Rocz Panstw Zakl Hig 2023;74(4):395-406
http://wydawnictwa.pzh.gov.pl/roczniki_pzh/ https://doi.org/10.32394/rpzh.2023.0285

ORIGINAL ARTICLE

PREVALENCE AND PREDICTIVE DETERMINANTS OF OVERWEIGHT AND OBESITY IN CHILDREN AGED 0-24 MONTHS IN MOROCCO: A CROSS-SECTIONAL STUDY

Fatima Zohra Benayad[1], Samia El Hilali[1,3], Rachid Razine[1,3], Karim Sbai Idrissi[3], Redouane Abouqal[1,3], Hajar Belhaj[2,4], Ahmed Kharbach[1,5], Majdouline Obtel[1,3]

[1]Laboratory of Biostatistics, Clinical Research and Epidemiology, Faculty of Medicine and Pharmacy, Mohammed V University of Rabat, Morocco
[2]Higher Institute of Nursing Profession and Health Techniques, Rabat, Morocco
[3]Laboratory of Social Medicine (Public Health, Hygiene and Preventive Medicine), Department of Epidemiology and Public Health, Faculty of Medicine and Pharmacy, Mohammed V University of Rabat, Morocco
[4]Biology, Ecology and Health Laboratory code UAE/L10/FST, Tetouan Faculty of Science, Abdelmalek Essaadi University, Morocco
[5]Higher Institute of Nursing Profession and Health Techniques, Agadir, Morocco

ABSTRACT

Background. Preventing overweight and obesity in early childhood is a priority for healthcare systems worldwide due to the harmful effects on health and economy over the medium and long term.

Objective. The aim of this study is therefore the identification of the determinants predictive of overweight and obesity during the first 24 months of a child's life.

Material and Methods. From May 2021 to January 2022, 1012 mother-child pairs were included in this study and were interviewed at urban and rural health centers in the Skhirat-Temara in Morocco prefecture using a questionnaire. The anthropometric measurements of the children were also taken according to World Health Organization standards.

Results. The prevalence of overweight and obesity in children aged 0-24 months was 16.5%. This prevalence increased with age (12.5% for the 0-6 months group, and 15.5% and 21.5% respectively for the 7-12 months and 13-24 months groups). Cesarean delivery (aOR=1.78; 95%CI: 1.26-2.51; p=0.001), more than two living siblings in the household (aOR=1.48; 95%CI: 1.03-2.12; p=0.03), male gender (aOR=1.56; 95%CI: 1.10-2.20; p=0.01), and child age (aOR=0.94; 95%: 0.92-0.97; p<0.001) are significant predictors of overweight and obesity. Paternal smoking (aOR=2.16; 95%CI: 1.15-4.06; p=0.01), short sleep duration (aOR=4.05; 95%CI: 1.27-12.88; p=0.01) in children aged 7-12 months, and combined breastfeeding (aOR=5.88; 95%CI: 2.07-16.72; p<0.001) during the first six months in children aged 13-24 months are also predictive determinants for this problem.

Conclusion. The identification of early predictors of overweight and obesity can be used by public health decision-makers as a roadmap for action to prevent and improve health.

Key words: *overweight, obesity, determinant, predictive, children, Morocco*

INTRODUCTION

The evidence shows that the first 1,000 days of a child's life are a critical window of opportunity for the child's future development, growth and health. This period covers the period from conception to the end of the first 24 months of life [12]. Over this time, the foetus, the newborn and the infant are confronted with major challenges resulting from a combination of biological, environmental, behavioral and individual factors that can affect their healthy development and expose them to the risk of overweight and obesity [26, 28].

In recent decades, overweight and obesity in early childhood has emerged as a serious public health problem due to the harmful repercussions that can result, and the major costs that can be incurred by the nations' healthcare systems [7, 63], particularly in the

Corresponding author: Fatima Zohra Benayad, Laboratory of Biostatistics, Clinical Research and Epidemiology, Faculty of Medicine and Pharmacy, Mohammed V University of Rabat, Morocco, Postal address: Benjimmi residence, block 3, building L n° 13, Temara, Morocco, tel. +212 6 67 97 91 70, e-mail: benayad.fatimaz@yahoo.fr

Publisher: National Institute of Public Health NIH - National Research Institute

knowledge that once established in early childhood, overweight and obesity can extend into adolescence and adulthood [42]. As a result, this problem has the potential to lead to a number of non-communicable diseases, such as type 2 diabetes, cardiovascular disease, high blood pressure, stroke, cancer, osteoarthritis and mental health disorders [40].

However, overweight and obesity could be prevented by identifying risk factors from an earlier stage, especially those most likely to overwhelm a child in the first 24 months of life [49]. Several studies have explored the determinants of overweight and obesity in early childhood, covering the period from conception to the second year of life. The main determinants are parental obesity, maternal weight gain during pregnancy, gestational diabetes, mode of delivery, birth weight of the newborn, maternal smoking, socio-economic status, sleep, breastfeeding, etc.[37, 27].

In fact, health policies throughout the world need resolve to tackle this growing epidemic, which has serious economic, social and health impacts, by planning, developing and strengthening programs to promote maternal and child health during this critical period in a child's life, covering diagnosis, monitoring, awareness raising and education.

The present study aims to identify and predict the determinants of overweight and obesity in children aged 0-24 months in the prefecture of Skhirat-Temara in Morocco, thus highlighting for public health decision-makers the possibilities for action in favor of modifiable risk factors for early and effective prevention of this problem.

MATERIAL AND METHODS

Study settings, design, period and population

This is a cross-sectional study with descriptive and analytical aims. It was conducted from May 2021 to January 2022 in urban and rural health centers in the prefecture of Skhirat-Temara, a province close to the capital Rabat, with a total population of 570887 and 134998 households, for which the estimated annual growth rate in population projections between 2014 and 2030 is 3%, the higher rate in the region [39]. The survey concerned consenting mother-child pairs, resident in the Skhirat-Temara prefecture, and whose children were aged 0-24 months, who consulted health centers for various preventive and curative primary health care services. Any couple whose child was born prematurely, had a history of infection or diarrhea within two weeks of the interview, or had a congenital malformation or metabolic disease affecting growth were excluded from the study.

Sample size determination

The estimated sample size was calculated on the following formula to ensure that the results of this study were representative [57]:

$$n = \frac{z^2 \times p \times (1 - p)}{m^2}$$

Where: n= sample size, z = 1.96 for a 95% confidence level, p is the estimated prevalence of childhood obesity, and m = 5% is the margin of tolerable sampling error.

The 2018 National Population and Family Health Survey [38] reported an obesity and overweight prevalence of 13.7% for children under 5 years of age in the Rabat-Salé-Kenitra region. Indeed, the sample size calculated for this study was 182 participants (with p=13.7%), although our study had included 1012 mother-child pairs.

Instruments and data collection

The study was carried out by a face-to-face questionnaire administered to the mothers, who were interviewed about their demographic, socio-economic and clinical background, as well as data on their partners and children. Based on evidence from previous studies [27, 41], these data represent the variables that have a potential risk for overweight and obesity:

Data concerning parents: the mother's age, the parents' level of education (illiterate, low, medium and high), the parents' occupation (working or not), the mode of delivery and the history of gestational diabetes. The mothers were also interviewed about the notion of passive smoking (smoking partner), as none of the mothers included in this study were smokers or ex-smokers.

Child data: the child's age, sex, rank in the siblings, the method of breastfeeding adopted during the first six months after birth: exclusive breastfeeding, combined breastfeeding (breast milk, artificial milk and other solid or pasty foods), or exclusive artificial feeding. Lastly, the hours slept by the child in accordance by age over a 24-hour period (compliant, non-compliant). According to the recommendations of the American Academy of Sleep Medicine [45]: for optimum health, the recommended hours of sleep for children aged 4-12 months are 12-16 hours in 24 hours, and 11-14 hours in 24 hours for children aged 12-24 months.

The household data: residence, number of living children and monthly household income, which was defined according to the Moroccan guaranteed minimum inter-professional income (SMIG) set at ≈ 2800 Moroccan dirhams (MAD) ≈ $282.The dependent variable for this study was overweight and obesity in children aged 0-24 months. Then, anthropometric measurements were taken by the investigator for each child included in this study, according to WHO standards. The variables measured were:

The weight: We measured the child's weight using a digital baby scale with a maximum capacity of 20 kg. The scale was calibrated before each weighing session.

The height was determined using a toise. The same instrument was used throughout the survey. The body mass index (BMI) calculated using the formula: Weight (kg) / Height^2 (m^2)

The WHO BMI-for-age (BMI/A) reference curves for girls and boys (0-24 months) were used to determine the BMI/A z-scores, and to classify the child's weight as normal, overweight, obese, wasted or severely wasted. For this study, overweight was defined as a weight-for-height Z score > 2 standard deviation (SD), obesity as a weight-for-height Z score >3SD, wasting as a weight-for-height Z score <-2SD and severe wasting as a weight-for-height Z score <-3SD in accordance with WHO recommendations [43].

Statistical analysis

In our study, the data collected were analysed according to three age groups: the first group-included children aged 0-6 months, while the second and third groups covered children aged 7-12 months and 13-24 months in succession.

The determinants: mode of breastfeeding and sleep duration, were only introduced into the analysis for the second and third classes in order to study the impact of the nature of breastfeeding during the first 6 months of the child's age on the development of possible overweight or obesity. Thus, the majority of studies looking at the evaluation of sleep duration, quality and behaviors have set 6 months as the youngest age at which to assess this determinant [64].

All data analyses for this study were performed using Jamovi statistical software, version 2.3.16. Statistical analyses were performed to generate: (i) the predictive factors of overweight and obesity in all the children participating in our study (children from 0 to 24 months; N=1012), and then to generate (ii) the predictive factors of overweight and obesity in the children for 3 age categories (children from 0 to 6 months, children from 7 to 12 months and children aged 13 to 24 months) after adjusting for confounding factors. The normality of quantitative variables was verified using the *Kolmogorov Smirnov* test. Quantitative variables with asymmetrical distributions are expressed as median and quartile, so the study of the association between the "overweight and obesity" outcome and the other quantitative variables investigated in this study was carried out using the *Mann-Whitney* U test. Categorical variables were summarized as frequencies and percentages. The *Chi*-square test and *Fisher's* exact test were conducted to compare differences in categorical variables among groups regarding the outcome variable (overweight and obesity).

Multiple logistic regression were used to generate adjusted odds ratios (aOR) for a 95% confidence interval. Variables with a p-value < 25% in the univariate analysis were entered into the multiple logistic regression models. The test was considered significant for a p-value < 0.05.

Ethical considerations

This study was approved by the Ethics Committee for Biomedical Research of the Faculty of Medicine and Pharmacy, Mohamed V University, Rabat, Morocco (ethical approval no. C68/20 issued on 18 February 2021). Prior to data collection, participants were informed of the purpose of the study and its benefits, as well as the respect of anonymity and confidentiality during processing and publication of results. Oral and written consent was then obtained from all participants.

RESULTS

Characteristics of the study participants

A total of 1012 mother-child pairs were included in this study. The prevalence of overweight and obesity among the children was 16.5% (167 overweight and obese children). The age median of the participating mothers was 29 years old, more than two thirds were illiterate or had a low level of education (64.9%), 6.4% had gestational diabetes. The study also revealed that the majority of participating households lived in urban areas (88.3%), 70.6% had 2 children at most, with less than $282 monthly for 42.1% of participating households. The median age of the children in the study was 8 months, more than half were boys (50.9%), and 32.4% had been delivered by caesarean section. The *chi*-square test and *Fisher's* exact test showed that mode of delivery, number of live births, child age and sex were significantly associated with childhood overweight and obesity in the current study (Table 1).

Determinants predictive of overweight and obesity in participating children

For children from 0 to 24 months, multiple regression models showed that: Cesarean delivery (aOR=1.78; 95%CI: 1.26-2.51; p=0.001), more than two living siblings in the household (aOR=1.48; 95%CI: 1.03-2.12; p=0.03), male gender (aOR=1.56; 95%CI: 1.10-2.20; p=0.01), and child age (aOR=0.94; 95%: 0.92-0.97; p<0.001) are significant predictors of overweight and obesity (Table 1).

Table 2 shows the results of the predictive factors of overweight and obesity in children aged 0 to 6 months, where three factors are significantly associated with the outcome variable. Children with the second or higher sibling rank are more likely to be overweight or obese compared to first-born children (aOR=1.87;

Table 1. Univariate and multiple logistic regression analysis of risk factors for overweight and obesity in children aged 0-24 months (N=1012)

Variables	Total N = 1012	Overweight / Obesity		*p*	aOR (95%CI)	p
		Yes n (%) 167 (16.5)	No n (%) 845 (83.5)			
Maternal age (year)						
Median (IQR)	29 (25-34)	29 (25-35)	29 (25-34)	0.37$^{\alpha}$		
Residence						
Urban	894 (88.3)	141 (84.4)	753 (89.1)	0.08		
Rural	118 (11.7)	26 (15.6)	92 (10.9)			
Mother's education level						
Illiterate	167 (16.5)	25 (15)	142 (16.8)	0.59		
Low	490 (48.4)	76 (45.5)	415 (49)			
Medium	174 (17.2)	31 (18.6)	143 (16.9)			
High	181 (17.9)	35 (21)	146 (17.3)			
Father's education level						
Illiterate	118 (11.7)	16 (9.6)	102 (12.1)	0.79		
Low	506 (50)	84 (50.3)	422 (49.9)			
Medium	222 (21.9)	37 (22.1)	185 (21.9)			
High	166 (16.4)	30 (18)	136 (16.1)			
Working mother						
Yes	168 (16.6)	31 (18.6)	137 (16.2)	0.45		
No	844 (83.4)	136 (81.4)	708 (83.8)			
Working father						
Yes	998 (98.6)	166 (99.4)	832 (95.5)	0.48$^{\beta}$		
No	14 (1.4)	1 (0.6)	13 (1.5)			
Monthly household income						
<$282	426 (42.1)	67 (40.1)	359 (42.5)	0.44		
$282– $504	369 (36.5)	58 (34.7)	311 (36.8)			
>$504	217 (21.4)	42 (25.2)	175 (20.7)			
Gestational diabetes						
Yes	65 (6.4)	9 (5.4)	56 (6.6)	0.55		
No	947 (93.6)	158 (94.6)	789 (93.4)			
Smoking husband						
Yes	241 (23.8)	49 (29.3)	192 (22.7)	0.06		
No	771 (76.2)	118 (70.7)	653 (77.3)			
Mode of delivery						
Cesarean	328 (32.4)	72 (43.1)	256 (30.3)	**0.001**	1.78 (1.26-2.51)	**0.001**
Vaginal	684 (67.6)	95 (56.9)	589 (69.7)		1	
Number of living sibling						
≤ 2	714 (70.6)	107 (64.1)	607 (71.8)	**0.04**	1	
> 2	298 (29.4)	60 (35.9)	238 (28.2)		1.48 (1.03-2.12)	**0.03**
Age of child (Month)						
Median (IQR)	8 (3-12)	9 (6-18)	7 (3-12)	**< 0.**001$^{\alpha}$	0.94 (0.92-0.97)	**<0.001**
Sex of child						
Male	515 (50.9)	101 (60.5)	414 (49)	**0.007**	1.56 (1.10-2.20)	**0.01**
Female	497 (49.1)	66 (39.5)	431 (51)			
Rank in the sibling						
1st	393 (38.8)	60 (35.9)	333 (39.4)	0.39		
2nd and more	619 (61.2)	107 (64.1)	512 (60.6)			

Note: *Most data values (except the median) are presented as frequencies and percentages; a p-value < 0.05 was statistically significant; α: Mann-Witney U test; β: fisher test*

Table 2. Univariate and multiple logistic regression analysis of risk factors for overweight and obesity in children up to the age of 6 months (N=464)

Variables	Total N = 464	Overweight/Obesity		*p*	aOR (95%CI)	*p*
		Yes n (%) 58 (12.5)	No n (%) 406 (87.5)			
Maternal age (years)						
Median (IQR)	28 (24-33)	28 (25-33)	28 (24-33)	0.67$^{\alpha}$		
Residence						
Urban	435 (93.8)	52 (89.7)	383 (94.3)	0.23$^{\beta}$		
Rural	29 (6.2)	6 (10.3)	23 (5.7)			
Mother's education level						
Illiterate	72 (15.5)	11 (19)	61 (15)	0.76		
Low	226 (48.7)	25 (43.1)	201 (49.5)			
Medium	70 (15.1)	10 (17.2)	60 (14.8)			
High	96 (20.7)	12 (20.7)	84 (20.7)			
Father's education level						
Illiterate	47 (10.1)	5 (8.6)	42 (10.3)	0.91		
Low	220 (47.4)	27 (46.6)	193 (47.3)			
Medium	108 (23.3)	13 (22.4)	95 (23.4)			
High	89 (19.2)	13 (22.4)	76 (18.7)			
Working mother						
Yes	393 (84.7)	7 (12.1)	64 (15.8)	0.46		
No	71 (15.3)	51 (87.9)	342 (84.2)			
Working father						
Yes	458 (98.7)	85 (100)	400 (98.5)	1$^{\beta}$		
No	6 (1.3)	0	6 (1.5)			
Monthly household income						
<$282	188 (40.5)	20 (34.5)	168 (41.4)	0.38		
$282-$504	171 (36.9)	21 (36.2)	150 (36.9)			
>$504	105 (22.6)	17 (29.3)	88 (21.7)			
Gestational diabetes						
Yes	31 (6.7)	3 (5.2)	28 (6.9)	0.78$^{\beta}$		
No	433 (93.3)	55 (94.8)	378 (93.1)			
Smoking husband						
Yes	101 (21.8)	15 (25.9)	86 (21.2)	0.41		
No	363 (78.2)	43 (74.1)	320 (78.8)			
Mode of delivery						
Vaginal	314 (67.7)	35 (60.3)	279 (68.7)	0.20	1	
Cesarean	150 (32.3)	23 (39.7)	127 (31.3)		1.83 (1-3.34)	**0.04**
Number of living sibling						
≤ 2	331 (71.3)	35 (60.3)	296 (72.9)	**0.04**		
> 2	133 (28.7)	23 (39.7)	110 (27.1)			
Median (IQR)	3 (2-4)	4 (3-6)	3 (2-4)	<0.001$^{\alpha}$	0.63 (0.53-0.76)	**<0.001**
Sex of child						
Male	30 (49.6)	33 (56.9)	197 (48.5)	0.23		
Female	234 (50.4)	25 (43.1)	209 (51.5)			
Rank in the sibling						
1st	193 (41.6)	17 (29.3)	176 (43.3)	**0.04**	1	
2nd and more	271 (58.4)	41 (70.7)	230 (56.7)		1.87 (1-3.48)	**0.04**

Note: *Most data values (except the median) are presented as frequencies and percentages; a p-value < 0.05 was statistically significant; α: Mann-Witney U test; β: fisher test*

Table 3**.** Univariate analysis and multiple logistic regression of risk factors for overweight and obesity in children aged 7-12 months (N=302)

Variables	Total N = 302	Overweight/Obesity		*p*	aOR (95%CI)	*p*
		Yes n (%) 56 (18.5)	No n (%) 246 (81.5)			
Maternal age (years)						
Median (IQR)	29 (25-34)	29.5 (26-35)	29 (25-34)	0.43		
Residence						
Urban	236 (78.1)	42 (75)	194 (78.9)	0.52		
Rural	66 (21.9)	14 (25)	52 (21.1)			
Mother's education level						
Illiterate	48 (15.9)	8 (14.3)	40 (16.3)	0.93		
Low	141 (46.7)	26 (46.4)	115 (46.7)			
Medium	62 (20.5)	11 (19.6)	51 (20.7)			
High	51 (16.9)	11 (19.6)	40 (16.3)			
Father's education level						
Illiterate	36 (11.9)	5 (8.9)	31 (12.6)	0.47		
Low	157 (52)	29 (51.8)	128 (52)			
Medium	58 (19.2)	9 (16.1)	49 (19.9)			
High	51 (16.9)	13 (23.2)	38 (15.5)			
Working mother						
Yes	57 (18.9)	11 (19.6)	46 (18.7)	0.87		
No	245 (81.1)	45 (80.4)	200 (81.3)			
Working father						
Yes	298 (98.7)	55 (98.2)	243 (98.8)	0.56$^{\alpha}$		
No	4 (1.3)	1 (1.8)	3 (1.2)			
Monthly household income						
<$282	131 (43.4)	23 (41.1)	108 (43.9)	0.6		
$282-$504	102 (33.8)	22 (39.3)	80 (32.5)			
>$504	69 (22.8)	11 (19.6)	58 (23.6)			
Gestational diabetes						
Yes	20 (6.6)	3 (5.4)	17 (6.9)	1 $^{\alpha}$		
No	282 (93.4)	53 (94.6)	229 (93.1)			
Smoking husband						
Yes	74 (24.5)	21 (37.5)	53 (21.5)	**0.01**	2.16 (1.15-4.06)	**0.01**
No	228 (75.5)	35 (62.5)	193 (78.5)		1	
Mode of delivery						
Vaginal	204 (67.5)	33 (58.9)	171 (69.5)	**0.12**		
Cesarean	98 (32.5)	23 (41.1)	75 (30.5)			
Number of living sibling						
≤ 2	212 (70.2)	37 (66.1)	175 (71.1)	0.45		
> 2	90 (29.8)	19 (33.9)	71 (28.9)			
Age of child (month)						
Median (IQR)	9 (9-12)	9 (9-12)	9 (9-12)	0.91	1 (0.84-1.2)	0.92
Sex of child						
Male	157 (52)	33 (58.9)	124 (50.4)	0.24		
Female	145 (48)	23 (41.1)	122 (49.6)			
Rank in the sibling						
1st	112 (37.1)	22 (39.3)	90 (36.6)	0.7		
2nd and more	190 (62.9)	34 (60.7)	156 (63.4)			
BF method						
Exclusive BF	144 (47.7)	22 (39.3)	122 (49.6)	0.32		
Combined BF	120 (39.7)	27 (48.2)	93 (37.8)			
Exclusive AF	38 (12.6)	7 (12.5)	31 (12.6)			
Sleep duration						
Non-compliant	13 (4.3)	6 (10.7)	7 (2.8)	**0.01**$^{\alpha}$	4.05 (1.27-12.88)	**0.01**
Compliant	289 (95.7)	50 (89.3)	239 (97.2)		1	

Note: *Most data values (except the median) are presented as frequencies and percentages; a p-value < 0.05 was statistically significant. BF= breastfeeding. AF= artificial feeding; α: Mann-Witney U test; β: fisher test*

Table 4. Univariate and multiple logistic regression analysis of risk factors for overweight and obesity in children aged 13-24 months (N=246)

Variables	Total N = 246	Overweight/Obesity		*p*	aOR (95%CI)	*p*
		Yes n (%) 53 (21.5)	No n (%) 193 (78.5)			
Maternal age (years)						
Median (IQR)	30 (25-36)	30 (24.5-36)	30 (25-35.5)	0.78$^{\alpha}$		
Residence						
Urban	223 (90.7)	47 (88.7)	176 (91.2)	0.59$^{\beta}$		
Rural	23 (9.3)	6 (11.3)	17 (8.8)			
Mother's education level						
Illiterate	47 (19.1)	6 (11.3)	41 (21.2)	**0.1**		
Low	123 (50)	25 (47.2)	98 (50.8)			
Medium	42 (17.1)	10 (18.9)	32 (16.6)			
High	34 (13.8)	12 (22.6)	22 (11.4)			
Father's education level						
Illiterate	35 (14.2)	6 (11.3)	29 (15)	0.59		
Low	129 (52.4)	28 (52.8)	101 (52.3)			
Medium	56 (22.8)	15 (28.3)	41 (21.3)			
High	26 (10.6)	4 (7.6)	22 (11.4)			
Working mother						
Yes	40 (16.3)	13 (24.5)	27 (14)	**0.06**		
No	206 (83.7)	40 (75.5)	166 (86)			
Working father						
Yes	242 (98.4)	53 (100)	189 (97.9)	0.58$^{\beta}$		
No	4 (1.6)	0	4 (2.1)			
Monthly household income						
<$282	107 (43.5)	24 (45.3)	83 (43)	**0.07**		
$282-504	96 (39)	15 (28.3)	81 (42)			
>$504	43 (17.5)	14 (26.4)	29 (15)			
Gestational diabetes						
Yes	14 (5.7)	3 (5.7)	11 (5.7)	1$^{\beta}$		
No	232 (94.3)	50 (94.3)	182 (94.3)			
Smoking husband						
Yes	66 (26.8)	13 (24.5)	53 (27.5)	0.66		
No	180 (73.2)	40 (75.5)	140 (72.5)			
Mode of delivery						
Vaginal	166 (67.5)	27 (50.9)	139 (72)	**0.004**	1	
Cesarean	80 (32.5)	26 (49.1)	54 (28)		1.96 (1-3.84)	**0.04**
Number of living Sibling						
≤ 2	171 (69.5)	35 (66)	136 (70.5)	0.53		
> 2	75 (30.5)	18 (34)	57 (29.5)			
Age of child (Month)						
Median (IQR)	18 (18-18)	18 (18-19)	18 (17.5-18)	0.007$^{\alpha}$	0.9 (0.78-1.03)	0.15
Sex of child						
Male	128 (52)	35 (66)	93 (48.2)	**0.02**	1.97 (1-3.87)	**0.04**
Female	118 (48)	18 (34)	100 (51.8)		1	
Rank in the sibling						
1st	88 (35.8)	21 (39.6)	67 (34.7)	0.5		
2nd and more	158 (64.2)	32 (60.4)	126 (65.3)			
BF method						
Exclusive BF	128 (52)	13 (24.5)	115 (59.6)	**<0.001**	1	
Combined BF	96 (39)	30 (56.6)	66 (34.2)		5.88 (2.07-16.72)	**<0.001**
Bottle feeding	22 (9)	10 (18.9)	12 (6.2)		1.79 (0.67-4.74)	0.23
Sleep duration						
Non-compliant	40 (16.3)	9 (17)	31 (16.1)	0.87		
Compliant	206 (83.7)	44 (83)	162 (83.9)			

Note: *Most data values (except the median) are presented as frequencies and percentages; a p-value < 0.05 was statistically significant. BF= breastfeeding. AF= artificial feeding;*

95%CI: 1-3.48; p=0.04). Children delivered by cesarean section have a 1.83 greater risk of being overweight or obese than those delivered vaginally. Likewise, the risk of overweight and obesity increases by 0.63 fold when the child's age is advanced by one month (aOR=0.63; 95%CI: 0.53-0.76; p<0.001).

Tables 3 and 4 present the results of univariate and multivariate logistic regression analysis for the age range of 7 to 12 months, and over 12 months successively. Paternal smoking (aOR=2.16; 95%CI: 1.15-4.06; p=0.01) and inadequate sleep duration (aOR=4.05; 95%CI:1.27-12.88; p=0.01) were associated with an increased risk of overweight and obesity in children aged 7 to 12 months. Beyond this age, delivery by caesarean section (aOR=1.96; 95%CI: 1-3.84; p=0.04), combined breastfeeding (aOR=5.88; 95%CI: 2.07-16.72; p<0.001) during the first six months of the child's life, and masculinity (aOR=1.97; 95%CI: 1-3.87; p=0.04) were found to be predictive of overweight and obesity in children in this age group.

DISCUSSION

In this study, the prevalence of overweight and obesity among all children in our population was 16.5%. However, this was higher than in Vietnam and Colombia (10.7% and 5.8% respectively) [19, 2], but slightly lower than in South Africa (17.3%) [56]. In addition, the distribution of children in the 3 age groups revealed an increase in the prevalence of overweight and obesity with age (12.5% for the 0-6 months group, and 15.5% and 21.5% respectively for the 7-12 months and 13-24 months groups). This could be explained by the dietary habits at this stage of life, the low physical activity levels, and screen time (television, tablet, mobile phone), especially as the period of this study was during the Covid-19 pandemic, which was characterised by confinement and a restriction on children playing outside [5, 62]. Furthermore, our study presents a series of predictors of overweight and obesity in relation to the socio-economic context, the peri- and post-natal context and other child-related determinants.

Socio-economic determinants

In contrast to previous studies [8, 54, 70] our study found that, children with more than 2 siblings, and particularly those who are not the eldest, are more likely to be overweight or obese. Possible explanations for this are: the low level of education, the poor standard of living in our population, or the high stress levels of mothers with many children, which inhibit them from adopting appropriate and healthy dietary behaviors [1, 6, 11, 50] in accordance with the child's age, knowing that the first four months of a child's life is a key period when the risk of developing obesity later in childhood is high [30]. It is therefore essential to have a good control of these determinants, which are closely linked and interact with each other, especially during the first 24 months of a child's life, in order to determine a child's nutritional status [26, 53].

Peri- and postnatal determinants

In this study, birth by caesarean section and paternal smoking were shown to be predictive risk factors for overweight and obesity in the child's first 24 months of life, however, contrary to previous research [3, 16, 28, 59], our study revealed no association of gestational diabetes with the risk of overweight and obesity in our population. In the first six months of a child's life and after the first year, birth by caesarean section successively represents a risk of overweight and obesity of 1.83 and 1.96 compared with vaginal birth. This finding is consistent with the results of previous studies that have demonstrated an increased risk of overweight and obesity during the first six months and at 24 months of age for Caesarean delivery [23, 31, 47, 65, 69]. In addition, scheduled caesarean section has been found, although not confirmed by other study [39], to increase the risk of overweight and obesity at the age of 12 months [10, 36, 69]. A series of studies have suggested an association between caesarean delivery and a predisposition to obesity, indicating that delivery by caesarean section alters the colonisation of the neonatal microbiome by vaginal microbes, leading to a lower abundance and diversity of intestinal microbiota [36, 55]. Nevertheless, exposure of the newborn to vaginal flora during vaginal birth is important and beneficial for improving metabolism and immune system function [18]. Therefore, the choice of caesarean section as the mode of delivery should be based on a medical indication to prevent the risk of overweight and obesity in newborns.

The involvement of the mother and her responsibility for the child's well-being or risk has always been emphasised, even before conception, but the father's contribution has often been discreet or underestimated, especially as regards the risk of overweight and obesity in the child [35]. Several studies have shown that direct exposure to tobacco in utero has a considerable impact on the risk of overweight and obesity in early childhood compared with exposure to paternal or family smoking [6, 22, 28]. In our study, children whose fathers smoked had a two times greater risk of developing overweight or obesity than children whose fathers were non-smokers.

In agreement with our finding *Lindholm* et al [29] revealed that paternal smoking was well associated with rapid weight gain between 6 and 12 months. Several other studies have also shown that passive smoking and paternal smoking, even well before and after conception, may be associated with the risk

of overweight in the child [9, 48, 66, 68]. Although the mechanism between exposure to smoking and overweight is not well defined, it is supposed that exposure to tobacco may cause metabolic and hormonal dysfunctions [25].

Child-related determinants

This study showed that the risk of overweight and obesity changes with age. Overall, the risk of overweight and obesity increases 0.94 fold when the child's age advances by one month between 0 and 24 months. It is lower during the first 6 months of life (aOR=0.63). These results are inconsistent with those reported in the study by *Gebremichael* et al, which revealed that the risk of overweight and obesity was higher in children aged less than 6 months (aOR = 5.19), followed by children aged 6 to 24 months (aOR = 1.97) [17]. The variation in these findings may suggest that these age groups represent periods when various factors contribute significantly to the development of overweight and obesity in children, highlighting the potential importance of infant diet in comprehending these outcomes [62].

Similar to our study, numerous studies revealed that the risk of overweight and obesity is greater in boys than in girls [1, 8, 15, 17, 54, 61]. The fact that boys are more overweight and obese than girls could be explained by genetic, metabolic and environmental differences [61]. In that context, studies have shown a positive association between obesity and the Y chromosome suggesting that paternal behaviors and the environment faced by fathers represent a critical challenge to the future health of the offspring through potential damage and modification of male germ cells. However, the evidence is currently limited and there is only hypothesis [13, 20, 35, 60, 68].

Various studies revealed an association between the risk of overweight and obesity in early childhood and later life with the feeding mode and duration, rather than the age of diversification and introduction of solid foods [44, 46, 50, 52, 70]. In our study, combined breastfeeding during the first 6 months of a child's life was a predictive risk factor for overweight and obesity from the age of 13 months. Our results are consistent with those of other studies which have shown that the introduction of complementary foods before the age of 6 months has a negative effect on the development and optimal growth of children. The benefits of exclusive breastfeeding have been demonstrated as a protective factor against overweight and obesity, as well as other virtues such as protection against short- and moderate-term illness [4, 50, 51, 67]. However, the beneficial effect of breastfeeding may be reduced in the long term due to a combination of genetic, environmental and behavioral factors [51]. The duration and choice of exclusive breastfeeding may depend on other factors, such as caesarean delivery, which appears to have a negative influence on the initiation of exclusive breastfeeding and to reduce the period to 3 months [50]. Moreover, a high level of maternal education makes mothers more vigilant, aware and favorably selective in terms of dietary habits and the lifestyle to be established in their households [11, 50].

Our study showed that children with inadequate sleep duration were five times more likely to be overweight or obese, but only in the 7-12 month age group. However, epidemiological studies have suggested that sleep duration may be associated with the risk of overweight and obesity throughout an individual's life [21]. In a systematic review of prospective studies, the authors revealed that insufficient sleep represents both a high risk of overweight or obesity in infants, children and adolescents, and also a modifiable risk factor expressed in the inverse relationship between the number of hours of sleep and the change in BMI z-scores and BMI [14, 34]. Similar results have been reported in Chinese studies reporting an inverse relationship between sleep duration and BMI z-scores in children aged 1-24 months [58, 71]. However, the mechanism by which sleep deprivation affects weight gain is not entirely clear, and studies have suggested that in early childhood sleep duration and quality may be at the origin of overweight and obesity through hormonal changes, especially in leptin and ghrelin secretion, in additional to specific dietary behaviors involving diet quality and meal timing [24, 32, 33]. Based on the studies available, parental awareness of the need to promote healthy and optimal sleep quality and quantity from early childhood is necessary to prevent the risk of overweight and obesity.

CONCLUSION

In this study we found an increase in the prevalence of overweight and obesity with age during the first 24 months of a child's life. Moreover, the risk of being overweight or obese depends on a combination of multiple genetic, environmental, behavioral and individual determinants, and the main ones being: gender, sibling rank, number of living siblings, caesarean delivery, paternal smoking, combined breastfeeding during the first 6 months of life, and inadequate sleep duration. However, this problem can be prevented by developing public health programs aimed at identifying and intervening early in modifiable risk factors, as well as consolidating monitoring and management programs for diagnosed cases. In addition, raising parents' awareness and educating them are colossal measures for preventing unhealthy dietary patterns and promoting appropriate behaviors, such as preparing children properly for sleep in order to improve its quantity and quality.

Strength and limitations of the study

To the best of our knowledge, our study is the first to investigate the predictive factors of overweight and obesity during the first 24 months of a child's life in the prefecture of Skhirat-Temara; however, several limitations can be identified; firstly, the type of cross-sectional study does not allow us to establish a causal relationship. Then, all the mothers classified as having a history of gestational diabetes had no laboratory evidence, even for the variable "number of hours of sleep of the child", which was assessed on the basis of the mothers' reports and not on the basis of objective measurements such as actigraphy.

Acknowledgements

The authors would like to thank all the people who collaborated in carrying out this research, in particular the mother-child pairs participating in the study and the health staff from the health centers in the Skhirat-Temara prefecture for their cooperation in organizing interviews with the participants, and taking anthropometric measurements.

Funding sources

This research received no external funding.

Conflict of interest statement

The authors have no conflict of interests to declare.

REFERENCES

1. *Ahmed, P. M. & Mostafa, N. M.*. The relationship between socio-demographic factors and the prevalence of childhood obesity in Egypt. Int. J Pub Policies in Egypt 2023(1):206-233.
2. *Aldana-Parra F, Vega GO, Fewtrell M.* Associations between maternal BMI, breastfeeding practices and infant anthropometric status in Colombia; secondary analysis of ENSIN 2010. BMC Pub Health. 2020;20(1):232.
3. *Ardıç C, Çolak S, Uzun K, Salı G, Aydemir T, Telatar G*. Maternal gestational diabetes and early childhood obesity: a retrospective cohort study. Childhood Obesity. 2020;16(8):579-85.
4. *Arif S, Khan H, Aslam M, Farooq M*. Factors influencing exclusive breastfeeding duration in Pakistan: a population-based cross-sectional study. BMC Publ Health. 2021;21(1):1-10.
5. *Arufe-Giraldez V, Sanmiguel-Rodríguez A, Zagalaz-Sánchez ML, Cachón J, González-Valero G*. Sleep, physical activity and screens in 0-4 years Spanish children during the COVID-19 pandemic: Were the WHO recommendations met? 2022 [cited 2023 nov 24]; Available from: http://rua.ua.es/dspace/handle/10045/110044.
6. *Baidal JAW, Locks LM, Cheng ER, Blake-Lamb TL, Perkins ME, Taveras EM*. Risk factors for childhood obesity in the first 1,000 days: a systematic review. Am J Prev Med. 2016;50(6):761-79.
7. *Boachie MK, Thsehla E, Immurana M, Kohli-Lynch C, Hofman KJ.* Estimating the healthcare cost of overweight and obesity in South Africa. Global Health Action. 31 déc 2022;15(1):2045092.
8. *Bohn C, Vogel M, Poulain T, Hiemisch A, Kiess W, Körner A*. Having siblings promotes a more healthy weight status—Whereas only children are at greater risk for higher BMI in later childhood. PLoS ONE. 19 juill 2022;17(7):e0271676.
9. *Braun JM, Daniels JL, Poole C, Olshan AF, Hornung R, Bernert JT,* et al. Prenatal environmental tobacco smoke exposure and early childhood body mass index. Paediatr Perinat Epidemiol. 2010;24(6):524-34.
10. *Cai M, Loy SL, Tan KH, Godfrey KM, Gluckman PD, Chong YS*, et al. Association of elective and emergency cesarean delivery with early childhood overweight at 12 months of age. JAMA network open. 2018;1(7):e185025-e185025.
11. *Claudia GC, Lucia MS, Miguel KK, Patricia C, Edgar DG*. Association between sociodemographic factors and dietary patterns in children under 24 months of age: a systematic review. Nutrients. 2019;11(9):2006.
12. *Darling JC, Bamidis PD, Burberry J, Rudolf MC*. The First Thousand Days: early, integrated and evidence-based approaches to improving child health: coming to a population near you? Archives of Disease in Childhood. 2020;105(9):837-41.
13. *Day J, Savani S, Krempley BD, Nguyen M, Kitlinska JB*. Influence of paternal preconception exposures on their offspring: through epigenetics to phenotype. Am J Stem Cells. 2016;5(1):11.
14. *El Halal C dos S, Nunes ML*. Sleep and weight-height development. J Pediatr (Rio J). 18 avr 2019;95:S2-9.
15. *Ferreira H da S, Albuquerque GT, Santos TR dos, Barbosa R de L, Cavalcante AL, Duarte LEC,* et al. Stunting and overweight among children in Northeast Brazil: prevalence, trends (1992-2005-2015) and associated risk factors from repeated cross-sectional surveys. BMC Public Health. 2020;20(1):1-15.
16. *Gao M, Wang H, Li W, Shao P, Li N, Liu* J, et al. Parental prepregnancy obesity and offspring overweight before two years of age among Chinese women with gestational diabetes. Primary Care Diabetes. 2023;17(1):85-90.
17. *Gebremichael MA, Mengesha MM, Hailegebreal S, Abdulkadir H, Arja A, Wolde BB*. Prevalence of overweight/obesity and associated factors among under-five children in Ethiopia: A multilevel analysis of nationally representative sample. Frontiers in Public Health. 2022 [cited 2023 sept 21];10. Available from: https://www.frontiersin.org/articles/10.3389/fpubh.2022.881296.
18. *Gensollen T, Iyer SS, Kasper DL, Blumberg RS.* How colonization by microbiota in early life shapes the immune system. Science. 2016;352(6285):539-44.
19. *Giao H, Le An P, Truong Vien N, Van Khanh T, Quang Vinh B.* Stunting and overweight among 12-24-month-old children receiving vaccination in Ho Chi Minh City, Vietnam. BioMed Research International [Internet]. 2019 [cited 2023 oct 9]; 2019. Available from: https://www.hindawi.com/journals/bmri/2019/1547626/abs/.

20. *Golalipour M, Hadadchi G.* High prevalence of Y chromosome partial microdeletions in overweight men. Avicenna Journal of Medical Biotechnology. 2015;7(3):97.
21. *Guo Y, Miller MA, Cappuccio FP.* Short duration of sleep and incidence of overweight or obesity in Chinese children and adolescents: A systematic review and meta-analysis of prospective studies. Nutrition, Metabolism and Cardiovascular Diseases. 2021;31(2):363-71.
22. *Hawkins SS, Baum CF, Rifas-Shiman SL, Oken E, Taveras EM.* Examining associations between perinatal and postnatal risk factors for childhood obesity using sibling comparisons. Childhood Obesity. 2019;15(4):254-61.
23. *Huang P, Shi X, Xiao F, Wang L, Liu W, Zeng J,* et al. Relationship between obstetric mode of delivery and risk of overweight/obesity in 1-to 4-year-old children. Obesity Facts. 2022;15(3):366-72.
24. *Ingram DG, Irish LA, Tomayko EJ, Prince RJ, Cronin KA, Parker T,* et al. Overnight sleep duration and obesity in 2–5 year-old American Indian children. Pediatric Obesity. 2018;13(7):406-12.
25. *Jaakkola JM, Rovio SP, Pahkala K, Viikari J, Rönnemaa T, Jula A*, et al. Childhood exposure to parental smoking and life-course overweight and central obesity. Ann Med. 2021;53(1):208-16.
26. *Lanigan J.* Prevention of overweight and obesity in early life. Proceedings of the Nutrition Society. août 2018;77(3):247-56.
27. *Larqué E, Labayen I, Flodmark CE, Lissau I, Czernin S, Moreno LA*, et al. From conception to infancy — early risk factors for childhood obesity. Nat Rev Endocrinol. août 2019;15(8):456-78.
28. *Liao XP, Yu Y, Marc I, Dubois L, Abdelouahab N, Bouchard L*, et al. Prenatal determinants of childhood obesity: a review of risk factors. Can J Physiol Pharmacol. 2019;97(3):147-54.
29. *Lindholm A, Bergman S, Alm B, Bremander A, Dahlgren J, Roswall J,* et al. Nutrition- and feeding practice-related risk factors for rapid weight gain during the first year of life: a population-based birth cohort study. BMC Pediatr. 5 nov 2020;20(1):507.
30. *Mannan H.* Early infant feeding of formula or solid foods and risk of childhood overweight or obesity in a socioeconomically disadvantaged region of Australia: a longitudinal cohort analysis. Int J Environ Res PublicHhealth. 2018;15(8):1685.
31. *Masukume G, O'Neill SM, Baker PN, Kenny LC, Morton SM, Khashan AS*. The impact of caesarean section on the risk of childhood overweight and obesity: new evidence from a contemporary cohort study. Scientific reports. 2018;8(1):15113.
32. *Miller AL, Miller SE, LeBourgeois MK, Sturza J, Rosenblum KL, Lumeng JC*. Sleep duration and quality are associated with eating behavior in low-income toddlers. Appetite. 1 avr 2019;135:100-7.
33. *Miller AL, Lumeng JC, LeBourgeois MK.* Sleep patterns and obesity in childhood. Curr Opin Endocrinol Diabetes Obes. févr 2015;22(1):41-7.
34. *Miller MA, Kruisbrink M, Wallace J, Ji C, Cappuccio FP.* Sleep duration and incidence of obesity in infants, children, and adolescents: a systematic review and meta-analysis of prospective studies. Sleep. 1 avr 2018;41(4):zsy018.
35. *Milliken-Smith S, Potter CM.* Paternal origins of obesity: Emerging evidence for incorporating epigenetic pathways into the social determinants of health framework. Social Science & Medicine. 2021;271:112066.
36. *Mitchell C, Chavarro JE.* Mode of delivery and childhood obesity: is there a cause for concern? JAMA network open. 2018;1(7):e185008-e185008.
37. *Morgen CS, Ängquist L, Baker JL, Andersen AMN, Michaelsen KF, Sørensen TI.* Prenatal risk factors influencing childhood BMI and overweight independent of birth weight and infancy BMI: a path analysis within the Danish National Birth Cohort. Int J Obes. 2018;42(4):594-602.
38. Moroccan Ministry of Health and Social Protection [Internet]. Enquête Nationale sur la Population et la Santé de Famille (ENPSF) – 2018. c2020 -[cited 2023 oct 7]. Available from: https://www.sante.gov.ma/Documents/2020/03/Rapport ENPSF 2018 2ème édition.pdf.
39. Moroccan High Commission for Planning (HCP) [Internet]. Projections de la population : région de Rabat- Salé-Kénitra 2014-2030. [cited 2023 oct 7]. Avaible from: https://www.hcp.ma/regionrabat/docs/ProjectionsPopulation/PorojectionsPopulationRegion2014_2030.pdf.
40. Obésité [Internet]. [cited 2023 oct 7]. Available from: https://www.who.int/fr/health-topics/obesity.
41. On behalf of the CALINA study group, *Iguacel I, Escartín L, Fernández-Alvira JM, Iglesia I, Labayen I,* et al. Early life risk factors and their cumulative effects as predictors of overweight in Spanish children. Int J Public Health. Mai 2018;63(4):501-12.
42. Organization. WHO. Ending childhood obesity implementation plan: executive summary. Geneva: WHO. 2017.
43. Organization. WHO. WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. World Health Organization; 2006.
44. *Pattison KL, Kraschnewski JL, Lehman E, Savage JS, Downs DS, Leonard KS, et al*. Breastfeeding initiation and duration and child health outcomes in the first baby study. Prev Medicine. 2019;118:1-6.
45. *Paruthi S, Brooks LJ, D'Ambrosio C, Hall WA, Kotagal S, Lloyd RM,* et al. Recommended amount of sleep for pediatric populations: a consensus statement of the American Academy of Sleep Medicine. J Clinical Sleep Medicine. 2016;12(6):785-6.
46. *Pearce J, Taylor MA, Langley-Evans SC*. Timing of the introduction of complementary feeding and risk of childhood obesity: a systematic review. Int J Obes. 2013;37(10):1295-306.
47. *Pei Z, Heinrich J, Fuertes E, Flexeder C, Hoffmann B, Lehmann I,* et al. Cesarean delivery and risk of childhood obesity. J Pediatrics. 2014;164(5):1068-73.
48. *Philips EM, Santos S, Trasande L, Aurrekoetxea JJ, Barros H, von Berg A,* et al. Changes in parental smoking during pregnancy and risks of adverse birth outcomes and childhood overweight in Europe and North America:

An individual participant data meta-analysis of 229,000 singleton births. PLoS Medicine. 2020;17(8):e1003182.
49. *Pietrobelli A, Agosti M, The MeNu Group.* Nutrition in the First 1000 Days: Ten Practices to Minimize Obesity Emerging from Published Science. Int J Environ Res Publ Health. Dec.2017;14(12):1491.
50. *Ponce-Alencastro J, Chilito-Osorio V, Ramos-Rivera P, Tenorio-Romero A, Castro-López E, Viña-Zambrano K,* et al. Association between Breastfeeding and Reduced Risk of Obesity in Childhood: A Cross-sectional Study in Ecuadorian Infants under Five Years of Age. J Med Health Studies. 2023;4(2):110-20.
51. *Portela DS, Vieira TO, Matos S, de Oliveira NF, Vieira GO.* Maternal obesity, environmental factors, cesarean delivery and breastfeeding as determinants of overweight and obesity in children: results from a cohort. BMC Pregnancy and Childbirth. 2015;15(1):1-10.
52. *Qiao J, Dai LJ, Zhang Q, Ouyang YQ.* A meta-analysis of the association between breastfeeding and early childhood obesity. J Pediat Nursing. 2020;53:57-66.
53. *Redsell SA, Edmonds B, Swift JA, Siriwardena AN, Weng S, Nathan D,* et al. Systematic review of randomised controlled trials of interventions that aim to reduce the risk, either directly or indirectly, of overweight and obesity in infancy and early childhood. Maternal & Child Nutrition. 2016;12(1):24-38.
54. *Saha J, Chouhan P, Ahmed F, Ghosh T, Mondal S, Shahid M,* et al. Overweight/Obesity Prevalence among Under-Five Children and Risk Factors in India: A Cross-Sectional Study Using the National Family Health Survey (2015-2016). Nutrients. 1 sept 2022;14(17):3621.
55. *Sassin AM, Johnson GJ, Goulding AN, Aagaard KM.* Crucial nuances in understanding (mis) associations between the neonatal microbiome and cesarean delivery. Trends in Molecular Medicine. 2022.
56. *Senekal M, Nel JH, Malczyk S, Drummond L, Harbron J, Steyn NP.* Provincial Dietary Intake Study (PDIS): Prevalence and Sociodemographic Determinants of the Double Burden of Malnutrition in A Representative Sample of 1 to Under 10-Year-Old Children from Two Urbanized and Economically Active Provinces in South Africa. IJERPH. 10 Sept 2019;16(18):3334.
57. *Serhier Z, Bendahhou K, Abdelaziz AB, Bennani MO.* Methodological sheet n° 1: How to calculate the size of a sample for an observational study? La Tunisie Medicale. 2020;98(1):1-7.
58. *Sha T, Yan Y, Gao X, Xiang S, Zeng G, Liu S*, et al. Association between Sleep and Body Weight: A Panel Data Model Based on a Retrospective Longitudinal Cohort of Chinese Infants. Int J Environ Res Publ Health. Mai2017;14(5):458.
59. *Shi X, Wang D, Lin M, Su W, Wang L, Xiao F,* et al. Maternal gestational diabetes mellitus and offspring body mass index from 1 to 4 years. Endocrine Practice. 2020;26(6):619-26.
60. *Siddeek B, Mauduit C, Simeoni U, Benahmed M.* Sperm epigenome as a marker of environmental exposure and lifestyle, at the origin of diseases inheritance. Mutation Research/Reviews in Mutation Research. 2018;778:38-44.
61. *Sserwanja Q, Mutisya LM, Olal E, Musaba MW, Mukunya D.* Factors associated with childhood overweight and obesity in Uganda: a national survey. BMC Public Health. Déc2021;21(1):1494.
62. *Tchoubi S, Sobngwi-Tambekou J, Noubiap JJN, Asangbeh SL, Nkoum BA, Sobngwi E.* Prevalence and Risk Factors of Overweight and Obesity among Children Aged 6–59 Months in Cameroon: A Multistage, Stratified Cluster Sampling Nationwide Survey. Blachier F, éditeur. PLoS ONE. 4 déc 2015;10(12):e0143215.
63. *Tremmel M, Gerdtham UG, Nilsson PM, Saha S.* Economic Burden of Obesity: A Systematic Literature Review. Int J Environ Res Publ Health. 2017;14(4):435.
64. *Tuohino T, Morales-Muñoz I, Saarenpää-Heikkilä O, Kiviruusu O, Paunio T, Hovi P,* et al. Short Sleep Duration and Later Overweight in Infants. Journal of Pediatrics. 1 sept 2019;212:13-9.
65. *Vinding RK, Sejersen TS, Chawes BL, Bønnelykke K, Buhl T, Bisgaard H*, et al. Cesarean Delivery and Body Mass Index at 6 Months and Into Childhood. Pediatrics. 1 juin 2017;139(6):e20164066.
66. *Vrijheid M, Fossati S, Maitre L, Márquez S, Roumeliotaki T, Agier L*, et al. Early-life environmental exposures and childhood obesity: an exposome-wide approach. Environ Health Perspect. 2020;128(6):067009.
67. *Yadav J, Sharma D, Prajapati A.* Patterns and Socio-demographic Determinants of Exclusive Breastfeeding in India. Int J Health Systems Implementation Research. 2022;6(2):24-30.
68. *You Y, Liu R, Zhou H, Wu R, Lin R, Li B, e*t al. Effect of exposure to paternal smoking on overweight and obesity in children: findings from the children lifeway cohort in Shenzhen, Southern China. Obesity Facts. 2022;15(4):609-20.
69. *Zhang L, Huang L, Zhao Z, Ding R, Liu H, Qu W,* et al. Associations Between Delivery Mode and Early Childhood Body Mass Index Z-Score Trajectories: A Retrospective Analysis of 2,685 Children From Mothers Aged 18 to 35 Years at Delivery. Frontiers in Pediatrics [Internet]. 2023 sep 22;8. Available from : https://www.frontiersin.org/articles/10.3389/fped.2020.598016.
70. *Zheng M, Hesketh KD, Vuillermin P, Dodd J, Wen LM, Baur LA,* et al. Determinants of rapid infant weight gain: A pooled analysis of seven cohorts. Pediatr Obes. oct 2022;17(10):e12928.
71. *Zhou Y, Aris IM, Tan SS, Cai S, Tint MT, Krishnaswamy G*, et al. Sleep duration and growth outcomes across the first two years of life in the GUSTO study. Sleep Medicine. 1 Oct 2015;16(10):1281-6.

Received: 14.10.2023
Accepted: 25.11.2023
Published online first: 01.12.2023