

# **GEORGIAN MEDICAL NEWS**

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**ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ**

Медицинские новости Грузии  
საქართველოს სამედიცინო სიახლენი

## GEORGIAN MEDICAL NEWS

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**GMN: Georgian Medical News** is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

**GMN: Медицинские новости Грузии** - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

**GMN: Georgian Medical News** – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

### WEBSITE

[www.geomednews.com](http://www.geomednews.com)

## К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman (Кириллица)**, для текста на грузинском языке следует использовать **AcadNusx**. Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - <http://www.spinesurgery.ru/files/publish.pdf> и [http://www.nlm.nih.gov/bsd/uniform\\_requirements.html](http://www.nlm.nih.gov/bsd/uniform_requirements.html) В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректурa авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

**При нарушении указанных правил статьи не рассматриваются.**

## REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or computer-printed on a single side of standard typing paper, with the left margin of 3 centimeters width, and 1.5 spacing between the lines, typeface - **Times New Roman (Cyrillic)**, print size - 12 (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: [http://www.nlm.nih.gov/bsd/uniform\\_requirements.html](http://www.nlm.nih.gov/bsd/uniform_requirements.html)  
[http://www.icmje.org/urm\\_full.pdf](http://www.icmje.org/urm_full.pdf)

In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

**Articles that Fail to Meet the Aforementioned  
Requirements are not Assigned to be Reviewed.**

## ავტორთა საქურაღებოლ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დაიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx**. შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შედეგის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფხიხლებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

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## OVERWEIGHT AMONG TUNISIAN SCHOOL-AGED CHILDREN: PREVALENCE AND ASSOCIATED FACTORS

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### Abstract.

**Aim:** To estimate the prevalence of overweight among school-aged children in Tunisia and to identify factors associated with overweight.

**Materials and Methods:** We conducted a cross-sectional descriptive study between January and April 2025 among children aged 6–11 years attending a Maternal and Child Protection Center in Tunis. Anthropometric measurements were collected, and dietary intake was assessed using a 24-hour dietary recall. Body mass index (BMI) categories were defined according to International Obesity Task Force (IOTF) references. Sociodemographic, perinatal, behavioral, and nutritional variables were analyzed. Multivariable logistic regression was used to identify factors associated with overweight.

**Results:** A total of 225 children aged 6 to 11 years (mean age  $9.18 \pm 1.73$  years; 58% girls). The mean BMI was  $18.05 \pm 3.6$  kg/m<sup>2</sup>. Based on French and IOTF growth references, 26.7% of participants were overweight, including 11.6% classified as obese, and 16.9% showed visceral fat excess. Multivariate analysis identified early adiposity rebound (OR = 1.43;  $p < 0.001$ ), grade retention (OR=3.28;  $p=0.039$ ), maternal obesity (OR=1.5;  $p=0.035$ ), breastfeeding duration under 6 months (OR=2.61;  $p=0.003$ ), introduction of cow's milk before 6 months (OR=1.78;  $p=0.003$ ), hyperphagia (OR=2.03;  $p=0.001$ ), snacking (OR=4.45;  $p=0.019$ ), lack of physical activity (OR=4.02;  $p=0.019$ ), low vitamin A intake (OR=1.02;  $p=0.029$ ), and high sodium intake (OR=1.15;  $p=0.043$ ) as independent factors associated with overweight.

**Conclusion:** These findings highlight the importance of early identification and intervention on modifiable behaviors and dietary habits to reduce the burden of childhood overweight.

**Key words.** Obesity, overweight, school-aged children, risk factors, nutritional intake.

### Introduction.

Childhood obesity has emerged as one of the most imminent global public health challenges. Its alarming rise is evident in both children and adults. According to the World Health Organization (WHO), the prevalence of overweight among children and adolescents aged 5 to 19 increased from 8% in 1990 to 20% in 2022, affecting over 390 million young individuals [1]. Tunisia is no exception to this trend: data from UNICEF indicate that the prevalence of obesity among children under 5 years increased from 14.3% in 2011 to 19% in 2022, with 44.2% of children at risk of overweight in 2018 [2].

Childhood obesity is a significant contributor to short- and long-term morbidity and mortality due to its numerous associated complications, including cardiovascular diseases, metabolic disorders, respiratory conditions, and an elevated risk of persistence into adulthood with profound physical and psychosocial consequences [3]. As a complex and multifactorial condition, childhood obesity arises from interactions between genetic predispositions and environmental factors. Changes in dietary habits, inappropriate lifestyles, physical inactivity, and unbalanced diets play critical roles in the development of the obesity pandemic [4].

In Tunisia, while the prevalence of childhood overweight has been extensively studied, few investigations have explored its determinants. The present study aimed to assess the prevalence of overweight among school-aged children followed at the Maternal and Child Protection Center (MCP) and to identify associated factors.

### Materials and Methods.

#### Study design and setting:

We conducted a cross-sectional descriptive study at the MCP center of Mellassine over a period of four months, from January 2025 to April 2025. The center is a preventive and social medicine service of the Bechir Hamza Children's Hospital in Tunis and a Positive Parenting Unit accredited by the Ministry of Women, Children, and Family, with the support of UNICEF and the contribution of the Italian Agency for Development Cooperation (AICS).

#### Study population:

We included children aged 6 to 11 years who presented for consultation at the MCP center of Mellassine, following informed consent from their legal guardians. Children with suspected secondary obesity (including syndromic, monogenic, or endocrine etiologies) or those receiving treatments known to potentially induce weight gain were excluded. Additionally, children whose parents or guardians were non-cooperative were not included in the study.

#### Sample size:

The sample size was calculated using Cochran's formula, with a z-score of 1.96 (corresponding to a 95% confidence level) and a prevalence (p) of 8%, based on the prevalence of childhood obesity in Tunisia as reported by the WHO in 2022 [5]. The minimum required number of participants was determined to be 213. A total of 225 children were included. Sampling was

conducted randomly among children followed at the MCP Center.

**Data collection:**

Data collection was conducted for each child using medical follow-up records, a standardized parental interview, and a clinical examination.

The collected information included general data, medical and surgical history, as well as lifestyle habits such as physical activity, sedentary behaviors, and average sleep duration. Family characteristics were recorded, along with socioeconomic status, estimated based on household income per person.

Perinatal and early life data included maternal preconception body mass index (BMI), gestational weight gain, maternal and neonatal complications, gestational age at delivery, mode of childbirth, birth weight, breastfeeding practices (type and duration), and the timing of introduction to complementary feeding. Gestational weight gain was evaluated according to the Institute of Medicine (IOM) guidelines, which are stratified by maternal pre-pregnancy BMI [6]. Complementary feeding initiated before the age of 6 months was considered early [7]. Eating behavior disorders were assessed in all children based on DSM-5 criteria, with adaptations specific to the pediatric population [8].

A dietary assessment was conducted using a 24-hour dietary recall. The data were analyzed using Nutrilog Online software, based on the CIQUAL 2020 food composition table validated

by ANSES. Dietary energy and macronutrient intakes were interpreted according to the 2019 recommendations of the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) [9]. Micronutrient intakes were evaluated based on the 2021 ANSES recommendations [10].

Each child underwent a thorough physical examination, which was complemented with anthropometric measurements including weight (W), height (H), waist circumference (WC). Body mass index (BMI) was computed and classified according to the International Obesity Task Force (IOTF) growth curves [11]. BMI categories were defined according to International Obesity Task Force (IOTF) age- and sex-specific cut-offs corresponding to adult BMI thresholds of 18.5, 25, and 30 kg/m<sup>2</sup>. Abdominal adiposity was defined as a waist-to-height ratio greater than 0.5 [12]. Adiposity rebound was defined as the age at which BMI reached its minimum before increasing again, based on growth curve trajectories available in medical follow-up records. Children for whom BMI trajectories did not yet show a clear adiposity rebound were excluded from analyses.

**Statistical analysis:**

Data were analyzed using SPSS version 21. Continuous variables were expressed as means ± standard deviations and categorical variables as frequencies and percentages. Comparisons between overweight and normal-weight groups were performed using the chi-square test for categorical variables and Student’s t-test for continuous variables.

**Table 1.** General characteristics of the study population.

		% or mean	SD
Age (years)		9.18 ± 1.73	1,73
Gender	Male	58	
	Female	42	
Socio-economic level	Low	86.5	
	Mild	13.5	
	High	0	
School grade	1st - 3rd grade	49.5	
	4th - 6th grade	50.5	
Grade retention		6.5	
Regular physical activity		17.6	
Maternal age at childbirth (years)		32.2	5
Parental age at childbirth (years)		39.5	7.4
Paternal consanguinity		17.5	
Maternal pre-pregnancy BMI (kg/m <sup>2</sup> )		26.29	3.89
Gestational weight gain (kg)		15.45	6.66
Mode of delivery	Vaginal	51.8	
	C-section	48.2	
Pregnancy complications	Gestational diabetes	15	
	Preeclampsia	6.5	
	Postpartum depression	4	
Type of feeding	Exclusive breastfeeding	40.5	
	Mixed feeding	44.5	
	Formula only	15	
Maternal breastfeeding duration	< 6 months	15.2	
	6 – 12 months	52.6	
	>12 months	32.2	
Age at food diversification	< 4 months	10.5	
	4 – 6 months	21.5	
	> 6 months	68	
Age of adiposity rebound (years)		6.27	2.93

**Table 2.** Association between general characteristics and overweight status.

	Overweight (N=60)	Normal weight (N=165)	p value
Age ≤ 9 years, % (n)	44.6 (27)	43.3 (71)	0.08
Gender, % (n)			
Male	41.4 (25)	40 (66)	ns
Female	58.9 (35)	60 (99)	
School grade, % (n)			
1st - 3rd grade	42.9 (26)	44.3 (73)	ns
4th - 6th grade	57.1 (34)	55.7 (92)	
Grade retention, % (n)	12.5 (8)	6.7 (11)	<b>0.039</b>
Age of adiposity rebound ≤ 6 years, % (n)	30.6 (18)	20.2 (33)	<b>&lt;0.001</b>
Regular physical activity, % (n)	10.9 (7)	33.3 (55)	<b>0.014</b>
Parental consanguinity % (n)	19.6 (12)	13.3 (22)	ns
Maternal obesity, % (n)	73.2 (44)	53.3 (88)	<b>0.035</b>
Maternal age at childbirth ≤ 32 years, % (n)	46.4 (28)	53.3 (88)	ns
Overweight among siblings, % (n)	12.9 (8)	6.9 (11)	ns

**Table 3.** Association between perinatal history and overweight status.

	Overweight (N=60)	Normal weight (N=165)	p value
Maternal pre-pregnancy BMI (kg/m <sup>2</sup> )	28.04 ± 4.72	26.16 ± 3.67	ns
Gestational weight gain (kg)	17.3 ± 9.27	13.54 ± 5.46	ns
Mode of delivery, % (n)			
Vaginal	33.3 (20)	15.6 (29)	ns
c-section	66.7 (40)	84.4 (136)	
Birth weight (kg)	3.56 ± 0.50	3.31 ± 0.55	ns
Maternal breastfeeding duration			
< 6 months	30.4 (18)	8.3 (14)	<b>0.015</b>
≥ 6 months	69.6 (42)	91.7 (151)	ns
Early introduction of cow's milk (< 6 months), % (n)	68.3 (41)	51 (31)	<b>0.022</b>

**Table 4.** Association between dietary intake and overweight status.

	Overweight (N = 60)	Normal weight (N = 165)	p value
Total energy intake (kcal/d)	2413.98 ± 384.4	1752.46 ± 253.2	<b>&lt;0.001</b>
Carbohydrate intake (g/d)	292.42 ± 51.9	210.93 ± 38.8	<b>&lt;0.001</b>
Fat intake (g/d)	104.56 ± 20.8	71.46 ± 14.1	<b>&lt;0.001</b>
Protein intake (g/d)	63.06 ± 13.2	54.59 ± 14.2	ns
Dietary fiber intake (g/d)	18.35 ± 3.5	23.88 ± 6.2	<b>0.041</b>
Vitamin A intake (µg/d)	301.04 ± 152.02	354.96 ± 532.45	<b>0.029</b>
Vitamin D intake (µg/d)	2.45 ± 0.95	2.11 ± 0.81	ns
Vitamin E (mg/d)	14.81 ± 5.07	8.70 ± 2.65	<b>&lt;0.001</b>
Vitamin C intake (mg/d)	127.99 ± 49.57	121.40 ± 0.22	ns
Vitamin B1 intake (mg/d)	0.82 ± 0.22	0.67 ± 0.13	<b>0.025</b>
Vitamin B2 intake (mg/d)	0.95 ± 0.21	0.84 ± 4.33	0.06
Vitamin B3 intake (mg/d)	11.17 ± 4.33	8.54 ± 3.11	ns
Vitamin B6 intake (mg/d)	1.42 ± 0.28	6.2 ± 2.75	0.05
Vitamin B9 intake (mg/d)	231.51 ± 66.20	192.16 ± 40.12	<b>0.042</b>
Vitamin B12 intake (µg/d)	1.78 ± 0.59	1.59 ± 0.54	ns
Magnesium intake (mg/d)	237.19 ± 49.27	180.50 ± 27.86	<b>p &lt; 0.001</b>
Calcium intake (mg/d)	555.07 ± 147.04	476.26 ± 123.25	ns
Phosphorus intake (mg/d)	1031.26 ± 242.29	803.73 ± 136.82	ns
Sodium intake (mg/d)	2505.85 ± 840.88	1693.1 ± 501.46	<b>0.014</b>
Iron intake (mg/d)	8.94 ± 2.13	6.69 ± 1.28	0.05
Zinc intake (mg/d)	6.17 ± 1.16	4.89 ± 0.80	ns
Selenium intake (µg/d)	111.04 ± 24.03	90.29 ± 17.51	ns

**Table 5.** Multivariate analysis of factors associated with overweight.

	OR (IC 95%)	p value
Age of adiposity rebound $\leq$ 6 years	1.43	< 0.001
Grade retention	3.28	0.039
Maternal obesity	1.5	0.035
Maternal breastfeeding duration < 6 months	2.61	0.011
Early introduction of cow's milk	1.78	0.003
Afternoon snack	2.07	0.004
Hyperphagia	2.03	0.001
Snacking	4.45	0.013
Lack of physical activity	4.02	0.019
Decreased vitamin A intake	1.02	0.029
Increased sodium intake	1.15	0.043

Multivariable logistic regression analysis was performed to identify factors associated with overweight. Variables with p-values <0.05 and those between 0.05 and 0.15 in univariate analysis were included in the initial model. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were reported. For continuous variables, ORs represent the change in odds per unit increase. A p-value <0.05 was considered statistically significant.

#### Ethical considerations:

The study protocol was conducted in accordance with the ethical principles of the Declaration of Helsinki. Prior to inclusion, informed consent was obtained from all participants (both children and their parents) after a full explanation of the study's objectives. Participants in whom abnormalities or concerns were identified during the interview were referred to specialized consultations (pediatrics, child psychiatry, etc.) for further management. The ethical committee of the Zouhair Kallel Institute of Nutrition and Food Technology of Tunis approved this study. This work has no conflicts of interest.

#### Results.

Our study included 225 children, whose general characteristics are summarized in Table 1. The mean BMI of the study population was  $18.05 \pm 3.6$  kg/m<sup>2</sup>. The prevalence of overweight was 26.7%, including 11.6% classified as obese. Underweight was observed in only 2.2% of the children. The average WC was  $60.42 \pm 10.26$  cm, with a mean WC/H ratio of  $0.44 \pm 0.06$ . Excess visceral fat was identified in 16.9% of participants.

The association between overweight status and general characteristics, as well as perinatal factors, are detailed in Tables 2 and 3, respectively.

No significant difference was observed in sleep duration between children with and without overweight ( $p = 0.46$ ). However, a daily screen time of  $\geq 60$  minutes was significantly associated with excess body weight ( $p = 0.01$ ).

No significant associations were found between overweight and medical history ( $p = 0.39$ ), surgical history ( $p = 0.54$ ), or previous hospitalizations ( $p = 0.068$ ).

Regarding dietary habits, the prevalence of overweight was significantly higher among children who consumed three or more meals per day ( $p < 0.001$ ), as well as those who reported having an afternoon snack ( $p = 0.004$ ). No significant association was found between overweight and the frequency of fast-food

consumption.

When examining eating behaviour disorders, overweight was significantly associated with snacking ( $p = 0.01$ ) and binge eating ( $p < 0.001$ ).

The association between overweight and dietary survey data is illustrated in Table 4. The results of the multivariate analysis are presented in Table 5.

#### Discussion.

Although numerous studies conducted in Tunisia have explored the prevalence of childhood obesity, few have been dedicated to investigating its determinant factors. The present study aimed to estimate the prevalence of overweight among school-aged children attending an MCP center, and to identify its associated factors.

Our study revealed overweight in 26.7% of children, including 15.1% classified as pre-obese and 11.6% as obese, consistent with WHO data and previous local studies [5,13]. The global rise in childhood obesity is the result of a complex interplay of genetic, psychosocial, and environmental factors. Key contributing determinants include changes in dietary habits, adoption of a sedentary lifestyle, lack of physical activity, and increasingly pronounced nutritional imbalances [1].

A significant association was found between overweight and grade repetition ( $p = 0.039$ ), with an odds ratio of 3.28 in multivariate analysis, which was consistent with findings reported in the literature [14]. This relationship may be explained by the psychological impact of academic failure, which can lead to feelings of sadness or even depression, thereby increasing the risk of developing eating behaviour disorders.

Our study identified a significant association between overweight and the age of adiposity rebound. These findings align with those reported by H. Thibault et al., who demonstrated that AR occurring between ages 3 and 6 serves as a critical predictive marker for overweight risk in late childhood [15].

Overweight was significantly associated with lack of leisure-time physical activity ( $p = 0.014$ , OR 4.01) and increased screen time ( $p=0.01$ ), consistent with previous studies [13,16]. Both factors reflect sedentary behavior, which contributes to energy imbalance and higher risk of overweight.

Moreover, our study identified a significant association between maternal obesity and childhood overweight ( $p = 0.035$ ), with an odds ratio of 1.5 in the multivariate analysis. This finding aligns with previous research, reflecting the combined influence

of genetic predisposition and shared familial environmental factors in the development of childhood obesity [17,18].

According to our research, overweight was significantly more frequent among children who had been breastfed for less than six months, compared to those who had received breastfeeding for six months or longer ( $p = 0.015$ ), with an odds ratio of approximately 2.61. According to the study by Maessen et al., breastfeeding may exert a protective effect against childhood obesity, particularly due to the presence of human milk oligosaccharides, which contribute to gut microbiota modulation and the development of the infant's immune system [19]. Breastfeeding for more than six months is advised by the Canadian Pediatric Society, WHO, and UNICEF as it is associated with a reduced risk of childhood overweight. This protective effect appears especially beneficial in children exposed in utero to excessive gestational weight gain.

In our study, childhood overweight was significantly associated with early introduction of cow's milk ( $p = 0.022$ ). While some studies suggest that early cow's milk consumption may increase obesity risk [20], others indicate that whole milk between 9 months and 2 years could have a protective effect by promoting satiety [21].

In the analysis of dietary habits, our research revealed a higher prevalence of overweight among children who consumed three or more meals daily ( $p < 0.001$ ), aligning with findings from prior studies [22].

Overweight was significantly associated with snacking ( $p = 0.01$ ) and binge eating ( $p < 0.001$ ), consistent with previous studies [22,23]. These behaviours had odds ratios of 4.45 and 2.03, respectively, and while clearly linked to overweight, the role of night eating syndrome warrants further investigation.

Analysis of dietary survey data revealed a significant association between overweight and higher carbohydrate and lipid intakes ( $p < 0.001$ ), consistent with numerous studies [22,24]. However, some research, including that of Tounian et al. did not find a significant link between carbohydrate consumption and obesity risk [25]. These discrepancies highlight the importance of considering carbohydrate quality, glycemic index, and timing of intake, in line with chrono-nutrition principles. As for lipids, their role in increasing meal energy density and promoting lipogenesis is well established [26]. Nevertheless, a recent study conducted by Legrand et al. offers a nuanced perspective, emphasizing interindividual differences in lipid metabolism and the critical importance of fat quality [27].

Our study revealed that overweight children had significantly lower vitamin A intake ( $p = 0.029$ ), consistent with previous studies [28,29]. In contrast, Liu et al. reported higher serum vitamin A levels in obese children, particularly those with abdominal obesity [30]. This discrepancy may be explained by the sequestration of fat-soluble vitamins in adipose tissue, potentially masking functional deficiencies despite normal plasma levels. Thus, the relationship between vitamin A and overweight remains complex and not fully understood. Vitamin E intake was significantly higher among overweight children compared to their normal-weight peers ( $p < 0.001$ ), contradicting the findings of Sbaji et al., who identified an association between vitamin E deficiency and overweight [31]. Intake of B vitamins

was also elevated: vitamin B1 ( $p = 0.025$ ) and vitamin B9, with some inconsistencies reported in the literature [32,33].

Overweight children exhibited significantly higher sodium intake ( $p = 0.014$ ). This association has also been reported in studies by Wang et al., who suggested that the elevated sodium excretion observed in obese children reflects their excessive salt consumption [33]. Such high intake may promote fat accumulation by stimulating lipogenic activity and increasing glucose conversion to lipids within adipocytes, thereby contributing to the development of overweight.

As for magnesium, intake was also significantly higher in overweight children ( $p < 0.001$ ). However, other studies have reported that low serum magnesium levels are associated with insulin resistance in obese children [34,35].

Our study is among the most recent Tunisian investigations focusing on factors associated with overweight in school-aged children, particularly those followed in a maternal and child protection center, aiming to strengthen early screening strategies and prevent obesity in adulthood and its metabolic complications. However, certain limitations should be acknowledged. The recruitment of children from a single public hospital center may limit the generalizability of the findings to the broader Tunisian pediatric population. Additionally, some data, especially those related to pregnancy history, were collected through parental recall, which may introduce recall bias.

## Conclusion.

In conclusion, childhood overweight remains a major public health concern in Tunisia. Our findings show a high prevalence of overweight and obesity among school-aged children, driven by early-life, dietary, and behavioral factors. Early, multidimensional prevention targeting these determinants is crucial to curb long-term metabolic risks.

## Conflicts of Interests.

The authors declare that they have no conflicts of interest.

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None to declare.

## Author contributions.

E.B. and N.T.: Study conception, data collection, and analysis.

S.K. and E.B.: Manuscript drafting.

H.A., K.O., and C.A.: Contributed to manuscript writing and interpretation of results.

N.T. and A.G.: Conducted and interpreted dietary surveys.

I.B.A., B.R., and D.B.: Provided expertise in the Mellassine Maternal and Child Protection Center.

H.J.: Provided expertise in the obesity unit.

C.A.: Supervised study design, implementation, and revision of the final manuscript.

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