Original Article

Metabolic Comorbidities in Pediatric Psoriasis—A Comparative Cross-Sectional Study in South-Asian Children

Ranjana E. Joseph, Dharshini Sathishkumar, Ankan Gupta, Sophy Korula[1]

Departments of Dermatology and [1]Pediatrics, Paediatric Endocrinology and Metabolism Division, Christian Medical College, Vellore, Tamil Nadu, India

Abstract

Background: There is only limited data on the association between psoriasis and metabolic comorbidities in South-Asian children. **Objective:** To examine metabolic comorbidities among South-Asian children with and without psoriasis. **Materials and Methods:** A hospital-based, comparative, cross-sectional study was conducted in children with and without psoriasis over 19 months. Anthropometric, clinical, and metabolic comorbidity details (including disease extent and severity scores, obesity, systemic hypertension, diabetes mellitus, lipid abnormalities, and metabolic syndrome) were obtained in both groups according to standard criteria. **Results:** Fifty-eight children with psoriasis (25 males/33 females, age 11.3 ± 3.0 years, range 4 to 17 years) and 62 children without psoriasis (37 males/25 females, age 11.0 ± 3.6 years, range 4 to 18 years) were recruited. The prevalence of obesity (31.0% versus 14.5%, P = 0.031, odds ratio 2.65) and metabolic syndrome (18.6% versus 4.6%, P = 0.044, odds ratio 4.68) were higher in children with psoriasis than without. The prevalence of other metabolic comorbidities (systemic hypertension, pre-diabetes, lipid abnormalities, elevated serum alanine aminotransferase, and non-alcoholic fatty liver disease) was not different between children with and without psoriasis and between obese and non-obese children with psoriasis. Among children with psoriasis, those with abdominal obesity had significantly lower disease severity and extent scores than those without. **Conclusion:** Psoriasis is associated with a significantly higher prevalence of obesity and close to significantly higher prevalence of metabolic syndrome in South-Asian children. Screening for metabolic comorbidities is essential even in non-obese children with psoriasis. Disease extent and severity are less in obese compared to non-obese South-Asian children with psoriasis.

Keywords: *Comorbidity, metabolic syndrome, obesity, pediatric psoriasis, South-Asian children*

Introduction

Psoriasis is a common, chronic, immune-mediated inflammatory skin disease with onset in childhood in almost one-third of patients.[1-3] Since 1970, the reported incidence of psoriasis in children has more than doubled.[4] Unlike the well-established relationship between metabolic comorbidities and psoriasis in adults, studies of this relationship have shown variable results in children.[1,5-11] Currently, there is only limited data on this association in South-Asian children. Our primary objective was to study the prevalence of metabolic comorbidities in children with psoriasis and compare it with children of the same age group with other skin diseases. Our secondary objectives were to study the relationship between excess adiposity and other metabolic comorbidities in children with psoriasis, and the relationship between disease severity and metabolic comorbidities.

Materials and Methods

This was a hospital-based, cross-sectional study comparing children clinically diagnosed to have psoriasis between 4 and 18 years of age (psoriasis group) with another group of children having skin diseases not known to be associated with systemic inflammation (e.g., mild superficial fungal infections, verruca vulgaris). Normal children who came for screening after contact with Hansen's disease patients were also included (comparative group). Children with psoriasis who did not have a definite clinical diagnosis and those with exclusive palmoplantar involvement were excluded from the study. Children with a family history of psoriasis or those with skin diseases that are known to be

How to cite this article: Joseph RE, Sathishkumar D, Gupta A, Korula S. Metabolic comorbidities in pediatric psoriasis—A comparative cross-sectional study in South-Asian children. Indian Dermatol Online J 2024;15:605-11.

Received: 21-Sep-2023. **Revised:** 21-Jan-2024. **Accepted:** 21-Jan-2024. **Published:** 26-Jun-2024.

Address for correspondence:
Dr. Dharshini Sathishkumar, Professor, Department of Dermatology, Christian Medical College, Vellore - 632 004, Tamil Nadu, India.
E-mail: dharshsathish@gmail.com

Access this article online

Website: https://journals.lww.com/idoj

DOI: 10.4103/idoj.idoj_729_23

Quick Response Code:

associated with systemic inflammation were excluded from the comparative group. The study was conducted from January 2019 to July 2020 after obtaining approval from the Institutional Review Board (IRB No. 11764, dated 07/01/2019). Informed consent was obtained from parents of all children who took part in this study. Relevant history, clinical examination findings, and anthropometric and metabolic parameters were recorded according to standard criteria [Table 1].[12-21] Patients with raised serum alanine aminotransferase levels (twice the upper limit of normal) underwent hepatic ultrasonography.

Statistical methods

Sample size

Based on a multicenter prospective case-control study, the prevalence of obesity among children less than 18 years of age with psoriasis was reported to be 28%.[22] The mean prevalence of obesity among 18,955 school children and adolescents attending private and government schools in Chennai, India was detected to be 6.82%.[23] Thus, the prevalence of obesity was estimated to be 28% and 6.82% for the case and comparative groups, respectively. To detect a difference of 21.18%, a sample of 50 in each group was required. The sample size was calculated for 80% power and 5% error.

Data analysis

Data entry and analysis were done using EpiData version 3.1 and IBM SPSS version 23, respectively. Bivariate analysis was done using the Chi-square test and Fisher's exact test. A comparison of continuous variables was done using the independent *t*-test for normal data distribution. A *P* value of <0.05 was considered statistically significant. These statistical methods were used for both group and sub-group analysis.

Result

Fifty-eight children with psoriasis (25 males/33 females, age 11.3 ± 3.0, range 4–17) and 62 comparative group children (37 males/25 females, age 11.0 ± 3.6 years, range 4–18) of South-Asian ethnicity were recruited [Figure 1]. The prevalence of obesity based on body mass index (BMI) was significantly higher in the psoriasis group than in the comparative group [Table 2]. Similarly, the proportions of patients with abdominal obesity and high-risk waist-to-height ratio, and the mean

Table 1: Criteria used for categorization of comorbidities and disease extent and severity

Parameter	Tool for assessment	Categorization
Body mass index (BMI)	World Health Organization BMI charts for age[12]	Obesity: >+2 SD[†] Overweight: >+1 SD Normal BMI: between −2 and +1 SD Thinness: <−2 SD
Abdominal obesity	Khadilkar's waist circumference percentile curve[13]	Above the 70th centile of Khadilkar's waist circumference percentile curve
Waist-to-height ratio	Kahn cutoffs[14]	High risk: ≥0.539
Systemic hypertension	Harriet Lane's blood pressure chart[15]	Systolic and/or diastolic blood pressure ≥ the 95th age, sex, and height-specific percentile
Fasting glucose level	Based on recommendations by Copeland[16]	Prediabetes: ≥100–125 mg/dL Diabetes mellitus: ≥126 mg/dL
Glycosylated hemoglobin (HbA1C)		Prediabetes: 5.7%–6.4% Diabetes mellitus: ≥6.5%
Serum alanine aminotransferase (ALT)	NASPGHAN[‡] guidelines[17]	NAFLD[§]: ALT level ≥44 for girls, ≥52 for boys (twice the upper limit of normal)
HDL[¶] in children <10 years of age	National Heart, Lung, and Blood Institute (NHLBI) Cholesterol Screening guidelines[18]	Abnormal: <40 mg/dL
Serum triglycerides in children <10 years of age		Abnormal: ≥100 mg/dL
HDL in children ≥10 years of age	The International Diabetes Federation (IDF) consensus criteria[19]	Reduced HDL: 10 to <16 years: HDL <40 mg/dL, ≥16 years: <40 mg/dL in males and <50 mg/dL in females
Serum triglycerides in children ≥10 years of age		Raised triglycerides: ≥150 mg/dL
Metabolic syndrome (children ≥10 years of age)		Abdominal obesity and ≥2 of elevated triglycerides/low HDL/high blood pressure/increased plasma glucose
Extent of psoriasis	Body surface area involved[20]	Mild: <3%, Moderate: 3%–10%, Severe: >10%
Severity of chronic plaque psoriasis	Psoriasis area and severity index score[21]	Mild: <3%, Moderate: 3%–10%, Severe: >10%

References as in the main text; [†]SD-standard deviation, [‡]NASPGHAN-North American Society for Pediatric Gastroenterology, Hepatology and Nutrition, [§]NAFLD-non-alcoholic fatty liver disease, [¶]HDL-serum high-density lipoprotein cholesterol

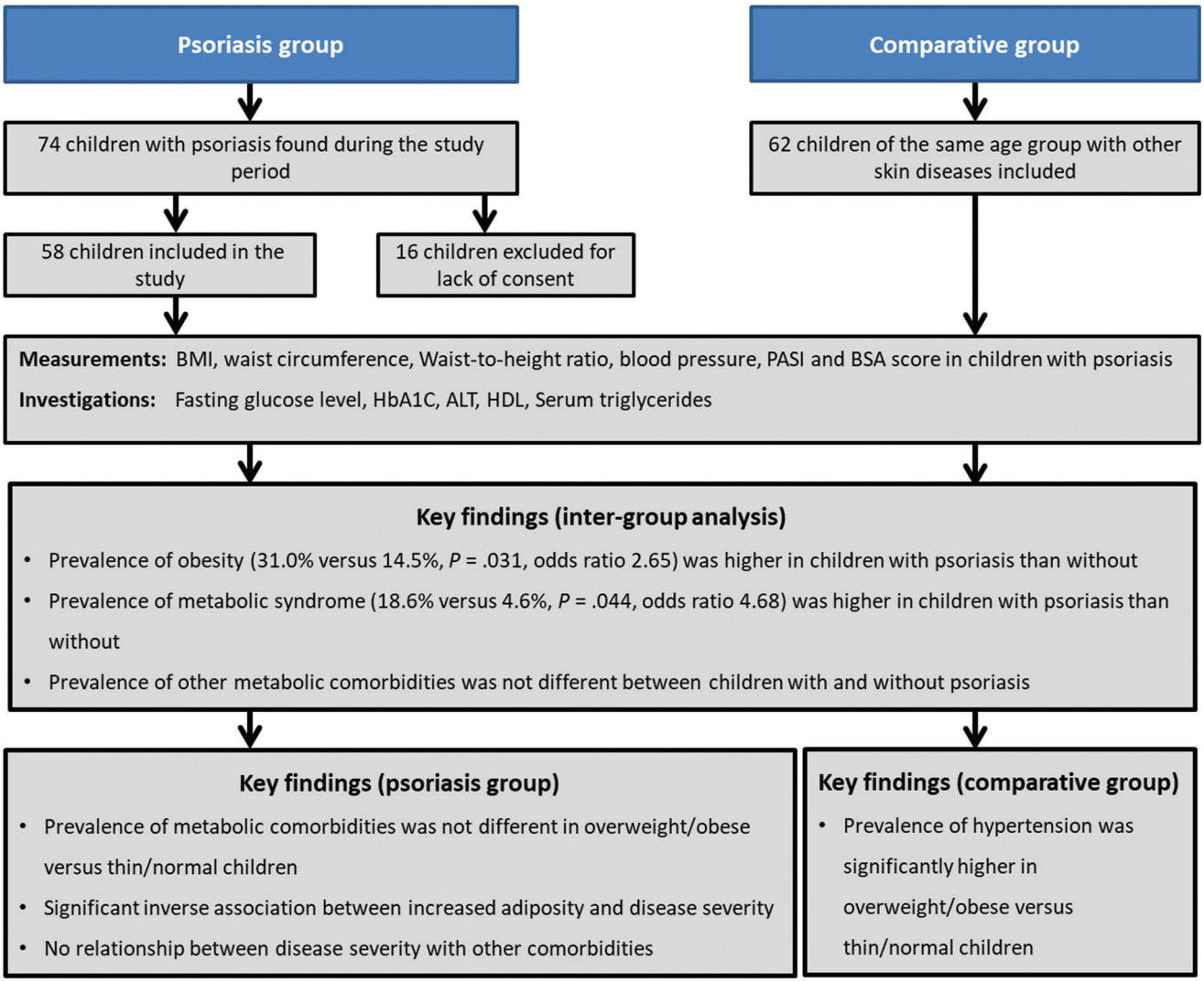

Figure 1: Flowchart of the study. Figure depicting study design, subject recruitment, and key findings. BMI-body mass index, PASI-psoriasis area and severity index, BSA-body surface area, HbA1C-glycosylated hemoglobin, ALT-serum alanine aminotransferase, HDL-serum high-density lipoprotein cholesterol

waist-to-height ratio were higher in the psoriasis group but not significantly so. All other comorbidities were not different between the two groups. Of the three children with raised serum alanine aminotransferase levels in the psoriasis group, two, aged 11 and 15 years, had high BMI, central obesity, and fatty liver on ultrasonography. The third patient, aged 16 years with normal BMI and normal hepatic ultrasonography, had been on treatment with methotrexate and acitretin for three months before recruitment. Other rare comorbidities found in the psoriasis group were H-syndrome (Online Mendelian Inheritance in Man # 602782) with associated type-1 diabetes and celiac disease in one child, and polycystic ovarian disease with exogenous obesity in another.

A non-significantly higher proportion of children with psoriasis had metabolic syndrome compared to the comparative group based on the International Diabetes Federation consensus criteria [see Table 2]. The addition of a child with psoriasis and abdominal obesity (based on waist circumference), deranged (high-density lipoprotein) HDL-cholesterol, and prediabetes (based on glycosylated hemoglobin), with normal fasting glucose, made metabolic syndrome significantly higher in the psoriasis group.

The prevalence of systemic hypertension in the psoriasis group was not different in thin/normal and overweight/obese children [Table 3]. However, in the comparative group, systemic hypertension was significantly more prevalent in overweight/obese children. In the converse analysis, among thin/normal subjects, children with psoriasis were more likely to be hypertensive than comparative group subjects, while in obese/overweight subjects, there was no difference. Similar to systemic hypertension, the prevalence of other comorbidities was not different between thin/normal and overweight/obese children with psoriasis [Table 4].

Table 2: Prevalence of comorbidities and metabolic syndrome in psoriasis children group & comparative children group

Comorbidities	Psoriasis group (*n*=58) Present *n* (%)	Comparative group (*n*=62) Present *n* (%)	*P*	Odds ratio (95% CI)
Obesity based on BMI[†]	18 (31.0)	9 (14.5)	0.031	2.65 (1.08–6.51)
Abdominal obesity (based on waist circumference)	28 (48.3)	20 (32.4)	0.074	1.96 (0.93–4.11)
High-risk waist-to-height ratio	18 (31.0)	10 (16.1)	0.054	2.34 (0.97–5.62)
Waist-to-height ratio (mean±standard deviation)	0.513±0.131	0.476±0.069	0.058	…
Thinness	6 (10.3)	2 (3.20)	0.119	3.46 (0.68–17.89)
Systemic hypertension	15 (25.9)	11 (17.7)	0.282	1.62 (0.67–3.89)
Prediabetes (based on AC[‡])	8 (13.8)	10 (16.1)	0.720	0.83 (0.30–2.27)
Diabetes mellitus (based on AC)	0	1 (1.6)	…	…
Prediabetes (based on HbA1c[§])	1 (1.8) (*n*=56)	3 (4.8)	0.360	0.35 (0.03–3.54)
Diabetes mellitus (based on HbA1c)	0 (*n*=56)	0	…	…
Deranged HDL	24 (41.4)	21 (33.9)	0.396	1.38 (0.6–2.89)
High serum triglyceride level	15 (25.9)	14 (22.6)	0.674	1.19 (0.52–2.76)
High serum alanine aminotransferase	3 (5.2)	0	…	…
Non-alcoholic fatty liver disease	2 (3.4)	0	…	…
Metabolic syndrome	7 (16.3) (*n*=43)	2 (4.6) (*n*=43)	0.078	3.98 (0.78–20.43)
	8 (18.6)* (*n*=43)	2 (4.6) (*n*=43)	0.044*	4.68 (0.93–23.53)*

[†]BMI, body mass index; [‡]AC, fasting glucose level; [§]HbA1c, glycosylated hemoglobin; [¶]HDL, serum high-density lipoprotein cholesterol. Data are number (percentage) unless specified otherwise. Children <10 years of age were excluded from the analysis of metabolic syndrome (according to International Diabetes Federation criteria). *Including a child with obesity, low HDL-cholesterol, and pre-diabetic HbA1c (rather than increased fasting glucose level as per International Diabetes Federation criteria)

Table 3: Prevalence of systemic hypertension in subgroups based on the presence/absence of psoriasis and adiposity of the subject

Group	Subgroups being compared	*n*	Systemic hypertension		*P*
			Present *n* (%)	Absent *n* (%)	
Psoriasis group (*n*=58)	Overweight or obese children	27	8 (29.6)	19 (70.4)	0.540
	Thin or normal children	31	7 (22.6)	24 (77.5)	
Comparative group (*n*=62)	Overweight or obese children	20	8 (40.0)	12 (60.0)	0.002
	Thin or normal children	42	3 (7.1)	39 (92.9)	
Thin or normal children (*n*=73)	Psoriasis group children	31	7 (22.6)	24 (77.5)	0.057
	Comparative group children	42	3 (7.1)	39 (92.9)	
Overweight or obese children (*n*=47)	Psoriasis group children	27	8 (29.6)	19 (70.4)	0.458
	Comparative group children	20	8 (40.0)	12 (60.0)	

Data are number (percentage)

Table 4: Prevalence of comorbidities based on adiposity status in children with psoriasis

Comorbidity	Obese or overweight (based on BMI[†]) (*n*=27) Present *n* (%)	Normal-weight or thin (based on BMI) (*n*=31) Present *n* (%)	*P*
Systemic hypertension	8 (29.6)	7 (22.6)	0.540
Prediabetes (based on fasting glucose level)	4 (14.8)	4 (12.9)	0.833
Prediabetes (based on glycosylated hemoglobin)	1 (3.7)	0	0.280
Deranged HDL[‡]	12 (44.4)	12 (38.7)	0.658
High serum triglycerides	7 (25.9)	8 (25.8)	0.992
High serum alanine aminotransferase	2 (7.4)	1 (3.2)	0.473
Non-alcoholic fatty liver disease	2 (7.4)	0	0.123

[†]BMI, body mass index; [‡]HDL, serum high-density lipoprotein cholesterol. Data are number (percentage)

Children with abdominal obesity (based on waist circumference) had significantly lower psoriasis area and severity index (PASI) scores and body surface area (BSA) scores than children without abdominal obesity [Table 5]. There was no relationship between disease severity (based on PASI and BSA score) with other comorbidities or metabolic syndrome (*P* values for the correlation between PASI and BSA scores and

Table 5: Relationship between abdominal obesity (based on waist circumference) and disease severity assessed by PASI and BSA scores

	PASI[†] score		*P*	BSA[‡] score		*P*
	Mean (SD[§])	Median (IQR[¶])		Mean (SD)	Median (IQR)	
Children with abdominal obesity (*n*=28)	2.82 (2.89)	2 (1.5–2.9)	0.008	7.99 (19.47)	2 (1.35–4.75)	0.005
Children without abdominal obesity (*n*=30)	5.85 (5.63)	3.40 (1.95–9.05)		15.15 (21.66)	5 (3.0–18.75)	

[†]PASI, psoriasis area severity index; [‡]BSA, body surface area; [§]SD, standard deviation; [¶]IQR, interquartile range

metabolic syndrome were non-significant, 0.27 and 1.37, respectively).

Eleven of the 58 children with psoriasis (18.96%) in our study had a positive family history, although their disease severity was not significantly higher than children with psoriasis without a positive family history.

Discussion

Psoriatic skin disease is considered the driver of a cascade of events leading to metabolic comorbidities in adults. A link between pediatric psoriasis and metabolic comorbidities such as obesity, type-2 diabetes mellitus, dyslipidemia, and systemic hypertension has been demonstrated.[1,6,24] The present study investigates the prevalence of metabolic comorbidities among South-Asian children with psoriasis; its strengths include a prospective collection of data and a large comparative group of children with non-inflammatory skin conditions or normal children.

Obesity was significantly associated with psoriasis in our study, the prevalence of which (31%) was comparable to that seen among Malaysian children[25] (23.9%), but higher than in the Malaysian group of a multicentric study[26] (12.9%), a Chinese study[27] (9%), and recent Indian studies (6.73%[7] and 7.7%[8]). The odds ratio for obesity (based on body mass index) in our study (2.65) was lower than in children with psoriasis from the USA (6.61) reported by Paller.[26] Similarly, the odds ratio for abdominal obesity based on waist circumference and the mean waist-to-height ratio was lower in our study (1.96 and 2.34, respectively) compared to the corresponding values in children with psoriasis from the USA (3.47 and 4.87, respectively).

A key finding of our study was the presence of a significant inverse relationship between increased adiposity and disease severity [see Table 5]. Similar, but non-significant, inverse relationships were reported in the Malaysian group of the study by Paller[26] and Choon[25] on Malaysian children with psoriasis. This is in contrast with studies from the USA,[24] Australia[10] %), and India,[7] which showed a positive correlation between increased adiposity and the severity of psoriasis among children. We postulate that children with a strong genetic predisposition may develop severe psoriasis even in the absence of environmental influences favoring increased adiposity. Conversely, environmental factors may play a contributory role in patients with a weak genetic predisposition resulting in a mild phenotype. Socioeconomic factors could influence both adiposity status and disease severity in children with psoriasis. Children from a low socioeconomic background are at higher risk of being underweight due to poor nutrition and having severe disease due to limited access to quality healthcare.

Apart from obesity and metabolic syndrome, other comorbidities including systemic hypertension, pre-diabetes, diabetes mellitus, deranged HDL, and hypertriglyceridemia were not significantly different between the psoriasis and control groups of children in our study [see Table 2]. A study from India[7] found that children with psoriasis had significantly lower HDL, although there was no significant difference in hypertriglyceridemia, blood pressure, fasting blood glucose, or metabolic syndrome between case and control groups [Table 6]. However, a systematic review of 16 studies on comorbidities in childhood psoriasis by Badaoui[11] revealed that apart from overweight and obesity, there was no association between other metabolic comorbidities or metabolic syndrome and pediatric psoriasis.

An important observation in our study was that the prevalence of systemic hypertension was not different between obese and non-obese children with psoriasis (29.6% versus 22.6%). In contrast, it was significantly higher in obese compared to non-obese children in the comparative group (40.0% versus 7.1%). A finding that came close to achieving significance was that among thin and normal children, systemic hypertension was more prevalent in the psoriasis group than in the comparative group [see Table 3]. This implies that psoriasis acts as a risk factor for systemic hypertension, independent of excess adiposity. The prevalence of systemic hypertension among only thin and normal-weight children with psoriasis in our study (22.6%) was lower than that reported by Caroppo[28] (46.2%) in normal-weight Italian children with psoriasis. Overall, the prevalence of systemic hypertension among children with psoriasis in our study (25.9%) was higher than that reported by Paller[6] in children from the USA (2.6%). Similar to systemic hypertension, the prevalence of other comorbidities was not different between adiposity-based groups in children with psoriasis [see Table 4]. This mandates that children with psoriasis should be screened for comorbidities regardless of the status of adiposity.

Guidelines emanating from the Pediatric Psoriasis Comorbidity Screening Initiative[29] recommend that all children with psoriasis and obesity or who are overweight with additional risk factors should be screened at 9–11 years of age for non-alcoholic fatty liver disease

Table 6: Comparison of the prevalence of comorbidities in pediatric psoriasis between the present study and previous studies

Studies/Authors	Present study	Moudgil[7]	Panjiyar[8]	Au[5]	Goldminz[9]	Lee[10]
Country	India	India	India	USA	USA	Australia
Year of study/publication	2020	2021	2019	2012	2013	2014–2015
Age (range)	4–18	6–17	2–18	9–17	9–17	5–16
Number of cases/controls	58/62	104/50	52/52	20/1563	20/20	135/73
Obesity (BMI†) (%)	31 vs. 14.5; *P*=0.031	6.73 vs. 2; *P*=0.224	7.7 vs. 7.7; NS‡	Mean BMI 22.7 vs. 22.3; *P*=0.74	BMI percentile 68.1 vs. 66.8; *P*=0.90	4 vs. 4; *P*=0.97
Abdominal obesity (%)	48.27 vs. 32.36; *P*=0.074	24 vs. 8; *P*=0.017	11.5 vs. 9.6 NS	NS	50 vs. 50 NS	WHtR§ ≥0.5 29 vs. 11; *P*=0.002
Hypertension (%)	25.86 vs. 17.74; *P*=0.282	Systolic BP*: 4.8 vs. 4; *P*=0.591; Diastolic BP: 3.8 vs. 8; *P*=0.276	1.9 vs. 1.9 NS	NS	30 vs. 15 NS	Mean systolic BP: 104.6 vs. 102.8 *P*=0.26; Mean diastolic BP: 66.5 vs. 66.7; *P*=0.80
Diabetes (fasting glucose) (%)	0 vs. 1.72 NS	Fasting glucose >100 mg/dL 7.7 vs. 6; *P*=0.703	5.8 vs. 5.8 NS	NS	0 vs. 0 NS	NA**
Diabetes (HbA1c¶) (%)	0 vs. 0; NS	NA	NA	NA	NA	NA
Blood glucose-mean (standard deviation), mg/dL	94.78 (27.08) vs. 93.40 (8.96); *P*=0.938	88.42 (7.86) vs. 87.08 (9.47); *P*=0.355	86.61 (8.11) vs. 89.05 (7.66); NS	NA	91.1 (7.4) vs. 82.9 (10.3); *P*=0.01	NA
		NA	NA	NA	NA	NA
Dyslipidemia based on high-density lipoprotein cholesterol (HDL) (%)	41.38 vs. 33.87; *P*=0.396	37.5 vs 12; *P*=0.001	l: 25 vs. 11.5 NS	Mean HDL: 44.3 mg/dL vs. 51.6 mg/dL, *P*=0.0017)	65 vs. 50 NS	NA
Dyslipidemia based on triglycerides (%)	25.86 vs. 22.58; *P*=0.674	4.8 vs. 4; *P*=0.822	13.5 vs. 17.3; NS	NS	10 vs. 0 NS	
Metabolic syndrome (%)	18.6 vs 4.6; *P*=0.044	1.9 vs. 2; NS	7.7 vs. 3.8; NS	30 vs. 7.4, *P*=0.045	30 vs. 5; *P*=0.04	8 vs. 0; *P*=0.29

†BMI, body mass index; ‡NS, no significant difference between the two groups but values/*P* values not available; §WHtR, waist to height ratio; *BP, blood pressure; **NA, not available; ¶HbA1c, glycosylated hemoglobin

with serum alanine aminotransferase levels. In our study, both of two children with psoriasis, high BMI, central obesity, and raised serum alanine aminotransferase levels had non-alcoholic fatty liver disease on ultrasonography, which validates the above guideline. A recent study from India[8] showed that children with psoriasis had a higher frequency of non-alcoholic fatty liver disease with disease severity, obesity, and decreased HDL acting as independent risk factors. However, the study revealed no differences in adiposity, metabolic comorbidities, or raised serum alanine aminotransferase levels between the case and control groups [see Table 6].

Limitations

The limitations of our study were that children in the psoriasis and comparative groups were not matched for gender and socioeconomic background. Children with psoriasis were not necessarily treatment-naïve at the time of enrolment, which could affect the assessment of disease severity. This lack of matching could have biased our results. We emphasize that this is a preliminary study to observe trends rather than to arrive at definitive conclusions. This being a comparative cross-sectional study, a prevalence odds ratio was generated as opposed to a true odds ratio.

Conclusion

The prevalence of obesity and metabolic syndrome was higher among South-Asian children with psoriasis than those without. However, in children with psoriasis, the prevalence of metabolic comorbidities did not differ with adiposity status. This suggests that psoriasis exerts its influence irrespective of adiposity status and is an independent risk factor for the development of metabolic comorbidities. Children with psoriasis should therefore be screened for comorbidities even in the absence of excess adiposity. Unlike studies from Western countries, but in line with Asian data, there was an inverse relationship between excess adiposity and the severity of psoriasis in our study.

Acknowledgment

We thank all the children who participated in this study.

Financial support and sponsorship

Funding was provided by the Fluid research grant of Christian Medical College, Vellore.

Conflicts of interest

There are no conflicts of interest.

References

1. Augustin M, Glaeske G, Radtke MA, Christophers E, Reich K, Schäfer I. Epidemiology and comorbidity of psoriasis in children. Br J Dermatol 2010;162:633-6.
2. Gelfand JM, Weinstein R, Porter SB, Neimann AL, Berlin JA, Margolis DJ. Prevalence and treatment of psoriasis in the United Kingdom: A population-based study. Arch Dermatol 2005;141:1537-41.
3. Raychaudhuri SP, Gross J. A comparative study of pediatric onset psoriasis with adult onset psoriasis. Pediatric Dermatology 2000;17:174-8.
4. Tollefson MM, Crowson CS, McEvoy MT, Maradit Kremers H. Incidence of psoriasis in children: A population-based study. J Am Acad Dermatol 2010;62:979-87.
5. Au SC, Goldminz AM, Loo DS, Dumont N, Levine D, Volf E, *et al*. Association between pediatric psoriasis and the metabolic syndrome. J Am Acad Dermatol 2012;66:1012-3.
6. Paller AS, Schenfeld J, Accortt NA, Kricorian G. A retrospective cohort study to evaluate the development of comorbidities, including psychiatric comorbidities, among a pediatric psoriasis population. Pediatr Dermatol 2019;36:290-7.
7. Moudgil S, Mahajan R, Narang T, Sachdeva N, Dayal D, Dogra S. Central obesity and dyslipidemia in pediatric patients with psoriasis: An observational study from India. J Am Acad Dermatol 2021;85:1655-7.
8. Panjiyar R, Mahajan R, Bhatia A, Narang T, Dogra S. Cross-sectional study to estimate the prevalence and risk factors of nonalcoholic fatty liver disease in children and adolescents with psoriasis. Clin Exp Dermatol 2023;48:12-9.
9. Goldminz AM, Buzney CD, Kim N, Au SC, Levine DE, Wang AC, *et al*. Prevalence of the metabolic syndrome in children with psoriatic disease. Pediatr Dermatol 2013;30:700-5.
10. Lee A, Smith SD, Hong E, Garnett S, Fischer G. Association between pediatric psoriasis and waist-to-height ratio in the absence of obesity: A multicenter Australian study. JAMA Dermatol 2016;152:1314.
11. Badaoui A, Tounian P, Mahé E. Psoriasis and metabolic and cardiovascular comorbidities in children: A systematic review. Arch Pediatr 2019;26:86-94.
12. Growth reference 5-19 years - BMI-for-age (5-19 years). https://www.who.int/tools/growth-reference-data-for-5to19-years/indicators/bmi-for-age. [Last accessed on 2022 Nov 29].
13. Khadilkar A, Ekbote V, Chiplonkar S, Khadilkar V, Kajale N, Kulkarni S, *et al*. Waist circumference percentiles in 2-18 year old Indian children. J Pediatr 2014;164:1358-62.e2.
14. Kahn HS, Imperatore G, Cheng YJ. A population-based comparison of BMI percentiles and waist-to-height ratio for identifying cardiovascular risk in youth. J Pediatr 2005;146:482-8.
15. Raees M. Cardiology. In: Hughes HK, Kahl LK, editor. The Harriet Lane Handbook. 21st ed. Elsevier; 2018. p. 7.157-62.
16. Copeland KC, Silverstein J, Moore KR, Prazar GE, Raymer T, Shiffman RN, *et al*. Management of newly diagnosed type 2 Diabetes Mellitus (T2DM) in children and adolescents. Pediatrics 2013;131:364-82.
17. Vos MB, Abrams SH, Barlow SE, Caprio S, Daniels SR, Kohli R, *et al*. NASPGHAN clinical practice guideline for the diagnosis and treatment of nonalcoholic fatty liver disease in children: Recommendations from the expert committee on NAFLD (ECON) and the North American Society of Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN). J Pediatr Gastroenterol Nutr 2017;64:319-34.
18. Bamba V. Update on screening, etiology, and treatment of dyslipidemia in children. J Clin Endocrinol Metab 2014;99:3093-102.
19. Alberti KGMM, Zimmet P, Shaw J. Metabolic syndrome--a new world-wide definition. A consensus statement from the International Diabetes Federation. Diabet Med 2006;23:469-80.
20. Gottlieb AB, Chaudhari U, Baker DG, Perate M, Dooley LT. The National Psoriasis Foundation Psoriasis Score (NPF-PS) system versus the Psoriasis Area Severity Index (PASI) and Physician's Global Assessment (PGA): A comparison. J Drugs Dermatol 2003;2:260-6.
21. Fredriksson T, Pettersson U. Severe psoriasis--oral therapy with a new retinoid. Dermatologica 1978;157:238-44.
22. Ergun T, Seckin Gencosmanoglu D, Karakoc-Aydiner E, Salman A, Tekin B, Bulbul-Baskan E, *et al*. Prevalence of obesity in paediatric psoriasis and its impact on disease severity and progression. Australas J Dermatol 2017;58:e182-7. doi: 10.1111/ajd.12491.
23. Jagadesan S, Harish R, Miranda P, Unnikrishnan R, Anjana RM, Mohan V. Prevalence of overweight and obesity among school children and adolescents in Chennai. Indian Pediatr 2014;51:544-9.
24. Koebnick C, Black MH, Smith N, Der-Sarkissian JK, Porter AH, Jacobsen SJ, *et al*. The association of psoriasis and elevated blood lipids in overweight and obese children. J Pediatr 2011;159:577-83.
25. Choon S, Ngim C, Supramaniam P, Tey KE, Madhavan NN. Clinico-epidemiological profile, including body mass index of Malaysian children with psoriasis. Med J Malaysia 2016;71:171-6.
26. Paller AS, Mercy K, Kwasny MJ, Choon SE, Cordoro KM, Girolomoni G, *et al*. Association of pediatric psoriasis severity with excess and central adiposity: An international cross-sectional study. JAMA Dermatol 2013;149:166-76.
27. Zhu KJ, He SM, Zhang C, Yang S, Zhang XJ. Relationship of the body mass index and childhood psoriasis in a Chinese Han population: A hospital-based study. J Dermatol 2012;39:181-3.
28. Caroppo F, Ventura L, Belloni Fortina A. High blood pressure in normal-weight children with psoriasis. Acta Derm Venereol 2019;99:329-30.
29. Osier E, Wang AS, Tollefson MM, Cordoro KM, Daniels SR, Eichenfield A, *et al*. Pediatric psoriasis comorbidity screening guidelines. JAMA Dermatol 2017;153:698-704.