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Research article

Impact of sociodemographic factors, sleep, physical activity, and sedentary lifestyle on central obesity in schoolchildren aged 6–12 years in Marrakech, Morocco

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ABSTRACT

Background: Central obesity is a growing public health concern globally, and the recognition of its specific impact on Moroccan demographics remains scarce. This study examined the associations of body mass index (BMI) and central obesity status (WtHR) with sociodemographic characteristics and lifestyle habits in a sample of school-aged children from Marrakech, Morocco.

Methods: The study sample consisted of 1161 children (9.43 ± 1.86 years old, 47 % boys) who attended nine public primary schools. Trained nurses conducted anthropometric measurements to determine the children's BMI and waist-to-height ratio, with a value of 0.5 or greater indicating central obesity. The study also collected data on children's lifestyle habits through a self-report questionnaire.

Results: Nine percent of the children were classified as centrally obese. The children's age, sex, place of residence, family structure, phone ownership, mother's literacy, and being a single child were significantly associated with BMI ($p < 0.05$). However, only being a single child and belonging to a single-parent family were significantly associated with central obesity ($p < 0.05$). Children with central obesity, compared to their noncentrally obese counterparts, reported poorer sleep duration, more sedentary habits, and less physical activity, but no significant associations were found ($p > 0.05$).

Conclusion: High rates of central obesity among schoolchildren in Marrakech, Morocco, require targeted interventions considering various factors, such as sociodemographic background, family dynamics, duration of sleep, and sedentary behavior. Addressing this issue is crucial for better health outcomes for Moroccan children.

1. Introduction

Childhood obesity is a significant public health issue in the 21st century, contributing to the burden of noncommunicable diseases. The prevalence of obesity and overweight among children and teenagers aged 5–19 years worldwide has significantly augmented ,

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increasing from 4 % in 1975 to just over 18 % in 2016 [1]. This global surge in overweight individuals occurred in both sexes, with 18 % of females and 19 % of males being overweight in 2016 [2]. Almost 50 % of children who are younger than 5 years of age and who suffer from excessive weight reside in Asia, while slightly more than 25 % reside in Africa [3]. The prevalence of childhood obesity in numerous countries within the Pacific, Eastern Mediterranean, Caribbean, and Americas is 20 % or greater among those aged 5–19 years [4].

Central obesity, characterized by excess abdominal fat, has become a critical public health issue, with increasing prevalence and significant implications for both current and future health outcomes [5,6]. This form of obesity is strongly associated with metabolic syndromes such as insulin resistance, type 2 diabetes, and cardiovascular diseases, making it particularly concerning [7–9]. Recent research underscores the multifaceted nature of risk factors contributing to this condition, with physical activity, sleep patterns, and sedentary behaviors playing pivotal roles [10–12].

Physical activity is a crucial determinant of energy balance and overall health, and a decline in physical activity among schoolchildren has been linked to increased rates of central obesity [13]. A study by Smith et al. [14] highlighted the inverse relationship between physical activity levels and the prevalence of general and central obesity, suggesting that regular engagement in moderate to vigorous physical activity can mitigate the risk of developing this condition. Conversely, sedentary lifestyle choices, such as excessive screen time and low engagement in physical activities, have been identified as significant predictors of central obesity among children [15].

Sleep patterns also play a crucial role in the development of central obesity. Insufficient sleep duration and poor sleep quality have been associated with hormonal imbalances favoring weight gain, particularly in the abdominal region. A recent meta-analysis by Li et al. [16] revealed a strong correlation between short sleep duration and the risk of central obesity in children, emphasizing the importance of adequate sleep for preventing the accumulation of visceral fat [17].

The interplay between physical activity, sedentary lifestyle, and sleep patterns underscores the complexity of factors contributing to central obesity among schoolchildren [18]. Addressing these risk factors through comprehensive public health interventions that promote physical activity, reduce sedentary time, and ensure adequate sleep could be pivotal to curb the increasing prevalence of central obesity in the infant population.

To provide a detailed analysis of the Moroccan case regarding central obesity among schoolchildren, focusing on the interplay between physical activities, sleep patterns, and sedentary lifestyles, it is essential to delve into recent studies that shed light on these aspects within the Moroccan context. The increasing prevalence of obesity in Moroccan schoolchildren is a reflection of broader lifestyle changes and socioeconomic factors influencing health behaviors [19].

Recent research conducted by Sahel et al. [20] in Morocco has shown a significant correlation between sedentary behaviors, particularly screen time, and rising rates of obesity among children/adolescents. The study highlighted that children in Morocco are becoming more involved in sedentary activities, resulting in a noticeable decline in their levels of physical activity. This change toward a more sedentary lifestyle is further amplified by urbanization and the increased availability of digital entertainment options, which are limiting the physical activity of children.

Furthermore, Cherkaoui Dekkaki et al. [21] highlighted the impact of inadequate sleep on the risk of developing general obesity among Moroccan schoolchildren. These authors suggested that insufficient sleep duration and poor sleep quality are linked to hormonal imbalances that can increase appetite and reduce energy expenditure, contributing to weight gain and central fat accumulation. This research underscores the importance of establishing healthy sleep habits as a preventive measure against obesity.

Addressing these issues requires a multifaceted approach that promotes physical activity in schools, encourages healthy sleep practices, and limits sedentary behaviors among children. Public health policies and interventions that focus on these areas could play a crucial role in mitigating the risk factors associated with central obesity in Moroccan schoolchildren. This analysis underscores the critical need for targeted interventions and policies that address the specific lifestyle factors contributing to central obesity among Moroccan schoolchildren, focusing on enhancing physical activity, improving sleep quality, and reducing sedentary behaviors.

Currently, there is a notable gap in the available information regarding the prevalence of central obesity among children in Morocco. Despite the recognition of obesity as a growing public health concern globally and the acknowledgment of its specific impact on Moroccan demographics, detailed data on central obesity among school-aged children in this region remain scarce. This lack of specific data underscores the critical need for comprehensive research focused on exploring the prevalence, risk factors, and consequences of central obesity among Moroccan children. Conducting such a study is relevant and essential for promoting public health strategies, interventions, and policies aimed at addressing and mitigating this health issue within the Moroccan context.

Overall, the present study aimed to determine the prevalence of central obesity and explore its association with sociodemographic and lifestyle factors among children aged 6–12 years who were enrolled in public primary schools in Marrakech, Morocco.

2. Methods

2.1. Study design and population

A cross-sectional study was carried out in Marrakech, Morocco, spanning from June 2020 to June 2021. The study included 1161 school-aged children, aged 6–12 years, of both genders who attended schools in all urban and rural communities within the Marrakech region.

The choice of the school as the place of investigation was motivated by the following advantages:

- Accessibility to the majority of children in a given population;

- Children who spend much time at school;
- Several stakeholders can form a strong synergistic group for investigative, improvement, and monitoring-evaluation actions.

2.2. Inclusion and exclusion criteria

In this survey, male and female participants who were living in urban or rural areas and aged 6–12 years were enrolled in a public school under the jurisdiction of the Marrakech Prefecture on the day of the survey. The exclusion criteria were as follows: (1) had cardiovascular, respiratory, or digestive diseases that could be a confounding factor; (2) did not consent to participate in the survey; (3) were absent from the survey; and (4) were unable to answer the questions.

2.3. Sampling base

One of the essential elements for establishing a probabilistic sampling plan is the creation of an adequate sampling base. The exhaustive list of schools and students aged between 6 and 12 years is estimated, according to 2021 statistics from the Regional Delegation of National Education in the prefecture of Marrakech, as follows:

- There were 321 primary schools, including 186 schools in rural areas and 135 schools in urban areas.
- There were 2052 primary classes, including 704 in rural areas.
- There were 104621 students in the 2020–2021 school year, including 63416 in urban areas.

2.4. Sample size

The sample size was calculated according to the following formula: $\mathbf{n} = \frac{\mathbf{D}\times\mathbf{z}^2\times\mathbf{p}(\mathbf{1}-\mathbf{p})}{\mathbf{m}^2}$

- $\mathbf{n}$ = sample size;
- $\mathbf{z}$ = confidence level according to the standard normal distribution (for a confidence level of 98 %, z = 2.33);
- $\mathbf{p}$ = estimated proportion of children with obesity. (50 % due to the lack of data regarding central obesity incidence among Moroccan children);
- $\mathbf{m}$ = margin of error tolerated (5 %);
- $\mathbf{D}$ = Sampling or cluster effect (Given that clusters are homogeneous and small in size, we will take an implicit value of the sampling effect of 2 because this value is generally used, especially for anthropometric surveys and vaccinations).

Thus, for a 98 % confidence interval, a sampling effect of 2, an obesity prevalence of 50 %, and a risk margin of 5 %, the sample size is estimated at 1084 students. This was rounded for statistical reasons to **1188** students based on **22** students per class.

2.5. Sampling method

In three-level stratified clusters (rural vs. urban), sample size "n" is estimated considering childhood obesity prevalence, sampling base "N", cluster effect, risk threshold, and confidence interval. Nine administrative divisions make up the urban and rural prefecture of Marrakech. To ensure fairness and inclusivity, one school from each urban and rural division was selected for inclusion in the sample. The selection process for the **first level** involved using stratified random sampling to choose **09** schools from the **321** schools in the prefecture of Marrakech, taking into account factors such as functional capacity, location (urban vs. rural), and availability of a functional school health service. For the **second level**, **06 classes** were randomly stratified for each of the nine chosen schools, considering variables such as sample size, levels of education (06 levels in primary education), and gender representation. Finally, at the **third level**, **1188** students were randomly and stratified among the students enrolled in **2021** in the **54** preselected classes (22 students per class).

2.6. Data collection

Before collecting any data, the school health team, along with the research team, conducted an information campaign. This was done during a public meeting with the students and/or their parents to explain the study's objectives, methods, and potential associated risks. During the data collection visits, 27 students were absent, which reduced the number of students studied to 1161.

2.7. Measurement of anthropometric parameters

At any specific time point, healthcare professionals trained in anthropometric measurements followed standardized international protocols to assess various physical attributes of the participants [22]. Body weight was measured using a calibrated digital scale (SECA4802), ensuring accuracy and reliability. Participants were instructed to wear minimal clothing, stand with their arms by their sides, and remove their shoes during the weighing process. Height was measured using a rod bodymeter (SECA208) on a flat surface. Participants stood barefoot with their backs against a wall and heelled together. Height was recorded in centimeters. Body mass index

(BMI), an indicator of weight relative to height, was calculated using the standard formula, which is calculated as weight in kilograms divided by height in meters squared. Waist circumference (WC) measurements were taken at the end of a normal exhalation, halfway between the lowest rib and the top of the hipbone. A nonstretchy measuring tape that was accurate to 0.1 cm was used to measure WC [23].

2.8. Survey instrument (Questionnaire)

Trained nurses administered the survey to students in the presence of their teachers. The questionnaire comprised four sections, including closed- and open-ended questions about children's lifestyles and environmental and sociodemographic characteristics. The following sections were used: (i) environmental and sociodemographic status of the parents, (ii) children's eating habits, (iii) physical activity, (iv) sedentary lifestyle, (iv) sleeping, and, finally, demographic questions. This paper does not address Section ii - Dietary Habits-.

2.9. Statistical analysis

SPSS software for Windows version 23.0 was used for data analysis. Means and standard deviations were applied in the case of nominal information, whereas frequencies were applied for qualitative data. Comparisons between multiple means of variables were completed by ANOVA, and the chi-square test was used for comparing categorical variables. Univariate and multivariate binary regression analyses were employed in this study. For this analysis, a p-value <0.05 was considered to indicate statistical significance.

2.10. Ethics and consent

The study followed the ethical principles of autonomy, beneficence, and nonmaleficence. The Ethics Committee of the Faculty of Medicine and Pharmacy of Marrakech approved this research in July 2019 (Reference: 21/2021). In addition, authorization from the Ministry of Health was obtained to collect data through school health program activities.

A consent form signed by the child's parents or guardian was required to participate in the study and collect anthropometric measurements. However, just before the measurement, the child was asked again for assent to participate in the study.

Table 1
Characteristics of the study population.

Characteristics/Modalities		N = 1161
Age (years) (Mean ± SD)		9.43 ± 1.86
Weight (kg) (Mean ± SD)		29.6 ± 10.26
Height (cm) (Mean ± SD)		137.36 ± 12.31
BMI (kg/m^2) (Mean ± SD)		15.34 ± 3.44
Waist (cm) (Mean ± SD)		59.33 ± 9.26
WtHR (Mean ± SD)		0.43 ± 0.53
Age groups (years)	[6–8[N (%)	233 (20.1)
	[8–10[N (%)	326 (28.1)
	[10–12[N (%)	602 (51.8)
Sex	Boys N (%)	546 (47.0)
	Girls N (%)	615 (53.0)
WtHR groups (obese ≥0.5)	Boys N (%)	51 (8.6)
	Girls N (%)	53 (9.3)
Residence	Urban N (%)	492 (42.4)
	Rural N (%)	669 (57.6)
Habitation	Exiguous N (%)	648 (55.8)
	Spacious N (%)	513 (44.2)
Both parents	Yes N (%)	1086 (93.5)
	No N (%)	75 (6.5)
Single child	Yes N (%)	44 (3.8)
	No N (%)	1117 (96.2)
Father Literacy	Literate N (%)	833 (78.7)
	Illiterate N (%)	225 (21.3)
Mother Literacy	Literate N (%)	637 (73.6)
	Illiterate N (%)	228 (19.6)
Father Working	Yes N (%)	1043 (94.5)
	No N (%)	61 (5.5)
Mother Working	Yes N (%)	255 (36.5)
	No N (%)	444 (63.5)

3. Results

3.1. Characteristics of the study population

Table 1 presents the demographic and anthropometric characteristics of the participants in the study. Of the **1161** children surveyed, 47 % were boys. The mean age of the study participants was 9.43 ± 1.86 years, with 51.8 % of the participants between the ages of 10 and 12 years. The average BMI was 15.34 ± 3.44 kg/m^2. The mean abdominal perimeter was 59.33 ± 9.26 cm. The majority of the population lives in rural areas (57.6 %). Additionally, 55.8 % of the population lived in nonexiguous habitation. 93.5 % of the children in the study had both parents present, while 6.5 % were single children. The majority of fathers were both literate (78.7 %) and employed (94.5 %). In contrast, only 73.6 % of mothers were literate, and 26.5 % were employed.

3.2. Prevalence and distribution of central obesity by sex

The mean waist-to-height ratio (WtHR) for the entire population was 0.43 ± 0.53. There were 104 individuals classified as centrally obese, accounting for 9.0 % (95 % CI, 7.38–10.75 %). Among the total population, this proportion was slightly greater for boys (9.3 %) than for girls (8.6 %) (Table 1).

3.3. Factors associated with BMI and the WtHR

This study examined the associations between BMI and central obesity (WtHR) with sample characteristics and lifestyle factors.

3.3.1. Sociodemographic and environmental characteristics

Age and residence were significantly associated with BMI ($p < 0.001$), indicating that older children and those living in urban areas tended to have higher BMIs. Similarly, gender ($p = 0.023$) and maternal literacy ($p = 0.035$) were significantly associated with BMI, suggesting that differences in BMI depend on the sex of the child and the mother's literacy level. In contrast, housing type showed a marginal association with BMI ($p = 0.058$), requiring cautious interpretation. Regarding parental literacy and parental work, no significant association was observed with BMI (Table 2). Furthermore, the prevalence of central obesity was relatively similar in all sociodemographic and environmental categories for the variables examined. No significant difference was observed (Table 2).

3.3.2. Family composition

The results showed a significant association between family composition and BMI as well as central obesity in participants. Children with two parents had a significantly lower average BMI than did children with one parent (15.25 ± 3.34 vs. 16.66 ± 4.47, p = 0,009). Similarly, single children had a significantly greater BMI than did those with two or more siblings (17.12 ± 3.98 vs. 15.27 ± 3.40, $p < 0{,}001$). Concerning central obesity, children whose parents were two had a significantly greater prevalence of a normal

Table 2
Relationship between BMI and Central Obesity with sociodemographic and environmental characteristics.

Variables	Modalities	BMI (Mean ± SD)	P value	WtHR N (%)		P value
				Normal <0.5	Central obese ≥0.5	
Age (years)	[6–8[	13.60 ± 2.32	<0.001	214 (91.8)	19 (8.2)	0.449
	[8–10[	14.71 ± 2.81		301 (92.3)	25 (7.7)	
	[10–12[	16.35 ± 3.75		542 (90.0)	60 (10.0)	
Sex	Male	15.10 ± 3.25	0.023	495 (90.7)	51 (9.3)	0.371
	Female	15.56 ± 3.59		562 (91.4)	53 (8.6)	
Residence	Urban	15.37 ± 3.83	<0.001	443 (90.0)	49 (10.0)	0.178
	Rural	15.32 ± 3.13		614 (91.8)	55 (8.2)	
Habitation	Exiguous	15.17 ± 3.10	0.058	591 (91.2)	57 (8.8)	0.454
	Spacious	15.56 ± 3.82		466 (90.8)	47 (9.2)	
Mother Literacy	Literate	15.07 ± 3.39	0.035	576 (90.4)	61 (9.6)	0.342
	Illiterate	15.64 ± 3.80		209 (91.7)	19 (8.3)	
Father Literacy	Literate	15.24 ± 3.32	0.191	758 (91.0)	75 (9.0)	0.693
	Illiterate	15.58 ± 3.68		207 (92.0)	18 (8.0)	
Father Work	No	15.62 ± 3.71	0.459	55 (90.2)	6 (9.8)	0.441
	Yes	15.28 ± 3.38		953 (91.4)	90 (8.6)	
Mother Work	No	15.47 ± 3.31	0.384	402 (90.5)	42 (9.5)	0.490
	Yes	15.24 ± 3.53		230 (90.2)	25 (9.8)	
Family Composition						
Presence of parents	Single parent	16.66 ± 4.47	0.009	61 (81.3)	14 (18.7)	0.005
	Both parents	15.25 ± 3.34		996 (91.7)	90 (8.3)	
Single child	No	15.27 ± 3.40	<0.001	1024 (91.7)	93 (8.3)	0.001
	Yes	17.12 ± 3.98		33 (75)	11 (25)	
Last child	No	15.43 ± 3.53	0.147	740 (91.2)	71 (8.8)	0.394
	Yes	15.13 ± 3.23		317 (90.6)	33 (9.4)	

WtHR than those whose parents were only one (91.7 % vs. 81.3 %, p = 0,005). Similarly, single children had a significantly greater prevalence of central obesity than did those with siblings (25 % vs. 8.3 %, p = 0,001). It should be noted that the position of the last child in her brotherhood was not significantly associated with either BMI or central obesity (Table 2).

3.3.3. Sleep patterns

Children who slept less than 8 h had a slightly greater mean BMI than those who slept 8 h or more (15.63 ± 3.40 vs. 15.23 ± 3.39), although the difference was not statistically significant (p = 0.148). A greater prevalence of central obesity was found among children sleeping less than 8 h than among those sleeping 8 h or more (12 % vs. 8.4 %), with a marginally significant difference (p = 0.087), suggesting a potential link between shorter sleep duration and central obesity (Table 3).

3.3.4. Physical activity

There was no significant difference in BMI or the incidence of central obesity between children who used active transport to school and those who used passive transport (p = 0.531 vs p = 0.161). Similarly, there was no significant difference in BMI or central obesity distribution between children who spent less than 30 min or who actively commuted to school (p = 0.252 vs p = 0.442). The study also revealed that regular gym activity was associated with a slightly greater BMI and percentage of individuals with central obesity, but this difference was not statistically significant (p = 0.731, p = 0.082). Finally, family leisure activities were not significantly different in terms of BMI or central obesity distribution (p = 0.480, p = 0.343) between children who participated in these activities at least once per week (Table 3).

3.3.5. Sedentary lifestyle

The study revealed no significant difference in BMI or the WtHR between children who spent 2 h or less in front of a screen on school days and those who spent more than 2 h (p = 0.082, p = 0.502). The same is true for those who had television in their bedroom (p = 0.085, p = 0.608) and who had full internet access (p = 0.625, p = 0.498). Owning a phone significantly increased the mean BMI (15.61 ± 3.30 vs. 15.15 ± 3.53, p = 0.025) but had no significant effect on central obesity distribution (p = 0.476) (Table 3).

4. Discussion

The present study aimed to measure central obesity among 6- to 12-year-old Moroccan children and to explore its association with sociodemographic characteristics, physical activity, sleep patterns, and a sedentary lifestyle in this population. The results were expected for certain factors but debatable for others.

The prevalence of central obesity in our sample was 9.0 %, which is marginally higher than that in Finland, Poland and Norway (8.7 %) [24–26] but considerably lower than that in Italy (13 %) [27], Australia (23 %) [28], or Greece (33 %) [18].

The analysis suggested that age, sex, and urban residence were significantly associated with a higher BMI among Moroccan

Table 3
Relationship between physical activity, sedentary lifestyle, and sleep duration with BMI and central obesity among children.

Variables	Modalities	BMI (Mean ± SD)	P- value	WtHR N(%)		P- value
				Normal (<0.5)	Centrally obese (≥0.5)	
Sleep						
Sleep duration	<8 h	15.63 ± 3.40	0.148	162 (88)	22 (12)	0.087
	≥8 h	15.23 ± 3.39		867 (91.6)	80 (8.4)	
Physical Activity						
Type of Transport to school	Active[a]	15.36 ± 3.48	0.531	984 (90.8)	100 (9.2)	0.161
	Passive[b]	15.10 ± 2.87		73 (94.8)	4 (5.2)	
Active time spent to school	<30min	15.29 ± 3.53	0.252	726 (90.6)	75 (9.4)	0.442
	≥30min	15.57 ± 3.35		249 (91.2)	24 (8.8)	
Regular Activity (Gym)	No	15.33 ± 3.40	0.731	144 (87.8)	20 (12.2)	0.082
	Yes	15.43 ± 3.70		913 (91.6)	84 (8.4)	
Family leisure activities at least once per week	No	15.40 ± 3.55	0.480	623 (90.7)	64 (9.3)	0.343
	Yes	15.26 ± 3.28		434 (91.6)	40 (8.4)	
Sedentary lifestyle						
Screen viewing (School days)	≤2 h	15.28 ± 3.41	0.082	948 (91.2)	91 (8.8)	0.502
	>2 h	15.85 ± 3.64		109 (89.3)	13 (10.7)	
Screen viewing (Off days)	≤2 h	15.47 ± 3.46	0.166	561 (91.2)	54 (8.8)	0.837
	>2 h	15.19 ± 3.43		496 (90.8)	50 (9.2)	
Own a phone	Yes	15.61 ± 3.30	**0.025**	436 (91.2)	42 (8.8)	0.476
	No	15.15 ± 3.53		621 (90.9)	62 (9.1)	
TV in bedroom	Yes	15.30 ± 3.53	0.085	499 (90.6)	52 (9.4)	0.608
	No	15.38 ± 3.37		558 (91.5)	52 (8.5)	
Full access to the internet	Yes	15.40 ± 3.44	0.625	433 (91.2)	42 (8.8)	0.498
	No	15.30 ± 3.41		624 (91.0)	62 (9.0)	

[a] On foot or by bike.
[b] By motor transport.

schoolchildren, which concords with the results of many studies [6,26,29,30]. Additionally, children whose mothers are literate tend to have a lower BMI. This can be attributed to mothers' increased knowledge of healthy lifestyle choices, which can help prevent obesity in their children [31]. A recent study showed that a lower level of parental education, as an indicator of socioeconomic status, was significantly associated with a higher BMI in children [32]. Conversely, studies suggest that children of highly educated parents who are forced to adopt healthy habits are more likely to engage in unhealthy behaviors [33].

However, in our sample, the prevalence of central obesity did not significantly vary across most sociodemographic variables, indicating that while certain factors influence BMI, they may not significantly affect the distribution of central obesity. These findings are in concordance with what has been found by Rodríguez Vargas et al. [34] and Fossou [35] but contrast with the majority of research that discusses abdominal obesity among children and might be explained by the use of the WtHR as an exclusive tool.

Family composition, particularly the presence of both parents and the number of children in the family, significantly impacted BMI and central obesity among our Moroccan schoolchildren sample. Children from single-parent families and single children are at a greater risk of obesity than their counterparts. According to a study conducted by Hesketh et al. [36], there is a strong correlation between family circumstances and childhood obesity. Various studies have demonstrated that having siblings and being part of a larger family increases opportunities for physical activity, shared healthy meals, and the transfer of good habits [37].

Our findings suggest that sleep duration may have a potential impact on central obesity among Moroccan schoolchildren, with shorter sleep durations associated with a greater incidence of central obesity. However, physical activity factors, including the type of transport to school, active time spent traveling to school, and regular gym activity, as well as participation in family leisure activities, did not significantly impact BMI or central obesity measures.

In line with these results, several studies have highlighted the importance of sufficient sleep quantity and quality in children's physical or psychological development and health [17,38,39]. Thus, insufficient sleep in children is linked to an increased risk of obesity. Research has shown that inadequate sleep in children is connected to a greater risk of obesity. A recent meta-analysis emphasized the significance of bedtime routines and sleep patterns in this correlation. The analysis also highlighted the crucial role of sleep duration in the association between sleep and obesity [39,40]. Another study confirmed our findings regarding the nonsignificant impact of physical activity on childhood obesity [41]. However, several other studies have reported different results and have emphasized the significant role of physical activity levels in increasing BMI or the WtHR among the pediatric population [4,10,42,43].

Furthermore, it has been found in the present research that owning a phone and leading a sedentary lifestyle may result in a higher BMI among schoolchildren in Morocco. The reason behind this is that owning a phone leads to increased usage, which has been proven to be significantly associated with a high BMI among children [44].

However, screen viewing time (both on school days and off days), having a TV in the bedroom, and full access to the internet did not significantly impact BMI or central obesity measures. These findings contradict those reported by Grigorakis [18], who reported that among all the lifestyle habits assessed, dietary habits and frequency of sedentary activities had the strongest cross-sectional association with the incidence of childhood central obesity.

These findings highlight the complexity of the relationship between sedentary behaviors and central obesity, suggesting that not all forms of screen time or technology access have the same impact on children's health. Further research is needed to explore these relationships in depth, considering other potential confounding factors and the quality of screen time activities.

4.1. Study strengths and limitations

The present study contains the ingredients of an original and pioneering study. To our knowledge, this is the first study in Africa and the Middle East and North Africa (MENA) region to simultaneously measure the prevalence of central obesity among schoolchildren aged 6–12 years using the WtHR tool in primary schools and its association with lifestyle factors (physical activity, sedentary lifestyle, and sleep duration). Other strengths of this study include the large sample size and its representativeness, which enhance the generalizability of the findings. Additionally, the anthropometric measurements were performed by trained healthcare professionals using internationally comparable methods, ensuring high reliability in the data collected.

Conversely, it is important to acknowledge that this study has several limitations. First, physical activity, sleep duration, and screen viewing time were retrospectively evaluated through self-reports, raising concerns about accuracy due to potential biases. Second, the cross-sectional design of the study makes causal relationships difficult. Third, the instrument used for data collection was not validated within the specific context of the study, affecting the robustness of the findings. Despite this limitation, the questionnaire was easily understood by the children involved, enhancing the data quality and providing a basis for future research. Fourth, in the absence of documented prevalence in the literature of childhood obesity among 6-12-year-olds in the Moroccan context, the study adopted a conservative approach by applying a prevalence of 50 % to maximize sample size and ensure statistical power, even if the actual prevalence later proved to be lower. This approach is crucial for exploring hypotheses and generating data for future research, as it can avoid biases in participant selection and ensure reliable results.

5. Conclusion

In conclusion, overweight and central obesity among schoolchildren are complex issues influenced by sociodemographic, lifestyle, and environmental factors. While studies from various countries have provided valuable insights into the prevalence and factors associated with overweight and especially central obesity among schoolchildren, the present study shed light on this topic in a specific and required local environment (Marrakech, Morocco). This study highlights the issue of central obesity among schoolchildren in Marrakech and emphasizes the need for interventions aimed at primary school children. Factors such as sociodemographic

background, family dynamics, duration of sleep, and sedentary behavior (such as smartphone usage) are important factors that need to be considered in such interventions. Public health authorities should pay close attention to this issue to improve the health of Moroccan children.

Regarding the trend and burden of central obesity as a public health concern for children, there is a need for more research focusing on the national context of Morocco. By understanding the global and local epidemiology of overweight and central obesity, targeted interventions can be developed to address these public health challenges among schoolchildren in Morocco.

CRediT authorship contribution statement

Youssef Lahyani: Writing – review & editing, Writing – original draft, Visualization, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Latifa Adarmouch:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Conceptualization. **Majda Sebbani:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Conceptualization. **Ouassim Mansoury:** Writing – review & editing, Software, Formal analysis, Data curation, Conceptualization. **Hicham EL Mouaddib:** Writing – review & editing, Writing – original draft, Validation, Methodology, Conceptualization. **Mohamed Amine:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Formal analysis, Data curation, Conceptualization.

Ethical statement

This study was performed in line with the principles of the Declaration of Helsinki. This study was reviewed and approved by the Ethics Committee of the Faculty of Medicine and Pharmacy of Marrakech with the approval number: 21/2021, dated July 10, 2021.

Data availability statement

Data will be made available on request.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e41176.

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