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The influence of dietary patterns on acne vulgaris in Koreans

The association between acne and food has been evaluated with inconsistent results. We enrolled 783 patients with acne and 502 control subjects. For the patients with acne, blood tests for insulin, insulin-like growth factor-1 (IGF-1), insulin-like growth factor binding protein-3 (IGFBP-3), post prandial 2 hours blood glucose (PP2), and dehydroepiandrosterone sulphate (DHEAS) were performed. The acne patients were divided into an "aggravated by food" group (AF) and a "not aggravated by food" group (NAF). All participants were asked to fill out a questionnaire. The frequency of vegetables (yellow, green leafy, cruciferous) ($P = .001$) and fish (white flesh and green fish, blue tuna) (($P = .03$) intake was significantly higher in the control group than in the acne group. Intake of instant noodles ($P = .01$), junk food ($P = .002$), carbonated drinks ($P = .005$), snacks ($P = .001$), processed cheeses ($P = .04$), pork (braised) ($P = .02$), pork (roast) ($P < .001$), chicken (fried) ($P = .001$), chicken (stewed) ($P = .001$), nuts ($P = .002$) and seaweed ($P = .003$) were significantly higher in the acne patients than in the controls. Intake of roast pork ($P = .02$), fried chicken ($P < .02$), and nuts ($P = .03$) was significantly higher in the AF than NAF. In addition, the regularity of inter-meal intervals ($P < .001$) and breakfast intake ($P < .001$) were significantly lower in the acne patients. IGF-1 and IGFBP-3 showed sexual differences. This study also showed that a high glycemic load diet, dairy food intake, high fat diet, and iodine in Korean foods appear to play a role in acne exacerbation. In addition, irregular dietary patterns were found to aggravate acne.

Key words: acne, diet, food, glycemic load

The association between acne and food has been evaluated with inconsistent results. Many previous reports have shown no relationship between food and acne [1-5]. However, in other reports, diet-induced hyperinsulinemia was suggested to cause an endocrine response that affected the development of acne [6, 7]. In addition, some patients report that certain foods make their acne worse. The effects of diet on acne have been explained by different mechanisms [7-9]. The diet may be an important source of the substrate needed for the synthesis of sebaceous lipids and it may influence androgen-mediated increases in sebum production. In addition, diet-induced hyperinsulinemia elevates the insulin-like growth factor-1 (IGF-1), while reducing insulin-like growth factor binding protein-3 (IGFBP-3) [10-12]. Hence, these alterations may stimulate follicular epithelial growth and keratinization.

Traditional Korean foods consist of a low glycemic load and low fat content. However, adoption of Western dietary habits over the past few decades has been associated with an increase in acne [13]. Previous studies on diet and acne have been mostly Western based research. The dietary patterns and food of Korea are different from those of Western countries. Therefore, the association of diet with acne may be different in Korea.

The aim of the present study was to investigate the effect of dietary patterns on acne vulgaris, and to evaluate the endocrine differences in acne patients divided into subgroups influenced and not influenced by food.

Methods

A total of 1,285 subjects were recruited for this study. Seven hundred and eighty three acne patients and 502 controls without acne were surveyed with a questionnaire about the association of acne and food. The controls were age-matched healthy people. They had no acne and did not receive any acne treatment. We recruited them using bulletin boards in high schools, universities and companies. The study was approved by the Institutional Review Board at Seoul National University Hospital, and informed consent was obtained from all subjects.

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The subject's age, gender, weight, height, and severity of acne were recorded. The body mass index (BMI) was calculated by dividing the weight (kilograms) by the square of the height (meters). All participants in the acne group had blood tests for insulin, insulin-like growth factor-1 (IGF-1), insulin-like growth factor binding protein-3 (IGFBP-3), post prandial 2 hours blood glucose (PP2), and dehydroepiandrosterone sulphate (DHEAS) at the initial visit.

Clinical assessment of the acne severity, including inflammatory and non-inflammatory acne counts and acne severity evaluations, were performed by two independent dermatologists, using Dr. Cunliffe's grading system [14]. The dietary data was collected by a self-completed questionnaire. The questionnaire used was based on the questionnaire used in the diabetes clinic of our hospital; it was modified for this study by the study investigators. The questionnaire was verified for accuracy, reproducibility and validity by specialists in nutrition and statistics. Many representative Korean foods were included in the questionnaire and they were specified by the methods of cooking. All participants were provided with a questionnaire and instructions on how to fill it out. The participants were required to indicate the type of food and amount of foods eaten during a week, including snacks and a midnight meal. We collected the questionnaire after one week. After evaluating the results from the questionnaire, we asked the subjects to confirm their answers. In addition to the questions on food intake over one week, the questionnaire also contained questions about the foods that aggravated their acne. In addition, questions about aggravating events were included, such as stress, food intake, menstruation, fatigue, and lack of sleep. All the questions were multiple-choice. If the aggravating factor was food, the aggravating foods were specifically requested. The regularity of meals was also investigated by questions about the inter-meal intervals and the frequency of skipping meals (skipping each meal more than 3 times a week was considered irregular meal habits). The data collected was analyzed by multiplying the frequency of consumption of each unit of food, and the differences among the three groups (control group, AF and NAF) were compared. In addition, the glycemic index (GI) and the glycemic load (GL) were investigated. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 13. The significant differences among the three groups (AF, NAF and control group) were determined using the t-test, the Chi-Square test and one way ANOVA. The Chi-square test was used to determine the statistical significance of the qualitative variables, and the t-test, and one way ANOVA were used to determine the significance of the quantitative variables. P-values of less than 0.05 were considered to be statistically significant.

Results

Among 1,285 patients included in this study, 783 (61%) patients were acne patients and 502 (39%) were controls. We divided them into a group aggravated by food (AF) and a group not-aggravated by food (NAF) according to the participants' answers to the questionnaire about the effect of food on the aggravation of the acne. The aggravation of acne was defined as an increase of more than 25% in acne lesions compared to before taking a specific food. Among the acne patients, 420 (54%) patients were in the AF subgroup and 363 (46%) patients in the NAF subgroup. The mean age of the subjects was 24.0 years, and the mean BMI was 21.3 kg/m^2. There were 565 men (44%) and 720 women (56%). There was no significant difference among the three groups with respect to age, gender or body mass index ($P > .05$). Mean baseline acne grades were 1.60 in the AF and 1.75 in the NAF groups *(figure 1)*. Overall, the severity of acne was mild and there was no significant difference between the two groups.

The events that aggravated the acne are shown in *figure 2*. Male acne patients answered that food intake (49.5%) was the most important factor for aggravating their acne; female acne patients answered that menstruation (60.1%) was the most important aggravating factor and food the second most important (56.3%). Among the foods, fatty food (71.5%) was found to be the food most significantly associated with the aggravation of acne compared to salty (22.1%), sugary (8.0%), and spicy (11.0%). Regularity of meal habits was significantly greater in the control group (71.3%) than in the acne patients (AF: 44.4%, NAF: 39.0%) ($P < .001$). In particular, a regular breakfast intake (*figure 3*, $P < .001$) was significantly greater in the control group than in the acne patients; however, there was no significant difference between the AF and NAF subgroups.

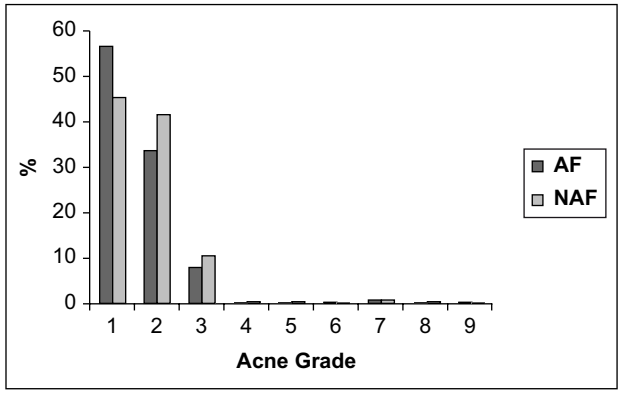

Figure 1. Grade of acne patients aggravated by food (AF) and acne patients not-aggravated by food (NAF).

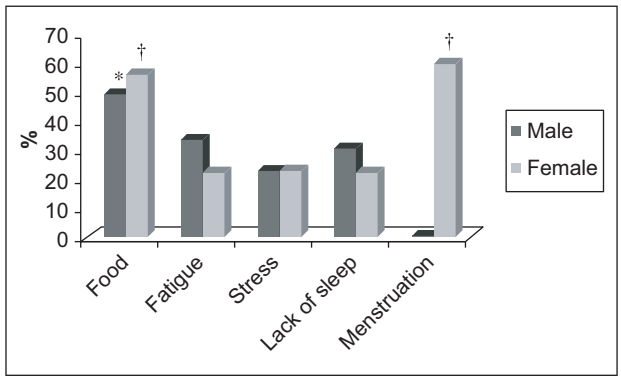

Figure 2. Events that aggravate acne. *$P < 0.05$, compared with the others in men. †$P < 0.05$, compared with the others in women.

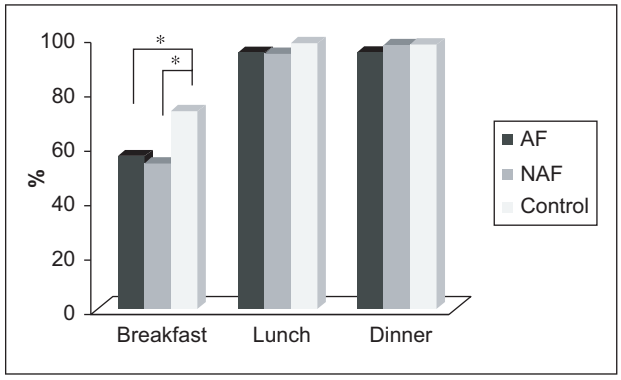

Figure 3. Regularity of dietary habits by each meal. *$P < 0.001$, compared among three groups. (AF: acne patients aggravated by food, NAF: acne patients not-aggravated by food).

Lists of the preferred foods for the acne and control groups are summarized in *table 1*. The frequency of vegetables (yellow, green leaf, cruciferous) ($P = .001$), fish (white flesh and green fish, blue tuna) ($P = .03$) and green peas ($P < .001$) was significantly higher in the control group than in the acne patients. The intake of instant noodles ($P = .01$), junk food (hamburger, doughnuts, croissants) ($P = .002$), carbonated drinks (cola, fanta, soda pop) ($P = .005$), snacks (rice cake, cracker, waffles) ($P = .001$), processed cheeses ($P = .04$), pork (braised) ($P = .02$), pork (roast) ($P < .001$), chicken (fried) ($P = .001$), chicken (stewed) ($P = .001$), seaweed (toasted laver, boiled sea mustard) ($P = .003$), and nuts (almond, peanuts, walnuts) ($P = .002$) were significantly higher in the acne patients compared to the controls. When comparing the preferred foods between the AF and NAF subgroups, intakes of roast pork ($P = .02$), fried chicken ($P < .02$), and nuts ($P = .03$) were significantly higher in the AF. In addition, the GL, total calorie and nutritional composition of the preferred foods of the patients with acne (AF, NAF) and the controls are summarized in *table 1*.

The IGF-1, IGFBP-3, insulin, PP2, and DHEAS levels of the acne group are summarized in *table 2*. The IGF-1 of the AF (543.9 ± 56.4 ng/mL) was significantly higher than that of the NAF (391.3 ± 118.2 ng/mL) ($P < 0.01$). Although not significantly different, the IGFBP-3 of the AF (3,876.9 ± 720.0 ng/mL) was lower than that of the NAF (4,458.0 ± 1,066.2 ng/mL). The IGF-1 level was significantly higher in the males in the AF (530 ng/mL) compared to the NAF (398 ng/mL) ($P = .03$), and the IGFBP-3 was significantly lower in the females in the AF (3,990.2 ng/mL) compared to the NAF (4,878.2 ng/mL) ($P = .02$).

Table 1. Lists of the food preferences of the acne and control groups. Glycemic load (GL) and nutritional components of the food

	Control (%)	AF (%)	NAF (%)	GL	per 100 g					
					Energy (kcal)	Water (g)	Protein (g)	Fat (g)	Ash (g)	CHO (g)
Vegetables (green and light color)*	58.4	44.3	44.4	< 10						
Green peas*	29.9	23.2	20.3	3						
Hamburger, doughnuts, croissant†	12.4	21.1	21	> 20						
Rice cake, cracker, waffles†	30.7	55.4	47.1	> 20						
Instant noodle†	8.9	15.3	15.9	> 20						
Carbonated drink (cola, fanta, soda pop)†	36.7	43.2	45.5	> 20						
Processed cheese†	4.5	6.3	5.8		312	47.6	18.3	24.2	4.4	5.5
Pork (braised)†	8.6	10.5	11.3		307	49	24.9	25.7	0.4	0
Pork (roast)†,#	8.7	14.4	12.2		368	43.7	30.1	25.6	0.6	0
Chicken (fried)†,#	4	15	13.8		324	46.2	19.9	21.8	1.2	10.9
Chicken (stewed)†	8.1	44.6	40.6		243	62.3	20.8	16.5	0.4	0
Fish (white flesh fish & green fish, blue tuna)*	14	12.1	11.2							
Alask pollack (broiled)					111	73	25.2	0.5	1.3	0
Hair tail (mild salted-cured and dried)					188	57.2	26.3	8.1	8.3	0.1
Yellow Croaker (salt)					332	32.6	44.4	15.2	7.4	0.4
Mackerel (broiled)					271	55.2	25.8	17.1	1.5	0.4
Seaweeds†	15.2	19.4	19.1							
Toasted laver					128	4	43.3	0.9	10	41.7
Boiled sea mustard					15	84.9	1.1	0	8.2	5.5
Nuts†,#	3.3	6.4	4.3							
Almonde (dried)					598	4.6	18.6	54.2	2.9	19.7
Peanuts (roasted)					567	2.2	25.6	48.2	2.4	21.6
Walnuts (dried)					652	3.5	15.4	66.7	1.8	12.6

AF: acne patients aggravated by food, NAF: acne patients not-aggravated by food.
**Represent the foods eaten significantly more in the control group ($P < 0.05$). †Represent the foods eaten significantly more in the acne group ($P < 0.05$). #Represent the foods that were significantly different between the AF and NAF ($P < 0.05$).*

Table 2. IGF-1, IGFBP-3, insulin, PP2, DHEAS levels of AF and NAF

	AF	NAF
	Mean (SD)	**Mean (SD)**
IGF-1 (ng/mL)	543.9 (56.4)*	391.3 (118.2)*
IGFBP-3 (ng/mL)	3,876.9 (720.1)	4,458.0 (1,066.2)
Insulin (μU/mL)	12.7 (4.0)	12.5 (4.4)
PP2 (mg/dL)	93.8 (12.4)	91.4 (22.0)
DHEA-S (ng/mL)	2,382.3 (1,260.0)	2,016.2 (946.3)

(AF: acne patients aggravated by food, NAF: acne patients not-aggravated by food).
$P < 0.05$, compared between the two groups.

Discussion

Hereditary factors have been shown to be important in the development of acne as demonstrated by familial studies [15]. However, environmental factors are also thought to strongly influence the development and aggravation of acne [16, 17], as acne has not been observed in non-westernized populations, such as Ache hunter-gatherers [6], Kitavan islanders [6] and Okinawa islanders [18]. According to Korean national data, the major preferred source of nutrients has shifted from carbohydrates to fat and meats; in addition, the consumption of snacks, junk food and carbonated drinks has significantly increased during the past several decades [19]. Furthermore, the number of diabetic, obese and overweight Koreans is increasing annually [20]. Along with these factors, the acne incidence in Korea has been increasing over the past several decades [13]. Dietary pattern changes are thought to be one of the most important causes of such changes. The results of our study confirm prior reports that food can affect acne; 54% of the patients with acne had their condition aggravated by food *(figure 2)*. In retrospective studies, participants are required to remember what they have eaten for a certain period of time; in such studies recall bias could seriously influence the study results. Therefore, this study used a prospective design to reduce such bias. Although there are some validated food frequency questionnaires [21-23], they could not be applied in the Korean setting. Hence we developed our own questionnaire to fit Korean dietary habits. In addition, our questionnaire also contained information on the regularity of meal habits. The regularity of meal habits was significantly higher in the control group than in the acne patients *(figure 3)*. There are no prior reports on the influence of irregular meal habits on acne. These findings may be explained by the following. Irregular meal habits may occur under stressful conditions. It is well-known that stress can exacerbate acne. Moreover, irregular meal habits might be associated with eating too fast and too much; which might result in an increase of the GL.

Diet-induced hyperinsulinemia elevates IGF-1 and reduces IGFBP-3 [6]. IGF-1 stimulates basal keratinocyte proliferation and sebum production. It also stimulates the synthesis of androgens in the ovary and testis, and inhibits the synthesis of the sex hormone binding globulin, hence increasing the effect of circulating androgens which stimulate sebum production. IGFBP-3 prevents IGF-1 from binding to its receptor, and IGFBP-3 is a pro-apoptotic factor in epithelial cells; hence a decreased level of IGFBP-3 stimulates follicular epithelial growth and keratinization. In our study, the AF patients showed significantly higher levels of IGF-1 than did the NAF patients; in addition, the AF patients had a lower level of IGFBP-3 than did the NAF patients *(table 2)*. These findings support the influence of a high glycemic diet on the aggravation of acne. A significantly higher IGF-1 level was observed in the male AF subgroup than in the male NAF subgroup, while a significantly lower IGFBP-3 level was found in the female AF subgroup than in the female NAF subgroup. The different response of IGF-1 and IGFBP-3, according to gender, has not been previously reported.

The GI of an individual food is defined as 100 times the ratio of the glycemic response of a test food to the glycemic response of an equal portion of a reference carbohydrate, usually white bread or glucose [24]. The GL includes both the quantity and quality of dietary carbohydrate per serving by the GI value of the food divided by 100 [24]. Therefore, high GI and GL foods cause a rapid increase in the blood glucose levels and subsequent insulin levels. In our study, high GL foods (hamburgers, doughnuts, croissant, rice cake, cracker, waffles, instant noodles, and carbonated drinks) were significantly more common in the acne patients compared to the controls, and low GL foods (green and light colored vegetables and green peas) were significantly lower in acne patients than in the control group *(table 1)*. Smith *et al.* reported the therapeutic effect of a low GL dietary intervention in patients with acne [25]. Twelve weeks of a low GL diet could reduce weight, acne severity and the free androgen index, and increase IGFBP-1. Smith *et al.* reported that a low glycemic load diet increased the ratio of saturated to monounsaturated fatty acids of the skin surface triglycerides [26]. The increase in the saturated to mono-unsaturated ratio was inversely correlated with the acne lesion counts ($r = –.03$), and increased follicular sebum outflow was also associated with an increase in the proportion of mono-unsaturated fatty acids in the sebum.

Recently, studies have reported a relationship between milk and acne [9, 21-23]. In these reports, dairy food intake, including cottage cheese and cream cheese, caused the aggravation of acne. In our study, processed cheese was consumed significantly more in the acne patients compared to the controls. It has been suggested that ingesting milk may stimulate endogenous IGF-1, mediate some of the effects of comedogenic factors and increase the production of sebum. In addition, milk also contains androgens, 5-alpha reduced steroids and other non-steroidal growth factors that affect the pilosebaceous unit. But there were no statistically significant differences of milk consumption between control and acne group in our study.

The acne patients in this study showed a significant preference for a high fat diet (nuts, chicken, pork and processed cheese) *(table 1)*. The association between a high fat diet and acne is controversial [2-4, 9, 27, 28]. Further evaluation of the effect of fatty diets on acne is required. In addition, the acne patients ingested significantly more seaweed, which is high in iodine. It is well established that iodine intake can exacerbate acne [29]. Therefore, seaweed may aggravate acne. But it needs further evaluation.

Studies on diet and acne have usually compared control and acne patients. In our study, in addition to the comparison between control and acne patient groups, we also compared the dietary patterns of the subgroups AF (acne patients aggravated by food) and NAF (acne patients not-aggravated by food). Although the dietary patterns between the acne and control groups showed significant differences, the dietary patterns between the AF and NAF subgroups did not show significant differences for most of the food intake, except for roast pork ($P = .02$), fried chicken ($P < .02$) and nuts ($P = .03$). In fact, the list of foods which are significantly different between AF and NAF should have been longer. Because people eat many kinds of food at each meal, they may not accurately identify the foods which aggravate acne.

In this study we showed differences in the dietary patterns of acne patients and controls, and between AF and NAF groups. We analyzed the whole type of food and amount of foods eaten, with a specified questionnaire, by the methods of cooking, during a week. But we have not proved the effect of individual food on acne. And the classification of AF and NAF was entirely based on the patients' answers to the questionnaire. Therefore the results might be changed slightly if we really performed an intervention study in all acne patients. Further study is needed in the future.

In conclusion, the results of our study suggest that a high glycemic load diet, processed cheese, a high fat diet, and iodine play a role in the exacerbation of acne in Koreans. In addition, irregular dietary habits may also aggravate acne. ■

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