Received: 7 September 2023 | Accepted: 17 April 2024

DOI: 10.1111/pde.15639

Pediatric Dermatology WILEY

The relationship between acrochordons, obesity, and metabolic syndrome in the pediatric population: A retrospective cohort study

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Abstract

Background: Acrochordons or skin tags are common benign skin growths. Several studies explored the relationship between obesity and metabolic syndrome in adults but remains unexplored in children.

Methods: This was a single-center retrospective cohort study of outpatient dermatology patients between 1 January 2000 to 1 January 2021. Children under 18 years old diagnosed with acrochordons using diagnostic codes International Classification of Diseases, 10th Revision (ICD-10) L91.8 and 9th Revision (ICD-9) 701.8 were included. We collected patient demographics, past medical history, laboratory values, vital signs, and physical exam. Body mass index (BMI) was calculated and stratified into categories based on the Center for Disease Control's BMI-for-Age Growth Charts. Metabolic syndrome was diagnosed when three of the five criteria were met. Data were propensity-matched and compared with NHANES (National Health and Nutrition Examination Survey), which offered a generalizable sample to the US population.

Results: Fifty-five patients under 18 years old with a diagnosis of acrochordons were mostly Caucasian (76%) and female (64%). The mean BMI was 27.3, with 49.5% categorized as obese and 20% as overweight. The mean age of diagnosis was 10.1 years. Acrochordon predominantly appeared in the axilla. In our cohort, three patients (5.5%) met the criteria for metabolic syndrome. The prevalence of obesity (42% vs. 21%), type 2 diabetes mellitus (4.8% vs. 0.6%), hyperlipidemia (8.1% vs. 0%), and hypertension (1.6% vs. 0%) was greater in our cohort compared with NHANES.

Conclusions: Like the adult population, acrochordons may serve as marker for metabolic disease in the pediatric population.

KEYWORDS

acanthosis nigricans, acrochordons, dyslipidemia, insulin resistance, metabolic syndrome, obesity, pediatric, skin tags

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1 | INTRODUCTION

Acrochordons, also known as skin tags or fibroepithelial polyps, are common benign skin growths. They appear as flesh colored or brown papules located in areas of frequent friction including the axilla, neck, inframammary folds, groin, or eyelids. Although the exact etiology of skin tags remains unclear, several studies have found associations with obesity and metabolic syndrome in adults. However, less is known about these relationships in the pediatric population.

Obesity is a major public health challenge, with a reported prevalence of 19.7% among children aged 2–19 years.[1] Obesity has known, deleterious effects on multiple organ systems, including the heart, liver, and kidneys. Obesity has been shown to affect the skin, impairing proper functioning of sebaceous glands, the skin barrier, collagen structure, lymphatics, wound healing, and subcutaneous fat in adults.[2] Obesity also comprises an element of metabolic syndrome (also known as insulin resistance syndrome, syndrome X, or dysmetabolic syndrome).[1] Metabolic syndrome refers to a cluster of clinical findings such as hypertension, dyslipidemia, insulin resistance, and increased abdominal girth that can increase the person's risk of stroke, atherosclerotic heart disease, and other cardiovascular diseases.

The association of skin tags with obesity and metabolic syndrome has been reported in adults,[3] but few studies have investigated their role in children and adolescents. Therefore, this study aimed to further investigate the association between skin tags, obesity, and metabolic syndrome in pediatric patients.

2 | METHODS

This was a single-center retrospective cohort study. Using the medical records search database DataDirect, we identified children under 18 years of age diagnosed with acrochordons at the outpatient dermatology clinics of Michigan Medicine, a large tertiary referral center, between 1 January 2000 and 1 January 2021. The diagnosis of acrochordons was determined using International Classification of Diseases, 10th Revision (ICD-10) diagnostic code L91.8 and 9th Revision (ICD-9) diagnostic code 701.8. Demographics, past medical history, laboratory values, vital signs, and physical exam were collected via chart review. Body mass index (BMI) was calculated for each patient and stratified into categories using the Center for Disease Control (CDC) BMI-for-Age Growth Charts. The stratified BMI categories included underweight (<5th percentile), normal (≥5th percentile but <85th percentile), overweight (>85th percentile but <95th percentile), or obese (>95th percentile).[4] Metabolic syndrome was diagnosed when three of the five criteria were met: low high-density lipoprotein (HDL) (≤40 mg/dL), hypertension (≥ 90th percentile), elevated triglycerides (≥110 mg/dL), obesity (≥90th percentile), and elevated fasting serum glucose (≥110 mg/dL).[5] BMI and laboratory results were obtained at the time point closest to the time of skin tag diagnosis. Laboratory results were included if they were performed within 2 years of skin tag diagnosis.

We compared our data to the National Health and Nutrition Examination Survey (NHANES).[6] NHANES generalizes the pediatric population, and we analyzed questionnaire and laboratory data. Questionnaire variables include sex, age, history of type 2 diabetes mellitus, hyperlipidemia, and BMI. Laboratory variables include insulin, triglycerides, HDL, low-density lipoprotein (LDL), aspartate transaminase (AST), and alanine transaminase (ALT).

Statistical analysis was performed using R software version 4.1.1 (R Core Development Team) and RStudio version 1.1.1717 (R Studio Inc). The means of two independent groups were compared using the Wilcoxon rank sum non-parametric test for continuous variables and either Pearson's Chi-squared test or Fisher's exact test for categorical variables. Results were presented as median (interquartile range) for continuous variables and frequency (percentage) for categorical variables. p value <.05 was considered statistically significant.

Propensity score matching was used to identify the comparative control group from NHANES to closely resemble the cohort population based on available demographic variables. Individual propensity scores were estimated through logistic regression on variables including age, race, and sex. Optimal matching was performed using the "MatchIt" package in R.

3 | RESULTS

3.1 | Subject characteristics

Our cohort included 55 pediatric patients diagnosed with acrochordons. The demographic information of our study cohort is shown in Table 1. The cohort was 64% (35/55) female and 76% (42/55) Caucasian. Past medical history demonstrated hypothyroidism in 3.6% (2/55) of patients, polycystic ovary syndrome in 7.3% (4/55), and type 2 diabetes mellitus in 5.5% (3/55). BMI was reported in 51 of 55 patients. The mean BMI was 27.3 (standard deviation [SD] 7.3). About 49% (25/51) of patients were obese and 20% (10/51) were overweight (Table 2).

The average age of acrochordon diagnosis was 10.1 years (SD ± 3.7). The location of the acrochordons was examined across 6 categories: the axilla, neck, eyelid, groin, trunk, and other. The axilla was the most common location, found in 38% (21/55) of our cohort followed by the neck in 25% (14/55) of our cohort. Notably, skin tags in the underweight group were found only in "other" locations. A small number of patients (9/55, 16.4%) presented with acrochordons in more than one location. There were no significant differences in the localization of acrochordons according to BMI category or sex.

Of the 55 patients, 21 patients (6 overweight, 15 obese) had a full laboratory workup measuring triglycerides, HDL, fasting glucose, and blood pressure to evaluate for metabolic syndrome. A total of 5.5% of patients (3/55) met the criteria for metabolic syndrome per Cook et al guidelines, all of whom were in the obese group (Table 3).[4] Of the obese patients, 73% (11/15) had elevated triglycerides, 53% (8/15) had high blood pressure, 50% (7/15) had low HDL, and 13% (2/15) had elevated fasting glucose. Of the overweight patients, 33% (2/6) displayed elevated triglyceride levels and 17% (1/6) had high blood pressure.

TABLE 1 Clinical characteristics of cohort according to sex.

Characteristic	Female, $N = 35$	Male, $N = 20$	Overall, $N = 55$
Age at diagnosis, mean (SD)	10.2 (3.6)	9.9 (4.0)	10.1 (3.7)
BMI, mean (SD)	27.8 (7.8)	26.4 (6.5)	27.3 (7.3)
Race, *n* (%)			
Caucasian	25 (71)	17 (85)	42 (76)
African American	5 (14)	0 (0)	5 (9.1)
Asian	2 (5.7)	2 (10)	4 (7.3)
Hispanic	3 (8.6)	0 (0)	3 (5.5)
Native American	0 (0)	1 (5.0)	1 (1.8)
Other	0 (0)	0 (0)	0 (0)
Hispanic or Latino, *n* (%)	4 (11)	0 (0)	4 (7.4)
Hypothyroidism, *n* (%)	1 (2.9)	1 (5.0)	2 (3.6)
PCOS, *n* (%)	4 (11)	0 (0)	4 (7.3)
DM2, *n* (%)	3 (8.6)	0 (0)	3 (5.5)
Genetic disorders, *n* (%)	4 (11)	0 (0)	4 (11)
Mental health history, *n* (%)	10 (29)	6 (30)	16 (29)

Abbreviations: BMI, body mass index; DM2, diabetes mellitus type 2; PCOS, polycystic ovarian syndrome; SD, standard deviation.

Of the patients stratified by BMI, 25.4% of patients (13/51) had acanthosis nigricans, with 92% of these patients (12/13) categorized as obese ($p < .001$), and 8% of patients (1/13) categorized as overweight. Furthermore, patients categorized as obese or overweight were more likely to have a mental health disorder: 17.1% of patients had depression (6/35), 8.8% of patients had anxiety (4/35), and 8.8% of patients had attention deficit hyperactivity disorder (4/35). The average age of patients at diagnosis of a concomitant mental health disorder was 11.3 years. No significant relationships were observed between specific psychiatric diagnoses and either acrochordon location or BMI category.

3.2 | Comparison to population data

The total NHANES dataset contained 6328 patients, with the matched NHANES cohort consisting of 55 patients. The prevalence of several diseases was greater in our study cohort compared to the matched NHANES cohort (Table 4). This included obesity (49% vs. 27%), type 2 diabetes mellitus (5.5% vs. 1.9%), hyperlipidemia (7.3% vs. 0%), and hypertension (1.8% vs. 0%). In our propensity-matched model, we found that patients in our cohort had a significantly higher median BMI (27 in cohort vs. 20 in NHANES, $p < .001$), median triglycerides (120 in cohort vs. 74 in NHANES, $p = .011$), median AST (23 in cohort vs. 18 in NHANES, $p = .005$), and median ALT (26 in cohort vs. 10 in NHANES, $p < .001$). Median HDL was significantly lower for our cohort (46 in cohort vs. 54 in NHANES, $p = .019$).

4 | DISCUSSION

This study attempted to address the gap in understanding the relationship between acrochordons, obesity, and metabolic syndrome in the pediatric population. We found that skin tags are associated with obesity and signs of metabolic syndrome including dyslipidemia and elevated liver function tests. Pediatric patients with skin tags were also more likely to have other skin manifestations of insulin resistance such as acanthosis nigricans.

Our findings resemble those reported in adult studies. For instance, Sari et al investigated 113 adult patients with skin tags and found an increased frequency of dyslipidemia (59.3%), metabolic syndrome (39.8%), obesity (33.6%), hypertension (30.1%), and insulin resistance (21.2%) compared to the general population.[7] Furthermore, Şenel et al compared 110 patients with acrochordons to 110 age- and gender-matched controls and found higher fasting plasma glucose, LDL cholesterol levels, liver enzyme levels, triglycerides, and increased systolic and diastolic blood pressure among the group with acrochordons.[8]

Obesity itself plays an important role in the study of acrochordons, as their incidence in children and adolescents has increased with the rise of pediatric obesity.[9] Plascencia Gomez et al researched skin disorders in 109 overweight and obese patients, 13 of whom were children.[10] In their cohort, 97% had acanthosis nigricans, and 77% had skin tags. They found acanthosis nigricans and skin tags to be directly associated with the degree of obesity, serving as clinical markers for hyperinsulinemia in nondiabetic obese patients. A study of 103 pediatric patients with obesity found 45% with acanthosis nigricans and 25.2% with acrochordons.[11] Another study compared 82 children with obesity to 86 children with normal weight, finding a higher prevalence of both acanthosis nigricans (63.4% vs. 3.5%, $p < .001$) and acrochordons (17.1% vs. 1.2%, $p < .001$) in the obese group.[12]

Acanthosis nigricans, a cutaneous manifestation of insulin resistance, is closely related to obesity as states of excess adipose impair sensitivity to insulin. This concept was corroborated in our pediatric study as 92% of the children with acanthosis nigricans were

TABLE 2 Dermatologic characteristics of cohort according to weight category.

Characteristic	Underweight, $N = 2$	Normal, $N = 14$	Overweight, $N = 10$	Obese, $N = 25$
Age at diagnosis, Mean (SD)	9.0 (9.9)	10.4 (2.9)	11.1 (3.2)	9.6 (4.2)
Sex, *n* (%)				
Female	2 (100)	7 (50)	8 (80)	16 (64)
Male	0 (0)	7 (50)	2 (20)	9 (36)
Race, *n* (%)				
Caucasian	2 (100)	13 (93)	7 (70)	16 (64)
African American	0 (0)	0 (0)	2 (20)	3 (12)
Asian	0 (0)	1 (7.1)	1 (10)	2 (8.0)
Hispanic	0 (0)	0 (0)	0 (0)	3 (12)
Native American	0 (0)	0 (0)	0 (0)	1 (4.0)
Other	0 (0)	0 (0)	0 (0)	0 (0)
Hispanic or Latino, *n* (%)	0 (0)	0 (0)	0 (0)	4 (16)
Hypothyroidism, *n* (%)	0 (0)	1 (7.1)	1 (10)	0 (0)
PCOS, *n* (%)	0 (0)	0 (0)	1 (10)	3 (12)
DM2, *n* (%)	0 (0)	0 (0)	0 (0)	3 (12)
Hyperlipidemia, *n* (%)	0 (0)	0 (0)	0 (0)	4 (16)
Genetic disorders, *n* (%)	0 (0)	0 (0)	0 (0)	4 (16)
Mental health history, *n* (%)	1 (50)	2 (14)	3 (30)	10 (40)
Hypertension, *n* (%)	0 (0)	0 (0)	0 (0)	1 (4.0)
Serum insulin, mean (SD)	(NA)	(NA)	(NA)	77.85 (90.72)
Triglycerides (<90 normal), mean (SD)	65.0 (NA)	(NA)	116.8 (80.8)	160.0 (76.3)
HDL (normal >40), mean (SD)	58.0 (NA)	(NA)	54.8 (13.3)	43.9 (10.6)
LDL (normal <130), mean (SD)	144.0 (NA)	(NA)	95.7 (13.4)	98.8 (41.4)
SBP, mean (SD)	89.5 (7.8)	117.7 (15.2)	109.0 (18.4)	118.2 (12.9)
DBP, mean (SD)	48.5 (19.1)	66.8 (12.4)	67.5 (8.6)	66.5 (13.0)
ESR, mean (SD)	(NA)	60 (NA)	(NA)	36 (26.9)
Fasting plasma glucose, mean (SD)	79.0 (NA)	87.5 (2.1)	82.1 (8.2)	97.1 (10.5)
HbA1c, mean (SD)	NA (NA)	NA (NA)	4.9 (0.2)	5.5 (0.5)
AST, mean (SD)	27.0 (NA)	28.0 (11.3)	21.7 (4.9)	26.8 (9.2)
ALT, mean (SD)	24.0 (NA)	25.5 (3.5)	21.9 (11.2)	38.2 (31.2)
Acanthosis nigricans, *n* (%)	0 (0)	0 (0)	1 (33)	10 (77)
Acrochordons in more than one location, *n* (%)	0 (0)	1 (7.1)	2 (20)	5 (20)

Abbreviations: ALT, alanine transaminase; AST, aspartate transaminase; BMI, body mass index; DBP, diastolic blood pressure; DM2, diabetes mellitus type 2; ESR, erythrocyte sedimentation rate; HbA1c, hemoglobin A1c; HDL, high-density lipoprotein; LDL, low-density lipoprotein; NA, not available; PCOS, polycystic ovarian syndrome; SBP; systolic blood pressure; SD, standard deviation.

categorized as obese. Likewise, most patients diagnosed with acrochordons were found to be obese or overweight. Obesity may play a role in acrochordon development as elevated leptin (secondary to obesity) can increase keratinocyte proliferation, thereby contributing to the development of skin tags.[13]

Knowing that metabolic abnormalities are observed in obesity, skin tags may then provide useful insight into important markers of health in pediatric patients. For instance, we found higher total cholesterol, higher triglycerides, higher LDL, and lower HDL in pediatric patients with acrochordons, particularly in those with obesity. Obese patients with acrochordons also had a higher prevalence of hypertension compared to overweight patients. When comparing our cohort to

TABLE 3 Prevalence of metabolic syndrome markers in patients with full metabolic workup.

Characteristic	Overweight, $N = 6$	Obese, $N = 15$
Triglycerides >110 mg/dL, *n* (%)	2 (33)	11 (73)
HDL <40 mg/dL, *n* (%)	0 (0)	7 (50)
Fasting glucose >110 mg/dL	0 (0)	2 (13)
High blood pressure,[a] mm Hg	1 (17)	8 (53)
Patients who meet metabolic syndrome criteria, n (%)	0 (0)	3 (20)

Abbreviation: HDL, high-density lipoprotein.
[a]High blood pressure defined as greater than or equal to the 90th-percentile for age.

TABLE 4 Clinical characteristics and biochemical parameters in our cohort versus NHANES database.

Characteristic	Cohort, $N = 55$	NHANES, $N = 55$	p-value[a]
Sex, *n* (%)			.84
Female	35 (64)	36 (65)	
Male	20 (36)	19 (35)	
Race, *n* (%)			>.99
Caucasian	42 (76)	43 (78)	
African American	5 (9.1)	5 (9.1)	
Asian	4 (7.3)	4 (7.3)	
Hispanic	3 (5.5)	3 (5.5)	
Native American	1 (1.8)	0 (0)	
Other	0 (0)	0 (0)	
Age, median (IQR)	10.0 (7.5–12.5)	11.0 (7.5–13.0)	.82
DM2, *n* (%)	3 (5.5)	1 (1.9)	.62
Hyperlipidemia, *n* (%)	4 (7.3)	0 (NA)	>.99
Hypertension, *n* (%)	1 (1.8)	0 (NA)	>.99
BMI, median (IQR)	27 (22–31)	20 (17–24)	**<.001**[b]
Serum insulin, median (IQR)	78 (46–110)	8 (8–16)	.18
Triglycerides, median (IQR)	120 (80–196)	74 (56–82)	**.011**[b]
HDL, median (IQR)	46 (40–54)	54 (47–64)	**.019**[b]
LDL, median (IQR)	97 (79–114)	85 (76–99)	.26
CRP, median (IQR)	7.50 (7.50–7.50)	0.64 (0.30–1.95)	.17
Fasting plasma glucose, median (IQR)	89 (83–100)	96 (92–98)	.19
AST, median (IQR)	23 (20–31)	18 (16–22)	**.005**[b]
ALT, median (IQR)	26 (16–36)	10 (10–18)	**<.001**[b]

Abbreviations: ALT, alanine transaminase; AST, aspartate transaminase; BMI, body mass index; CRP, c-reactive protein; DM2, diabetes mellitus type 2; HDL, high-density lipoprotein; IQR, interquartile range; LDL, low-density lipoprotein; NA, not available; NHANES, National Health and Nutrition Examination Survey.
[a]Pearson's Chi-squared test or Fisher's exact test for categorical variables; Wilcoxon rank sum test or Wilcoxon rank sum exact test for continuous variables.
[b]Significance at $\alpha = 0.05$ (bolded).

NHANES, we found that, similar to adults, acrochordons in children were also associated with signs of metabolic syndrome including type 2 diabetes, hyperlipidemia, hypertension, and elevated liver enzymes.

The association with metabolic syndrome carries important considerations for children including the prevention and management of type 2 diabetes and premature coronary artery disease. Thus, the clinical relevance of pediatric skin tags warrants further investigation for underlying metabolic syndrome, especially in children with obesity. In addition, the relationship with mental health should be acknowledged as our study found a higher likelihood of mental health disorders in obese and overweight children. Hasse et al similarly discussed findings of lower quality of life metrics in these patients with obesity and skin findings.[11]

Given the possible implications on pediatric health, care should be taken in evaluating children for acrochordons. Of clinical relevance, we found the median age at time of skin tag diagnosis to be approximately 10 years old. The early presence of skin tags may reflect an increased risk of metabolic syndrome in adolescents and teenagers, and the size and number of skin tags have been shown to increase with age.[14–16] In managing pediatric patients with acrochordons, clinicians should consider screening for hypertension and obtaining a targeted laboratory workup to identify underlying metabolic abnormalities. Laboratory workup should be considered when a patient presents with a BMI that is defined as "overweight" or "obese" based on the patient's age. Recommended tests to perform include screening for fasting glucose, lipid profile, liver function tests, and hemoglobin A1c to assess for insulin resistance, dyslipidemia, non-alcoholic fatty liver disease, and diabetes.[13] Based on these results, referral to a general pediatrician or pediatric endocrinologist may be warranted for further management of metabolic syndrome.

In our study, the axilla was the most common location for skin tags, as was also found by Hasse et al.[11] In contrast, Demir and Demir reported the neck to be the most common location in adults.[17] The areas of high friction are thought to contribute to acrochordon development, but the exact etiology remains incompletely understood as other possible mechanisms such as hormone imbalances, tissue growth factor, epidermal growth factor, aging, and infection are also thought to contribute.[13,17,18]

When comparing the low-to-normal BMI patient group with obese/overweight patient group in our study, we found that patients with lower BMI tended to have lower fasting glucose, however, this difference was not significant. One patient in this cohort was noted to have a history of anorexia, and 2 patients were noted to have genetic disorders. Various factors could contribute to the development of skin tags in individuals with low-to-normal BMI. A study in 350 adult females found that the rate of acrochordons was significantly higher in patients with autoimmune disorders, suggesting an immune system-related mechanism underlying acrochordon pathogenesis.[19] Among pediatric patients, acrochordon development has been linked to genetic diseases such as tuberous sclerosis[20] or syndromes of growth hormone excess.[21,22]

Limitations for this study include the relatively small sample size, single institution cohort, and primarily Caucasian demographic. Future studies with a larger, more diverse patient cohort involving multiple study centers could strengthen the validity and generalizability of the findings. In addition, the retrospective nature of our study limits data availability as exemplified by inadequate available laboratory information for the normal weight and underweight patients of this study. Furthermore, the laboratory data were also not necessarily obtained at the time of skin tag diagnosis, which may pose limitations on the accuracy of conclusions drawn about associations between laboratory results and acrochordons. Finally, some studies in adults support that greater waist circumference correlates with more skin tags and that waist circumference is an important consideration for obesity and metabolic syndrome. This parameter was unfortunately not assessed in our study due to a lack of available data.[23]

5 | CONCLUSION

Pediatric obesity is increasing in prevalence, presenting a major public health problem. While skin tags are largely benign and idiopathic, their presence may indicate underlying metabolic abnormalities in both adults and children, especially in the setting of obesity. The findings of this study contribute to the limited understanding of the relationship between acrochordons, obesity, and metabolic syndrome specific to the pediatric population. Ultimately, the associations observed in pediatric acrochordon patients suggestive of poorer health and comorbidities should prompt clinicians to closely evaluate children with acrochordons. Early identification and intervention of metabolic disease can reduce its negative impact and promote better health outcomes into adulthood.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Raw data were generated at University of Michigan. Derived data supporting the findings of this study are available from the corresponding author [MN] on request.

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How to cite this article: Greene RK, Gangidi S, Zhao R, Nelson JM, Harms K, Nakamura M. The relationship between acrochordons, obesity, and metabolic syndrome in the pediatric population: A retrospective cohort study. *Pediatr Dermatol*. 2024;41(4):660-666. doi:10.1111/pde.15639