	Excess weight N (%)	COR <sup>a</sup> ( 95 % CI)	P value
<b>Gender</b>					0.08
Boys	187 (51.4)	136 (54.4)	51 (44.7)	Reference	
Girls	177 (48.6)	114 (45.6)	63 (55.3)	1.47 [0.94-2.3]	
<b>Age group (year)</b>					0.98
3	125 (34.3)	84 (33.6)	41 (36.0)	Reference	
4	109 (29.9)	75 (30.0)	34 (29.8)	0.92 [0.53-1.61]	
5	130 (35.7)	91 (36.4)	39 (34.2)	0.87 [0.51-1.49]	
<b>Birthweight category(g)</b>					0.38
<2500	21(06.8)	17(07.2)	4(03.6)	Reference	
2500-3999	288(82.8)	195(82.3)	93(83.8)	2.03[0.66-6.19]	
$\geq 4000$	39(11.2)	25(10.5)	14(12.6)	2.38 [0.66-8.48]	
<b>Breastfeeding</b>					0.3
Yes (exclusive BF/ BF+Formula)	316(88.5)	214(87.3)	102(91.1)	Reference	
No	41(11.5)	31(12.7)	10(08.9)	0.67 [0.31-1.43]	
<b>Age of solid food introduction (nonths)</b>					0.44
6 months	167(48)	118(70.6)	121(66.9)	Reference	
$\leq 4$ months	181(52)	49(29.3)	60(33.1)	1.19 [0.75-1.88]	
<b>Gestational diabetes</b>					0.65
No	309(89.6)	212(89.1)	97(90.7)	Reference	
Yes	39(10.4)	26(10.9)	10(09.3)	0.84 [0.39-1.81]	
<b>Number of children in the family</b>					0.48
One child	60 (16.5)	44 (17.6)	16 (14.0)	Reference	
2 children	185 (50.8)	122(48.8)	63(55.3)	1.42[0.74-2.71]	
$\geq 3$ children	119(32.7)	84(33.6)	35(30.7)	1.14[0.57-2.29]	
<b>Civil status</b>					0.38
2 parents household	347(96.1)	240(96.8)	107(94.7)	Reference	
1 parent household	14(03.9)	8(03.2)	6(05.3)	1.68[0.574.96]	
<b>Caregiver</b>					0.12
Both parents	172(55.1)	128(58.7)	44(46.8)	Reference	
One parent	122(39.1)	77(35.3)	45(47.9)	1.70 [1.02-2.81]	

Other caregiver	18(05.7)	13(06.0)	5(05.3)	1.11 [0.37-3.17]	
<b>Mother's education</b>					0.07
High school/College	294(81.2)	196(78.7)	98(86.7)	Reference	
Less than high school	68(18.8)	53(21.3)	15(13.3)	0.56[0.3-1.05]	
<b>Father's education</b>					0.76
High school/ College	280(78.4)	194(78.9)	86(77.5)	Reference	
Less than high school	77(21.6)	52(21.1)	25(22.5)	1.08[0.63-1.86]	
<b>Mother's occupation</b>					0.18
Housewife	219(61)	102(41.3)	38(33.9)	Reference	
Working mother	140(39)	145(58.7)	74(66.1)	1.37[0.86-2.18]	
<b>Father's occupation</b>					0.38
Unemployed	6(1.7)	3(1.2)	3(2.7)	Reference	
Employed	353(98.3)	244(98.8)	109(97.3)	0.44[0.08-2.84]	
<b>Family's income</b>					0.52
≥ 1200DT	96(27)	63(25.8)	33(29.7)	Reference	
600-1200 DT	139(39.2)	94(38.5)	45(40.5)	0.91[0.52-1.85]	
<600 DT	120(33.8)	87(35.7)	33(29.7)	0.72[0.40-1.29]	
<b>At least one parent is overweight</b>					0.25
No	28(7.7)	21(8.4)	7(6.1)	Reference	
Yes	175(48.1)	113(45.2)	62(54.4)	2.05[0.58-7.23]	

<sup>a</sup>COR: crude odds ratio

**Table-3.** Lifestyle factors associated with overweight/obesity among preschool children in Sousse, Tunisia (2017)

Variables	Total (n=364) N (%)	Normal weight N (%)	Excess weight N (%)	COR <sup>a</sup> (95 % CI)	p value
<b>Daily breakfast</b>					0.1
Yes	172(50.6)	112(47.7)	60(57.1)	Reference	
No	168(49.4)	123(52.3)	45(42.9)	0.68 [0.43-1.08]	
<b>Eating in front of a screen</b>					0.02
Never/sometimes	322(89.0)	227(91.5)	95(83.3)	Reference	
Always	40(11.0)	21(8.5)	19(16.7)	2.16 [1.11-4.2]	
<b>Eating irregularly</b>					0.7
Rarely/sometimes	309(91.2)	215(91.5)	94(90.4)	Reference	
Always	30(8.8)	20(8.5)	10(9.6)	1.14 [0.51-2.53]	
<b>Sweets<sup>b</sup>/day</b>					0.03
No	217(59.8)	158(63.5)	59(51.8)	Reference	
Yes	146(40.2)	91(36.5)	55(48.2)	1.61 [1.03-2.54]	
<b>PA<sup>c</sup> duration at home/day</b>					0.86
≥ 30 min/day	172(52.8)	121(53.1)	51(52.0)	Reference	
<30 min/day	154(47.2)	107(46.9)	47(48.0)	1.04[0.64-1.67]	
<b>Sedentary behavior</b>					0.49
None	198(54.4)	138(55.2)	60(32.6)	Reference	
Week+weekend	70(19.2)	44(17.6)	26(22.8)	1.35 [0.76-2.4]	
<b>Nighttime sleep duration</b>					0.03
≥ 10h	199(54.7)	129(54.2)	70(67.3)	Reference	
<10h	143(39.3)	109(45.8)	34(32.7)	0.57[0.35-0.93]	
<b>irregular nighttime sleep</b>					0.31
Rarely/sometimes	240(68.6)	170(70.2)	70(64.8)	Reference	
always	110(31.4)	72(29.8)	38(35.2)	1.28[0.79-2.07]	

<sup>a</sup>COR: crude odds ratio<sup>b</sup>sugar-sweetened beverages; <sup>c</sup>PA: Physical Activity

As shown in table 3, the odds of child excess weight increased significantly in preschoolers who eat always in front of a screen and consume daily unhealthy snack with sugar-sweetened food and beverages. Also, the risk of being overweight/obese was decreased significantly ( $p=0.03$ ) among children who had short nighttime-sleep duration; the parents of 32.7% of overweight/obese preschoolers said that their children sleep less than 10 hours at night compared with normal weight children(45.8%).

**Table-4.** Binary logistic regression analysis of factors associated with overweight/obesity among preschool children in Sousse, Tunisia (2017)

Variables		AOR <sup>a</sup> [95% CI]	p-value
Child's gender	boys	Reference	
	Girls	1.74 [1.07-2.83]	0.024
Mother's education	High school/College	Reference	
	Less than high school	0.44 [0.22-0.89]	0.023
Mother's occupation	Housewife	Reference	
	Working mother	1.75 [1.04-2.92]	0.032
Eating in front of a screen	Never/sometimes	Reference	
	always	2.63 [1.23-5.18]	0.011
Sweets/day	No	Reference	
	Yes	1.95 [1.19-3019]	0.007
Sedentary behavior	None	Reference	
	Week + weekend	1.87 [1.01-3.51]	0.049
Sleep duration	10h	Reference	
	<10h	0.41 [0.24-0.71]	0.001

<sup>a</sup>AOR: adjusted odds ratio

Final results of the binary logistic regression to determine correlates of weight excess amid socio-demographic, child characteristics, eating and physical activity habits are presented in [table 4](#). Girls were 1.74 times more likely to have excess weight when compared to boys (AOR=1.74;CI<sub>95%</sub>:[1.07-2.83]). Spending more than two hours a day in sedentary behavior (AOR=1.87;CI<sub>95%</sub>:[1.01-3.51]), having an employed mother(AOR=1.87;CI<sub>95%</sub>:[1.01-3.51]), eating sugar-sweetened food and beverages in the snack (AOR=1.95;CI<sub>95%</sub>:[1.19-3.19]), eating while watching television (AOR=2.53; CI<sub>95%</sub>:[1.23, 5.18]) increased the odds of being overweight/obese for preschoolers. In addition, nighttime-sleep duration<10 hours and maternal education level were negatively associated with overweight/obesity (AOR=0.41;CI<sub>95%</sub>:[0.24-0.71] and AOR=0.35;CI<sub>95%</sub>:[0.12-0.96] respectively). ([Table 4](#))

## 4. Discussion

This cross-sectional study provided one of the most up-to-date data sets on the weight status and related factors of preschool children enrolled in kindergartens in an urban area of a LMIC country. This is one of the few studies investigating the burden of overweight and obesity among preschool-aged children in Tunisia. The sampling procedure asserts that the size and scale of the sample was representative of the number of kindergartens and enrolled preschool children. Vigorously standardized anthropometric measures were obtained from a total of 364 girls and boys, aged 3-5 years. Approximately, one out of three preschool-children(31.4%; CI<sub>95%</sub>:[26.7%-36.5%]) was identified as overweight/obese according to the IOTF classification while the overall prevalence of obesity and overweight among preschoolers was 11.3% and 20.1% respectively. Girls had greater prevalence of overweight/Obesity than boys (35.6% Vs 27.3%; p=0.08. The present study confirmed the alarming prevalence of excess weight since we used the IOTF reference, which is considered as the least severe criteria to classify weight status [10]. The current prevalence of child obesity was in line with an earlier study carried out in eastern region of Tunisia with 121preschool children aged4 to 6 years (9.1%),whereas the overweight prevalence was two times lower (11.6%) [7]. The observed discrepancy could be attributed to the use of different classification reference of overweight and obesity (e.g. the curves of the French reference of Rolland Cachera) and the smaller sample size than ours. Comparing to the international results, the prevalence of excess weight(30.3%) exceeded largely the prevalence estimates for 2010 in worldwide, developing and developed countries, whereby the rates of overweight/obesity were 6.7%, 6.1% and 11.7% respectively [11].

Upon multivariable adjustment for all covariates in a backward stepwise elimination procedure, positive correlates of weight excess remained were as follows: being a girl, maternal employment, sedentary behavior, consumption of sugar-sweetened food and beverages, eating while watching television were positively associated with weight excess. The inverse association with nighttime-sleep duration and low educated mother persisted in multivariable-adjusted logistic regression models. Regarding gender, our findings concur with previous reports [12] that girls are more likely than boys to suffer from excess weight. However, the association between gender and excess weight in children is varying in literature. Some studies have reported boy predominance [13], others have reported no gender differences [14] in excess weight. Indeed, gender differences in early childhood would be explained by differences in physical activity, diet and family culture, that is weight problems arise as a result of a complex interaction between social, environmental and genetic factors [15]. According to the influential Barker's theory, birth weight is inversely correlated with increased risk of early death in adult life secondary to coronary heart diseases [16]. However, likewise other studies [17], our results indicated that there was not a significant association between weight excess in preschoolers and their weight birth. Further studies are needed in order to elucidate this relationship especially in our local context. Our findings did not show any significant association between family income and the probability of excess weight occurrence in preschool children. This is likely to be linked to the emerging economic crisis and further limitation of purchasing power that Tunisia has underwent after the political and social major events of 2010-2011. Evidence across literature suggests that there exists a negative correlation between household income and childhood obesity in high income countries (i.e. the probability of being overweight/obese increases with the declining of household income) [12, 18]. Inversely, data from low and middle income countries stated that high prevalence of overweight children is present in subjects with a high socio-



economic status [19]. Our study revealed that working mothers are more likely to have overweight and obese children than unemployed mothers and there was a decreased risk of children obesity with lower levels of maternal education. This trend does not seem influenced first-hand by the mother's level of education, so it could depend on different factors. In fact, occupation and education among mothers are interrelated. In most cases, higher educated mothers are generally employed, whereas lower educated mothers are housewives. According to previous review including 15 publications from 7 countries [20], maternal employment was associated with an increased risk of childhood obesity and overweight. Usually, the household load and food preparation are entirely dependent on the mother. Consequently, working mothers did not dispose of a sufficient time to prepare healthy food and the child will be more exposed to processed and packaged food or whose composition is unknown. Working mothers with high-level education may need further attention in future interventions. Furthermore, provided evidence has indicated that maternal employment was significantly associated with irregular mealtimes and unfixed snacking times [21]. Previous research overwhelmingly demonstrated that the education level of parents is inversely correlated with the childhood overweight and obesity [18]. Consistent with our results, a previous study demonstrated that there was a strong association between sedentary behavior and preschoolers' weight excess [12]. This may be due to socio-cultural transition, the adoption of new leisure means with the substantially increasing time of watching television, and other forms of screen-based entertainment [14, 22]. Additionally, we found that eating while watching a screen was a significant predictor of preschoolers' weight excess. This could be explained by the fact this behavior pushes children to be more mindless eating, less sensitive to internal cues of satiety leading to greater food consumption and more exposed to food advertisement at meal time [23]. This latter has strong influence on individual food choice in ultra-early ages and obese children have a multiplied sensitivity to broadcast messages [13]. In agreement with recent studies [22, 24], we also found a strong relationship between eating sugar-sweetened food and beverages and childhood weight excess. This is possibly related to the high-energy density with inadequate calorie compensation, especially if the child has already a sedentary behavior or a genetic predisposition. Interestingly, our data analysis pointed out that nighttime-sleep duration less than 10 hours is an independent protector factor, unlike what is commonly reported in literature [21]. This may be partly explained by our procedure of measurement of nighttime-sleep duration that was based on self-reported information. However, a different or additional explanations could be that children who are physically active during the day have shorter total nighttime-sleep duration compared to the least active children [25]. Therefore optimizing sleep duration may have an important impact for slowing down the incidence of childhood excess weight [26]. Besides to risk factors analyzed by our study, the high prevalence of overweight and obesity of preschool children in Sousse may be attributed also to other determinants such as kindergarten policies (e.g., canteens, snacks, play grounds, inclusion of sports hours) and teacher influence [27]. Additionally, poorly planned urbanization poses a big challenge for all major cities in Tunisia including Sousse.

Nonetheless, this research has some limitations that need to be considered. The cross-sectional nature of the present study does not offer basis to confirm causal link and might not show temporal relationship. Therefore, a longitudinal research is needed to evaluate the relationships among variables. However, several variables seem sure enough to be risk factors for overweight and obesity such as eating in front of screen or mother education level because they cannot be induced or influenced by the weight status of children. Another limitation regarding the instrument, we used indirect measures by self-reported questionnaire to collect data particularly regarding lifestyle behaviors. Even though we attempted to mitigate potential measurement error by incorporating widely used standardized measures.

## 5. Conclusion

Our results revealed that there is a noticeable burden of overweight and obesity among preschool-aged children within urban area. Prevention of obesity should start early in life and must receive more attention especially in Tunisian urban areas. Our study offers several considerations for prevention. First, the behavioral risk factors could be targeted in different levels from the family sphere to the kindergarten's rules, through well-established educational and intervention program that takes account of this age group's specificities. Second, appropriate social marketing campaigns and lifestyle change communication programs should target especially employed and high educated mothers and be adapted for different audiences and agribusiness. Third, the prevention and control of childhood obesity strategies should be implemented at multisectoral level with implication of stakeholders and local authorities.

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## Declarations

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**Conflict of interest:** No financial or non-financial benefits have been received or will be received from any party related directly or indirectly to the subject of this article.

**Availability of data and material:** The data used to support the findings of this study are available from the corresponding author upon request.

**Ethical approval:** Ethical approval for this study was obtained from Ethics Committee of the University Hospital Farhat Hached, Sousse, Tunisia.

**Author's contribution:** This project was carried out in collaboration between all authors. Authors RG, JM, and HG contributed to the design of the study research protocol. Authors RG, NZ and SBF, participated in the coordination of data collection and entry. Authors SBF, SA, RG, NZ, AA, YH and SCh participated in the data analysis, interpretation of results, and the manuscript redaction. All authors read and approved the final manuscript.

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