Evaluation of the connection among Dietary intake and lipid profile parameters in obese children

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ABSTRACT

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Obesity, characterized by an excess accumulation of body fat, presents a critical public health challenge due to its association with numerous serious illnesses. This study aimed to assess how dietary habits correlate with lipid profiles in obese children. A total of 100 children aged 4-12, from the National Nutritional Institute's obesity clinic in Cairo, participated, with 70 classified as obese and 30 as controls. Body mass index and dietary patterns, along with serum lipid profiles, were key parameters analyzed. The findings indicated significant differences between the groups in calorie intake, protein, fat, carbohydrates, and fiber ($P<0.05$). Additionally, mineral and vitamin intake was notably higher in the obese group, except for calcium, magnesium, and vitamin A, while vitamin C intake was lower compared to controls. In comparison to controls, obese children had a notable decrease in high-density lipoprotein cholesterol (HDL-C) of 14.2% and a striking increase in total cholesterol (TC), triglycerides (TG), and low-density lipoprotein cholesterol (LDL-C) ($p<0.05$). The study underscores the importance of early nutritional and metabolic assessment in combating childhood obesity and its associated health risks, aiming to mitigate long-term complications and foster healthier futures for children.

Keywords: *obesity, dietary habits, lipid profiles, atherogenic index.*

PREFACE

With its prevalence rising quickly, childhood obesity has emerged as a major global public health concern (**Nguyen et al., 2020; Wang and Lim, 2012)**. In conclusion According to **WHO (2021)** data, 38 million kids below their fifth birthday were overweight or obese globally in 2020. This is a considerable increase from previous years and emphasizes the significance of early nutrition. Given the health hazards that come with pediatric obesity, such as dyslipidemia, and diabetes, including type 2, and heart problems, it is alarming that this trend is continuing **(Skinner and Skelton, 2014; Franks et al., 2010).** Dyslipidemia, characterized by abnormal lipid levels, is particularly prevalent among obese children, predisposing them to early onset of atherosclerosis and other metabolic complications **(Nguyen and Others 2019; Morrison and Work Team 2020).** Dyslipidemia can occasionally be caused by genetic predisposition, but lifestyle variables like food choices have a big impact on how it develops and progresses **(Daniels and Copartner 2018; Mujika, 2019).** Understanding the relationship between dietary intake and lipid profile parameters is crucial for devising effective preventive and therapeutic strategies for obese children at risk of dyslipidemia-related complications.

Investigating the dietary intake of obese children is crucial for understanding the relationship between nutrition and health outcomes **Dicken and Batterham (2021)**. Recent studies have highlighted the importance of assessing dietary patterns rather than focusing solely on individual nutrients **(Smith et al., 2022)**. Understanding the lipid profiles of obese children can provide insights into their cardiovascular risk factors **(García-Rodríguez et al., 2024**). Emerging research suggests that dietary interventions tailored to specific lipid profiles may be more effective in managing obesity-related health complications **(Chen et al., 2024)**. Analyzing dietary habits alongside lipid profiles can offer a comprehensive approach to managing obesity in children **(Brown and Else 2023).**

Despite numerous studies investigating this association, there remains a need for comprehensive research elucidating the specific dietary factors influencing lipid profiles in obese children, considering the complexity of dietary patterns and metabolic responses **(Chiu and another 2018; Serra-Majem et al., 2021).** Thus, by analyzing the relationship between habits of eating and lipid profiles in obese children, this study hopes to fill this knowledge gap.

SUBJECTS AND METHODS

Inclusive Subjects

- Egyptian children aged 4 – 12 years.
- Obese children have a BMI ≥95th percentile.

Exclusive subject

The study excluded children who suffered from diabetes mellites, a chronic condition associated with obesity (e.g. Prader-Willi syndrome), and also, who were on chronic medications known to cause weight gain (e.g. corticosteroids).

METHODOLOGY

Evaluations of the body's mass index (BMI):

A calculation of the BMI had been taken. Assessments of height (m) and Body weight /kg (BW/kg) were taken when the subjects were fasting, dressed comfortably, barefoot, and had their bladders empty. BMI is calculated as follows:

[BMI = weight (kg) / height^2 (meter)].

The United States Centers for Disease Control and Prevention (CDC) growth reference (2023) was used to generate the body mass index z-scores.

Healthy weight ≥5 and <85 percentile; Overweight is ≥85 and <95 percentile, and Obesity has ≥95percentile.

Dietary Patterns and Biochemical Investigations:

Assessments of nutritional intakes were performed by using 24hrs dietary recalls. Blood samples were collected after fasting for 12 hours into appropriately cleaned igniters. Blood samples were centrifuged at 4000 rpm for 5 minutes to produce non-hemolysis serum. The resulting serum samples were then separated and kept at -20°C. Subsequently, sera specimens were used to compute LDL-c using the formula from **Guder and Teammate (2000)** and to determine the lipid profile, which includes serum TC, TG, and HDL-c **(Martin and Coworker 2013).** The atherogenic index (AI), cardiac risk ratio (CRR), and atherogenic coefficient (AC) are calculated **(Kim et al., 2022).**

Statistical analysis:

According to **Colman and Pulford (2011)**, the data were scientifically described using the mean along with the standard deviation (SD). T-tests were used at ($p<0.05$) by mathematical modeling using SPSS, PC statistical software (version 16 SPSS Inc., Chicago, USA).

Ethical approval

The study received ethical approval from the research ethics committee of the General Organization for Teaching Hospitals and Institutes. Before commencing the study, written consent was obtained from the parents agreeing to participate. The approval number IN000134 has been registered accordingly.

RESULTS AND DISCUSSION

Data presented in **Table (1)**, illustrate that there was significant elevation ($p<0.05$) in BMI and BW/kg of the obese children compared to the normal group with percent change reaching 62.37% and 33.9 respectively. These results suggest that BMI is a useful indicator of obesity, which is frequently linked to sedentary lifestyles, poor eating patterns, competition from others, and social activities **(Ahila et al., 2015)**. **D'souza and Shekar (2015)** have pointed out that hereditary variables can have an impact on obesity and raise BMI values.

The comparison of daily macronutrient intake between the groups of children with normal and those with obesity is shown by the results in **Table (2).**

Calories, protein, fat, carbs, and fiber were found to differ greatly between the two groups ($p < 0.007$, 0.001, 0.01, 0.00, and 0.02), in that order. Also, clarified that the dietary intake of the obese group in all macronutrients was higher than normal group. These results are in harmony with those reported by **Romieu and another (2017)** who observed that increased energy intake is the primary factor contributing to excessive weight and obesity.

Major-Smith et al., (2023) display that obese children often consume diets high in refined carbohydrates and saturated fats, contributing to weight gain and metabolic disturbances. Similarly, a study by **Buckland and Others (2022)** demonstrated a positive correlation between high dietary fat intake and adiposity in children. These findings underscore the need for dietary interventions aimed at optimizing macronutrient composition to manage childhood obesity effectively.

Except for calcium, magnesium, and vitamin A **Table (3&4),** the food intake of the obese group was considerably higher than that of the normal group in all minerals and vitamins ($P<0.05$). These results match with **Verma et al., (2023)** who observed the availability and affordability of nutrient-poor, energy-dense foods contribute to this dietary trend, exacerbating the risk of mineral overload. Dietary patterns in obese children often include high consumption of processed foods and sugary beverages, leading to an increased intake of minerals such as calcium, magnesium, and sodium. **Brown and Fellow Workers (2023)** demonstrated that obesity-related gastro-intestinal alterations, such as increased gastric pH and altered gut microbiota composition, can impair minerals and vitamin absorption in obese children. These changes disrupt the normal absorption processes in the gastrointestinal tract, leading to the malabsorption of essential minerals and vitamins despite their increased dietary intake. It is known that type 2 diabetes, dyslipidemia, and hypertension are all associated with obesity.

Serum lipids and lipoproteins are frequently altered in overweight and obese people. The two most frequently noted alterations among them are decreased HDL-C levels and hyper-triglyceridemia **(Elsawi et al., 2014).**

Statistical analysis of the obtained data in **Table (5)** evident that serum levels of TC, TG, and LDL-C, were considerably elevated ($p<0.05$) with percent changes reaching 31.3%, 78.7%, and 48% respectively, compared to normal children. On the contrary serum level of HDL-C had greatly reduced ($p<0.05$) with a percent change reaching 14.2% compared to the normal. These findings are in agreement with the outcomes of **(YOON et al., 2013; Elochukwu, 2015)**. In addition, the normal children's HDL-C level was noticeably higher than that of the obese subjects. This is also consistent with research by **Elokukwu (2015)**, who demonstrated a significant inverse relationship between HDL-C levels and obesity. Furthermore, HDL-C is made to transport cholesterol from tissues and the bloodstream into the liver for elimination, according to a study by **Arimura et al. (2012)**

Furthermore, compared to the normal group, the obese group showed substantial increases in the AI [log (TG/HDL-C)] by 112.83%, the AC (total cholesterol - HDL-C / HDL-C) by 76.81%, and the cardiac risk ratio (total cholesterol / HDL-C) by 52.8%. These findings are consistent with those **of Kim and Else (2022),** who found a link between cardiovascular risk and AI. According to **Sadeghi et al. (2021),** AI is determined by the ratio of TG to HDL-C, and TG is correlated with serum LDL-C levels **(Brunzell and Hokanson, 1999).** Consequently, the association between AI and the risk of CVD is most likely explained by its relationship to the lipoprotein particle size **(Dobiasova, 2006).** AI is inversely correlated with the diameter of LDL-C particles and serves as a stand-in for minute, dense LDL particles. Consequently, an increase in AI denotes a rise in the portion of particles that are more likely to oxidize, which leads to the formation of foamy cells. On the other hand, this propensity causes a rise in the combination of oxidized apoprotein B and LDL-C, which is highly atherogenic **(Cure et al., 2013).**

CONCLUSION:

The complex association between dietary intake patterns and lipid profile characteristics in obese children is clarified by this study, in conclusion. The results indicate substantial differences in the nutritional intake of obese and non-obese children, with the former consuming more specific minerals and vitamins and the latter consuming less vitamin C. Crucially, as compared to controls, obese children had unfavorable lipid profiles with higher levels of LDL-C, TG, and TC and lower levels of HDL-C. The need for early nutritional and metabolic assessments in the treatment of childhood obesity is highlighted by these findings. Early identification and management of nutritional determinants impacting lipid profiles allows for the customization of therapies aimed at reducing obesity's long-term health consequences and improving children's health**.**

RECOMMENDATION:

Based on the findings of this study, several recommendations can be made to address the implications of dietary habits on lipid profiles in obese children:

1. **Nutritional Counseling:** Implement structured nutri-tional counseling programs aimed at educating both children and their families about healthy dietary practices. Emphasize bala-nced intake of calories, proteins, fats, carbohydrates, fiber, and essential vitamins and minerals.
2. **Promotion of Balanced Diets:** Encourage the adoption of balanced diets rich in fruits, vegetables, lean proteins, and whole grains, while minimizing intake of processed foods high in saturated fats, sugars, and empty calories.
3. **Monitoring and Follow-up:** Establish regular monitoring

and follow-up protocols to track dietary changes and lipid profile improvements over time. This could involve periodic assessments of BMI, lipid profiles, and dietary intake to gauge progress and adjust interventions as needed.

4. **Physical Activity Promotion:** Combine dietary interventions with physical activity promotion to enhance overall health outcomes. Encourage daily physical activity and limit sedentary behaviors to support healthy weight management and cardiovascular health.
5. **Community and Policy Initiatives:** Advocate for community-wide initiatives and policies that support healthy eating environments in schools, neighborhoods, and recreational settings. This could include improving access to nutritious foods and promoting nutrition education in educational curricula.
6. **Multidisciplinary Approach:** Foster collaboration among healthcare providers, nutritionists, educators, and policymakers to develop comprehensive strategies that address the multifaceted nature of childhood obesity and its associated health risks.

By implementing these recommendations, healthcare professionals and policy-makers can contribute to effective early interventions that not only manage childhood obesity but also promote long-term health and well-being among children and adolescents.

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Table (1): BMI measurements in the control and obese groups

Parameters	*Groups*		P value
	Normal N=30	**Obese N=70**	
Age (years)	9.3± 0.31	9.6± 0.32	0.41
Height (cm)	149.1± 15.1	143± 20.1*	0.02
Weight (kg)	43.4 ± 1.07	65.5 ± 3.1*	0.00
BMI (kg/m^2)	19.4 ± 0.12	31.5± 0.85*	0.00
Z-score	0.93± 0.02	2.5± 0.03*	0.00
BMI percentile	82.5± 0.0.63	99.4± 0.06*	0.00

Significant difference from the normal control group at p-value ≤0.05

Table (2): Macronutrients in the normal and obese participates

Macronutrients	Groups		P value
	Normal N=30	Obese N=70	
Calories	1607.6 ± 63.8	2560.3± 123.1*	0.007
RDI	2000		
% of RDI	80.38%	128.02%	
Protein /g	60.0±3.3	94.0±6.3*	0.001
RDI	50		
% of RDI	120%	188%	
Fat /g	60.7±5.5	84.7±7.7*	0.01
RDI	78		
% of RDI	77.8%	108.5%	
Carbohydrates/g	203.9±10.3	354.7±16.3*	0.00
RDI	278		
% of RDI	73.3%	127.5%	
Fiber /g	6.0±0.7	8.8±0.9*	0.02
RDI	28		
% of RDI	21.4%	31.4%	

**Significant difference from the normal children at p-value ≤0.05 RDI: Recommended Daily Intake*

Table (3): Micronutrients (Minerals) in the control and obese participate

Micronutrients	*Groups*		*P value*
	Normal N=30	*Obese N=70*	
Sodium (Na) mg /d	2202 ± 129.1	3095± 175.9*	0.04
RDI	2300		
% of RDI	95.7%	134.5%	
Potassium (K)	1774±103.7	2954±209.8*	0.02
RDI	4700		
% of RDI	37.7%	62.8%	
Calcium (Ca) mg/d	465.6±34.08	505.4±47.6	0.06
RDI	1300		
% of RDI	35.8%	38.8%	
Phosphorous (Ph) mg/d	707.8±42.05	1010.6±81.5*	0.001
RDI	1250		
% of RDI	56.6%	80.8%	
Magnesium (Mg) mg/d	113.8±13.5	165.6±22.7*	0.13
RDI	420		
% of RDI	27.1%	39.4%	
Iron (Fe) mg/d	9.84±0.71	17.4±1.67*	0.001
RDI	18		
% of RDI	54.6%	96.6	
Zinc (Zn) mg/d	7.378±0.41	11.6±0.75*	0.001
RDI	11		
% of RDI	67%	105.4%	
Copper (Cu) mg/d	1.16±0.11	0.61±0.05*	0.003
RDI	0.9		
% of RDI	129%	67.8%	

**Significant difference from the normal control group at p-value ≤0.05*

Table (4): Micronutrients (vitamins) in the normal and obese children

Micronutrients	*Groups*		P value
	Normal **N=30**	**Obese** **N=70**	
Vitamin A (µg RE)	218.5 ± 36.1	1838± 905.5	0.08
RDI	900		
% of RDI	24.2%	204.2%	
Vitamin C (mg/d)	56.7±16	46±8.6*	0.1
RDI	90		
% of RDI	63%	51%	
Vitamin B1 (mg/d)	0.54±0.06	1.07±0.12*	0.00
RDI	1.2		
% of RDI	45%	89.1%	
Vitamin B2 (mg/d)	0.52±0.04	1.35±0.33*	0.00
RDI	1.3		
% of RDI	40%	103.8%	

**Significant difference from the normal control group at p-value ≤0.05*

Table (5): Serum lipid profile and risk factors (Mean ±SE) of the Normal and obese samples

Parameters	Reference range	*Groups*		*P value*
		Control/ Normal Number =30	*Obese* Number =70	
Total cholesterol (mg/dl)	Acceptable <170 High >=200	134 ±3.0	176 ± 4.4*	0.04
Triglycerides (mg/dl)	Acceptable<75 High >=100	80.2±3.5	142.5±10.9*	0.01
HDL-cholesterol (mg/dl)	Acceptable>45 low<40	42±0.9	36±1.2*	0.00
LDL-cholesterol (mg/dl)	Acceptable <110 High≥130	75.8±2.9	112.13±4.2*	0.00
VLDL-cholesterol (mg/dl)	Normal (2 - 30)	16±0.70	28.5±2.1	0.00
Atherogenic Index (AI)	0.11-0.21	0.265±0.021	0.564±0.03*	0.04
Atherogenic Coefficient (AC)	2.02	2.2±0.09	3.89±0.23*	0.01
cardiac risk ratio (CRR)	below 3.5:1	3.2±0.12	4.89±0.23*	0.01

**Significant difference from the normal control group at p-value ≤0.05*

تقييم علاقة الغذاء المتناول وصورة دهون الدم في الاطفال الذين يعانون من السمنة

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3.قسم كيمياء التغذية والتمثيل الغذائي ،المعهد القومي للتغذية ،القاهرة،مصر.

الملخص العربي

تعتبر السمنة تراكمً الدهون المفرط في الجسم، وتعد السمنة واحدة من أكثر مخاوف الصحة العامة إلحاحًا اليوم حيث ترتبط الحالة بالعديد من الأمراض والاضطرابات الخطيرة. كان الغرض من هذا البحث هو تقييم العلاقة بين نماذج الغذاء المتناول الغذائي وصورة دهون الدم لدى الأطفال الذين يعانون من السمنة المفرطة. مائة طفل تتراوح أعمارهم بين 4-12 سنة، 70 طفلاً يعانون من السمنة المفرطة و30 طفلاً مجموعة ضابطة من عيادة السمنة في المعهد القومي للتغذية بالقاهرة. تم التعامل معهم كالاتي: قياس مؤشر كتلة الجسم ، الأنماط الغذائية، حالة الدهون. وأظهرت نتائج الدراسة الحالية وجود فروق ذات دلالة إحصائية بين المجموعتين في تناول السعرات الحرارية والبروتين والدهون والكربوهيدرات والألياف ($P < 0.05$). كما أوضحت أن تناول المعادن والفيتامينات كانت أكبر من المجموعة الطبيعية والمعنوية ($P<0.05$) باستثناء الكالسيوم والمغنيسيوم وفيتامين A. علاوة علي ذلك تناول عنصر النحاس وفيتامين ج كان المتناول اقل من المجموعة الضابطة، وكانت مستويات الكوليسترول الكلي (TC)، والدهون الثلاثية (TG)، وكوليسترول البروتين الدهني منخفض الكثافة (LDL-C)، مرتفعة بشكل ملحوظ ($P < 0.05$) مقارنة بالمجموعة الضابطة. وعلى العكس من ذلك انخفض مستوى الكولسترول الدهني عالي الكثافة (HDL-C) في مصل الدم بشكل معنوي ($p<0.05$) وبنسبة تغير بلغت 14.2% مقارنة بالمجموعة الضابطة. الاستنتاج: دراسة تقييم الخلل الغذائي والتمثيل الغذائي في وقت مبكر من الحياة للأطفال الذين يعانون من السمنة المفرطة أمر ضروري لتطوير تدخلات فعالة لمكافحة السمنة لدى الأطفال والمضاعفات الصحية المرتبطة بها. كما يمكن الحد من العواقب طويلة المدى للسمنة لدى الأطفال وتعزيز مستقبل أكثر صحة للأطفال.

الكلمات المفتاحية: السمنة، العادات الغذائية،صور الدهون، مؤشر تصلب الشرايين