Dietary glycemic load in adolescent girls with and without acne

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Background: Acne is a chronic inflammatory skin disease and a cosmetic problem with considerable emotional and psychological side effects and symptoms, such as pain and pruritus. Some controversies exist concerning the involvement of dietary factors, including glycemic load (GL), in the pathogenesis of acne. Accordingly, we aimed to determine the role of GL and anthropometric measures in acne development among girls aged 12-18 years in Tehran, Iran.

Methods: In this cross-sectional study, 99 girls (45 girls without acne and 54 girls with acne) aged 12-18 years completed a three-day food record. Anthropometric measures, such as height, weight, waist circumference, and body mass index (BMI), were also assessed. Additionally, an expert dermatologist scored the severity of acne, and then, anthropometric measures and GL were examined in the groups.

Results: The results showed no significant difference in dietary GL, height, weight, BMI, and waist circumference between the groups. Furthermore, the severity of acne was not significantly associated with GL.

Conclusion: The present results did not confirm the association between acne and dietary carbohydrates, including GL. However, further research can contribute to determination of the effect of diet on acne and its severity.

Keywords: acne vulgaris, diet, glycemic load, anthropometry

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INTRODUCTION

Acne is a common inflammatory skin disease, which mostly presents during adolescence. It affects a significant proportion of adolescents, with a prevalence of 79-95% in Western countries [1,2]. The prevalence of acne has increased among adults in developed countries. It may present, persist, or recur in the third and fourth decades of life [3].

It predominantly affects the skin and is consequently associated with psychological distress, low self-esteem, poor body image, social withdrawal, and depression [4,5]. The pathogenesis of acne is complex and attributed to excessive sebum production, follicular hyperkeratinization, intra-follicular colonization by bacteria and yeast, and inflammation [3,6].

There is some evidence regarding the involvement of environmental factors, including diet, in the acne pathogenesis [6]. Various hormonal mediators, such as insulin-like growth factor-1 (IGF-1), insulin-like growth factor binding protein-3 (IGFBP-3), and sex hormone-binding globulin (SHBG), are involved in acne development by promoting the growth of keratinocytes and sebaceous glands, along with sebum production [7,8]. There is also controversial evidence regarding the association of dietary patterns with acne pathogenesis. Some studies have indicated the impact of dietary glycemic load (GL) on acne [9], while some have reported different results [10,11]. Therefore, the role of GL is particularly intriguing and requires major consideration [8].

Glycemic load refers to the type and amount of consumed carbohydrates and is interpreted as an index of diet-induced insulin demand [9]. A low glycemic index is associated with the reduction of insulin resistance. Therefore, GL can be implicated in acne development due to diet-induced hyperinsulinemia, in addition to the subsequent cascade of hormonal responses and acne exacerbation. Insulin resistance and increased IGF-1 levels change the concentrations of circulating hormones, binding proteins, and receptors, which are associated with the stimulation of unregulated tissue growth androgens, sebum production, and acne-promoting pathways [9].

The role of dietary carbohydrates in acne pathogenesis has not been established yet. Evidence suggests no significant difference in the level of glucose, insulin, and dietary GL between acne patients and healthy control individuals [10,12]. Considering the high prevalence of acne during adolescence and its negative effects on self-image and self-esteem, it is necessary to determine the effective factors in acne, including dietary GL. In this study, we aimed to investigate the possible association of dietary GL with acne in 12- to 18-year-old girls, using a validated questionnaire for GL.

PARTICIPANTS AND METHODS

Participants and study design

Fifty-four females with acne, aged 12-18 years, were recruited in this study. Forty-five age-matched controls were also selected from the Dermatology Outpatient Department of Ziaeian Hospital, which is one of the educational centers affiliated with Tehran University of Medical Sciences, Tehran, Iran. Two groups of patients were excluded from the study: acne patients with a history of acne treatment and patients with a history of systemic disorders, such as diabetes. Patients with acne were divided into three groups by an expert dermatologist: mild (comedonal acne), moderate (papular and pustular lesions), and severe (nodular lesions).

Anthropometric and clinical data collection

Demographic and anthropometric measures, including age, waist circumference, weight, body mass index (BMI), and height, were recorded for all participants. Height (cm) was measured using a wall tape in a standing position without shoes. Weight (kg) was measured using a digital scale with minimal clothing. Furthermore, waist circumference was measured at the mid-point between the lower rib margin and the iliac crest in a standing position with normal breathing. Moreover, the participants' dietary intake was determined using a three-day food record questionnaire, in which they were asked to document their food, snack, and beverage intake completely over three days (two weekdays and one weekend). An expert nutritionist guided them on how to record their food intake. The questionnaires were completed after one week [13].

All subjects were informed about the study procedures and objectives and provided an informed consent to participate in the study. Additionally, the participants were ensured about the confidentiality of their information. The study protocol was approved by the Ethics Committee of Tehran University of Medical Sciences and performed in accordance with the Declaration of Helsinki (IR TUMS VCR REC13951849).

The glycemic index of foods was determined, using the International Tables of Glycemic Index and GL Tables [14]. The total carbohydrate and fiber contents of dietary intake were calculated, using the United States Department of Agriculture (USDA) Tables [15]. The dietary information, collected from the food diaries, were converted to grams, and the content of carbohydrate, fiber, and other food components was calculated, using the Modified Nutritionist 4 software. We used the three-day food records to calculate daily GL as follows:

Daily GL = GI for food item × carbohydrate content (g)/100

Statistical methods

The sample size was calculated with an alpha level of 0.05 and beta level of at least 80% according to previous studies [13]. The calculated sample size for each group was measured to be 40. Considering the possibility of sample attrition, 55 participants were included in each group. During the study, one patient from the acne group and 10 individuals from the control group withdrew from the study; accordingly, their incomplete information was not included in the final report. Data were analyzed and compared between the two groups, using student's t-test and one-way analysis of variance (ANOVA) in the SPSS software version 24. P value less than 0.05 was considered statistically significant.

RESULTS

A total of 99 participants were investigated in two groups: acne group (n = 54) and control group (n = 45). Height, weight, waist circumference, and BMI were calculated in the acne and control groups. Our results showed no significant difference between the groups regarding any of the mentioned measurements (Table 1).

Assessment of the adolescents' dietary intake revealed that generally GL ranged from 55.33 to 199.33, with a mean of 99.91 ± 25.24. The mean GL was not significantly different between the two study groups (98.45 ± 24.88 vs. 101.67 ± 25.85; $P = 0.903$; Table 2). The association between dietary GL and acne severity was examined in the acne group. ANOVA test did not demonstrate any significant differences in the average GL between the three acne groups ($P = 0.406$).

Table 1. General and demographic characteristics of the two groups.

Characteristics	Acne (n=54)	Control (n=45)	*P*-value
	Mean ± SD		
Age (years)	15.07 ± 1.97	14.84 ± 14.84	0.43
Height (cm)	159.54 ± 5.74	159.62 ± 7.26	0.51
Weight (kg)	59.85 ± 13.79	57.96 ± 14.70	0.94
BMI (kg/m^2)	23.37 ± 4.56	22.77 ± 5.02	0.77
Waist (cm)	73.70 ± 7.04	74.18 ± 10.04	0.59

BMI, body mass index; cm, centimeter; kg, kilogram; n, number; SD, standard deviation

Only eight patients had mild acne with an average GL of 88.98 ± 16.7. Thirty-two patients were diagnosed with moderate acne, whose average GL was calculated to be 101.77 ± 28.48. Finally, 14 patients were diagnosed with severe acne with an average GL of 96.30 ± 18.70 (Table 2).

DISCUSSION

Our results indicated that dietary GL in Iranian adolescent girls with acne was not higher than that of control subjects. Additionally, no significant association was found between dietary GL and acne severity. Furthermore, BMI and waist circumference of the two groups were not significantly different.

Acne is a common skin disorder affected by different factors, such as genetics [16], lifestyle and habits [16,17], seasonal changes [17], obesity [18,19], and diet [2,9,20]. However, there are disagreements about the impact of each factor. Many studies support the association between dietary carbohydrates and acne development [9,20-24]. In this regard, a study compared the inhabitants of Kitua Island (Tanzania) and Paraguay hunters, consuming large amounts of vegetable and meat (with lower levels of carbohydrates), with individuals consuming a Western diet; it was found that acne was rarely found in these populations. Therefore, a low-glycemic diet can protect against acne owing to the absence of hyperinsulinemia and activation of the subsequent endocrine cascade [2].

Ismail *et al.* found an association between dietary GL and acne in Malaysian young adults. Their study showed that GL was significantly higher in the acne group than in the healthy controls, aged 18-30 years. They reported no significant difference in BMI between the case and control groups [13]. Another community-based study reported that individuals maintaining a Mediterranean diet (a low-carbohydrate diet) were less likely to develop acne [25]. Moreover, a cross-sectional study showed that dietary GL was higher among individuals with

Table 2. Glycemic load calculated in the control and acne groups.

	Control (n=45)	Acne (n=54)	Mild acne	Moderate acne	Severe acne
	Mean ± SD		Mean ± SD		
Glycemic load	101.67 ± 25.85	98.45 ± 24.88	88.98 ± 16.7	101.77 ± 28.48	96.30 ± 18.70
P-value	0.903			0.406	

n, number; SD, standard deviation

moderate to severe acne (mean age = 21.8 ± 3.5 years), compared to those with mild acnes [9].

The mechanism underlying the association between dietary GL and acne has been well described. A high-GL diet causes hyperinsulinemia with subsequent activation of a signaling cascade, leading to an increase in insulin and IGF-1 activities while reducing IGFBP-3 [9,25]. Reduction of IGFBP-3 significantly increases the bioavailability of IGF-1 as a key stimulator in acne pathogenesis [26,27]. IGF-1 stimulates lipogenesis and proliferation of keratinocytes and sebocytes [28,29]. Both insulin and IGF-1 increase the synthesis of gonadal and adrenal androgens [30]. Moreover, IGF-1 reduces the synthesis of SHBG in the liver and occupies androgenic receptors. Consequently, it directly increases the bioavailability of androgens [31,32]. Androgens promote the production of fat as a factor playing a role in acne development. In addition, IGFBP is a strong pro-apoptotic factor in keratinocytes [33].

Although several studies have been conducted in this area, the association between dietary carbohydrates and acne has not been approved in any investigations, including the current study. In this regard, Kaymak *et al.* in a prospective cohort study, reported no significant difference in terms of serum glucose, insulin, and leptin content, overall glycemic index, and dietary GL between university students with and without acne. It should be noted that they only focused on dietary carbohydrates, similar to our study. However, they suggested a relationship between high glycemic index and duration of acne, which was not addressed in the current study [10].

Furthermore, the results of a non-randomized clinical trial demonstrated that acne improved in adolescent boys on both low- and high-GL diets, while the difference between the groups was not significant. They found no significant correlation between changes in acne severity and insulin concentration or sensitivity. They also reported that diet significantly affected IGFBP-1, but not IGFBP-3 or IGF-1 [11]. In this respect, Smith *et al.* conducted four interventional studies to investigate the effect of dietary GL on acne severity. In two clinical trials, low dietary GL significantly reduced acne severity and plasma levels of free androgens, while it increased insulin and IGFBP sensitivity [34,35].

Consistent with the findings reported by Smith *et al.*, recent studies including a clinical trial, have provided histopathological evidence regarding the benefits of a low-GL regimen in reducing acne development. They found that low GL was associated with reduced acne severity, sebum production, expression of sterol regulatory element-binding proteins, lipid synthesis, and inflammatory cytokines like interleukin-8 [9]. Nevertheless, Pavithra *et al.* did not find any improvement in acne development following adherence to a low-GL diet [23]. Overall, the impact of weight loss secondary to a low-GL diet has not been examined in any of the mentioned studies, while BMI is an important contributor to acne development.

In a number of studies, the effect of low-GL diet could not be detected when the data were statistically adjusted for BMI changes [13]. In the current study, there was no significant difference in BMI between adolescents with and without acne, which could explain the lack of association between GL and acne development. Additionally, some previous studies demonstrated no significant correlation between BMI and presence of acne or its severity [13, 36-38].

The Iranian dietary pattern is high in refined grains, including white rice and bread, potato, tea, whole grains, hydrogenated fats, legumes, and broth, and differs from Mediterranean and Western dietary patterns [39]. It has been revealed that the Iranian diet is not associated with general or central obesity [39], and the mean GL in the present study is similar to that of previous reports. Although many foods rich in carbohydrates are included in the typical Iranian diet, it appears that some other healthy food groups in this diet, such as legumes and whole grains, could alleviate the effect of high-carbohydrate components [39]. Other factors, such as genetics [16], tobacco use, and different climatic conditions [17] may be also influential in acne development. Furthermore, differences in the age range of participants may explain the discrepancy between our findings and previous reports.

This study had some limitations. First, we used a three-day food record owing to time and cost constraints, while other food recording methods, such as repeated three-day questionnaire and food frequency questionnaire, would be more effective in calculating GL, especially in patients with chronic diseases [13,40]. Second, the sample size was calculated to be sufficient to analyze the differences based on independent t-test. Consequently, the sample size was not large enough for advanced statistical analyses.

CONCOLUSION

Chronic skin diseases, including acne, are often accompanied by significant emotional and psychological burdens negatively affecting the individual's quality of life. Thus, control of modifiable factors to reduce acne is necessary. Change of dietary habits is a controversial treatment option for patients with acne. The results of the present study did not confirm the effects of dietary GL on acne in young girls. Moreover, no significant difference in BMI and waist circumference was observed between the acne and healthy groups.

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