ISSN Print: 2664-8350
ISSN Online: 2664-8369
Impact Factor: RJIF 5.26
IJPN 2024; 6(2): 06-10
www.pediatricsjournal.net
Received: 04-05-2024
Accepted: 09-06-2024

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Identification of risk factors, comorbidities and effects of life style interventions in sample of overweight and obese children and adolescents

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DOI: https://doi.org/10.33545/26648350.2024.v6.i2a.74

Abstract
Background: Obesity is a complex disease, which is intertwined with biological, developmental, environmental, behavioral, and genetic factors. Aim of the study: Identification of risk factors for obesity, evaluate the associated co morbidities, and study the effects of lifestyle modification on body mass index and glycosylated hemoglobin in obesity in children and adolescence.
Method: A prospective non-randomized research at the Children Welfare Teaching Hospital-Medical City/Baghdad included overweight and obese children aged six to fifteen who attended the Paediatric Endocrinology Clinic from January to July 2022. Personal lifestyle data included daily exercise, screen time, sleep pattern, and nutrition. Physical, laboratory, abdominal ultrasonography, and bone age assessments were done. Diet, exercise, sleep, and screen time advice for patients and families. Body mass index and glycosylated haemoglobin were measured six months after lifestyle modification.
Results: The research included 74 kids. The most prevalent age was 6-10. 39(52.7%), more girls were born. 39 (52.7%) 64 (86.5%) babies were normal weight. A family record. 15 (20.27%) had obesity/diabetes mellitus, 16 (21.6%) had both, and 42 (56.8%) had no family history of obesity. One study indicated that 85.1% of children had less than 30 minutes of daily physical exercise, 48.6% slept less than 9 hours, 75.7% had over 2 hours of screen usage, and 97.3% had bad diets. Additionally, 40.5% of children had elevated HbA1C. BMI and HbA1C dropped considerably after 6 months (P=0.000).
Conclusion: Obesity is linked to poor diet, lack of exercise, sleep deprivation, and screen time. Hypertension, NAFLD, and dyslipidemia are the primary obese co-morbidities. A family history of obesity increases the chance of childhood obesity. Reducing BMI and glycosylated haemoglobin by changing family and child lifestyles works.

Keywords: Risk factors, comorbidities, effects, life style, interventions, overweight, obese children, adolescents

Introduction
Obesity is a complex, multifactorial disease influenced by biological, developmental, environmental, behavioral, and genetic factors. The global prevalence of obesity, particularly among children and adolescents, has been rising at an alarming rate, prompting significant public health concern. According to recent estimates, the number of overweight children under the age of five reached over 42 million in 2013, with the majority (about 31 million) residing in developing countries [1]. The pathogenesis of obesity is predominantly due to an imbalance between caloric intake and expenditure. This energy imbalance leads to excess adipose tissue accumulation, posing significant risks for developing numerous non-communicable diseases (NCDs) at an early age and increasing the likelihood of premature death in adulthood [2]. A critical period for predicting future obesity is the adiposity rebound (AR) in early childhood, which can influence obesity trajectories into adolescence and adulthood [3]. Genetic predispositions play a substantial role in obesity. The interaction between genes and environmental factors creates a complex system that regulates energy balance. This regulation is mediated by neurons in the hypothalamic arcuate nucleus, which control food intake and energy expenditure through responses to circulating neuropeptide hormones. Additionally, the microbiome and various peripheral signals originating from

adipose tissue, the stomach, pancreas, and other organs contribute to the regulation of short-term and long-term energy balance [4]. The increase in pediatric obesity has become a global epidemic, affecting both developed and developing nations. For instance, a study in Romania revealed that one in four children is overweight or obese, with risk factors including male sex, prepubertal age, and urban living conditions [5]. In the United States, data show significant increases in obesity and severe obesity among children, particularly among those from lower-education households and less urbanized areas. The prevalence is notably higher among non-Hispanic Black and Hispanic youth compared to their non-Hispanic white counterparts [6]. Environmental factors, such as dietary patterns and physical activity levels, are crucial determinants of childhood obesity. In low- and middle-income countries, children are often exposed to high-fat, high-sugar, and high-salt energy-dense foods that are low in micronutrients. This dietary pattern, combined with reduced physical activity, contributes significantly to the rise in childhood obesity [7]. Body Mass Index (BMI) is a widely used metric for diagnosing obesity, calculated as weight in kilograms divided by height in meters squared. BMI is strongly correlated with body fat and provides reference values for comparison across different age and sex groups. However, BMI alone does not account for the distribution of fat or differentiate between muscle and fat mass, which are important considerations in understanding the health implications of obesity [8]. Interventions to combat childhood obesity focus on lifestyle modifications, including dietary changes, increased physical activity, and behavioral adjustments. Studies have shown that school-based interventions, such as banning sugar-sweetened beverages and increasing the availability of fruits and vegetables, can significantly reduce obesity prevalence [9]. Furthermore, promoting physical activity and reducing sedentary behaviors, such as screen time, are effective strategies in managing and preventing obesity [10]. The identification of obesity risk factors. Assess the concomitant co-morbidities. Examine the impact of lifestyle modifications on BMI and HbA1c levels among adolescents and children who are obese.

Methods

The methodological approach of this study is meticulously designed to achieve its aim of identifying the risk factors for obesity, evaluating the associated comorbidities, and examining the effects of lifestyle modification on Body Mass Index (BMI) and glycosylated hemoglobin (HbA1c) in overweight and obese children and adolescents. This prospective non-randomized study was conducted at the Children Welfare Teaching Hospital, Medical City in Baghdad. It included overweight and obese children who attended the Pediatric Endocrinology Clinic from January 1st to July 1st, 2022. The study focused on children aged six to fifteen years who presented with complaints of overweight or obesity. Exclusion criteria included syndromic obesity (e.g., Prader-Willi syndrome), endocrinological diseases (such as thyroid or adrenal disorders, diabetes mellitus), and drug-induced obesity. Detailed personal information was collected, which included lifestyle behaviors concerning physical activity, screen time, sleep patterns, and dietary habits. Physical activity was categorized based on the daily time of exercise, while screen time was measured by the time spent watching television or using mobile devices. Sleep patterns were categorized into less than 9 hours, 9-12 hours, and more than 12 hours per 24 hours. Dietary behavior was assessed by examining the consumption of high-calorie, high-fat, high-carbohydrate, low-fiber foods, and sugar-containing beverages. The physical examination involved measuring BMI, waist circumference, and identifying signs of Acanthosis Nigricans. BMI was calculated as weight in kilograms divided by height in meters squared and was interpreted using age- and sex-specific percentiles. Waist circumference was measured using a tape measure placed around the patient's middle, just above the hipbones. Blood pressure was also measured and categorized according to established percentiles. Comprehensive biochemical tests were conducted, including fasting blood sugar (FBS), HbA1c, lipid profile, liver function tests, thyroid function tests, adrenocorticotropic hormone (ACTH), cortisol, and vitamin D3 levels. Blood samples were taken between 8 to 10 a.m. and analyzed in the Children Welfare Teaching Hospital Laboratory and Teaching Laboratories at Medical City. Follow-up samples were collected six months later to monitor changes in HbA1c levels. Bone age was assessed using an X-ray of the left hand and wrist, employing the Tanner-Whitehouse method. Findings were categorized into delayed, normal, or advanced bone age, based on the deviation from chronological age. The management intervention included educating patients and their families about the risks of obesity and comorbidities. Specific advice on weight management was provided during health education lectures, covering dietary interventions (Such as nutrition education and balanced meals), physical activity promotion (Encouraging exercise and reducing sedentary behavior), sleep time alterations, and screen time limitations. Detailed written instructions were provided to reinforce the educational sessions. Data analysis was performed using the Statistical Package for Social Sciences (SPSS) version 26. Variables were expressed as mean/standard deviation and frequency/percent, according to their type. Paired t-tests were used to assess the association between continuous variables, with a confidence level of 95% and a p-value of ≤ 0.05 considered statistically significant.

Results

The study included 74 obese children. Those children were assessed after six months for BMI and HBA1C. The mean age of the children was 10.11±2.42 years with age range 6-15 years. The age group (6-10 years) was the most common 39 (52.7%), followed by the age group (11-15 years) 35(47.3%). Regarding gender, female children were more common 39 (52.7%) while male children constitute 35 (47.3%) of the children as shown in Table 1.

Table 1: Socio-demographic variables of the children

Variable		Frequency N=74	Percent %
Age Group	6-10 years	39	52.7
	11-15 years	35	47.3
Gender	Male	35	47.3
	Female	39	52.7

Regarding birth weight, 64 (86.5%) children had normal birth weight. For family history, 42 (56.8%) child had no family history in relevant to obesity while 10 (13.5%) had

obesity, 11 (14.9%) had obesity/hypertension,15 (20.27%) had obesity/diabetes mellitus and 16 (21.6%) of them had more than one condition in Table 2.

Table 2: Socio-demographic variables of the children

Variable		Frequency N=74	Percent %
Birth weight	SGA	3	4.1
	Normal	64	86.5
	LGA	7	9.5
Family Hx.	None	42	56.8
	Obesity	10	13.5
	Obesity +Hypertension	11	14.9
	Obesity+ Diabetes Mellitus	15	20.27
	More than one	16	21.6

It was found that 63 (85.1%) of the children did physical activity <30 minutes/day 36 (48.6%) slept <9 hours/day, 56 (75.7%) had screen time more than 2 hours/day and 72 (97.3%) of them had unhealthy dietary behavior as shown in Table 3.

Table 3: Lifestyle of the children

Variable		Frequency N=74	Percent %
Physical activity	>60 minutes	4	5.4
	30-60 minutes	7	9.5
	<30 minutes	63	85.1
Sleep pattern	>12 hours	12	16.2
	9-12 hours	26	35.1
	<9 hours	36	48.6
Screen time	>2 hours	56	75.7
	2 hours	10	13.5
	<2 hours	8	10.8
Dietary behavior	Healthy	2	2.7
	Unhealthy	72	97.3

Regarding FBS, 11 (14.9%) and 2 (2.7%) of the children were found to have prediabetes and diabetes respectively. Moreover, 30 (40.5%) of the children had high HbA1C levels at baseline level as shown in Table 4.

Table 4: Fasting blood sugar of the children.

Variable		Frequency N=74	Percent %
FBS	Normal	61	82.4
	Pre-diabetes	11	14.9
	Diabetes	2	2.7
HBA1C	Normal	44	59.5
	High	30	40.5

Among the 74 obese children studied, 13 (17.6%) of them were found to have hypertension, 2 (2.7%) diabetes, 16 (21.6%) non-alcoholic liver disease, 4 (5.4%) dyslipidemia and 4 (5.4%) metabolic syndrome as shown in Table 5.

Table 5: Co-morbidities of the children

Variable	Frequency N=74	Percent %
Hypertension	13	17.6
DM	2	2.7
Nonalcoholic liver disease	16	21.6
Dyslipidemia	4	5.4
Metabolic syndrome	4	5.4

For thyroid function test, 63 (85.1%), 71 (95.9%) and 65 (87.8%) of the children were found to have normal TSH, T4 and T3 values respectively and others had either low or high values as shown in Figure 1.

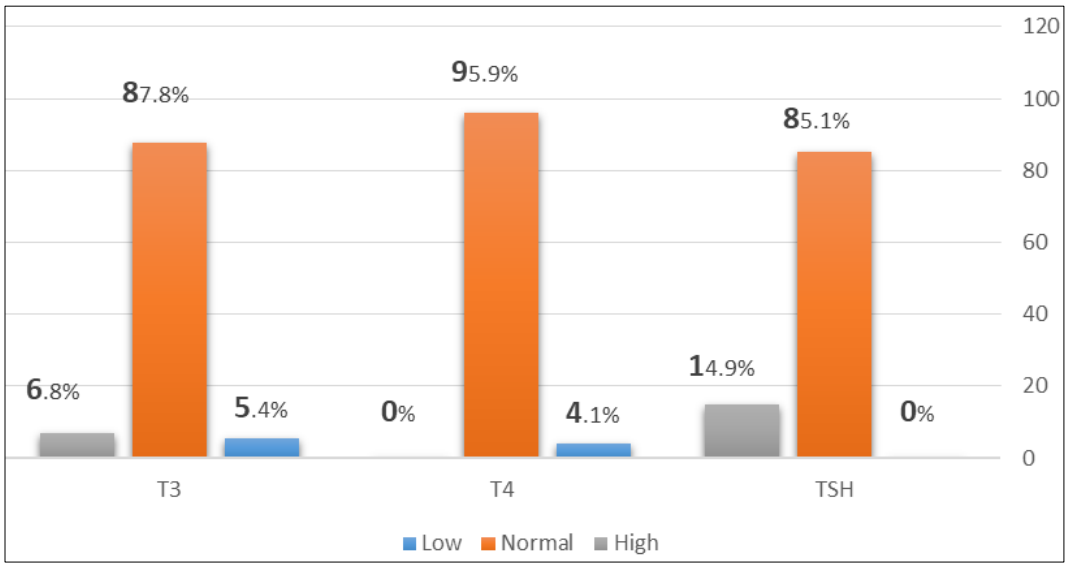

Fig 1: Distribution of the children according to thyroid function test.

After a follow-up period of 6 months, BMI and HbA1C values decreased significantly (P=0.000) as shown in Table 6. and Figure 2.

Table 6: Six-months follow-up of the children

Variable	Baseline	After 6 months	t test	P value
	Mean ± SD	Mean ± SD		
BMI	31.1±6.82	28.7±7.69	4.05	0.000*
HBA1C	5.52±0.57	5.32±0.58	5.06	0.000*

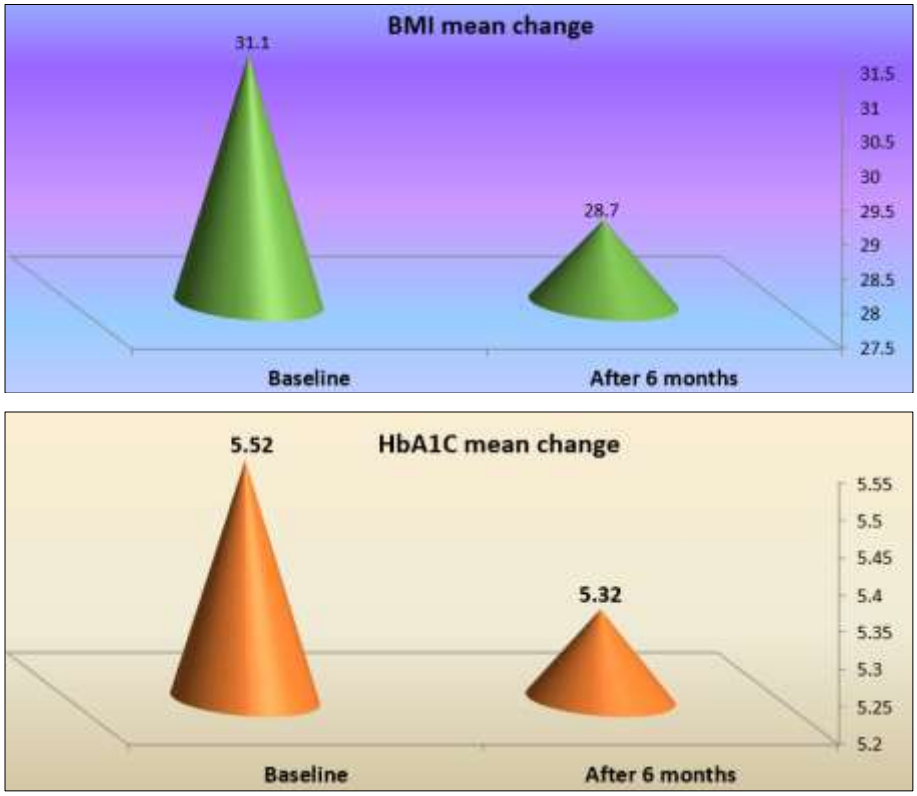

Fig 2: Six-months follow-up of the children BMI and HBA1C.

Discussion

The study aimed to identify risk factors, evaluate comorbidities, and assess the impact of lifestyle interventions on BMI and HbA1C levels among overweight and obese children. The findings are consistent with the current understanding of pediatric obesity, indicating that lifestyle factors such as physical inactivity, unhealthy dietary habits, excessive screen time, and inadequate sleep are significant contributors to obesity in children. The age distribution revealed that younger children (6-10 years) constituted a larger proportion of the study population compared to older children (11-15 years). This aligns with previous studies suggesting that early childhood is a critical period for the development of obesity. Gender analysis showed a slightly higher prevalence of obesity among females, which could be attributed to cultural and behavioral factors influencing physical activity and dietary patterns [11]. A significant majority of the children exhibited low levels of physical activity, with 85.1% engaging in less than 30 minutes of daily exercise. This sedentary lifestyle, coupled with high screen time (75.7% spending more than two hours per day), exacerbates the risk of obesity. These findings are supported by existing literature emphasizing the negative impact of prolonged sedentary behavior on children's weight status [11]. Dietary habits were predominantly unhealthy among the study participants, with 97.3% consuming high-calorie, low-nutrient foods. This dietary pattern is a well-documented risk factor for obesity and related comorbidities. The role of diet in obesity management cannot be overstated, as proper nutrition is essential for maintaining a healthy weight and preventing metabolic complications [12]. The study identified several obesity-related comorbidities among the children, including hypertension (17.6%), non-alcoholic fatty liver disease (21.6%), dyslipidemia (5.4%), and metabolic syndrome (5.4%). These conditions highlight the severe health implications of childhood obesity, which extend beyond mere weight gain to include significant metabolic and cardiovascular risks [13, 14]. The follow-up after six months of lifestyle intervention demonstrated significant improvements in both BMI and HbA1C levels. The mean BMI decreased from 31.1 to 28.7, and HbA1C levels dropped from 5.52% to 5.32%, indicating improved glycemic control and overall metabolic health. These results underscore the effectiveness of lifestyle modifications in managing obesity and its complications [15, 16]. The findings reinforce the importance of comprehensive lifestyle interventions in the management of childhood obesity. Educational programs targeting both children and their families about healthy eating, physical activity, and limiting screen time are crucial. School-based interventions, such as promoting physical education and providing healthier meal options, have also been shown to be effective strategies [17]. The study's limitations include its non-randomized design, single-center setting, and the relatively short follow-up period of six months. These factors may affect the generalizability of the results. Future research should consider longer follow-up periods and include a more diverse population to validate these findings and extend their applicability.

Conclusion

Major lifestyle factors contributing to obesity include the consumption of unhealthy food, low levels of physical activity, sleep deprivation, and excessive screen time. The primary comorbidities associated with obesity are hypertension, non-alcoholic fatty liver disease, and dyslipidemia. A family history of obesity is a significant risk factor for childhood obesity. Modifying the lifestyles of both families and children is an effective method for reducing BMI and HbA1C levels.

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How to Cite This Article
Hadi TM, Al-Zubaidi MA, Amir ADA. Identification of risk factors, comorbidities and effects of life style interventions in sample of overweight and obese children and adolescents. International Journal of Pediatrics and Neonatology. 2024;6(2):06-10.