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Dietary modifications in atopic dermatitis: patient-reported outcomes

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Abstract

Background—Patients with atopic dermatitis (AD) commonly turn to dietary modifications to manage their skin condition.

Objectives—To investigate patient-reported outcomes and perceptions regarding the role of diet in AD.

Methods—One hundred and sixty nine AD patients were surveyed in this cross-sectional study. The 61-question survey asked about dietary modifications, perceptions and outcomes.

Results—Eighty seven percent of participants reported a trial of dietary exclusion. The most common were junk foods (68%), dairy (49.7%) and gluten (49%). The best improvement in skin was reported when removing white flour products (37 of 69, 53.6%), gluten (37 of 72, 51.4%) and nightshades (18 of 35, 51.4%). 79.9% of participants reported adding items to their diet. The most common were vegetables (62.2%), fish oil (59.3%) and fruits (57.8%). The best improvement in skin was noted when adding vegetables (40 of 84, 47.6%), organic foods (17 of 43, 39.5%) and fish oil (28 of 80, 35%). Although 93.5% of patients believed it was important that physicians discuss with them the role of diet in managing skin disease, only 32.5% had consulted their dermatologist.

Conclusions—Since dietary modifications are extremely common, the role of diet in AD and potential nutritional benefits and risks need to be properly discussed with patients.

Keywords

Atopic dermatitis; patient-reported outcomes; diet

Introduction

Atopic dermatitis (AD) is a chronic relapsing inflammatory skin disease with prevalence estimated of 10–12% in US children and 7–10% in US adults (1). In the past several decades, the prevalence of AD has increased, suggesting that environmental exposures may

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be triggering and/or flaring the disease in predisposed individuals (2,3). Diet has been suggested as an important factor in triggering AD besides many other environmental exposures, such as climate, pollution and UV radiation (3).

Much research has been done to better understand the role of diet in AD, however, the literature is controversial and inconclusive. A Cochrane review of nine randomized controlled trials (RCTs) with 421 participants assessed the effects of dietary exclusions for the treatment of established AD and concluded that the evidence available lends little support to the use of exclusion diets in unselected patients (4). However, a recent cross-section study assessed the dietary habits and the prevalence of AD in 17,497 adults and found a significant association between instant noodles, meat and processed food and increased prevalence of AD (5). A 2012 Cochrane review evaluated dietary supplements for treating established AD. They reported that fish oil, vitamin D and vitamin E supplementations have shown symptoms of improvement in several randomized trials, but the evidence was found to be of questionable clinical significant since many of them were small and with poor quality (6). In a recent RCT, however, daily supplementation with 1600 IU of vitamin D significantly improved AD compared to placebo (7).

Studies examining the role of probiotics in AD also demonstrated mixed results; a recent meta-analysis of 25 RCTs suggested that probiotics could be an option for the treatment of AD (8), whereas several studies did not find a correlation between supplementation of probiotics and improvement of the disease (9–11).

Surprisingly, despite the lack of evidence-based recommendations, many patients with AD report eliminating/avoiding particular foods suspected of causing a reaction in a hope that following this dictum might improve their symptoms. In a study by Johnston et al., 75% of patients with AD that were interviewed regarding dietary manipulations reported a trial of dietary change. Only half had those patients consulted a doctor or dietitian before commencing the diet (12,13). Furthermore, the lack of supervision of those dietary changes in AD patients has been associated with risk of nutrient deficiency in both children and adults (14–16).

Presently, only few studies have investigated the relationship between AD and dietary modifications using patient-reported outcomes. To fill this gap, our study surveyed AD patients on how different dietary modifications affected their disease. Objectives of our study include: (1) To investigate the prevalence of specific food exclusions and additions reported by AD patients; (2) To determine where there is consensus among AD patients regarding the influence of certain dietary behaviors on the severity of their skin condition; (3) To understand the attitudes and perceptions of AD patients regarding the role of diet in managing their skin condition.

Materials and methods

Study design and subjects

This is a cross-sectional study that surveyed 169 AD patients between 1 August 2014 and 31 January 2015 to examine the association between diet and AD. The survey was distributed to

AD patients online via the National Eczema Association (NEA) and the Eczema Society of Canada (ESC) webpages, newsletters and Facebook pages. Both the NEA and the ESC are nonprofit patient advocacy groups for patients with AD. The NEA and the ESC approvals for use of their online webpage, newsletter and Facebook page were obtained. The study was restricted to participants aged 18 or older.

Our survey included 61 questions (Appendix): The questions focused on trials of reduction or addition of different food groups, how skin disease changed with different food groups, patients' attitudes surrounding diet as a management strategy for their AD, and participant demographics. Questions were developed based on the National Health and Nutrition Examination Survey (information for the survey is found at the following link: http://epi.grants.cancer.gov/nhanes/dietscreen/evaluation.html), topics of interest found in NEA and ESC discussion forums, popular literature, patient discussion and a review of the scientific literature. The study was approved by the Institutional Review Board at the University of California, San Francisco.

Statistical analysis

Current age and age onset of eczema were calculated as mean and standard deviation. All dietary changes, attitude/perception, and the demographic data were compiled and frequencies reported. Education level was categorized into four groups: less than high school, high school, undergraduate and graduate/professional degree. Body mass index (BMI) was calculated as weight (in kg) divided by square of height (in m) and was categorized into four groups: underweight (<18.5), normal (18.5–24.9), overweight (25–29.9) and obese (30+). Body surface involvement was categorized into five groups: Barley or very little, <5% body surface, 5–10% body surface, 11–20% body surface and >20% body surface. Severity of eczema was categorized into three groups: mild, moderate and severe. Common dietary items that were specifically reported in the free response portion of the questionnaire to be triggers or to improve skin lesions were compiled and percentiles were reported. In regards to survey inquiries identifying skin responses to the addition or removal of specific dietary items, a positive response is defined as subjects marking *fully clear* or *improved* response of their skin lesions, while a negative response is *worsening* or *no change* following the specific dietary change. Frequencies of the most consistent dietary changes that had a positive response on skin lesions were reported. Similarly, percentiles of positive responses to free response questions regarding specific diets (such as Atkins, Paleo, gluten free) were compiled.

Results

Patient characteristics

A total of 169 participants completed the survey. A summary of patient characteristics is shown in Table 1. The mean (SD) age of the sample population was 43.0 (16.7) and 131 respondents (77.5%) were females. Our sample population was predominantly white (124; 74.7%) and the majority had a relatively high education level (133 responders, 80.1%, had either undergraduate or graduate degree). Geographically, most of the responders reside in the US (n =80, 70.2%) and the majority lived in an urban setting (130, 79.3%). Less than

15% of the participants reside in either Canada (*n* =16, 14%), Europe (*n* =12, 10.5%), Australia (*n* =2, 1.7%) or Asia (*n* =4, 3.5%). The mean (SD) BMI of our sample population was 27.2 (8.2) and 84 patients (49.7%) were either overweight (BMI 25–29.9) or obese (BMI >30).

The mean (SD) age onset of eczema was 18.2 (20.7) and family history of eczema was present in the majority of patients (*n* =94, 56%). The sample population represented all levels of AD severity: 22 (13.1%) with mild disease, 66 (39.3%) with moderate disease and 80 (47.6%) with severe disease. In addition, the body surface area involvement reported by the participants was predominantly less than 10%: 48 patients (28.6%) reported body surface area <5% and 44 patients (26.2%) reported body surface area between 5 and 10%. Thirty-eight patients (22.6%) reported body surface involvement area >20%. In addition, 36 patients (21.3%) reported psoriasis as their secondary skin condition.

Perceived dietary triggers

Participants were asked to report what foods or drinks made their AD worse. Among survey respondents (*n* =169), the most common reported triggers were dairy (*n* =42, 24.8%), gluten (*n* =31, 18.3%), alcohol (*n* =29, 17.1%), sugar (*n* =28, 16.5%), tomatoes (*n* =22, 13%), citrus (*n* =17, 10%) and eggs (*n* =12, 7.1%) (Figure 1). Less commonly reported triggers (2–5% of reported triggers) included meat, soda, spicy foods, processed foods and seafood.

Participants were also asked to report what foods, drinks or supplements made their AD better. The following were reported as foods that may improve their AD when incorporated in patients' diet: consumption of dietary supplements (probiotics, vitamin D, vitamin C, zinc or omega 3, *n* =43, 25.4%), water (*n* =24, 14.2%), vegetables (*n* =20, 11.8%), oils (primrose oil, hempseed oil, cod liver oil, olive oil or coconut oil) (*n* =16, 9.5%) and fruits (*n* =11, 6.5%) (Figure 2). Only three patients (1.7%) reported fish as foods that may improve their AD.

Dietary modifications

Table 2 presents the food categories that were avoided/reduced or added by participant.

Most of the survey participants (*n* =147, 87%) reported a trial of avoiding or reducing the following food categories from their diet: junk foods (candy and pastries, chocolate, French fries, potato chips, sweets; *n* =100, 68%), dairy (*n* =73, 49.7%), gluten (wheat, barley, rye products, *n* =72, 49%), white flour products (*n* =69, 46.9%), alcohol (*n* =59, 40.1%), high fat foods (*n* =55, 37.4%), red meat (*n* =54, 36.7%), caffeine (*n* =51, 34.7%), tobacco (*n* =47, 32%), sodium/salt (*n* =43, 29.3%), shellfish (*n* =38, 25.9%), nightshades (tomatoes, eggplant, peppers, paprika, white potatoes, *n* =35, 23.8%), pork (*n* =31, 21.1%) and other (*n* =20, 13.6%). Similarly, most of the survey respondents (*n* =135, 79.9%) noted a trial of adding the following foods to their diet: vegetables (*n* =84, 62.2%), fish oil/omega-3 (*n* =80, 59.3%), fruits (*n* =78, 57.8%), oral vitamin D (*n* =65, 48.1%), probiotics (*n* =62, 45.9%), organic foods (*n* =43, 31.9%) and other (*n* =14, 10.4%).

Special diets

Among all of the survey respondents, 63 respondents (37.3%) reported trying a special diet (e.g. vegetarian diet, gluten-free, Mediterranean, Ornish, South Beach, Paleo, Atkins, etc.). The most common diets tried were a gluten free diet (*n* =25, 39.7%), vegetarian diet (*n* =17, 27%), Paleo (*n* =11, 17.5%), low carb diet (*n* =9, 14.2%), dairy free diet (*n* =8, 12.7%), Atkins (*n* =7, 11.1%), Mediterranean diet (*n* =3, 4.7%), South beach (*n* =1, 1.6%) and other (*n* =4, 6.3%). On the whole, the mean (SD) diet length was 17.7 (45.9) months and 60.3% of patients (*n* =38) reported weight loss on these diets.

Responses/outcomes to dietary modifications

Perceived improvement in skin disease after removing or adding the aforementioned foods by survey respondents is reported in Table 3. A positive response was reported in respondents removing the following foods: white flour products (37 of 69, 53.6%), gluten (37 of 72, 51.4%), nightshades (18 of 35, 51.4%), junk foods (51 of 100, 51%), alcohol (30 of 59, 50.8%), dairy (37 of 73, 50.7%), high fat foods (24 of 55, 43.6%), tobacco (19 of 47, 40.4%), shellfish (14 of 38, 36.8%), caffeine (17 of 51, 33.3%), pork (10 of 31, 32.2%), red meat (13 of 54, 24.1%) and sodium/salt (10 of 43, 23.2%). In addition, a positive response was noted when adding the following foods/supplements: vegetables (40 of 84, 47.6%), organic foods (17 of 43, 39.5%), fish oil/omega-3 (28 of 80, 35%), fruits (27 of 78, 34.6%), oral vitamin D (23 of 65, 34.4%) and probiotics (24 of 62, 28.7%).

Special diets

Several patients reported disease improvement after trying a specific diet. The three most successful reported diets were dairy free diet (six of eight, 75%), Paleo diet (eight of 11, 72.7%) and a gluten free diet (13 of 25, 72.2%). Other diets reported to be relatively successful in AD improvement included a low carb diet (three of nine, 33.3%), vegetarian diet (five of 17, 29.4%) and Atkins (two of seven, 28.6%).

Attitudes or perceptions about diet

Patients were asked about barriers and difficulties encountered when modifying their diet, as well as their attitudes surrounding diet as a management strategy for their disease (Table 4). Of note, 61.5% of patients (*n* =104) found it very difficult or somewhat difficult to follow a special diet, with the most common difficulty reported as lack of willpower or that following a special diet was too limiting (*n* =45, 44.1%). Overall, 55% of patients (*n* =93) found it very time-consuming or somewhat time-consuming to follow a special diet and 56.8% of patients (*n* =96) found it very expensive or somewhat expensive to follow a special diet.

The motivation for using diet as a means of improving AD varied among patients. Patients cited the following reasons: previous treatments failed (*n* =72, 42.6%), recommended by friends/family (*n* =27, 16%), recommended by other patients (*n* =17, 10.1%), diet is a natural method (*n* =52, 30.8%), diet may improve other health problems (*n* =55, 32.5%), as well as other miscellaneous reasons (*n* =16, 9.5%). About 24.3% of patients (*n* =41) reported that they had not tried any dietary modification.

Although 93.5% of patients (n =158) found it very important or somewhat important that physicians discuss with patients the role of diet in managing skin disease, only 32.5% had discussed dietary changes with their dermatologist; 11.8% (n =20) discussed dietary changes with their dermatologist prior to modifying their diet, 16.6% (n =28) during or after making a dietary change and 4.1% (n =7) discussed diet with their dermatologist but have not made dietary modifications. About 46.2% of respondents (n =78) did not discuss any dietary changes with their dermatologists prior to their dietary change.

We asked patients to rate the importance of diet compared to other interventions or treatments for management of their AD: 37.9% (n =64) reported that diet was more important than taking over-the-counter medications, 36.1% (n =61) reported that diet was more important than taking prescription medications, 32% of patients (n =54) reported that diet was more important than taking complementary medications, 30.8% (n =52) felt diet was more important than exercise and 11.2% (n =19) reported that diet is more important than stress reduction. Patients were also asked what role is diet playing in managing their skin condition: 42.6% (n =72) reported that they are not sure how diet affects their skin condition, 26% (n =44) noted that their diet is helping slightly with their skin condition, 17.2% (n =29) reported that diet is helping significantly with their skin condition and only one patient (0.6%) reported that his skin condition was fully controlled with diet; 10.7% (n =18) of patients think that diet has not effect on their skin condition.

The majority of the patients learned about the foods/drinks that affect their skin condition by either trial and error (n =77, 45.6%) or from the internet (n =76, 45%). About 39.6% of patients (n =55) learned about foods/drinks that affect their skin condition from family, friends or other patients. Only 3.6% (n =6) of the patients reported TV as the source of the information.

Discussion

Despite tremendous gains in understanding the pathogenesis and treatment of AD, many patients seek alternative and complementary therapies especially when standard treatments are non-effective or have undesired side effects (17). In this study, which focused on patient-reported outcomes, we report an extremely high number of patients pursuing dietary modifications. Our results are consistent with previous reports (12,13).

The most common food categories that were reported to be avoided/reduced in our study were junk foods and dairy products; about 68% of patients reported a trial of avoiding/ reducing junk foods and the majority reported full clearance or improvement of their skin condition following this trial. Our data is in agreement with previous studies that reported an association between junk foods and increased prevalence and severity of AD (5,18). This association might be related directly to food additives that have been found to aggravate AD in a randomized control study (19), or indirectly, to obesity which is associated with impaired skin barrier function and chronic inflammatory state (20,21).

In our study, 49.7% of patient reported a trial of avoiding/ reducing dairy product from their diet with the majority reporting a full clearance or improvement following the elimination.

Similarly, Atherton et al. reported a possible association between dairy products and the severity of AD (22). However, Bath-Hextall et al. conducted a Cochrane review of nine RCTs of dietary exclusions in AD patient, with six trials studying eggs and milk exclusions. They concluded that the evidence available lends little support to the use of elimination diets since the studies were too small and poorly reported. Overall, food elimination diets were not found to be beneficial and are not recommended in the American Academy of Dermatology (AAD) guidelines (23,24).

While some dietary elements are posited to trigger AD, other foods have been suggested to improve the disease symptoms. For example, 59.3% of patients in our study added fish oil or omega-3 polyunsaturated fatty acids (PUFAs) to their diet and 35% reported an improvement in their skin condition following this addition. PUFA and PUFA rich foods such as cold-water fish and fish oils are thought to modulate the production of eicosanoids. Uncontrolled studies in healthy adults (25) and a meta-analysis of RCTs (26) have demonstrated that consumption of PUFA enriched fish oil reduces the conversion of free arachidonic acids to leukotriene B4, which plays a key role in inflammatory and atopic conditions (27). In addition, Fujii et al. recently tested mice that have been fed a diet with low PUFA and found that deficiency in n-6 PUFA is mainly responsible for AD like symptoms (28). Despite the above evidence, a meta-analysis of 34 placebo-controlled essential fatty acids (EFA) trials concluded that the effect of EFAs was negligible and that supplementation with EFA has no clinically relevant effect on the severity of AD (29).

Other foods that improved AD symptoms in our surveyed subjects are vegetables. Almost half of the patients in our study reported a full clearance or improvement of their AD following the addition of vegetables to their diet. Vegetables provide a wealth carotenoids, flavonoids, vitamins and minerals that have been inversely correlated with oxidative stress and inflammatory cytokines such as TNF-alpha and C-reactive protein (30). Furthermore, vegetarian diet has been previously reported to ameliorate symptoms of AD through reduction of number of peripheral eosinophils and of PGE2 synthesis by monocytes (31). However, evidence on the direct effect of vegetables on disease activity remains inconclusive and further RCTs are required.

In addition to specific foods, study participants were surveyed about their response to dietary supplements. Vitamin D improved AD symptoms in 34.4% of survey respondents. This may be explained by the antiproliferative and immunomodulatory effects of the active form of vitamin D, 1,25-dihydroxyvitamin D3 (32). Vitamin D also stimulates the production and the regulation of skin antimicrobial peptides such as cathelicidins, and its deficiency might predispose patients with AD to skin superinfection by *Staphylococcus aureus* (33). The role of vitamin D supplementation in AD is controversial in the literature. Two recently published RCTs found that vitamin D supplementation significantly improved AD symptoms; however, one study failed to compare vitamin D with placebo (7), while the other only examined a specific population of children with winter-related AD (34). In contrast, two RCTs by Hata et al. and Sidbury et al. found no significant improvement with supplementation of vitamin D (35,36) and a 2008 Cochrane review concluded that studies were of poor quality and too small to provide conclusive evidence for the benefit of vitamin D supplements in AD. Surprisingly, even the recent guidelines for vitamin D

supplementation in AD are not clear; while the AAD notes that there are insufficient data to recommend it, the Joint Task Force on Practice Parameters (allergy and immunology groups) supports it (17,37).

Dietary supplementation of probiotics has been also suggested for improving the skin condition of AD patients. Probiotics are live microorganisms that modify the overall composition of the gut microbiota and potentially modulate the host immune response (23). The mechanism for alleviation of AD symptoms by probiotics harkens back to the hygiene hypothesis, whereby the early exposure to diverse gut microbiota steers the immune system away from a Th2 response and upregulates Th1 cytokine production (2,38). The association between probiotics and AD may also stem from the finding that the intestinal microbiota are different in those with and without AD (39). In our study, 45.9% of patients performed a trial of probiotic supplementation and 28.9% reported skin improvement following this trial. Similarly, a recent meta-analysis of 25 RCTs with 1599 infants, children and adults, found significant differences in the Scoring Atopic Dermatitis (SCORAD) index favoring probiotics over the control (8). However, Cochrane review of 12 RCTs involving 785 patients included a variety of probiotic strains and found no significant difference in symptoms or disease severity compared to placebo. Considering the little evidence of the beneficial effect of probiotics in AD, the current AAD guidelines do not recommend the use of probiotics (lever of evidence II) (23).

Attitudes or perceptions about diet

Patient centered research has become an area of interest especially since the establishment of the Patient Centered Outcomes Research Institute (PCORI) in 2010 (40). Unfortunately, traditional medical research is not always able to address the questions and concerns of both patients and clinicians; patient centered research aims to fill this gap by directing studies that particularly address these concerns. Surveying patients regarding their attitudes or perceptions about diet gives the opportunity to investigate the individual and anecdotal perceptions of patients regarding the effect of diets on their skin condition. Although the majority of patients in our study noted that following a special diet is difficult, expensive and time consuming, three-quarters of the patients reported an actual trial of dietary modification (either elimination or supplementation). This extremely high number of patient pursuing dietary modifications is consistent with the literature (12,13) and highlights the significance of diet as a management tool in AD from the perspective of patients. Furthermore, this also presents a knowledge gap between the perspective of patients regarding the role of diet in AD and the evidenced-based literature.

Surprisingly, the literature reveals that patients may be receiving different opinions from different clinicians. While primary care providers and allergologists are convinced of the causative role of food in the onset and severity of AD, dermatologists are convinced of the contrary (41,42). These conflicting viewpoints combined with the failure and undesirable side effects of the standard treatments lead patients to explore alternative therapies such as elimination diets often without consulting a professional. For example, in this study, 93.5% of patients believed it was important that physicians discuss with them the role of diet in

managing their skin disease. However, only 32.5% of patients had actually consulted their dermatologist regarding their dietary manipulations.

Limitations

Limitations of the study include the self-selecting nature of the survey, which restricts generalizability of the findings. Other barriers to generalizability include the predominance of female gender, white race and urban living respondents. Additionally, recall bias might decrease the reported incidence, so that the true figure for dietary modifications in this population may be even higher than that reported. Furthermore, the length of dietary modifications was not assessed as well as the quantitative reduction or addition of the specific dietary modification, which may be a contributing factor to variation in skin responses reported among respondents. For example, respondents reporting favorable skin responses may have undergone dietary modifications that were longer and stricter than respondents who did not report a favorable response.

Conclusions

To the best of our knowledge, this is the first study to investigate patient-reported outcomes and perceptions regarding the role of diet in AD in the adult population. This patient centered study highlights the significance of diet as a management tool in AD from the perspective of patients. Our study also raises the concern about unsupervised dietary manipulations that could potentially lead to nutrient deficiencies as previously reported (14–16,23). Since dietary modifications are extremely common, the role of diet in AD needs to be discussed with patients and proper medical supervision, nutritional counseling and supplementations should be included for patients pursuing prolonged dietary modifications. Undoubtedly, future research on patient-reported outcomes and more RCTs are necessary in order to assess best practices for diet in patients with AD.

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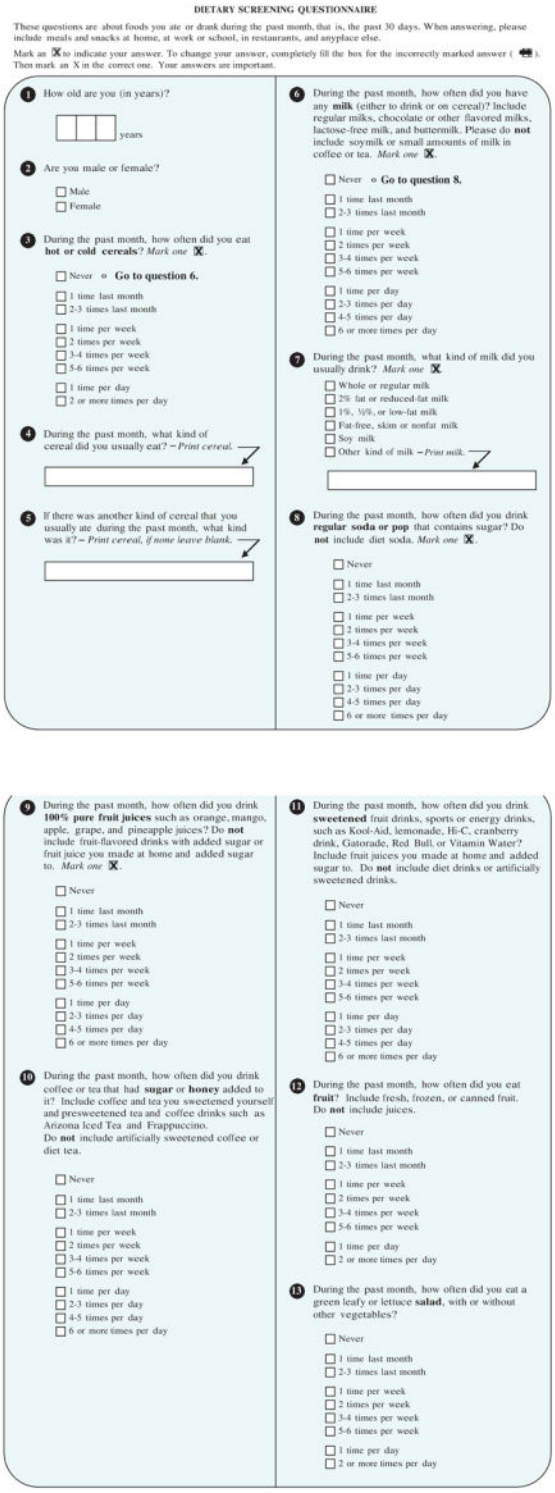
Appendix. DIETARY SCREENING QUESTIONNAIRE

These questions are about foods you ate or drank during the past month, that is, the past 30 days. W hen answering, please include meals and snacks at home, at work or school, in restaurants, and anyplace else.

Mark an ☒ to indicate your answer. To change your answer, completely fill the box for the incorrectly marked answer ( ). Then mark an X in the correct one. Your answers are important.

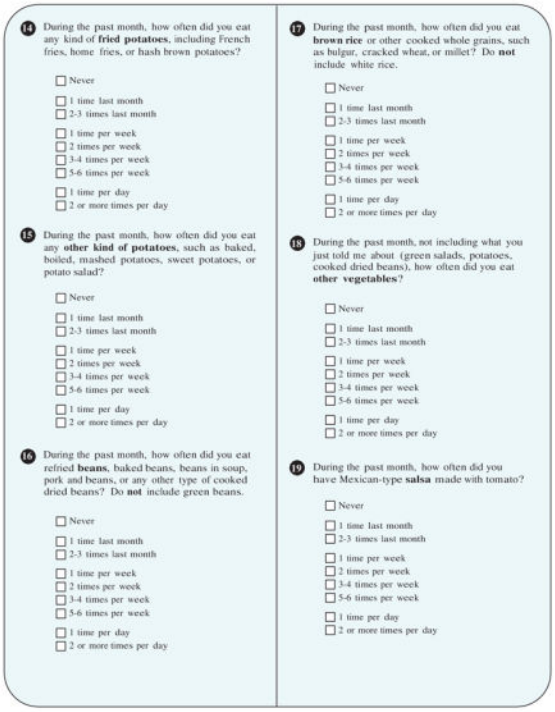


DIETARY SCREENING QUESTIONNAIRE

These questions are about foods you ate or drank during the past month, that is, the past 30 days. When answering, please include meals and snacks at home, at work or school, in restaurants, and anyplace else.

Mark an X to indicate your answer. To change your answer, completely fill the box for the incorrectly marked answer ( ). Then mark an X in the correct one. Your answers are important.

1. How old are you (in years)?
   ☐☐☐ years
2. Are you male or female?
   ☐ Male
   ☐ Female
3. During the past month, how often did you eat **hot or cold cereals**? *Mark one* X.
   ☐ Never → **Go to question 6.**
   ☐ 1 time last month
   ☐ 2-3 times last month
   ☐ 1 time per week
   ☐ 2 times per week
   ☐ 3-4 times per week
   ☐ 5-6 times per week
   ☐ 1 time per day
   ☐ 2 or more times per day
4. During the past month, what kind of cereal did you usually eat? – *Print cereal.*
5. If there was another kind of cereal that you usually ate during the past month, what kind was it? – *Print cereal, if none leave blank.*
6. During the past month, how often did you have any **milk** (either to drink or on cereal)? Include regular milks, chocolate or other flavored milks, lactose-free milk, and buttermilk. Please do **not** include soymilk or small amounts of milk in coffee or tea. *Mark one* X.
   ☐ Never → **Go to question 8.**
   ☐ 1 time last month
   ☐ 2-3 times last month
   ☐ 1 time per week
   ☐ 2 times per week
   ☐ 3-4 times per week
   ☐ 5-6 times per week
   ☐ 1 time per day
   ☐ 2-3 times per day
   ☐ 4-5 times per day
   ☐ 6 or more times per day
7. During the past month, what kind of milk did you usually drink? *Mark one* X.
   ☐ Whole or regular milk
   ☐ 2% fat or reduced-fat milk
   ☐ 1%, ½%, or low-fat milk
   ☐ Fat-free, skim or nonfat milk
   ☐ Soy milk
   ☐ Other kind of milk – *Print milk.*
8. During the past month, how often did you drink **regular soda or pop** that contains sugar? Do **not** include diet soda. *Mark one* X.
   ☐ Never
   ☐ 1 time last month
   ☐ 2-3 times last month
   ☐ 1 time per week
   ☐ 2 times per week
   ☐ 3-4 times per week
   ☐ 5-6 times per week
   ☐ 1 time per day
   ☐ 2-3 times per day
   ☐ 4-5 times per day
   ☐ 6 or more times per day
9. During the past month, how often did you drink **100% pure fruit juices** such as orange, mango, apple, grape, and pineapple juices? Do **not** include fruit-flavored drinks with added sugar or fruit juice you made at home and added sugar to. *Mark one* X.
   ☐ Never
   ☐ 1 time last month
   ☐ 2-3 times last month
   ☐ 1 time per week
   ☐ 2 times per week
   ☐ 3-4 times per week
   ☐ 5-6 times per week
   ☐ 1 time per day
   ☐ 2-3 times per day
   ☐ 4-5 times per day
   ☐ 6 or more times per day
10. During the past month, how often did you drink coffee or tea that had **sugar** or **honey** added to it? Include coffee and tea you sweetened yourself and presweetened tea and coffee drinks such as Arizona Iced Tea and Frappuccino. Do **not** include artificially sweetened coffee or diet tea.
    ☐ Never
    ☐ 1 time last month
    ☐ 2-3 times last month
    ☐ 1 time per week
    ☐ 2 times per week
    ☐ 3-4 times per week
    ☐ 5-6 times per week
    ☐ 1 time per day
    ☐ 2-3 times per day
    ☐ 4-5 times per day
    ☐ 6 or more times per day
11. During the past month, how often did you drink **sweetened** fruit drinks, sports or energy drinks, such as Kool-Aid, lemonade, Hi-C, cranberry drink, Gatorade, Red Bull, or Vitamin Water? Include fruit juices you made at home and added sugar to. Do **not** include diet drinks or artificially sweetened drinks.
    ☐ Never
    ☐ 1 time last month
    ☐ 2-3 times last month
    ☐ 1 time per week
    ☐ 2 times per week
    ☐ 3-4 times per week
    ☐ 5-6 times per week
    ☐ 1 time per day
    ☐ 2-3 times per day
    ☐ 4-5 times per day
    ☐ 6 or more times per day
12. During the past month, how often did you eat **fruit**? Include fresh, frozen, or canned fruit. Do **not** include juices.
    ☐ Never
    ☐ 1 time last month
    ☐ 2-3 times last month
    ☐ 1 time per week
    ☐ 2 times per week
    ☐ 3-4 times per week
    ☐ 5-6 times per week
    ☐ 1 time per day
    ☐ 2 or more times per day
13. During the past month, how often did you eat a green leafy or lettuce **salad**, with or without other vegetables?
    ☐ Never
    ☐ 1 time last month
    ☐ 2-3 times last month
    ☐ 1 time per week
    ☐ 2 times per week
    ☐ 3-4 times per week
    ☐ 5-6 times per week
    ☐ 1 time per day
    ☐ 2 or more times per day



14 During the past month, how often did you eat any kind of **fried potatoes**, including French fries, home fries, or hash brown potatoes?

☐ Never
☐ 1 time last month
☐ 2-3 times last month
☐ 1 time per week
☐ 2 times per week
☐ 3-4 times per week
☐ 5-6 times per week
☐ 1 time per day
☐ 2 or more times per day

15 During the past month, how often did you eat any **other kind of potatoes**, such as baked, boiled, mashed potatoes, sweet potatoes, or potato salad?

☐ Never
☐ 1 time last month
☐ 2-3 times last month
☐ 1 time per week
☐ 2 times per week
☐ 3-4 times per week
☐ 5-6 times per week
☐ 1 time per day
☐ 2 or more times per day

16 During the past month, how often did you eat refried **beans**, baked beans, beans in soup, pork and beans, or any other type of cooked dried beans? Do **not** include green beans.

☐ Never
☐ 1 time last month
☐ 2-3 times last month
☐ 1 time per week
☐ 2 times per week
☐ 3-4 times per week
☐ 5-6 times per week
☐ 1 time per day
☐ 2 or more times per day

17 During the past month, how often did you eat **brown rice** or other cooked whole grains, such as bulgur, cracked wheat, or millet? Do **not** include white rice.

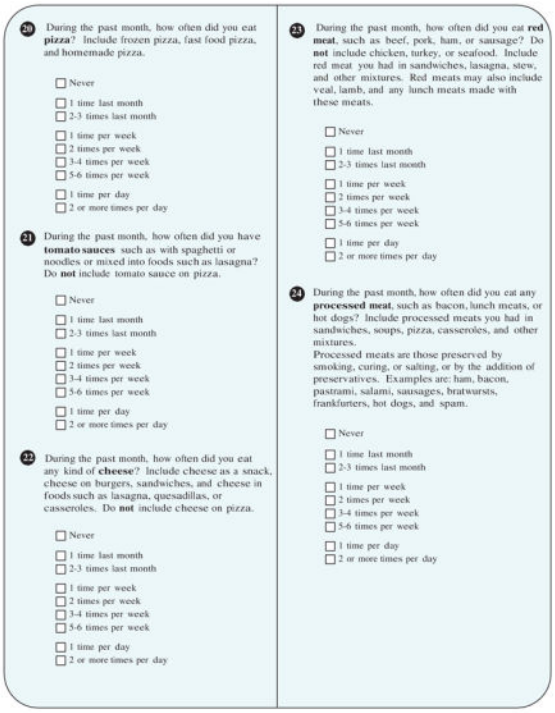
☐ Never
☐ 1 time last month
☐ 2-3 times last month
☐ 1 time per week
☐ 2 times per week
☐ 3-4 times per week
☐ 5-6 times per week
☐ 1 time per day
☐ 2 or more times per day

18 During the past month, not including what you just told me about (green salads, potatoes, cooked dried beans), how often did you eat **other vegetables**?

☐ Never
☐ 1 time last month
☐ 2-3 times last month
☐ 1 time per week
☐ 2 times per week
☐ 3-4 times per week
☐ 5-6 times per week
☐ 1 time per day
☐ 2 or more times per day

19 During the past month, how often did you have Mexican-type **salsa** made with tomato?

☐ Never
☐ 1 time last month
☐ 2-3 times last month
☐ 1 time per week
☐ 2 times per week
☐ 3-4 times per week
☐ 5-6 times per week
☐ 1 time per day
☐ 2 or more times per day



20 During the past month, how often did you eat **pizza**? Include frozen pizza, fast food pizza, and homemade pizza.

☐ Never
☐ 1 time last month
☐ 2-3 times last month
☐ 1 time per week
☐ 2 times per week
☐ 3-4 times per week
☐ 5-6 times per week
☐ 1 time per day
☐ 2 or more times per day

21 During the past month, how often did you have **tomato sauces** such as with spaghetti or noodles or mixed into foods such as lasagna? Do **not** include tomato sauce on pizza.

☐ Never
☐ 1 time last month
☐ 2-3 times last month
☐ 1 time per week
☐ 2 times per week
☐ 3-4 times per week
☐ 5-6 times per week
☐ 1 time per day
☐ 2 or more times per day

22 During the past month, how often did you eat any kind of **cheese**? Include cheese as a snack, cheese on burgers, sandwiches, and cheese in foods such as lasagna, quesadillas, or casseroles. Do **not** include cheese on pizza.

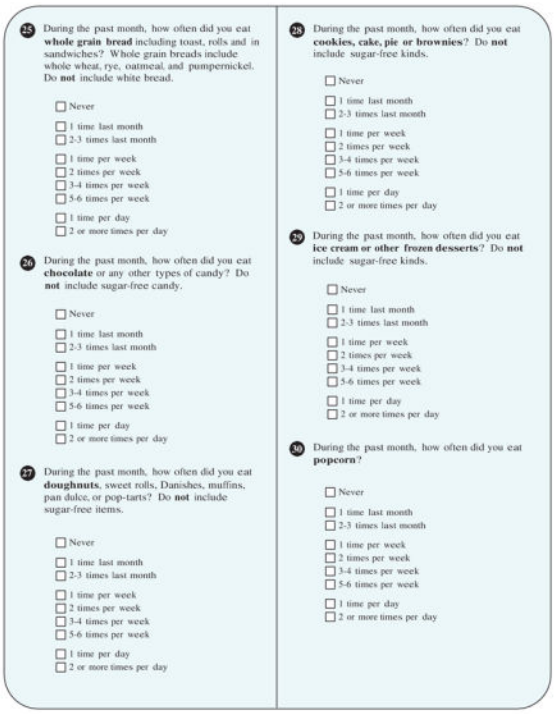
☐ Never
☐ 1 time last month
☐ 2-3 times last month
☐ 1 time per week
☐ 2 times per week
☐ 3-4 times per week
☐ 5-6 times per week
☐ 1 time per day
☐ 2 or more times per day

23 During the past month, how often did you eat **red meat**, such as beef, pork, ham, or sausage? Do **not** include chicken, turkey, or seafood. Include red meat you had in sandwiches, lasagna, stew, and other mixtures. Red meats may also include veal, lamb, and any lunch meats made with these meats.

☐ Never
☐ 1 time last month
☐ 2-3 times last month
☐ 1 time per week
☐ 2 times per week
☐ 3-4 times per week
☐ 5-6 times per week
☐ 1 time per day
☐ 2 or more times per day

24 During the past month, how often did you eat any **processed meat**, such as bacon, lunch meats, or hot dogs? Include processed meats you had in sandwiches, soups, pizza, casseroles, and other mixtures.
Processed meats are those preserved by smoking, curing, or salting, or by the addition of preservatives. Examples are: ham, bacon, pastrami, salami, sausages, bratwursts, frankfurters, hot dogs, and spam.

☐ Never
☐ 1 time last month
☐ 2-3 times last month
☐ 1 time per week
☐ 2 times per week
☐ 3-4 times per week
☐ 5-6 times per week
☐ 1 time per day
☐ 2 or more times per day



25 During the past month, how often did you eat **whole grain bread** including toast, rolls and in sandwiches? Whole grain breads include whole wheat, rye, oatmeal, and pumpernickel. Do **not** include white bread.

- ☐ Never
- ☐ 1 time last month
- ☐ 2-3 times last month
- ☐ 1 time per week
- ☐ 2 times per week
- ☐ 3-4 times per week
- ☐ 5-6 times per week
- ☐ 1 time per day
- ☐ 2 or more times per day

26 During the past month, how often did you eat **chocolate** or any other types of candy? Do **not** include sugar-free candy.

- ☐ Never
- ☐ 1 time last month
- ☐ 2-3 times last month
- ☐ 1 time per week
- ☐ 2 times per week
- ☐ 3-4 times per week
- ☐ 5-6 times per week
- ☐ 1 time per day
- ☐ 2 or more times per day

27 During the past month, how often did you eat **doughnuts**, sweet rolls, Danishes, muffins, pan dulce, or pop-tarts? Do **not** include sugar-free items.

- ☐ Never
- ☐ 1 time last month
- ☐ 2-3 times last month
- ☐ 1 time per week
- ☐ 2 times per week
- ☐ 3-4 times per week
- ☐ 5-6 times per week
- ☐ 1 time per day
- ☐ 2 or more times per day

28 During the past month, how often did you eat **cookies, cake, pie or brownies**? Do **not** include sugar-free kinds.

- ☐ Never
- ☐ 1 time last month
- ☐ 2-3 times last month
- ☐ 1 time per week
- ☐ 2 times per week
- ☐ 3-4 times per week
- ☐ 5-6 times per week
- ☐ 1 time per day
- ☐ 2 or more times per day

29 During the past month, how often did you eat **ice cream or other frozen desserts**? Do **not** include sugar-free kinds.

- ☐ Never
- ☐ 1 time last month
- ☐ 2-3 times last month
- ☐ 1 time per week
- ☐ 2 times per week
- ☐ 3-4 times per week
- ☐ 5-6 times per week
- ☐ 1 time per day
- ☐ 2 or more times per day

30 During the past month, how often did you eat **popcorn**?

- ☐ Never
- ☐ 1 time last month
- ☐ 2-3 times last month
- ☐ 1 time per week
- ☐ 2 times per week
- ☐ 3-4 times per week
- ☐ 5-6 times per week
- ☐ 1 time per day
- ☐ 2 or more times per day

31. What foods or drinks do you think make your skin condition worse? (write-in)
My triggers: _____

32. What foods, drinks, or supplements do you think make your skin condition better? (write-in)
Helpful: _____

33. Have you tried **avoiding** or **reducing** any of the following in your diet? (Check all that apply and circle how it affected your skin condition):

☐ **Red meat**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Pork**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Shellfish**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Sodium / Salt**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Gluten** (Wheat, barley, rye products)
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **White flour products**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Nightshades** (tomatoes, eggplant, peppers, paprika, white potatoes)
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Dairy**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **High fat foods**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Junk foods** (candy and pastries, chocolate, French fries, potato chips, sweets)
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Caffeine**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Alcohol**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Tobacco**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Other avoided (write in):**_____
Skin response (circle): Fully Clear Improved No Change Worsened

34. Have you tried **adding** any of the following to your diet? (Check all that apply and circle how it affected your skin condition):

☐ **Fruits**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Vegetables**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Organic foods**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Probiotics**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Fish oil / Omega-3**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Oral vitamin D**
Skin response (circle): Fully Clear Improved No Change Worsened
☐ **Other added (write in):**_____
Skin response (circle): Fully Clear Improved No Change Worsened

35. How did you learn about the foods/drinks that affect your skin condition? (circle all that apply)
Family Friends Other Patients Trial & Error Internet TV Books
Other:_____

36. Have you tried going on any special diets? (e.g. Vegetarian diet, Gluten-free, Mediterranean, Ornish, South Beach, Paleo, Atkins, etc). If so, please list your diet(s) below and how it affected your skin condition:

Name of Diet:_____ **Length Diet Tried:**_____ **Experience Weight Loss? Yes / No**
Skin response (circle): Fully Clear Improved No Change Worsened

Name of Diet:_____ **Length Diet Tried:**_____ **Experience Weight Loss? Yes / No**
Skin response (circle): Fully Clear Improved No Change Worsened

Name of Diet:_____ **Length Diet Tried:**_____ **Experience Weight Loss? Yes / No**
Skin response (circle): Fully Clear Improved No Change Worsened

37. If you stopped any of the above diets, did your skin symptoms worsen? (circle one)
Yes (If Yes, how long before it worsened:_____) No Not Applicable

38. Currently, what role is diet playing in managing your skin condition? (select one)
☐ With diet alone, my skin condition is completely controlled
☐ My diet is helping significantly with my skin condition
☐ My diet is helping slightly with my skin condition
☐ My diet has no effect on my skin condition

39. Did your diet have any benefits on your general health? (e.g. blood pressure, cholesterol)
Yes (If Yes, benefits:_____) No Not Applicable

40. Have there been any problems or adverse side effects resulting from your dietary changes?
Yes (If Yes, what problems:_____) No Not Applicable

41. How difficult / burdensome is it to follow a special diet? (circle one)
Very difficult Somewhat difficult Not difficult Not Applicable

42. What difficulties did you encounter modifying your diet? (if any)

Write-in: _____

43. How time-consuming is it to follow a special diet? (circle one)
Very time-consuming Somewhat time-consuming Not time-consuming Not Applicable

44. How expensive is it to modify your diet? (circle one)
Very expensive Somewhat expensive Not expensive Not Applicable

45. Does exercise help your skin condition? (circle)
Yes No Not sure I don't exercise

46. Please rate the importance of diet in managing your skin condition relative to other factors: (circle)

Prescription medications:	Diet more important	Diet less important	About the same	N/A
Over-the-counter medications:	Diet more important	Diet less important	About the same	N/A
Complementary medicine:	Diet more important	Diet less important	About the same	N/A
Exercise:	Diet more important	Diet less important	About the same	N/A
Stress Reduction:	Diet more important	Diet less important	About the same	N/A

47. What motivated you to try dietary modification for your skin condition? (circle all that apply)

Other treatments failed Recommended by friends/family Recommended by other patients

It is a natural method It might improve other health problems I have not tried a diet modification

Other:_____

48. Have you ever discussed dietary changes with your dermatologist? (check one)
☐ Yes, I discussed with the dermatologist before modifying my diet
☐ Yes, I mentioned it to the dermatologist during or after I made the dietary change
☐ Yes, I discussed with the dermatologist but have not modified my diet yet
☐ No, I have not discussed with my dermatologist even though I have already tried dietary change
☐ No, I have not discussed with my dermatologist and I haven't tried any dietary change

49. How important is it that physicians discuss with patients the role of diet in managing skin disease? (circle one)
Very important Somewhat important Minimally important Not important at all

50. What is your primary skin condition?
☐ Psoriasis If yes, do you have psoriatic arthritis? Yes / No / Not sure
Psoriasis subtype(s): Plaque Guttate Pustular Inverse Erythrodermic Palm/Sole
☐ Eczema / Atopic dermatitis
☐ Other: _____

51. Age when skin condition began: _____

52. Do you have a family history of your skin condition? Yes / No / Not Sure

53. Do you have celiac disease (sensitivity to dietary gluten)? Yes / No / Not Sure

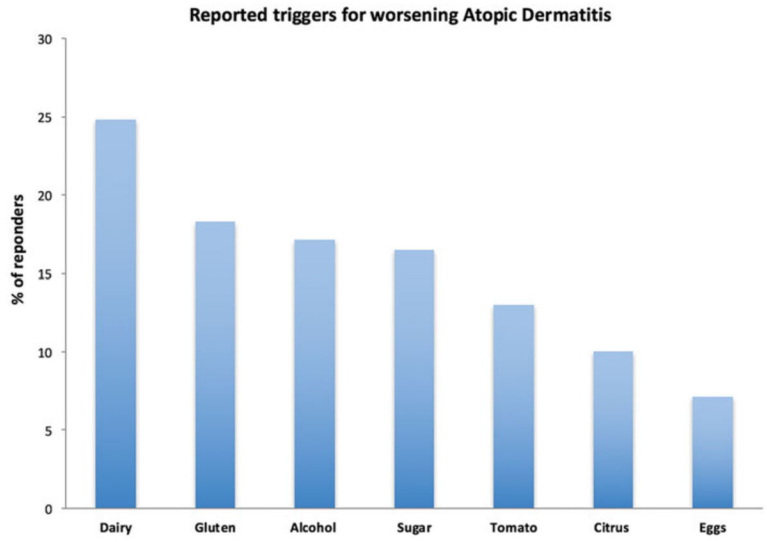


Figure 1.
Reported triggers for worsening atopic dermatitis.

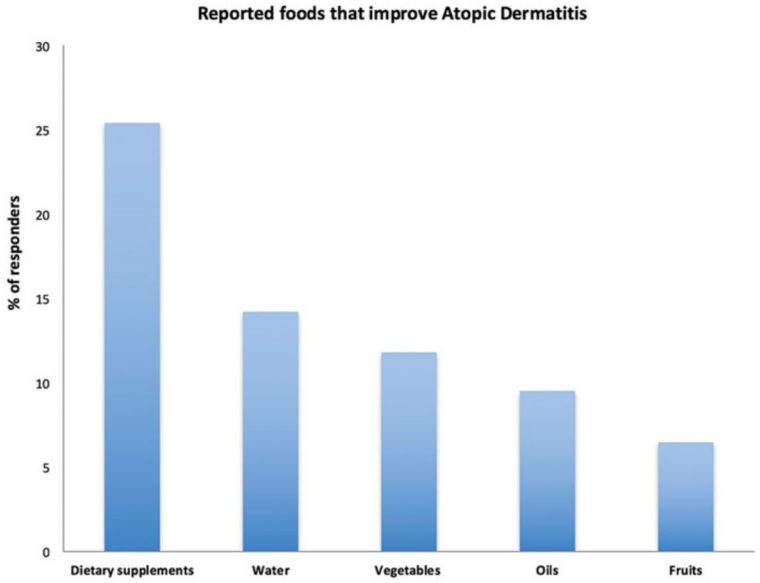


Figure 2.
Reported foods that improve atopic dermatitis.

Table 1

Patient characteristics.

Variable	Value, *N* =169
Age, Y	
Mean (SD)	43.0 (16.7)
Sex, *n* %	
Male	38 (22.5)
Female	131 (77.5)
Race, *n* (%)	
White	124 (74.7)
Asian/Pacific Islander	21 (12.7)
Hispanic	7 (4.2)
Native American	4 (2.4)
African American	4 (2.4)
Other	16 (9.6)
Highest level of education, *n* (%)	
Less than high school	10 (6.0)
High school graduate	23 (13.9)
Undergraduate	55 (33.1)
Graduate/professional degree	78 (47.0)
Area in which the patient lives, *n* (%)	
Urban/suburban	130 (79.3)
Rural	34 (20.7)
Country in which the patient lives, *n* (%)	*N* =114
USA	80 (70.2)
Canada	16 (14.0)
Europe	12 (10.5)
Australia	2 (1.7)
Asia	4 (3.5)
Average annual household income, *n* (%)	
<$20,000	14 (8.7)
$20,000–$40,000	17 (10.6)
$40,001–$60,000	21 (13.0)
$60,001–$100,000	29 (18.0)
>$100,000	40 (24.8)
Prefer not to say	40 (24.8)
Age onset of Eczema, mean (SD)	18.2 (20.7)
Family history of Eczema, *n* (%)	
Yes	94 (56.0)
No	52 (31.0)
Not sure	22 (13.1)
Severity of Eczema (without treatment), *n* (%)	

Variable	Value, *N* =169
Mild	22 (13.1)
Moderate	66 (39.3)
Severe	80 (47.6)
Average BMI, mean (SD)	27.2 (8.2)
Underweight (<18.5), *n* (%)	12 (7.1)
Normal (18.5–24.9), *n* (%)	72 (42.6)
Overweight (25–29.9), *n* (%)	34 (20.1)
Obese 30+, *n* (%)	50 (29.6)

Table 2

Food categories that were avoided/reduced or added by participant.

Variable	Value
Food categories that were avoided/reduced by participants, *n* (%)	*N*=147
Junk foods[a]	100 (68.0)
Dairy	73 (49.7)
Gluten[b]	72 (49.0)
White flour products	69 (46.9)
Alcohol	59 (40.1)
High fat foods	55 (37.4)
Red meat	54 (36.7)
Caffeine	51 (34.7)
Tobacco	47 (32.0)
Sodium/salt	43 (29.3)
Shellfish	38 (25.9)
Nightshades[c]	35 (23.8)
Pork	31 (21.1)
Other	20 (13.6)
Food categories that were added by participants, *n* (%)	*N*=135
Vegetables	84 (62.2)
Fish oil/Omega-3	80 (59.3)
Fruits	78 (57.8)
Oral vitamin D	65 (48.1)
Probiotics	62 (45.9)
Organic foods	43 (31.9)
Other	14 (10.4)

[a]Candy and pastries, chocolate, French fries, potato chips, sweets.

[b]Wheat, barley, rye products.

[c]Tomatoes, eggplant, peppers, paprika, white potatoes.

Table 3

Response/outcomes to dietary modifications.

Response/outcomes to dietary modifications	Value
Positive response[a] with removal of the following from the diet, *n* (%)	
White flour products	37 of 69 (53.6)
Gluten	37 of 72 (51.4)
Nightshades	18 of 35 (51.4)
Junk foods	51 of 100 (51.0)
Alcohol	30 of 59 (50.8)
Dairy	37 of 73 (50.7)
High fat foods	24 of 55 (43.6)
Tobacco	19 of 47 (40.4)
Shellfish	14 of 38 (36.8)
Caffeine	17 of 51 (33.3)
Pork	10 of 31 (32.2)
Red meat	13 of 54 (24.1)
Sodium/salt	10 of 43 (23.2)
Positive response after the addition of the following to the diet, *n* (%)	
Vegetables	40 of 84 (47.6)
Organic foods	17 of 43 (39.5)
Fish oil/Omega-3	28 of 80 (35.0)
Fruits	27 of 78 (34.6)
Oral vitamin D	23 of 65 (34.4)
Probiotics	24 of 62 (28.7)

[a]Full clearance or improvement of atopic dermatitis.

Table 4

Attitudes or perceptions about diet.

Survey questions regarding attitudes or perceptions about diet	*N* (%)
How difficult/burdensome is it to follow a special diet?	
Very difficult	32 (18.9)
Somewhat difficult	72 (42.6)
Not difficult	35 (20.7)
Not applicable	30 (17.8)
What difficulties did you encounter modifying your diet?	
Will power/too limiting	45 (44.1)
Time/inconvenience	20 (19.6)
Family/social pressures	11 (10.7)
Dining out/travel	22 (21.5)
Affordability	8 (7.8)
Access	11 (10.8)
How time-consuming is it to follow a special diet?	
Very time-consuming	31 (18.3)
Somewhat time-consuming	62 (36.7)
Not time-consuming	45 (26.6)
Not applicable	31 (18.3)
How expensive is it to modify your diet?	
Very expensive	22 (13.0)
Somewhat expensive	74 (43.8)
Not expensive	43 (25.4)
Not Applicable	30 (17.8)
What motivated you to try dietary modification for your skin condition?	
Other treatments failed	72 (42.6)
Recommended by friends/family	27 (16.0)
Recommended by other patients	17 (10.1)
It is a natural method	52 (30.8)
It might improve other health problems	55 (32.5)
I have not tried a diet modification	41 (24.3)
Other	16 (9.5)
How important is it that physicians discuss with patients the role of diet in managing skin disease?	
Very important	121 (71.6)
Somewhat important	37 (21.9)
Minimally important	6 (3.6)
Not important at all	5 (3.0)
Have you ever discussed dietary changes with your dermatologist?	
Yes, I discussed dietary changes with my dermatologist	55 (32.5)
No, I have not discussed dietary changes with my dermatologist	78 (46.2)
I haven’t tried any dietary changes	36 (21.3)

Survey questions regarding attitudes or perceptions about diet	***N* (%)**
The importance of diet compared to other interventions or treatments for management of the Eczema	
Diet is more important than taking prescription medications	61 (36.1)
Diet is more important than over-the-counter medications	64 (37.9)
Diet is more important than complimentary medications	54 (32.0)
Diet is more important than exercise	52 (30.8)
Diet is more important than stress reduction	19 (11.2)
Currently, what role is diet playing in managing your skin condition	
Skin condition complete controlled with diet	1 (0.6)
Diet is helping significantly with skin condition	29 (17.2)
Diet is helping slightly with skin condition	44 (26.0)
Diet has no effect on skin condition	18 (10.7)
Not sure how diet effects skin condition	72 (42.6)
Other	5 (3.0)
How did you learn about the foods/drink that affect your skin condition	
Family	30 (17.8)
Friends	20 (11.8)
Other patients	17 (10.1)
Trial and error	77 (45.6)
Internet	76 (45.0)
TV	6 (3.6)
Books	27 (16.0)
Other	25 (14.8)
Not applicable	30 (17.8)