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Insulin Resistance in Obese Children and Adolescents in Relation to Breastfeeding Duration

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Authors' contributions

This work was carried out in collaboration among all authors. Author MHME designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SME, WSM and AAEE managed the analyses of the study. Author AAE managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background: Childhood obesity is unarguably a major public health challenge, which is associated with the incidence of many health problems like insulin resistance which is the main trigger of metabolic syndrome, that is characterized by many comorbidities like dyslipidemia, hypertension, diabetes, steatosis and many cardiovascular problems. Breast milk is an essential way for supplying the needed nutrients for infants' growth and development. The aim of this work was to assess insulin resistance in obese children and adolescents and to detect its relation to duration of breastfeeding.
Methods: This case controlled study was started at June 2018 till July 2020 and carried out on 120 children who were divided into 2 equal groups: Group (1) obese children. Group (2) healthy controls -of matched age and sex- that weren't obese.
Results: Weight, body mass index, waist circumference and blood pressure were significantly higher among obese children than healthy controls. There was no statistically significant difference

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between both groups regarding duration of breastfeeding. HOMA-IR was higher among obese children who received shorter duration of breastfeeding but without statistically significant difference. There was a significant positive correlation between HOMA-IR of obese children and both of fasting blood glucose and fasting serum insulin levels. While a significant negative correlation was observed between HOMA-IR and high density lipoproteins of obese children.

Conclusion: Obese children and adolescents had higher HOMA-IR indices than healthy controls which indicate their predisposition for having insulin resistance and metabolic syndrome. HOMA-IR can be used as a useful tool for evaluation of metabolic syndrome risk in obese children as evidenced by the strong correlation between it and other components of metabolic syndrome. No significant relation was found between insulin resistance and breastfeeding duration in obese children and adolescents.

Keywords: Insulin resistance; obese children; breastfeeding duration.

1. INTRODUCTION

Obesity had been defined by World Health Organization (WHO) as increased body fat secondary to excess energy accumulation [1]. Childhood obesity is unarguably a major public health challenge, which is associated with the incidence of many non-communicable diseases [2]**.** In pediatrics, obesity is considered to be an important trigger for insulin resistance which represents the inability to increase glucose consumption to produce energy and hyperglycemia results [3]. Insulin resistance is considered the main trigger for the onset of many components of metabolic syndrome, which is characterized by clusters of comorbidities like dyslipidemia, hypertension, diabetes mellitus, hepatic steatosis and many cardiovascular problems [4].

Breast milk is an essential way for supplying the needed nutrients for infants' growth and development. It was reported to provide many protective effects against systemic hypertension, obesity and type 2 diabetes mellitus [5]. The WHO and the American Academy of Pediatrics had highlighted these benefits by recommending exclusive breastfeeding for the first six months of life as it represents the best way of feeding infants for its developmental, economic, health, nutritional and social benefits for both the mother and the baby [6]. It has been shown to be a protective factor for childhood obesity as evidenced by recent studies which reported a negative correlation of breastfeeding to development of obesity in children [7,8]. This could be attributed to slower growth velocity among breastfed subjects secondary to lower levels of Insulin like Growth Factor-1 if compared to formula fed subjects who are associated with decreased insulin sensitivity which favors development of metabolic syndrome in genetically prone subjects [9]. These protective effects have been observed primarily in developed countries. Meanwhile, developing countries didn't observe these benefits. Genetic and environmental factors may contribute to these results, thus large-scale studies are needed to confirm these data [10].

This pushed us to detect the relation of insulin resistance to breastfeeding duration among children and adolescents with obesity to confirm the outstanding role of breastfeeding in developing countries. The aim of this work was to assess insulin resistance in obese children and adolescents and to detect its relation to duration of breastfeeding.

2. METHODOLOGY

This case-controlled study was started at June 2018 till July 2020 and carried out on 120 children who were divided into two groups: Group (1) included sixty obese children aged from 9 to 18 years, recruited from Pediatric Endocrinology Unit, Tanta University and Mansoura University Children Hospitals. Obesity was defined with body mass index more than the 95^{th} percentiles for age and sex. Group (2) composed of sixty healthy non-obese controls of matched age and sex.

2.1 Exclusion Criteria

Patients with conditions affecting their weight or metabolic functions like thyroid disorders, Cushing syndrome, or systemic steroid use. Also children who didn't receive breast feeding at all were excluded.

2.2 All Subjects Were Subjected to the Following

2.2.1 Complete history taking

With stress on breastfeeding duration (and classified to have a short duration if below 6 months and long duration if more than 6 months).

2.2.2 Thorough clinical examination

Including chest, heart, abdomen, auxological measures including weight, height, body mass index and waist circumference and blood pressure.

2.2.3 Laboratory investigations

Included high density lipoproteins (HDL), low density lipoproteins (LDL), triglycerides, fasting blood glucose and fasting serum insulin. Homeostasis Model Assessment for Insulin Resistance (HOMA-IR) was calculated.

2.3 Sample Collection

Three milliliters of venous blood were collected from each subject by use of disposable plastic syringe. Serum was separated by centrifugations for 20 minutes at the speed of 3000 r.p.m. then divided in 2 aliquots. One for assessment of fasting insulin level assay by ELISA and the other for measurement of fasting blood glucose, HDL, LDL and triglycerides.

2.4 Statistical Analysis

Data were collected, coded, revised and entered to IBM SPSS version 21. The data were presented as numbers and percentages for the qualitative data, mean, standard deviations and ranges for the quantitative data with parametric distribution. Chi-square test (χ^2) was used in the comparison between two groups with qualitative data while Independent t-test was used in the comparison between two groups with quantitative data and parametric distribution. Significance was adopted at $p < 0.05$ for interpretation of results of tests of significance. Spearman correlation coefficients were used to assess the significant relation between two quantitative parameters in the same group.

3. RESULTS AND DISCUSSION

The mean age of Group I was [11.867±1.895 years] (range 9-18 years), whereas the mean age of Control group was [11.875±1.593 years] (range 10-15 years), with no statistically significant difference in age between the studied groups Table 1.

As regards sex; Group I comprised 25 males (41.7 %) and 35 females (58.3 %), whereas control group comprised 33 males (55 %) and 27 females (45 %), with no statistically significant difference in sex between the studied groups. There was no statistically significant difference between both groups regarding duration of breastfeeding Table 2.

Weight, body mass index, waist circumference and blood pressure were significantly higher among obese children than healthy controls Table 3.

Triglycerides, low density lipoproteins, fasting blood glucose, fasting serum index and HOMA-IR were significantly higher among obese children than healthy controls. On the other hand, high density lipoproteins were significantly lower in group I Table 4.

Table 5 and Fig. 1 show that HOMA-IR was higher among obese children who received shorter duration of breastfeeding but without statistically significant difference.

There was a significant positive correlation between HOMA-IR of obese children and both of fasting blood glucose and fasting serum insulin levels. While a significant negative correlation was found between HOMA-IR and HDL of obese children Table 6.

With an about 125 million children with obesity globally, the WHO has classified childhood obesity as one of the most important public health challenges of the 21st century. Two in ten children between the ages of 2 and 20 fulfill the criteria for being obese in the USA [11]. Obesity contributes to the emergence of serious co-morbidities that can occur early in life, like diabetes mellitus, hepatic steatosis and neurodegenerative disorders [12]. Pediatric obesity is considered to be an important inducer for insulin resistance which is responsible for the adverse problems of obesity [13,14]. So we aimed to assess insulin resistance in obese children and adolescents and to assess its relation to breastfeeding duration.

In our study, weight, body mass index, waist circumference, systolic and diastolic blood pressures were significantly higher among obese

children than healthy controls. In consistence to these results, Huerta-Delgado et al. [15] stated that the median body mass index of obese children with metabolic syndrome was significantly higher compared to that of healthy controls (26.0 vs. 17.8) and measured higher waist circumference in obese children than healthy controls (p <0.001). Selvaraju et al. [16] investigated obese children and observed that the anthropometric measurements including weight and body mass index z-score of overweight and obese children were significantly higher than those with normal weight, (p <0.0001). Jmal et al. [17] study showed a significant difference for waist circumference, systolic and diastolic blood pressure readings between controls and obese subjects. Yin et al. [18] found that systolic blood pressure readings were significantly higher among obese children than healthy controls.

In the present study, triglycerides and low density lipoproteins were significantly higher among obese children than healthy controls. On the other hand, high density lipoproteins were significantly lower. This agrees with that reported by other previous studies like Saeed et al. [19] who observed that obese children had increased triglyceride levels, (p= 0.049). Song et al. [20] stated that triglyceride levels were higher in obese children than overweight children. Higher levels of triglycerides were also found in patients with obesity versus controls, (p <0.001) according to Huerta-Delgado et al. [15] who noticed also higher levels of high density lipoproteins in healthy controls, (p <0.001). Moreover, Ba et al. [21] reported that obese patients also had significantly higher total cholesterol (p= 0.003), triglycerides (p= 0.003) and low density lipoproteins levels (p= 0.037).

Table 1. Age of obese patients and controls

		Groups						T-Test	
		Group I (n=60)			Group II (n=60)			t	*P*-value
Age (Years)	Range	9	-	18	10	-	15	-0.026	0.979
	Mean ±SD	11.867	±	1.895	11.875	±	1.593		

Table 2. Sex and breastfeeding duration of the studied groups

		Groups				Chi-Square	
		Group I (n=60)		Group II (n=60)		X^2	*P*-value
		N	%	N	%		
Sex	Male	25	41.67	33	55.00	2.136	0.144
	Female	35	58.33	27	45.00		
Breast Feeding Duration	Short (< 6 months)	25	41.67	26	43.33	0.034	0.853
	Long (> 6 months)	35	58.33	34	56.67		

Table 3. Anthropometric and blood pressure measurements of the studied groups

		Groups						T-Test	P-value
		Group I (n=60)			Group II (n=60)				
Weight (kg)	Range	56	-	100	29	-	62	15.906	<0.001*
	Mean ± SD	78.198	±	12.815	45.900	±	9.120		
Height (cm)	Range	132.5	-	170	137	-	170	0.865	0.389
	Mean ± SD	152.517	±	9.298	151.042	±	9.389		
BMI (%)	Range	26.64	-	40.2	14.9	-	24.2	26.966	<0.001*
	Mean ± SD	33.328	±	3.116	19.390	±	2.514		
WC (cm)	Range	70	-	119.5	58	-	73	17.409	<0.001*
	Mean ± SD	94.783	±	12.755	64.708	±	4.046		
Systolic BP (mmHg)	Range	100	-	150	100	-	120	2.241	0.027*
	Mean ± SD	116.750	±	11.155	112.917	±	7.148		
Diastolic BP(mmHg)	Range	60	-	100	60	-	80	3.101	0.002*
	Mean ± SD	77.500	±	11.626	72.000	±	7.318		

BMI= Body mass index, WC= Waist circumference, BP= Blood pressure

Table 4. Laboratory investigations of the studied groups

		Groups						T-Test	*P*-value
		Group I (n=60)			Group II (n=60)				
HDL (mg/dl)	Range	33	-	75	38	-	62	-2.587	0.011*
	Mean ±SD	45.303	±	8.660	48.900	±	6.401		
LDL (mg/dl)	Range	61	-	153	63	-	104	8.106	<0.001*
	Mean ±SD	116.297	±	24.825	86.617	±	13.711		
Triglycerides (mg/dl)	Range	50	-	205	65	-	125	4.225	<0.001*
	Mean ±SD	117.100	±	38.996	94.233	±	15.396		
FBG (mg/dl)	Range	82	-	122	78	-	95	12.469	<0.001*
	Mean ±SD	104.167	±	10.639	85.433	±	4.717		
FSI (µIU/ml)	Range	9.05	-	21.5	5.11	-	9.04	15.176	<0.001*
	Mean ±SD	14.760	±	3.736	7.227	±	0.909		
HOMA-IR	Range	1.83	-	6.37	1.01	-	2.03	13.803	<0.001*
	Mean ±SD	3.870	±	1.292	1.529	±	0.241		

HDL: High Density Lipoproteins, LDL: Low Density Lipoproteins, FBG: Fasting blood glucose, FSI: Fasting Serum Insulin, HOMA-IR: Homeostasis Model Assessment of Insulin Resistance

Table 5. Relationship of HOMA-IR to breastfeeding duration in obese children

		HOMA-IR				T-test	
		N	Mean	±	SD	t	*P*-value
Breast Feeding Duration	Short (< 6 months)	25	4.225	±	1.326	1.832	0.072
	Long (> 6 months)	35	3.617	±	1.222		

HOMA-IR: Homeostasis Model Assessment of Insulin Resistance

Table 6. Correlation coefficient between HOMA-IR and variable clinical and laboratory parameters of obese children

Correlations		
	HOMA-IR	
	r	P-value
Age (Years)	0.045	0.735
Weight (kg)	-0.047	0.724
Height (cm)	-0.121	0.358
Body mass index (%)	0.026	0.842
Waist circumference (cm)	0.066	0.616
Systolic BP (mmHg)	0.208	0.110
Diastolic BP (mmHg)	0.247	0.057
HDL (mg/dl)	-0.290	0.025*
LDL (mg/dl)	0.165	0.207
Triglycerides (mg/dl)	-0.073	0.578
Fasting Blood Glucose (mg/dl)	0.866	<0.001*
Fasting Serum Insulin (µIU/ml)	0.980	<0.001*

BP= Blood pressure, HDL: High Density Lipoproteins, LDL: Low Density Lipoproteins

Our results showed that fasting blood glucose, fasting serum index and HOMA-IR indices were significantly higher among obese children than healthy controls. In consistence to our results, Zhang et al. [22] stated that there was significant difference between the studied groups as regards HOMA-IR; healthy controls (1.74±0.43) and obese children (2.55±1.03). Ba et al. [21] also revealed significantly higher HOMA-IR and fasting insulin levels among patients with obesity (p <0.001). Moreover, Zhang et al. [23] observed that fasting glucose among obese children with metabolic syndrome was higher than controls. In contrast to these results, Mărginean et al. [24] reported no significant statistical difference between obese children and healthy controls regarding glycemic levels.

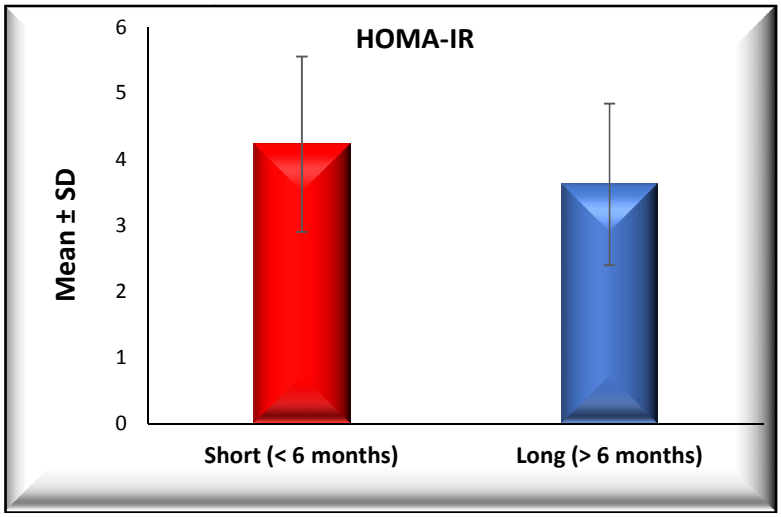

Fig. 1. HOMA-IR in obese children in relation to breastfeeding duration

In our work, there was a significant positive correlation between HOMA-IR indices of obese children and both of fasting blood glucose and fasting serum insulin levels. This coincides with [25] who found that HOMA-IR indices were positively correlated with fasting blood glucose and serum insulin levels of the participants.

Regarding relation of HOMA-IR to breastfeeding duration, HOMA-IR indices were higher among obese children who received shorter duration of breastfeeding than those received a longer duration but without statistically significant difference. In consistence to these results, Modrek et al. [26] observed that there was no statistically significant association between the duration of exclusive breastfeeding and the possibility of being overweight or obese by the age of two. Many studies haven‘t found any relationship between breastfeeding and childhood obesity [27]. In contrast to these results, Kong et al. [28] reported that infants who were breastfed for a short duration were more likely to experience rapid weight gain than those who took longer duration more than 12 months, (p= 0.875). Wang et al. [29] found that longer breastfeeding duration more than 6 months was a protective factor for obesity and metabolic syndrome. Veena et al. [30] also found that increased breastfeeding duration was associated with lower HOMA-IR at 5-years. The benefits of breastfeeding may be attributed to bioactive substances, which promote the maturation of the immune system, reduce insulin resistance and prevent excessive weight gain during childhood. But this issue is still controversial and further larger-scale studies are needed to clarify this relation.

4. CONCLUSION

Obese children and adolescents had higher HOMA-IR indices than healthy controls which indicate their predisposition for having insulin resistance and metabolic syndrome. HOMA-IR can be used as a useful tool for evaluation of metabolic syndrome risk in obese children as evidenced by the strong correlation between it and other components of metabolic syndrome. No significant relation was found between insulin resistance and breastfeeding duration in obese children and adolescents.

CONSENT AND ETHICAL APPROVAL

Written informed consent was obtained from all parents or guardians of the children. The study was approved by the Ethical Committee of Faculty of Medicine, Tanta University.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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