

Association between metabolic syndrome and acne in teenage girls: a cross-sectional study

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Background: Acne is a common chronic inflammatory skin disease predominantly occurring during adolescence; this condition adversely affects a person's self-esteem and can be associated with metabolic disorders. This study aimed to investigate the prevalence of metabolic syndrome and its components in adolescent girls with acne compared to a control group.

Materials and Methods: In this cross-sectional study, 105 adolescent girls aged 12-18 years were assigned to either the acne (case; n = 55) or control group (n = 50). The case group was selected from the Dermatology Department of a general hospital in Tehran, Iran, between January and August 2017. Acne was diagnosed and graded by a dermatologist. Clinical and biochemical parameters were evaluated for all participants.

Results: The prevalence of metabolic syndrome in patients with and without acne was 18.2% and 14%, respectively. Metabolic syndrome was not correlated with acne in adolescent girls ($P = 0.561$). In addition, the mean body mass index ($P = 0.89$), waist circumference ($P = 0.62$), mean systolic and diastolic blood pressures ($P = 0.57$ and 0.62 , respectively), fasting blood sugar ($P = 0.59$), total cholesterol, and low-density lipoprotein cholesterol levels were comparable between the studied groups ($P > 0.05$). Moreover, triglyceride levels were significantly lower in the acne group ($P = 0.028$), whereas this group featured a higher level of high-density lipoprotein cholesterol ($P = 0.02$). However, the logistic regression results showed that none of the measured lipids were associated with acne.

Conclusion: The findings indicated that metabolic syndrome and its components (representing metabolic imbalance) were not correlated with acne in adolescent girls.

Keywords: acne vulgaris, metabolic syndrome, adolescent

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INTRODUCTION

Acne is known as a chronic inflammatory skin disease predominantly affecting the face, shoulders, back, and chest of adolescent girls. Excess sebum production, follicular hyperkeratinization, *Propionibacterium acnes* colonization,

and inflammation fulfill leading roles in the pathogenesis of acne^{1,2}. It has been suggested that hormonal changes, especially during puberty, such as an increase in the production of androgens and their conversion in peripheral tissues, are associated with the pathogenesis of this disease³. Changes in the levels of insulin-like growth factor (IGF)-1,

insulin-like growth factor binding protein (IGFBP)-3, and sex hormone binding globulin (SHBG) are also involved in the development of acne⁴⁻⁶.

During puberty, physiological insulin resistance and hyperinsulinemia are responsible for increased free IGF-1 concentrations, androgen synthesis, and reduced IGFBP-3 levels⁷. On the other hand, hyperinsulinemia, by increasing the levels of plasma fatty acids, initiates or aggregates a cluster of metabolic abnormalities as the components of metabolic syndrome⁸. Similarities in the underlying mechanisms of the development of acne and metabolic syndrome indicate the possible link between these two disorders. The relationship between an impaired metabolic profile and acne has previously been addressed^{8,9}.

It has been shown that metabolic syndrome represents an integral part of polycystic ovary syndrome (PCOS) as a common endocrine disease in girls associated with the formation of acne lesions; this syndrome is typically characterized by hyperandrogenism, peripheral insulin resistance, and obesity¹⁰. A recent study reported that young boys with acne had decreased insulin sensitivity and metabolic imbalance with higher values of body mass index (BMI), waist circumference (WC), waist-hip ratio, systolic blood pressure, diastolic blood pressure, basal and 120-min levels of the oral glucose tolerance test (OGTT) results, serum insulin concentrations, basal glucose concentrations, and homeostasis model assessment–insulin resistance (HOMA-IR), as well as lower levels of high-density lipoprotein cholesterol (HDL-C)⁹. In addition, another study on young boys demonstrated that boys with post-adolescent acne commonly suffered from insulin resistance, which was positively correlated with the severity of the disease. However, they reported that the prevalence of metabolic syndrome was comparable between patients with acne and those without acne lesions⁸.

The results of studies on the association between impaired metabolic profiles and acne are contradictory. The prevalence of each criterion for the diagnosis of metabolic syndrome is also yet to be investigated among adolescent girls with acne regardless of having PCOS. Accordingly, the objective of this study was to investigate the relationship between acne and metabolic syndrome in adolescent girls at the peak age range of acne.

PATIENTS AND METHODS

Participants

In this case-control study, 105 adolescent girls aged 12-18 years were assigned to either the acne (case; n = 55) or control group (n = 50). All cases were selected from the Dermatology Department of a general hospital in Tehran, Iran, from January to August 2017.

Inclusion criteria included an age range of 12-18 years and the diagnosis of acne according to a clinical examination by a dermatologist. Patients with cardiovascular diseases and immunosuppression were excluded. The control group was selected from patients without any inflammatory or systemic diseases referring to outpatient clinics.

All participants were subjected to clinical and paraclinical evaluations. Patients with acne were divided into three groups by a dermatologist, namely the mild comedonal form, moderate form with papules and pustules, and severe form with nodular lesions¹¹.

A sample size of 50 subjects in each group was initially calculated based on previous studies¹² using a formula for comparing two ratios of a qualitative trait in two independent populations and by calculating the percentage of sample attrition. Finally, 105 patients were studied, including 55 subjects in the acne group and 50 subjects in the control group.

Evaluations

All subjects in the case and control groups were clinically evaluated for their waist circumference (WC; as an indicator of obesity), weight, height, BMI, and blood pressure. After overnight (at least 8 h) fasting, 10 ml of peripheral venous blood was obtained from each participant to evaluate the glucose and lipid levels. The fasting blood sugar (FBS), triglyceride (TG), total cholesterol (TC), low-density lipoprotein (LDL), and high-density lipoprotein HDL levels were evaluated in each subject using the Hitachi 917 Analyzer. The association between these variables and acne was subsequently evaluated. Systolic and diastolic blood pressures were recorded after five minutes of rest and then ten minutes later. The WC (cm) was measured at the midpoint between the lower margin of the rib and the top of the iliac crest,

while the height (cm) was measured from the top of the head to the bottom of the feet.

Metabolic syndrome

To evaluate the correlation between acne and metabolic syndrome, we investigated all cases considering the diagnostic criteria for metabolic syndrome based on the Third National Health and Nutrition Examination Survey (NHANES III)¹³. Each patient with three of the following items was diagnosed with metabolic syndrome: 1) WC greater than or equal to the 75th percentile based on age and sex; 2) systolic or diastolic blood pressure greater than or equal to the 90th percentile based on the height, age, and sex; 3) serum TG level greater than or equal to 100 mg/dl; 4) serum HDL level less than or equal to 50 mg/dl; and 5) serum glucose level greater than or equal to 110 mg/dl.

Statistical analysis

The sample size was calculated using G*power 3. Assigning 50-55 subjects to each group was sufficient to achieve 80% power and to detect a difference of 0.27 (0.09 vs. 0.36) between two proportions¹⁴. Statistical analysis was performed by SPSS version 24 (Chicago, Illinois, United States) using parametric and non-parametric tests, such as the Student's *t*-test, Chi-squared test, and logistic regression. *P*-values less than 0.05 were considered statistically significant.

Statement of ethics

For ethical considerations, the necessary permissions for human subject studies were obtained. Informed consent was received from the subjects and their guardians and the evaluations were performed in accordance with the Declaration of Helsinki. This study was extracted from a thesis for the M.D. degree (IR.TUMS.MEDICINE.REC.1396.2812).

RESULTS

Study population

In the current study, 105 girls aged 12-18 years with a mean age of 15 ± 2 years were evaluated. The mean height was 159.7 ± 6.3 cm and the mean weight was 59 ± 14 kg; the average BMI was 23 ± 4.7 kg/m². The mean systolic and diastolic blood pressure values were 109 ± 14.7 mmHg and 64.3 ± 7.4 mmHg, respectively. The laboratory test results are shown in Table 1. According to the obtained results, 17 (16.19%) cases were suffering from metabolic syndrome, accounting for 18.2% of those with acne and 14% of individuals in the control group.

Metabolic syndrome

The prevalence of acne among the patients who were diagnosed with metabolic syndrome was

Table 1. Main descriptive characteristics of the study population (adolescents with acne and the control group)

Characteristic	Total	Patients (n = 55)	Controls (n = 50)	<i>P</i> *
		Mean \pm SD		
Age (years)	15 \pm 2.07	15.09 \pm 2.29	14.98 \pm 1.81	> 0.05
Height (cm)	159.72 \pm 6.33	159.71 \pm 5.7	159.74 \pm 7	0.98
Weight (kg)	59.06 \pm 14.09	59.36 \pm 13.6	58.74 \pm 14.7	0.82
BMI (kg/m ²)	23.09 \pm 4.79	23.16 \pm 4.6	23.03 \pm 5	0.89
Waist circumference (cm)	73.99 \pm 8.57	73.54 \pm 7.29	74.36 \pm 9.84	0.62
Triglyceride (mg/dl)	93.03 \pm 81.94	75.56 \pm 38.02	112.26 \pm 109.20	0.02
Cholesterol (mg/dl)	136.62 \pm 26.22	137.50 \pm 26.10	135.66 \pm 26.58	0.72
LDL (mg/dl)	77.97 \pm 21.72	80.36 \pm 24.03	75.28 \pm 24.03	0.23
HDL (mg/dl)	40.37 \pm 7.90	42.03 \pm 8.00	38.54 \pm 7.54	0.02
FBS (mg/dl)	96.35 \pm 23.76	95.13 \pm 9.71	97.67 \pm 32.90	0.59
SBP (mmHg)	109 \pm 14.71	109.81 \pm 15.69	108.2 \pm 13.65	0.57
DBP (mmHg)	64.3 \pm 7.45	64.72 \pm 7.41	64 \pm 7.55	0.62
Metabolic syndrome	16.1%	18.2%	14%	0.56

n, number; SD, standard deviation; cm, centimeters; kg, kilogram; BMI, body mass index, SBP; systolic blood pressure, DBP; diastolic blood pressure; LDL, low-density lipoprotein; HDL, high-density lipoprotein; FBS, fasting blood sugar.

*Significant *P* values are shown in bold

41.17%, but was 56.8% in healthy subjects. There was no significant association between metabolic syndrome and the presence of acne ($P = 0.56$). Table 2 shows the comparison between the cases with and without metabolic syndrome in terms of acne severity. Statistical analysis showed that there was no correlation between the severity of acne and the diagnosis of metabolic syndrome ($P = 0.95$).

Physical evaluation

The mean ages of individuals in the acne and control groups were 15 ± 2.2 years and 14.9 ± 1.8 years, respectively ($P > 0.05$). There was no significant difference in weight ($P = 0.82$), height ($P = 0.98$) and BMI ($P = 0.89$) between the groups. Moreover, there was no remarkable difference in systolic and diastolic blood pressures between the two groups (Table 1).

The results indicated that the mean WC of individuals in the acne group (73.5 ± 7.2 cm) was not statistically different from that of the control group (74.3 ± 9.8 cm; $P = 0.62$). According to the obtained results, none of the studied variables were significantly different between the acne and control groups.

Laboratory evaluation

The FBS, TC, and LDL levels were not statistically different between the acne and control groups ($P > 0.05$). Interestingly, patients in the acne group had markedly lower TG levels ($P = 0.028$), whereas HDL levels were significantly higher in this group ($P = 0.024$). Table 1 demonstrates the mean values

of the laboratory results in both groups.

Multivariate analysis

The incidence of acne could be influenced by several variables studied in this research. Hence, multivariate analysis was performed through stepwise forward logistic regression. The results indicated that none of the variables could affect the odds ratio (OR) for the occurrence of acne.

DISCUSSION

This cross-sectional study, for the first time, demonstrated the relatively low prevalence of metabolic syndrome in girls with acne aged 12-18 years compared with age and sex-matched controls regardless of having PCOS. In addition, BMI, WC, mean systolic and diastolic blood pressures, FBS, TC, and LDL levels were comparable between the studied groups.

An increased prevalence of metabolic syndrome has been reported among adult patients with certain skin inflammatory disorders, such as acne inversa and psoriasis¹². Consistent with our findings, the study of Nagpal *et al.* on 100 adult males with an average age of 22.7 years showed no significant difference in the prevalence of metabolic syndrome in patients with and without acne or a severe form of acne⁸. Similarly, the research of Balta *et al.* on 35 male and female post-adolescent patients with acne (mean age: 30.8 years) indicated no significant difference between the case and control groups in terms of the metabolic parameters¹⁶.

In contrast, Del Prete *et al.*, in a study with a limited sample size and disregard for controlling

Table 2. Metabolic syndrome and severity of acne

	Acne Severity				Total	P	
	None	Mild	Moderate	Severe			
Metabolic Syndrome							
Yes							
Count	7	2	5	3	17	0.95	
Percentage	41.2%	11.8%	29.4%	17.6%	100.0%		
No							
Count	43	8	24	13	88		
Percentage	48.9%	9.1%	27.3%	14.8%	100.0%	0.56	
Total							
Count	50	10	29	16	105		
Percentage	47.6%	9.5%	27.6%	15.2%	100.0%		

the age of the subjects, showed that the prevalence of metabolic syndrome in male acne patients with a mean age of 18.6 years was 36%, which was significantly higher than the control group. In that study, metabolic syndrome was diagnosed with the presence of two or more of the five parameters, which can be regarded as the reason for the high prevalence of metabolic syndrome in patients with acne. In addition, the small sample size and lack of sampling based on age may also explain their different results ⁹.

The prevalence of metabolic syndrome is associated with age ¹⁷. A study on the urban population in Eastern India reported prevalence values of 6.7 and 65.6% in the age groups of 20-29 and 60-69 years, respectively ¹⁸. The prevalence of metabolic syndrome in children is around 2% but varies significantly based on the diagnostic criteria applied ¹⁹. In our study, the prevalence of metabolic syndrome in female acne patients aged 12-18 years was 18.2%, which was not significantly different from that of the age-matched control group (14%). However, the estimated prevalence was higher than the reported rate according to the classification proposed by Bussler ¹⁹. The wide range for the prevalence of metabolic syndrome can be explained by racial differences.

Our results indicated normal lipid profiles in adolescent girls with acne. However, our results are to some extent inconsistent with the findings of previous studies on the correlation between dyslipidemia and acne. Balta *et al.* ¹⁶, de Cunha *et al.* ²⁰ and Nagpal *et al.* ⁸ reported no significant differences in TG and HDL levels between adult patients with and without acne, which is consistent with our findings. However, de Cunha *et al.* found that both TC and LDL levels were higher in women with the severe form of acne. They studied patients with severe acne vulgaris, whereas the present study was performed on patients with all forms of acne. Accordingly, discrepant findings may be ascribed to the different sampling methods ²⁰. In addition, the differences in findings can possibly be due to the effect of racial, environmental and genetic factors, smoking, nutrition, and medications on serum lipid levels ²¹.

Interestingly, our results revealed that the FBS level was not significantly different in the acne group. Hyperglycemia is one of the main risk factors for metabolic syndrome; thus, we confirmed

a lack of correlation between acne and metabolic syndrome. Balta *et al.* also expressed no significant difference between case and control groups in FBS levels, which is consistent with our findings ¹⁶. In contrast, Nagpal *et al.* stated that the average FBS levels and the prevalence of insulin resistance were significantly higher in young men with acne relative to the controls ^{8,9}.

Our findings also demonstrated that elevated blood pressure, as a diagnostic component of metabolic syndrome, was not significantly more common among adolescent girls with acne compared with the control group. However, Del Prete *et al.* ⁹ and Nagpal *et al.* ⁸ showed that systolic and diastolic blood pressure values of patients with acne were statistically higher than those of the control groups.

In addition, Balta *et al.* ¹⁶ did not establish any correlation between BMI and acne development in adult patients, which is consistent with our results regarding adolescent girls. However, Del Prete ⁹, Schmidt *et al.* ¹⁰, and Alan *et al.* ²² reported positive correlations between BMI and the severity of acne. Diet, as a confounding factor, was not studied in our study; this can be considered as a limitation.

CONCLUSION

The present work revealed a lack of correlation between metabolic syndrome and the development of acne in adolescent girls. Moreover, mean BMI, WC, systolic and diastolic blood pressure, FBS, and lipid profile values were not significantly different between adolescent girls with and without acne. Further studies are recommended to assess the correlation between metabolic syndrome and acne in the teenage population, which is highly vulnerable to the consequences of both conditions.

Conflict of interest: None declared.

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