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ORIGINAL ARTICLE

Study of the relationship between nutrition, physical activity and overweight/obesity in children in a school context

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ABSTRACT

Aim: This study aimed to describe the behavior, eating habits, and lifestyle of schoolchildren from different regions of Bejaia, and to evaluate their food consumption on the one hand and their Physical Activity Level (PAL) on the other hand. **Methods:** This study involved children (n = 240, B/G = 120/120), aged from 6 to 12, that are enrolled in different institutions (primary schools, colleges) in different regions of Bejaia. The children's body weight and height were measured (BMI), and their eating habits and level of physical activity were assessed using adapted questionnaires. Food consumption was estimated by the 24-hour recall method. **Results:** Results showed observable BMI rise including drastic changes in BMI Z-score as a function of age, height and mainly weight, BMI Z-score values were between 0 and +2 in overweight for obese girls and boys and less than +1 for normal-weight girls and boys. The PAL evaluation was low in overweight and obese children compared to normal-weight children. The correlation test showed a positive correlation between BMI and PAL in both sexes. According to the results of the dietary habits, the frequency of consumption of the different food groups distributed according to the fourth daily intakes (breakfast, lunch, dinner and snacking between meals) was very rich in carbohydrates and fats in overweight and obese children, compared to normal-weight children and according to the recommended threshold. **Conclusion:** This study shows that there is an increase in BMI values, high BMI Z-scores in overweight and obese children compared to normal-weight children. Children have bad eating habits (snacking between meals, consumption of fast food and sugary drinks). These habits may act as obesity promoting factors when associated with sedentary activities.

Keywords: Children, overweight-obesity, normal-weight, BMI, Physical Activity Level, food habits, food consumption.

ARTICLE INFORMATION

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1 Introduction

The frequency of overweight and obesity is increasing rapidly around the world, especially among children. Obesity increase is so important that the World Health Organization (WHO) has considered obesity, since 1998, an "epidemic" and a major issue of "public health" on a global scale. In view of this, the WHO has asked each country to create programs for the prevention and management of obesity [1]. The fight against obesity is one of the main public health challenges. It is now known that obesity established in childhood, could persist into adolescence and adulthood, with serious consequences on health by considerably increasing the risk of associated chronic diseases and by reducing life expectancy [2]. Since the management of obesity remains difficult, it is essential to prevent excessive body weight gain in children from an early age.

The determinants of obesity are multiple, and their interactions are complex. Beyond individual biological or genetic factors that cannot be neglected, obesity results from an imbalance between food intake and energy expenditure. However, this imbalance is strongly conditioned by the

environment of individuals, both at an early life stage and throughout their life [3]. Our study focused on the overweight and obesity of children, since nowadays, it is a problem that is continuously increasing in our society. This alarming increase of childhood obesity represents a real health hazard, especially since the number of affected children is quickly increasing every year. Because of this complex situation, it seems essential to study this social phenomenon.

The current study will only deal with overweight and obesity in children aged from 6 to 12 years, i.e., up to the pre-adolescence stage. Like hereditary diseases or even world epidemics, overweight and obesity are currently a major public health problem affecting the entire population, i.e., all social categories, and concern both adults and children [4]. Moreover, the number of people (children and adult persons) in a situation of overweight and obesity has not stopped increasing since the last decade [5]. However, it was only at the end of the 90s [5] that the data became alarming and started to worry the public authorities. It is no longer a simple aesthetic concern but a real disease.

The prevalence of overweight and obesity has increased significantly over the past three decades [6]. Globally, an estimation of 170 million children (under 18) are overweight[7]. The high prevalence of overweight and obesity has serious health consequences. Increased body mass index (BMI) is a major risk for diseases such as heart disease, type 2 diabetes and several cancers [8, 9]. These so-called non-communicable diseases cause premature mortality and long-term morbidity. Overweight and obesity in children are also associated with a significant decline in quality of life [10], increased exposure to harassments, bullying, and social isolation [6].

Algeria, just like Tunisia, Morocco, Brazil, China, and India, undergoes a nutritional transition through several characteristics. Anthropometric data among children and adolescents attending school in the Algerian city of Constantine revealed the existence of overweight and obesity in this population [11].

The nutritional situation in Algeria is that children tend to develop bad eating habits associated with a decrease in regular physical activity. Regarding physical activity, the population of young people whose physical activity does not reach the minimum expert recommendations is very important according to the results of surveys carried out in different countries [12].

In Algeria, few studies have been published on overweight in early childhood (less than five years) [13, 14]. However, several studies on children and adolescents in school at the age of 4 to12 years old have been published at several regional levels; for example in Constantine in 2009, 2014 and 2020, the prevalence of overweight and obesity in children was equal to 23.10 % from 6 to 12 years old [15], and 8.5 % (overweight) and 19.3 % (obese) from 10 to 11 years old, and 22.8 to 28.3 % from 6 to10 years [16], respectively. In Tebessa, in 2007 and 2010, the prevalence was 17.39 % from 4 to 13 years old and 6.36 % from 5 to 8 years old [17, 18]. In Oran, in 2012, the prevalence was 13.1 % of 6 to 11 years old [19]. In Tiaret, in 2016, the prevalence reached 8.18 % of 6 to 11 years old [20]. Two other surveys, conducted in 2017 and 2018 in Constantine among children and adolescents aged 6-18 years, showed a prevalence of overweight and obesity in girls and boys together of 13.7 and 3.0 %, respectively [21, 22]. In 2021, a recent study in Bejaia found a prevalence of overweight and obesity to be 3.3 % among adolescents of 11 to 23 years old[23]. The objective of the present study was to describe the behavior, eating habits, and lifestyle of schoolchildren from different regions of Bejaia (Algeria), as well as to evaluate their food consumption and their Physical Activity Level (PAL).

2 Material and Methods

2.1 Studied population

The study involved a sample of 240 children of both sexes (boys/girls = 120/120) whose age varies between 6 and 12 years, schooled in classes from primary school first year to middle school first year. Our descriptive survey concerned ten (10) schools of the primary and college cycles in Bejaia, where obese and overweight children (B/G: 60/60) and normal-weight children (B/G: 60/60) were selected. The accessibility to the school children was facilitated by the directors of the establishments. The objective of this study was explained to the children's parents, who agreed for their children participation in this investigation.

2.2 Study design and survey methodology

It is a descriptive cross-sectional survey in the form of questionnaires, distributed to students of different primary and college schools in the wilaya of Bejaia.

A descriptive or explanatory research was carried out. The descriptive research aimed to systematically list and describe a certain order of phenomena, to establish data groupings and classifications. Explanatory research aimed at finding causes, principles, or laws that allow accounting for phenomena.

2.2.1 Anthropometric parameters measurements

Anthropometric parameters (height and body weight) were measured using a scale and a height gauge. The measurements were recorded to the nearest 0.1 cm. The body weight was taken with a minimum of clothing and recorded to the nearest 0.1 kg. The measurement techniques were carried out in accordance with the WHO recommendations. The body mass index (BMI) was calculated according to the formula: body weight/height^2

(kg/m²), using a software that is available online on the www.bmi.fr website, as follow:

$$BMI = \frac{W}{H^2} \quad \ldots\ldots. (1)$$

For adults there is a single BMI reference value through the WHO classification of adult weight status. BMI is considered as normal body weight when it is lower than 25 kg/m², overweight if it is between 25 and 29,99 kg/m², and obese if over 30 kg/m² [24].

In children under 18 years old, the BMI is plotted based on its body weight curves to situate a child's weight status according to his/her age and sex. Indeed, in children, the reference values of BMI vary according to age, so it is impossible to refer to a single reference value of BMI as in adults.

A BMI Z-score was used because it provides a relative measurement of age-adjusted adiposity and minimizes the effect of time variation between baseline and follow-up [25]. Overweight can be expressed as a "BMI Z-score" which provides a numerical indication of the deviation from the median for gender and age; the BMI Z-score is used in clinical practice to accurately quantify overweight and obesity, particularly above the IOTF-3 threshold. The WHO recommends the indication of overweight by a Z-score > +1 SD. Obesity is indicated by a Z-score > +2 SD. The Z-score expresses the number of standard deviations below or above the mean or median reference value for an anthropometric variable [26].

2.2.2 Physical Activity Level (PAL)

PAL is the estimated number of hours spent per day on each type of activity, averaged over the duration of these activities recorded over a week. The more accurate the estimate, the closer the calculated PAL will be to reality.

PAL was calculated according to the following formula:

Average PAL = (sum of PAL * number of hours per category)/ 24 [27] as shown in Table 1.

$$PAL = \frac{Coefficient\ of\ the\ PAL \times duration\ (hours)}{24}$$

2.2.3 Children's eating behavior and habits

The questionnaire was composed of 25 questions that mainly involve eating habits to assess the lifestyle of children and adolescents (to know how many meals are taken, fruit and vegetable consumptions, meat and dairy product consumptions, frequency of consumption of fast food, baked goods, commercial desserts, sweets and sweetened beverages, and salt-coated foods) [28], according to the Clinical Research Institute of Montreal-2008 (https://sqha2.hypertension.qc.ca/wpcontent/uploads/2015/04/questionnaire.pdf).

Table 1. Physical activity level (PAL) in children and adolescents Dietary Reference Intake (DRI) [27]

Category	PAL	Different activities
A	1	Sleep and nap, extended rest
B	1.75	Sitting position. (TV, computer, homework, meals, transportation)
C	2.1	Standing position (shopping, cooking, short trips, toilet)
D	2.6	Light activities of low intensity (games)
E	3.5	Moderate activities (brisk walking, manual work)
F	5.2	Sport activities (club training, physical activities and sports...)
G	10	Sport competition

2.1.1 24-hour dietary recall

The children and adolescents' food consumption was estimated using the "24-hour recall" method [29]. This method consists of describing food intake during the 24 hours preceding the survey (composition of each meal, name of food). These questions aim to find out the frequency of food consumption; meals and daily consumption to detail the food groups intake (such as sugary drinks, vegetables, fruits and dairy products) of children and adolescents during the three main meals (breakfast, lunch and dinner), and during snacks (morning and evening) and snacking (food eaten, timing of snacking, snacking practice, frequency), and also the frequency of consumption of drinks during and outside meals. The 24-hour recall was calculated based on the energy value of each food, the energy intake supply is available (kcal per 100 grams of food) and the nutrient content (proteins, fat and carbohydrates in grams per 100 grams of food). According to the protein, lipid and carbohydrate contents of each food, daily protein, lipid and carbohydrate intakes were calculated for each consumed food. Then the sum of all consumed foods was calculated. Thus, we obtained the consumed amount of protein, fat and carbohydrates per day[23].

2.3 Statistical analysis

Results are expressed as mean ± standard deviation (SD) and as percentages. The correlation was determined between body mass index (BMI) and physical activity level (PAL) using XLSTAT 2009.

2.4 Ethical consideration

In order to meet ethical considerations, we ensured confidentiality and respect for all participants during this research after having explained to the students and their parents the objectives of the study and their implications.

Thus, the survey was conducted in the form of an interview with each student individually, before starting our study, we requested an authorization from the director of education of the wilaya of Bejaia, who authorized us to work with the students of all the primary schools of the Wilaya. Thus, we certify that the study was performed in accordance with the ethical standards, and confirm that all participants were consent to be involved in this study as well as their corresponding visited schools. No images were used, we declare that no informed consent was necessary.

3 Results

3.1 Body Mass Index (BMI)

Table 2 displays height, body weight, BMI and BMI Z-score values of normal-weight and overweight girls and boys from 6 to 12 years old. A noticeable rise of BMI with age, height and especially body weight factor was recorded. However, the average BMI values for the different sexes were 22.20 ± 2.36 Kg/m² and 21.40 ± 2.64 Kg/m² for overweight and obese girls and boys, respectively. The mean BMI for normal-weight girls and boys was 17.21 ± 1.29 Kg/m² and 16.65 ± 1.35 Kg/m², respectively.

In overweight and obese girls and boys, the BMI Z-score from age 6 to 10 years old was less than +1, while the BMI Z-score from age 11 - 12 years was comprised between +1 and +2. The BMI Z-score for normal-weight girls and boys was less than +1.

3.2 Physical Activity Level (PAL)

Table 2 shows that the physical activity level (PAL) in overweight and obese boys is on average 1.72. On the other hand, the normal-weight average is 2.35. While, the physical activity level (PAL) in overweight and obese girls is on average 1.66, and a normal-weight girl is on average 2.23.

The correlation test for overweight and obese boys, showed a positive correlation between BMI and PAL (r = 0.54), while in normal-weight boys there was a strong correlation between BMI and PAL (r = 0.53) (Table 3). The correlation test for overweight and obese girls, showed a significant correlation between BMI and PAL (r = 0.50), and for normal-weighted girls the correlation between BMI and PAL was positive (r = 0.52) (Table 3).

3.3 Children eating behaviors and habits

3.3.1 Breakfast intake

Breakfast was taken daily by 50.83 % of normal-weight children and 87.5 % of overweight and obese children.

Children breakfast is mainly composed of milk, accompanied by highly sweet products such as jam and honey, and fatty foods such as butter and margarine.

Table 3. PAL of boys and girls and the correlation test between BMI and PAL

Sex	PAL OW + Ob	PAL NW	BMI-PAL NW*	BMI-PAL OW + Ob*
Boys	1.72	2.35	0.53	0.54
Girls	1.66	2.23	0.52	0.50

PAL: physical activity level; OW: overweight; Ob: obese; NW: normal body weight; *: correlation

Table 2. Results from the preliminary study for MAE

	Overweight-Obese Girls				Normal-weight Girls				Overweight-Obese Boys				Normal-weight Boys			
Age (year)	H (m)	BW (kg)	BMI, (kg/m²)	BMI Z score	H (m)	BW (kg)	BMI, (kg/m²)	BMI Z score	H (m)	BW (kg)	BMI, (kg/m²)	BMI Z score	H (m)	BW (kg)	BMI, (kg/m²)	BMI Z sco
6	1.13	32.1	25.2	0.45	1.12	19.7	15.7	0.04	1.33	45.1	25.6	0.42	1.13	19.3	15.1	0.03
7	1.14	32.6	25.3	0.16	1.14	20.6	15.9	0.02	1.44	53.6	25.9	0.32	1.14	20.1	15.5	0.06
8	1.18	35.6	25.6	0.38	1.17	22.3	16.3	0.03	1.19	37.6	26.4	0.29	1.18	22.1	15.9	0.08
9	1.2	37.2	25.8	0.25	1.2	24	16.7	0.05	1.23	41.6	27.6	0.62	1.21	24	16.4	0.05
10	1.25	43.5	27.9	0.45	1.25	27.8	17.8	0.04	1.25	44.4	28.5	0.85	1.24	26.5	17.2	0.02
11	1.33	53	30	1.80	1.33	32.30	18.3	0.03	1.31	52.3	30.5	1.36	1.34	32.3	18	0.02
12	1.36	56.3	30.5	1 .98	1.35	34.4	18.9	0.09	1.36	58.1	31.5	1.75	1.36	34.1	18.5	0.01

FW=Fresh weight (g); DW=Dry weight (g); Size (mm); Volume (cm3); P/S = Pulp stone ratio; Firmness (N); Juice yield (%); CE= electrical conductivity (ms/cm); SSC= Soluble solids content (°Brix); TA= titratable acidity; RI= ripening index. Data are mean ± SE (n=3). Separation within columns was performed by Scheffe test ($p \leq 0.05$). Values are the means (n = 6) ± SE. Different letters a, b, c, indicate difference among treatments in the same cultivar.

Table 4. Frequency and food consumption during breakfast and morning snack

		Total n=240		Normal body weight n=120		Overweight +obese n=120	
Breakfast	**Intake frequency**	**n**	**%**	**n**	**%**	**n**	**%**
	- Always	166	69.17	61	50.83	105	87.5
	- Sometimes	64	26.66	54	45	10	8.33
	- Never	10	4.17	5	4.17	5	4.17
	Food	**N**	**%**	**n**	**%**	**n**	**%**
	- Cakes, biscuit, chocolate, cereals	37	15.41	12	10	25	20.83
	- Whole meal bread	31	12.92	11	9.17	20	16.67
	- Jam, honey, cheese, yogurt, butter, margarine	51	21.25	16	13.33	35	29.17
	- Milk only, coffee with milk, chocolate milk	59	24.58	24	20	35	29.17
	- Fruits -vegetables	52	21.67	50	41.67	2	1.66
	- Never	10	4.17	7	5.83	3	2.5
Morning Snack	**Intake frequency**	**n**	**%**	**n**	**%**	**n**	**%**
	- Always	165	68.75	60	50	105	87.5
	- Sometimes	60	25	50	41.67	10	8.33
	- Never	15	6.25	10	8.33	5	4.17
	Composition of the morning snack	**n**	**%**	**n**	**%**	**n**	**%**
	- Cakes, biscuit, chocolate, cereals	61	25.42	21	17.5	40	33.33
	- Baguette bread, whole meal	20	8.33	10	8.33	10	8.33
	- Jam, honey, cheese, yogurt, butter, margarine	58	24.17	25	20.83	33	27.5
	- Milk only, coffee with milk, chocolate milk	45	18.75	15	12.5	30	25
	- Fruits -vegetables	30	12.5	23	19.17	7	5.83
	- Never	26	10.83	26	21.67	0	0

In fact, the consumption of milk alone, coffee with milk or milk with chocolate was noted in 20 % of normal-weight children and 29.17 % of overweight and obese children. Cakes, pastries and cookies were consumed by 10 % of normal-weight children and 20.83 % of overweight and obese children. Bread was consumed by 9.17 % of normal-weight children and 16.67 % of overweight and obese children. Whereas, jam honey and butter were consumed by 13.33 % of normal-weight children and 29.17 % of overweight and obese children (Table 4).

3.3.2 Morning snack intake

The morning snack was taken daily by 50 % of normal-weight children and 87.5 % of overweight and obese children. The composition of the morning snack varied. Cakes, chocolates and cookies were consumed by 17.5 % of normal-weight children and 33.33 % of overweight and obese children. The consumption of jam, cheese, and yogurt was reported in 20.83 % of normal-weight children and 27.5 % of overweight and obese children. Sweetened drinks and chocolate bars were consumed by 12.5 % of normal-weight children and 25 % of overweight and obese. We noticed that bread consumption was identical among the children of both categories, with a rate of 8.33 % (Table 4).

3.3.3 Lunch intake

Lunch was taken daily by 95.83 % of normal-weight children and by all overweight and obese children. A rate of 83.33 % of normal-weight children and 87.5% of overweight and obese children took lunch at home with their family members. However, the percentage of children who took lunch alone was low, with only 12.5 % of normal-weight children and 8.33 % of overweight and obese children (Table 5).

3.3.4 Snack intake

49.17 % of normal-weight children and 87.5 % of overweight and obese children took a snack daily. Milk alone, coffee with milk, or milk with chocolate were consumed by 25 and 16.87 % of children of normal-weight and overweight and obese children, respectively. Bread was consumed by 14.17 % of normal-weight children and 27.5 % of overweight and obese children. While 11.67 % of normal-weight children and 21.66 % of overweight and obese children consumed cakes, cereals, and cookies. The consumption of jam, honey, cheese, and yogurt was recorded in 8.33 % of normal-weight children and 25 % of overweight and obese children, when only 6.67 % of overweight and obese children did not consume them. Regarding fruits, it was noticed that only 14.16 % of normal-weight children consumed them during snacks (Table 5).

3.3.5 Dinner

Dinner was taken daily by 60.83 % of normal-weight children and all overweight and obese children. 95.83 % of overweight and obese children and 90% of normal-weight children took dinner at home with their families. Furthermore, only 4.17 % of overweight and obese children took it alone (Table 6).

3.3.6 Snacking

Snacking was recorded in 16.67 % of normal-weight children and 91.67 % of overweight and obese children. The reasons that explain this practice are that the children watch television while swallowing large quantities. While, 56.67 % of normal-weight children never take snacks. In contrast, 66.67 % of overweight children snack constantly. The most frequently consumed foods were chips, candy, sweetened drinks, peanuts, and corn. Cakes, cookies, cereals, and chocolate, were consumed by 22.5 % of overweight and obese children and 8.33 % of normal-weight children. Bread and sandwiches were consumed by 8.33 % of normal-weight children and 20 % of overweight and obese children. Jam, cheese, butter, and margarine were consumed by 15 % of normal-weight children and 25.83 % of overweight and obese children. A rate of 25 % of normal-weight children consume fruits and vegetables, while only 4.17 % of overweight children do (Table 6).

3.3.7 Consumption of sugary drinks and fast food

The results showed that 33.33 % of normal-weight children consumed sweetened drinks, while 88.33 % of overweight and obese children consumed these types of drinks daily. Fruit juice was consumed by 74.17 % of normal-weight children, and only 15.83 % of overweight and obese children consumed it. On the other hand, we also noticed that soda was consumed by 84.17 % of overweight and obese children, and 25.83 % of normal-weight children. A rate of 43.33 % of overweight and obese children were used to eat fast food once a week or more, while only 15.5 % of normal-weight children were used to eat fast food (Figure 1).

Instead, 68.33 % of normal-weight children never eat fast food, compared to 4.17 % of the overweight and obese children. These results show that 91.67 % of normal-weight children and 83.33 % of overweight and obese children declare to eat meals at fixed times (Figure 2). It was found that 40.83 % of normal-weight children spend 1 to 3 hours a day in front of television, while more than 58.34 % of overweight and obese children spend more than 3 hours a day in front of television (Figure 2).

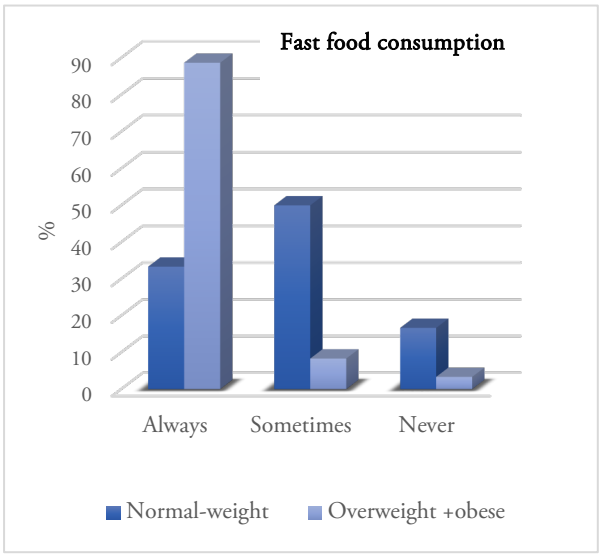
According to Figure 2 data, protein intake represented 20.83 %, carbohydrate intake was of 50 %, and fat intake was of 29.17 %. Quantitatively, food intake for normal-weight children remained within the recommended limits.

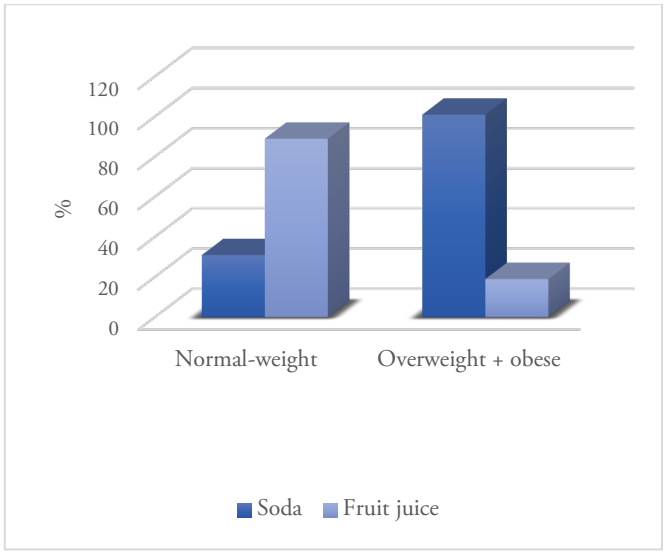
Table 5. Frequency and foods consumption during Lunch and snack

	/	Total n=240		Normal body weight n=120		Overweight +obese n=120	
Lunch	**Intake frequency**	**n**	**%**	**n**	**%**	**n**	**%**
	- Always	235	97.91	115	95.83	120	100
	- Sometimes	5	2.08	5	4.17	0	0
	- Never	0	0	0	0	0	0
	Meal location						
	- At home with a family member	205	85.41	100	83.33	105	87.5
	- With friends	10	4.17	5	4.17	5	4.17
	- At home alone	25	10.42	15	12.5	10	8.33
Snack	**Intake frequency**	**n**	**%**	**n**	**%**	**n**	**%**
	- Always	164	68.33	59	49.17	105	87.5
	- Sometimes	36	15	29	24.17	7	5.83
	- Never	40	16.67	32	26.67	8	6.67
	Composition of the morning snack	**n**	**%**	**n**	**%**	**n**	**%**
	- Cakes, biscuit, chocolate, cereals	40	16.67	14	11.67	26	21.66
	- Baguette bread, whole meal	50	20.83	17	14.17	33	27.5
	- Jam, honey, cheese, yogurt, butter, margarine	40	16.67	10	8.33	30	25
	- Milk only, coffee with milk, chocolate milk	50	20.83	30	25	20	16.67
	- Fruits -vegetables	20	8.33	17	14.16	3	2.5
	- Never	40	16.67	32	26.67	8	6.67

Table 6. Frequency and food consumption during dinner party and snacking

	/	Total n=240		Normal body weight n=120		Overweight +obese n=120	
Dinner party	**Intake frequency**	**n**	**%**	**n**	**%**	**n**	**%**
	- Always	193	80.42	73	60.83	120	100
	- Sometimes	42	17.5	42	35	0	0
	- Never	5	2.08	5	4.17	0	0
	Meal place						
	- I eat at home with my parents	223	92.92	108	90	115	95.83
	- I eat at the restaurant	1	0.41	1	0.83	0	0
	- I eat alone	16	6.67	11	9.17	5	4.17
Snacking	**Intake frequency**	**n**	**%**	**n**	**%**	**n**	**%**
	- Always	130	54.17	20	16.67	110	91.67
	- Sometimes	42	17.5	32	26.67	10	8.33
	- Never	68	28.33	68	56.66	0	0
	Reasons for snacking	**n**	**%**	**n**	**%**	**n**	**%**
	- Doing homework	18	7.5	10	8.33	8	6.67
	- When you have money	25	10.42	20	16.67	5	4.17
	- When you are with friends	26	10.83	25	20.83	1	0.83
	- Watching TV	66	27.5	5	4.17	61	50.83
	- Because you want to eat	65	27.08	60	50	5	4.17
	- Because you are greedy	40	16.67	0	0	40	33.33
	Snacking time						
	- Morning	15	06.25	10	8.33	5	4.17
	- Afternoon	52	21.67	42	35	10	8.33
	- In the evening	25	10.42	0	0	25	20.83
	- All the time	80	33.33	0	0	80	66.67
	- Never	68	28.33	68	56.67	0	0
	Snacking time	**n**	**%**	**n**	**%**	**n**	**%**
	- Cakes, cookies, cereals, chips, chocolate	37	15.41	10	8.33	27	22.5
	- Sandwich, Whole meal bread	34	14.41	10	8.33	24	20
	- Jam, honey, cheese, yogurt, butter, margarine	49	20.41	18	15	31	25.83
	- Sweetened drinks, chocolate and cereal bars	41	17.08	10	8.33	31	25.83
	- Fruit-vegetables	35	14.58	30	25	5	4.17
	- Never	44	18.35	42	35	2	1.7





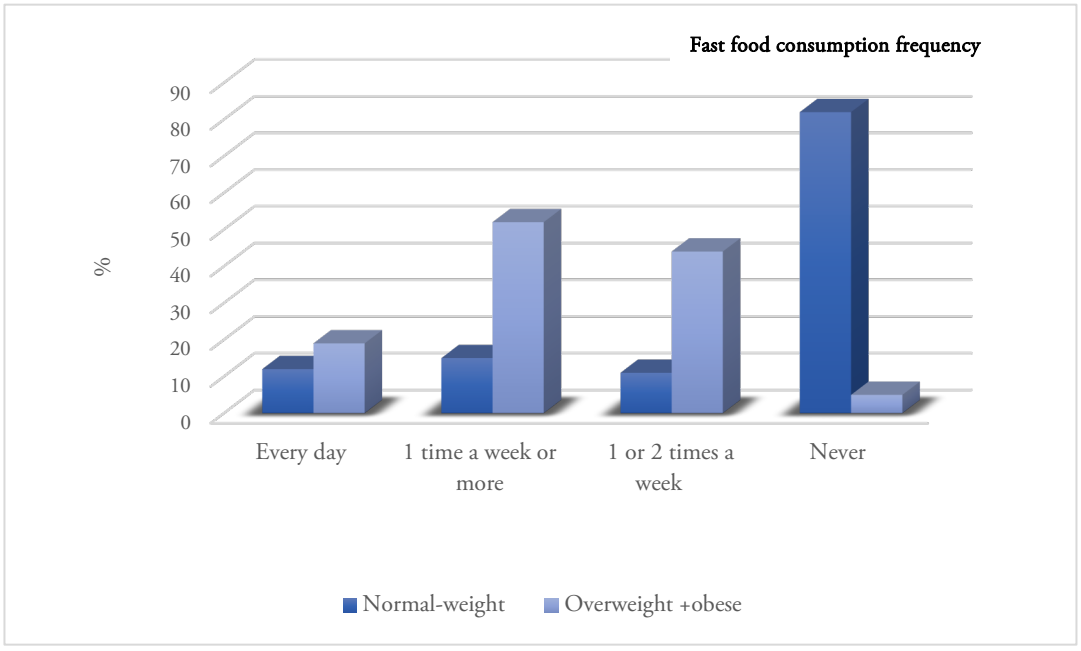


Figure 1. Distribution of children by frequency of consumption of fast food and sugary drinks

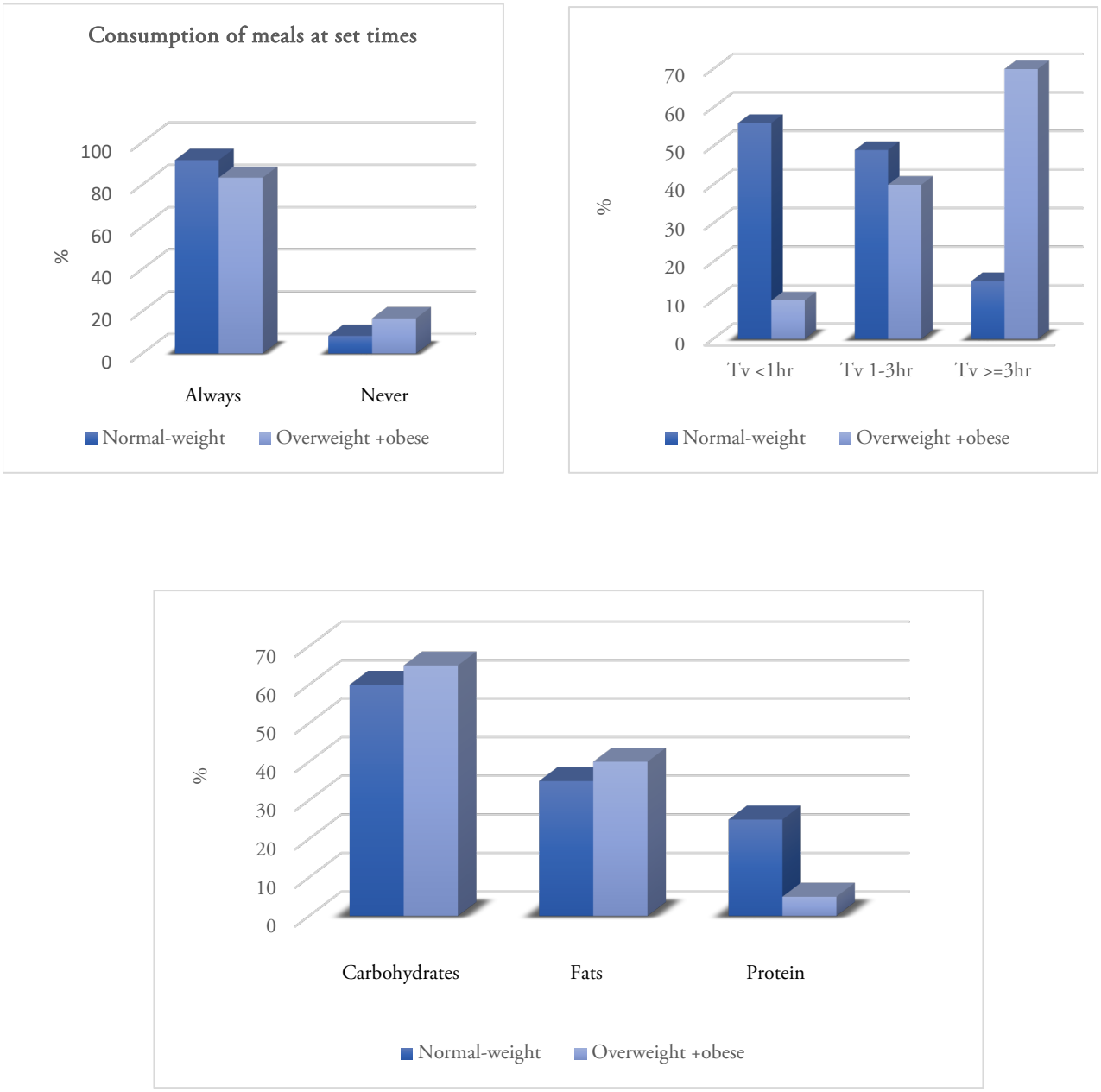


Figure 2. Time spent in front of television and the frequency of consumption of various food staffs according to their types at fixed times

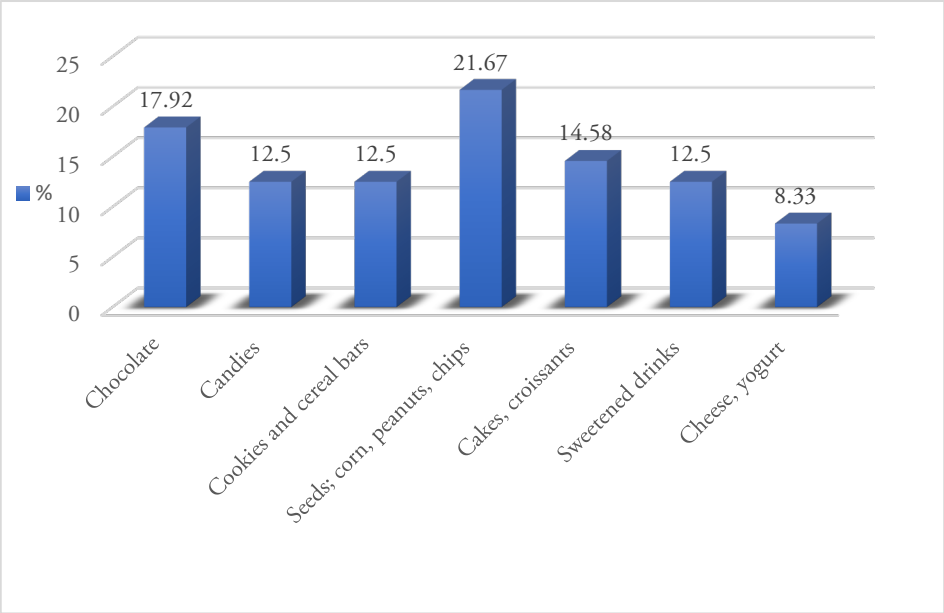


Figure 3. Distribution of children consumption according to the different food items purchased with their pocket money

4 Discussion

4.1 Body Mass Index (BMI)

The study on the measurement of the calculated body mass index, showed that children are obese if BMI Z-score > +2 SD and overweight if BMI Z-score > +1 SD. On the other hand, children are of normal body mass if BMI Z-score is lower than +1 [30, 31]. As a result, age, height and especially body weight play an important role in the increase of the BMI.

We found that children from families with obese parents present a significantly higher risk of obesity compared to those with normal body weight parents [32]. If this trend continues into adulthood, prevention of childhood obesity should target girls (whose mothers have a BMI of 25) and boys (whose mothers have a BMI > 30). Indeed, these results could guide obesity prevention and treatment strategies that would most likely be effective [33].

The study of Gundogdu [34] reports that children over 12 years old have a slightly increased risk of hypertension, probably reflecting the influence of the duration of obesity. Therefore, based on the results of our study, we believe that BMI is a more appropriate measure for assessing the risk of being overweight in girls than in boys, a universal approach should be developed to use anthropometric data to screen overweight and obesity. In addition, this approach should take into consideration the stages of maturation [35].

4.2 Physical Activity Level (PAL)

Through our analysis we noticed that there was a difference between the physical activity level (PAL) in normal-weight and overweight children, as overweight and obese children are characterized by a decrease in the practice of physical activity and an increase in sedentary activities such as video games, computer, television, etc. On the other hand, normal-weight children devote most of their time to practicing physical activities in school and/or extracurricular establishments. In addition, according to the international recommendations on the PAL, the recommended threshold for children is estimated by a level of 1.75 for boys, and 1.68 for girls daily with a moderate intensity [36].

Thus, the behavior of children (sport practice and sedentary lifestyle) plays a potential role on their PAL and their corpulence (normal and overweight).

The majority of normal-weight children goes to school by walking, while overweight and obese children prefer taking bus as transportation mean, which leads to a lower energy expenditure.

In our study, the average number of hours of sleep was higher in normal-weight children. It is well established that decreased sleep duration is associated with increased risk of obesity. The Study of Davidson et al. [37] reported that overweight and obese children sleep less than 10 hours compared to normal weight children. Most normal-weight children engage in school and/or extracurricular physical activity, whereas sedentary behaviors characterize overweight and obese children. The increase in exercise intensity leads to a more preponderant use of carbohydrates, to the detriment of lipids [38].

4.3 Children eating behavior and habits

In this study, more than half of the children receive pocket money. This money is often used to purchase sweet products, such as candies and chocolate bars. These foods, consumed outside of meals, promote the development of overweight and obesity (Figure 3); these results agree with those to those of Wang et al. [39-41].

The eating behavior analysis showed that lunch and dinner were the most regular meals for all the children studied. Breakfast was the least regular meal, especially among normal-weight children, while overweight and obese children were more likely to take breakfast. This irregular intake being due to lack of appetite and lack of time. These results disagree with those of Soo et al. [42], which showed that more normal-weight people take breakfast. In fact, it has been noticed that breakfast consumption is associated with weight gain [43, 44]. The breakfast meal of the studied children is composed of milk and cereal products. They tend to have a morning snack, with excessive consumption of sugary products, and the afternoon snack is a traditional meal consumed by most children. Its composition is very variable, with high consumption of foods rich in sugar and fat (cakes, cookies, sweetened drinks, etc.).

Most children take snacks but with varied frequency. Overweight and obese children were more likely to snack compared to other groups. These results are comparable to those of Alam [45], who observed that obese children snack more than normal-weight children. Indeed, snacking is associated with an increase in BMI [46]. High energy density foods rich in fats and sugars are the most commonly taken snacks, and their consumption promotes obesity [47].

4.4 Consumption of sugary drinks and food

Almost all the studied children consumed sweetened beverages, especially overweight and obese children, who were more likely to consume them daily, with a rate of 88.33 %. This consumption is associated with obesity as reported by several studies [48-50].

The habit of consuming fast food was recorded in half of the studied children, especially those who are overweight and obese and are more likely to consume fast food once a week or more. In fact, studies have underlined that school-age children have a high frequency of consumption of fast food[51, 52]. These foods are associated with increased BMI and energy density of foods in children [53]. Most studied children took their meals at fixed times, and dinner meal is their favorite meal due to the family atmosphere. Overweight and obese children tend to consume more meat, dairy, and fat products and fewer vegetables and fruits.

Concerning time spent in front of television, we observed that overweight and obese children spend more than 3 hours daily. Several studies have shown that the increase in the number of hours spent in front of the television is associated with overweight [36, 54-56]. Overweight and obese children are characterized by bad eating habits associated with decreased physical activity and increased sedentary activities. As we can see, subjects with unbalanced eating behavior, both boys and girls, are classified as obese subjects with a very high BMI, so overnutrition leads to a considerable increase in the BMI level.

For overweight and obese children, we noticed an excess consumption of these types of food when we compare them with the recommended thresholds.

The food intake for these normal-weighted children remains within the recommended limits, for the protein, we notice a low contribution of 4.17 % compared to the recommended threshold that it is of 20 %. For carbohydrates and lipids, we observed an excess of consumption 54.16 % and 41.67 %, respectively. When we compare these results with the recommended intakes, we find a significant difference, for carbohydrates, the recommended intake is 50 %, and for fats it is of 30 %.

Finally, we can state that a low physical activity level and overnutrition both contribute to the emergence of overweight in children.

5 Conclusion

This study shows that there is an increase in BMI values as we observe high BMI Z-scores in overweight and obese children compared to normal-weight children, especially in younger groups, which could lead to an increased burden of obesity in the future. Our results show that overweight and obese children consume more meat products, while normal weight children consume less fat and sugary foods. Overweight and obese children consume fewer fruits and vegetables compared to the recommendations. The studied children have bad eating habits (snacking between meals, consumption of fast food and sugary drinks). All these habits were associated with sedentary activities and can be

considered as obesity promoting factors. Indeed, an energy imbalance was observed, which is in favor of body weight variations. A nutritional education associated with the promotion of physical activity in schools seems necessary, aiming to improve the children's health status.

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