



Original Research Article

Cutaneous manifestations of Paediatric Obesity: Relation with insulin resistance

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ABSTRACT

Background: Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. Gender-specific BMI-for-age percentile curves are used to define overweight and obesity in paediatric age group.

Aim: To study the prevalence of cutaneous manifestations of obesity in pediatric population and to analyse the relation with BMI and Insulin Resistance. Materials and methods: A total of 138 overweight obese children between 5-18 years were enrolled. Anthropometric measurements and dermatological examination and relevant blood investigations were done. Insulin resistance was calculated using HOMA-IR (Homeostatic Model Assessment for Insulin Resistance).

Results: Maximum number of patients were between 15-18 years of age (n=63). Among 138 children, 75 were males, while 63 were females. According to BMI values, 72 cases were categorized as overweight and 66 obese. The cutaneous manifestations were seen to be present in 89.1% of patients. It was more in obese (96.96%) as compared to overweight children (81.94%). HOMA-IR >2.6 was observed among 75 (54.35%) cases. It was observed that cutaneous manifestations were more in children with HOMA-IR levels >2.6 (96%) as compared to HOMA-IR levels <2.6 (80.95%).

Conclusion: Obesity is strongly related to several skin alterations that could be considered as markers of excessive weight. Insulin resistance (IR) has emerged as an important disorder among young obese individuals. Thus, improving insulin sensitivity can prove to be highly effective potential therapeutic strategy for obesity and obesity-related comorbidities.

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1. Introduction

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. The prevalence of obesity in children and adolescents has increased manifold over the last few years in both the developed and developing nations, and is now widely considered as a major public health problem.¹

Childhood obesity is associated with a wide range of serious medical complications like metabolic disturbances, type 2 diabetes, Insulin Resistance (IR) and hypertension.^{2,3}

IR represents a major factor associated with many of the metabolic and cardiovascular complications linked with

obesity, and also plays a role in the cutaneous manifestations of obesity.

Dermatologic conditions seen in association with obesity include Acanthosis Nigricans (AN), acrochordons, keratosis pilaris, hirsutism, striae distensae, plantar hyperkeratosis, cellulitis, skin infections, hidradenitis suppurativa, and psoriasis.⁴

2. Materials and Methods

This was a cross-sectional descriptive study to determine prevalence of cutaneous manifestations of obesity in paediatric population and to analyse the relation with BMI and Insulin Resistance.

A total of 138 overweight/ obese children, between 5-18 years, fulfilling the WHO Criteria for Childhood

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Overweight and Obesity as per the revised IAP Guidelines, attending the outpatient clinic of the Department of Dermatology, Venereology and Leprosy, at a tertiary care hospital were enrolled after obtaining approval from Institutional Ethics Committee. Children and adolescents with a BMI higher than the 85th percentile but less than the 95th percentile for specific gender and age are categorized as overweight, and those with a BMI over the 95th percentile are categorized as obese.^{5,6}

Patients not willing to participate in the study were excluded.

After informed and written consent of the participating patient's guardians, detailed history was taken and clinical and dermatological examination was done. Anthropometric measurements were taken. Fasting serum Glucose and serum Insulin Investigations were done and Insulin resistance calculated using HOMA-IR (Homeostatic Model Assessment for Insulin Resistance); cut-off value of HOMA-IR > 2.6 was used to define insulin resistance.⁷

The data was analysed using SPSS (Statistical Package for Social Sciences) version 20.0 software. Comparison of data was done statistically by using chi square test. P value of less than 0.05 indicates a significant difference.

3. Results

Table 1 Distribution of children according to age:

Age distribution among total 138 children showed 4 cases in 5-7 years age group, 15 cases in 8-10 years age group, 56 cases in 11-14 years age group, and 63 cases in 15-18 years age group. (Table 1) The mean age among the cases was 14.08 ± 3.10 years.

Table 2 Distribution of children according to sex:

Among cases, 75 were males, while 63 were females. (Table 2)

Table 3 Distribution of children according to BMI:

According to BMI values, 72 cases were categorized as overweight, and 66 obese. (Table 3)

Table 4 Distribution according to incidence of cutaneous manifestations:

Cutaneous manifestations were seen to be present in 123 out of 138 patients. (Table 4)

Table 5 Distribution of cutaneous manifestations among Children:

Among these, Acanthosis Nigricans was observed in 102 cases (Figure 1), striae in 56 (Figure 2), hirsutism in 3 (Figure 3), gynaecomastia in 1, acrochordons in 12 (Figure 4), acne in 77 (Figure 5), and skin infections in 50 cases (Figure 6). (Table 5)

Table 6 Association of BMI and cutaneous manifestations:

It was observed that cutaneous manifestations were more in obese children (96.96%) as compared to overweight children (81.94%) with statistically significant difference. ($P < 0.001$) (Table 6)

Table 7 Distribution of patients according to HOMA IR: HOMA-IR >2.6 was observed among 75 (54.35%) cases. (Table 7)

The mean HOMA-IR among cases was 4.23 ± 2.81 .

Table 8 Correlation of cutaneous manifestations and investigations:

It was observed that mean serum glucose in children with cutaneous manifestations was 88.93 ± 12.19 gm/dl as compared to children without cutaneous manifestations 79.54 ± 8.76 gm/dl with statistically significant difference. ($P < 0.05$) Mean serum insulin in children with cutaneous manifestations was more (16.56 ± 11.23) as compared to children without cutaneous manifestations (9.63 ± 4.52) with statistically significant difference. ($P < 0.05$) Mean HOMA-IR in children with cutaneous manifestations was more (5.51 ± 3.12) as compared to children without cutaneous manifestations (2.03 ± 1.28) with statistically significant difference. ($P < 0.05$) (Table 8)

Table 9 Association of cutaneous manifestations and HOMA-IR:

It was observed that cutaneous manifestations were more in children with HOMA-IR levels >2.6 (96%) as compared to HOMA-IR levels <2.6 (80.95%) with statistically significant difference. ($P < 0.001$) (Table 9)

Table 10 Distribution of cutaneous manifestations in patients with Insulin Resistance (HOMA-IR >2.6, n=75):

The maximum numbers of cutaneous manifestations in insulin resistance children was Acanthosis Nigricans (85.3%) followed by Acne (62.6), Striae (42.6%), Skin infections (32%) (Table 10)

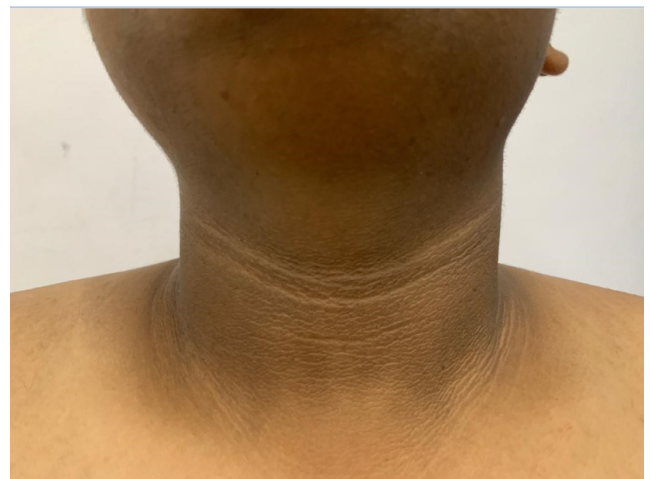


Fig. 1: Acanthosis Nigricans

4. Discussion

In the present study, the maximum number of cases was in the age group of 15-18 years (45.65%), followed by in 11-14 years (40.58%). The mean age among cases was 14.08

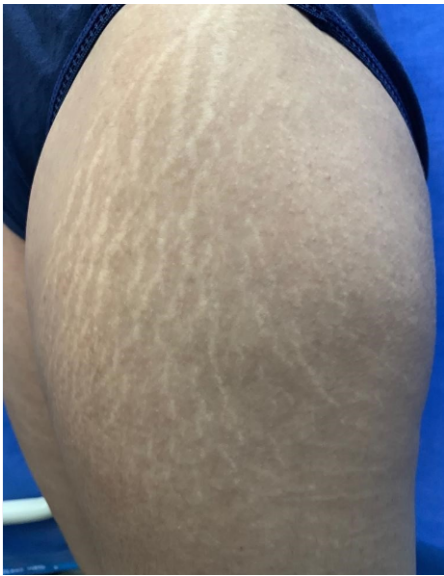


Fig. 2: Striae Distensae



Fig. 4: Acrochodron with AN



Fig. 3: Hirsutism



Fig. 5: Acne Vulgaris

Table 1: Distribution of children according to age

Age group (years)	No of children	Percentage
5-7	04	02.90
8-10	15	10.87
11-14	56	40.58
15-18	63	45.65
Total	138	100

Table 2: Distribution of children according to sex

Sex	No of children	Percentage
Male	75	54.35
Female	63	45.65
Total	138	100



Fig. 6: Dermatophytic infection

Table 3: Distribution of children according to BMI

BMI (In Centiles)	No of children	Percentage
85-95 (Overweight)	72	52.17
>95 (Obese)	66	47.83
Total	138	100

Table 4: Distribution according to incidence of cutaneous manifestations

Cutaneous manifestations	No of children	Percentage
Present	123	89.13
Absent	15	10.87
Total	138	100

Table 5: Distribution of cutaneous manifestations among Children

Cutaneous Manifestations	No of Children	Percentage
Acanthosis nigricans	102	73.91
Striae	56	40.58
Hirsutism	03	2.17
Gynaecomastia	01	0.72
Acrochordons	12	8.70
Acne	77	55.79%
Skin Infections	50	36.23%
Dermatophytosis (27)		
Bacterial Infections (13) Viral Infections (3) Intertrigo (7)		
Others	38	27.54

(*Multiple response present)

Table 6: Association of BMI and cutaneous manifestations

BMI	Cutaneous Manifestations		P value
	Present	Absent	
BMI 85-95 (percentiles)	59	13	X ² =11.70 P<0.001
>95	64	02	
Total	123	15	

(*P<0.05 statistically significant by chi square test)

Table 7: Distribution of patients according to HOMA IR

HOMA-IR	No of Patients	Percentage
<2.6	63	45.65
>2.6	75	54.35
Total	138	100

Table 8: Correlation of cutaneous manifestations and investigations

Investigations	Cutaneous Manifestations		P value
	Present	Absent	
Serum Glucose	88.93 ±12.19	79.54 ±8.76	<0.05
Serum Insulin	16.56 ± 11.23	9.63 ± 4.52	<0.05
HOMA-IR	5.51 ±3.12	2.03 ±1.28	<0.05

Table 9: Association of cutaneous manifestations and HOMA-IR

HOMA-IR	Cutaneous Manifestations		Total
	Present	Absent	
<2.6	51	12	63
>2.6	72	03	75
Total	123	15	138

Table 10: Distribution of cutaneous manifestations in patients with Insulin Resistance(HOMA-IR>2.6, n=75)

Cutaneous Manifestations	No of Children	Percentage
Acanthosis nigricans	64	85.3
Striae	32	42.6
Hirsutism	3	4
Gynaecomastia	1	1.3
Acrochordons	05	6.6
Acne	47	62.6
Skin Infections	24	32

±3.10 years. (Table 1)

Most of the cases were males (75 males, 54.35%) while 63 cases (45.65%) were females. (Table 2) The maximum numbers of cases among males were in the age group of 11-14 years (33 cases; 44%), while in females it was in age group 15-18 (50.79%).

Mrinal et al conducted a prospective study in 100 obese children, in which 61 cases were males and 39 females. Mean age of the cases included was 11.3±1.3 years.⁸

Arth Koshiya et al conducted a prospective study including 100 obese children, 67 males and 33 females. The mean age of the participants was 13.5 ± 1.5 years.⁹

Out of 138 cases, the maximum numbers of cases were overweight (72 cases, 52.17%), followed by obese (66 cases, 47.83%) (Table 3) The maximum numbers of overweight cases were among age group of 11-14 years (35 cases; 48.61%), while in obese it was in age group 15-18 (60.60%) The maximum numbers of overweight and obese cases were both observed among the males (52.78% and 56.06% respectively).

The overall incidence of cutaneous manifestations among children showed that out of 138 cases, 123 cases showed presence of cutaneous manifestations (89.13%). (Table 4) Further, it was noted that the maximum numbers of cutaneous manifestations were in age group 15-18 years.

In Yogitha HR et al study on cutaneous manifestations of obesity in adolescent age group most of the patients belonged to age group between 17 – 19 years (84%) followed by 11 – 13 years (12%) and 14 – 16 years (4%).¹⁰

In our study, maximum numbers of cutaneous manifestations were seen in males and in the overweight category.

The most common cutaneous finding seen in our study was Acanthosis nigricans (73.91%). This was followed by acne (55.79%), striae (40.58%), skin infections (36.23%),

acrochordons (8.7%), hirsutism (2.17%) and gynaecomastia (0.72%) (Table 5). Other less commonly associated cutaneous findings were psoriasis, lichen planus, xanthoma, wart, vitiligo, etc.

Mrinal Gupta in a prospective study on cutaneous manifestations of obesity in children observed most common cutaneous manifestations among the children were acanthosis nigricans (42%), striae (19%), fungal infections and intertrigo (16%), acrochordons (12%), acne (10%), hirsutism (8%), and viral and bacterial infections (5%). Other less common associations were psoriasis, xanthomas, corns, plantar hyperkeratosis, and miliaria.⁸

In Yogitha HR et al study on cutaneous manifestations of obesity in adolescent age group most common skin condition was Acanthosis Nigricans (69.33%), followed by skin tags (50.66%), bacterial infections (38.66%) fungal infection (25.33%), intertrigo (14.66%) and striae (9.33%). Hirsutism was seen in only two female patients.¹⁰

Similarly by Arth Koshia et al in a study on various cutaneous manifestations in obesity and analyse the relation with body mass index (BMI) in paediatric population most common cutaneous manifestations among the children were Acanthosis Nigricans (41%), striae (20%), fungal infections and intertrigo (18%), acrochordons (12%), acne (10%), hirsutism (8%), and viral and bacterial infections (7%). Other less common associations were psoriasis, xanthomas, corns, plantar hyperkeratosis, and miliaria.⁹

The overall association between BMI and cutaneous manifestations showed that cases with higher BMI (>95 percentile) showed more cutaneous manifestations compared to BMI (85-95 percentile) with statistically significant difference. (P<0.05) (Table 6)

The incidence of cutaneous manifestations is greater when accompanied by the various co morbidities associated with obesity, like diabetes, insulin resistance syndrome, PCOS, Hyperandrogenism etc. A number of studies now strongly associate skin manifestations of obesity with hyperinsulinemia, a biochemical state that leads to the binding of insulin to insulin-like growth factor receptors present on the keratinocytes and fibroblasts, leading to hyperplasia of the skin. An elevated fasting insulin level confirms the presence of hyperinsulinemia. Patients with high insulin levels often maintain normal glucose levels even with insulin resistance. Commonly, blood glucose levels are in the normal range, although non-insulin dependent diabetes may be present.

The exact mechanisms by which excessive adiposity causes a state of insulin resistance remains unclear. But recent years have witnessed a massive increase in our understanding of the pathophysiology behind this association. Among the several well documented hypotheses explaining Insulin Resistance, inflammation, mitochondrial dysfunction, hyperinsulinemia and lipotoxicity have been the important concepts, that

ultimately result in impairment of insulin signalling pathways and decreased insulin sensitivity and IR.¹¹ Insulin resistance can manifest in a wide variety of cutaneous manifestations. These include: Acanthosis Nigricans, skin tags, hirsutism (ovarian hyperandrogenism), and androgenetic alopecia.

It was observed that HOMA-IR >2.6 was seen in 54.35% cases (Table 7). The correlation between various investigations and cutaneous manifestations in the present study showed that cases with cutaneous manifestations had higher serum glucose, serum insulin and HOMA-IR compared to cases without cutaneous manifestations with statistically significant difference. (P<0.05). The mean HOMA-IR among cases was 4.23 ± 2.81 (Table 8).

In our study, 75 (54.35 %) patients had increased values of HOMA-IR. Among these, 72 patients (96%) had cutaneous findings and 3 patients (4%) had no cutaneous findings. Thus, the association between HOMA-IR and cutaneous manifestations showed that cases with higher HOMA-IR (>2.6) shows more cutaneous manifestations compared to HOMA-IR (<2.6) with statistically significant difference. (P<0.05)(Table 9)

Most frequently observed finding was AN, seen in 64 (85.3%) patients. This was followed by acne in 47 patients (62.6%); striae in 32 patients (42.6%); and skin infections in 24 patients (32%). (Table 10)

Yosipovitch G et al in a study on skin physiology and skin manifestations of obesity observed association of insulin resistance and cutaneous manifestations of obesity.¹²

In a study by Wafa Y. Al-Saeed et al to determine the most frequent skin disorders in obese female schoolchildren observed acne and dandruff associated with insulin resistance in schoolchildren.¹³

The biologic plausibility of this association relies on the fact that hyperinsulinemia activates insulin growth factor-1 (IGF-1) receptors located in fibroblasts and keratinocytes directly and indirectly, stimulating their proliferation. Hyperinsulinemia also has an effect on the production of sex steroids. Insulin and IGF-1 increase levels of ovarian androgens by stimulating the ovaries to produce androgens via the increase of 17-hydroxylase local activity and inhibiting hepatic synthesis of sex hormone-binding globulin (SHBG), which increases the availability of free testosterone.

Obesity is a complex, multifactorial condition affected by genetic and non-genetic factors. In children and adolescents, the overweight state is generally caused by a lack of physical activity, unhealthy eating patterns resulting in excess energy intake, or a combination of the two resulting in energy excess. Genetics and social factors (socio-economic status, race/ethnicity, media and marketing and the physical environment) also influence energy consumption and expenditure. A similar pattern was observed in the cases enrolled in our study, where most

of the children had minimal outdoor/physical activity and a sedentary life style, with increased screen time or study hours. They also had consistent dietary patterns showing consumption of junk food and aberrant meal patterns like skipping breakfast.

In accordance with the increasing prevalence of obesity among children, the paediatricians and dermatologists should be well aware of its various manifestations including the cutaneous ones to ensure their early diagnoses and treatment, which are as common as in adults, and can be a source of great physical or psychological morbidity.

Health education programs should be conducted on skin diseases and obesity targeting all schoolchildren, their families and teachers. Effective school-based programs for prevention, early detection and treatment of malnutrition should be initiated. Further similar studies at different educational levels in various parts of the country should be encouraged.

5. Conclusion

Obesity is strongly related to several skin alterations that could be considered as markers of excessive weight. Skin care of obese patients deserves particular attention, not only because of the high prevalence of cutaneous manifestations but also because many of these disorders are preventable and can be treated, improving patient's quality of life.

IR has emerged as an important disorder among young obese individuals. Studies have emphasized that patients with IR have a higher predisposition to the future development of metabolic syndrome (MS), type II diabetes mellitus (DM2), and cardiovascular disease. Thus, improving insulin sensitivity can prove to be highly effective potential therapeutic strategy for obesity and obesity-related comorbidities, including its cutaneous manifestations.

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No financial support was received for the work within this manuscript.

7. Conflict of Interest

The authors declare they have no conflict of interest.

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