Original Research Article

Comparison of macro and micronutrients intake in an Indian subpopulation with acne vulgaris versus controls: an observational study

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ABSTRACT

Background: Diet plays an important role in the development and severity of acne, a debilitating and psychologically distressing skin condition attributable to chronic inflammation. The diverse food cultures, influence of globalisation and confounding genetic and environmental factors have prompted studies of specific diet on acne. However, diet being a controllable factor, it would be useful to discern the beneficial and harmful effects of certain foods on acne. The aim of the study was to compare macro and micronutrient intakes in persons with acne vulgaris versus controls in an Indian subpopulation in Mumbai city. Current case-controlled, prospective, observational survey was conducted during September to December 2017 with 210 participants aged 18 to 40 years.
Methods: We used semi-quantitative Food frequency questionnaire and 24-hour recall tests to identify the pattern of food consumption between acne and non-acne individuals. Statistical analysis was performed using "t" test and ANOVA.
Results: Our analysis revealed that the individuals with acne consume a higher portion of dairy products, refined cereals and relatively smaller portions of whole cereals. Acne group had a significant lower ($p<0.05$) intake of pulses, omega-3 and 6 fatty acids, α-linolenic acid than the non-acne group. Significant difference indicated a lower consumption of micronutrients including zinc ($p=0.012$), thiamine ($p<0.05$), and niacin ($p=0.01$) among acne individuals.
Conclusions: Study findings suggest an increased consumption of inflammation triggering foods and lower consumption of foods with anti-inflammatory and antioxidant property in the acne group of individuals.

Keywords: Acne, Diet, Macronutrients, Micronutrients

INTRODUCTION

Acne is the most common inflammatory skin condition with a complex multifactorial pathogenesis influenced by both genetic and environmental factors. The Global Disease Burden estimate of 2010 ranks acne amongst the eight most prevalent disease.[1-3] Due to the hormonal factors, female population is particularly more susceptible to acne than men. Further, the high prevalence of acne, especially among the students of adolescent and young adult age, imposes a significant psychological burden that severely impairs the quality of life of the affected individuals.[4] Contrary to the classic belief of perceiving inflammation as an endpoint of acne,

the current insights identify trigger factors that enable micro inflammation to patterns of chronic inflammatory response.[5] Among these triggers, surmounting evidence considers diet to play a unique prominent role in the development and progression of acne.

An imbalance of diet skewed towards higher consumption of inflammation-inducing food and relatively lower amount of food rich in antioxidants is considered to be one of the trigger factors for acne.[6] The AAD guidelines of 2016 acknowledged the role of diet, namely, high glycaemic index foods and dairy consumption, in acne with moderate level of evidence.[3] A recent systematic review of literature of 53 articles focusing on acne and diet reported detrimental effects of high glycaemic index foods, dairy products, fat food and chocolate, beneficial effects of consuming fruits, vegetables and polyunsaturated fatty acids (PUFA) on acne.[7] In addition to the macronutrients, the role of micronutrients including minerals such as zinc, selenium and iron is being increasingly realized due to their influence on anti-inflammatory and pro-inflammatory enzymes.[8-10] With the vast disparities in food patterns across the world along with genetics and environmental factors, generalizing the influence of specific diet on acne has been particularly challenging. This is particularly daunting to study among the population in India, a country with rich and affluent diverse food cultures confined to localized regions. Furthermore, the influence of globalization has led towards an increased dependency on packaged foods, sweetened beverages, high consumption of refined wheat and polished rice, sugar, milk, oils and energy dense foods.[11] Concurrently, there is a declining trend in the consumption of fibre rich grains such as Bajra, Jowar.[12,13] Therefore, there is an undisputed need to tease out the diet-acne relationship in a specific local population to discern the influence of the contemporary pattern of food consumption on acne. In this aspect, the Food Frequency questionnaire (FFQ) and the 24-hour dietary recall test are useful tools to document the diverse food habits and translate it to general biochemical parameters.[14] Aim of the study was to explore the differences in the pattern of food component consumption and the nutrient (macronutrients and micronutrients) intake between the acne and non-acne participants, in a subpopulation residing in the Indian city of Mumbai.

METHODS

Settings and design

A case-controlled, prospective, non-randomized, non-blinded, observational survey was conducted during September 2017 to December 2017 with 210 participants in the age group of 18 to 40 years. The participants included students from SNDT University, Santacruz-Mumbai and individual residing in the neighbourhood. Participation was voluntary and non-incentivised. Sampling was of the non-probability snowball technique. All participants provided informed consent prior to their enrolment. Following enrolment, all participants underwent skin examination and categorized into acne and non-acne groups. The outline of the approach adopted for the screening of participants is provided in (Figure 1).
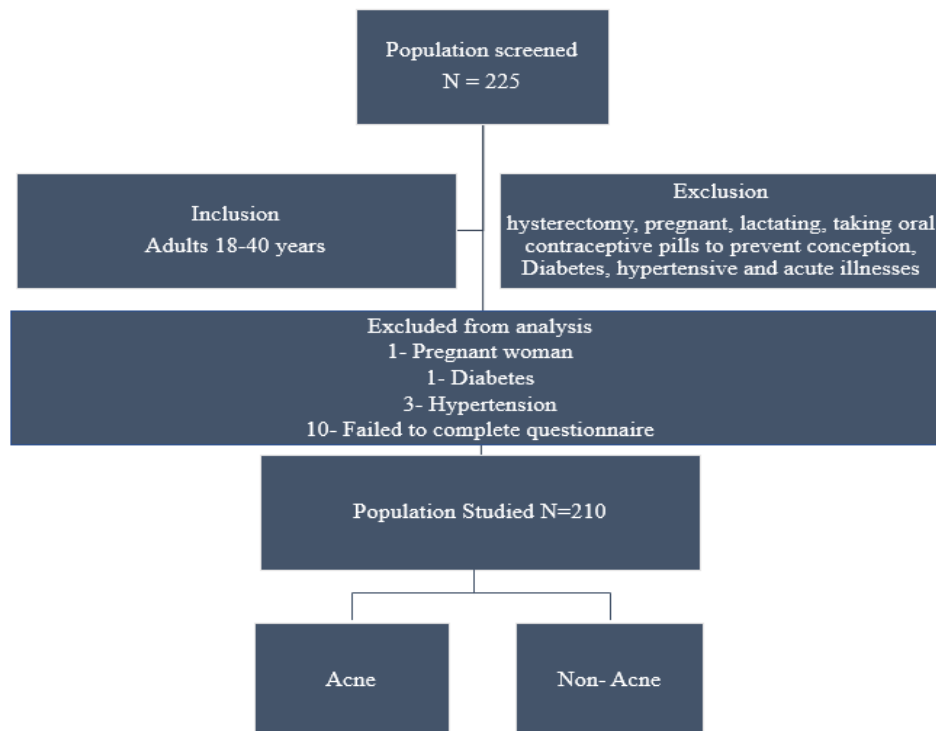

Figure 1: Study flow chart.

Further, based on the severity of acne, the patients with acne were sub grouped into those with grade 1 (comedones, occasional papules); grade 2 (papules, comedones and few pustules); grade 3: predominant pustules, nodules and grade 4: mainly cysts, widespread scarring acne.[15] Participants without acne made up the control group.

Dietary assessment

The participant's dietary pattern was assessed using a FFQ, 24-hour recall and 3-day food diary. FFQ is a semi-quantitative questionnaire comprising of 286 questions, directed towards the pattern of consumption of a type of food.[16-18] The 24-hour diet recall interview is a quantitative method for nutritional assessment.

Data collection

Demographic information and medical history of the participants was collected followed by anthropometric measurements, BMI (kg/m^2) and body composition analysis using Omron HBF 375 Body Composition Monitor.[16] BMI was classified according to WHO 2004 Asian cut-offs.[17] The participants' dietary habits were collected by a qualified interviewer who noted down their response to FFQ test and the 24-hour recall test.

The food categories broadly considered for evaluation included cereals, pulses, dairy products, food high on sugars and fats, rich in antioxidants, vitamins and minerals. FFQ is a semi-quantitative questionnaire comprising of 286 questions, directed towards the pattern of consumption of a type of food.[18] The responses were captured based on the consumption of a portion of food (number of portions per week) and the frequency of intake (number of times a week) of a particular type of food, over a duration of 15 days. The 24-hour diet recall interview is a quantitative method for nutritional assessment. Details pertaining to food intake of the participants within the past 24 h (midnight of the previous day to the midnight of the test day) were

recorded. Details such as the time of consumption during the day, source of food, portion size of each food and beverage were captured. To ensure standard measurements across the participants, standardized vessels, spoons and cups were displayed to account for and define the quantity of food consumed by each participant.

The CS dietary software by Harvest Plus was used to estimate the nutrient content, including vitamins and minerals of the diet consumed by the participants. At the end of the interview, participants were imparted with instructions to fill the 3-day food diary. However, the data received could not be analysed due to incomplete forms, incorrect and repeated data entries.

Statistical analysis

The data collected were tabulated in Microsoft excel worksheet and computer-based analysis was performed using the statistical product and service solutions (SPSS) version 20 software. Descriptive analysis calculated percentages, means and standard deviations (SDs). The significance of descriptive data for anthropometric measurements, FFQ and 24-hour recall was calculated using t-test. One-way analysis of variance (ANOVA) examined the differences of anthropometric measurements, FFQ and 24-hour recall between the different grades of acne. Test for proportions was performed using Chi-square test, $p<0.05$ was considered to be statistically significant.

RESULTS

Among the 225 enrolled participants, aged 18 to 40 years, one pregnant woman, three hypertensive individuals and one diabetic patient were excluded. Due to incomplete response to questionnaires, 10 participants' response were excluded from analysis, Among the 210 participants, majority (N=121, 57.6%) were students. Table 1 shows the demographic profile, baseline characteristics of skin examination and anthropometric measurements of the study population.

Table 1: Demographics of the participants.

Characteristics	Overall	Group	
		With acne	Without acne
	N (%)	N (%)	N (%)
Grades		n=131 (62.3)	
Grade 1		85 (64.9)	
Grade 2	210	35 (26.7)	79 (37.6)
Grade 3		10 (7.6)	
Grade 4		1 (0.8)	
Age (mean±SD)	23.08±5.2	22.3±4.5	23.7±6.1
Sex			
Female	140 (66.7)	90 (68.7)	50 (63.3)
Male	70 (33.3)	41 (31.3)	29 (36.7)

Continued.

Characteristics	Overall	Group	
Community			
Muslim	110 (52.4)	67 (51.1)	43 (54.4)
Hindu	97 (46.2)	62 (47.3)	35 (44.3)
Catholic	2 (0.9)	1 (0.8)	1 (1.3)
Buddhist	1 (0.5)	1 (0.8)	0 (0)
Occupation			
Student	121 (57.6)	80 (61.1)	41 (51.9)
Professionals	7 (3.3)	5 (3.8)	2 (2.5)
Homemaker	24 (11.4)	13 (9.9)	11 (13.9)
Businessmen	15 (7.2)	8 (6.1)	7 (8.9)
Others	43 (20.5)	25 (19.1)	18 (22.8)
Level of education			
Incomplete	12 (5.7)	3 (2.3)	9 (11.4)
SSC	8 (3.8)	6 (4.6)	2 (2.5)
HSC	59 (28.1)	33 (25.2)	26 (32.9)
Bachelor's	81 (38.6)	54 (41.2)	27 (34.2)
Master's	35 (16.7)	24 (18.3)	11 (13.9)
PhD	0 (0)	0 (0)	0 (0)
Diploma	15 (7.1)	11 (8.4)	4 (5.1)
Personal history			
Smoking	20 (9.5)	16 (12.2)	4 (5.1)
Tobacco chewing	18 (8.6)	10 (7.6)	8 (10.1)
Presence of dark skin	16 (7.6)	15 (11.5)	1 (1.3)

Skin examination revealed that about 2/3rd of the enrolled participants had acne. In the acne group, the results revealed a significant association between acne and the presence of dark skin, scalp type, hair thinning and acanthosis nigricans.

Majority of the acne individuals suffered from grade 1 (64.9%) and grade 2 (26.7%) acne. Less than 10% had moderate grade 3 acne. The proportion of women with irregular periods and PCOS were significantly higher in the acne women population (Table 2). Also, in women, acne flares up during menstruation and severity of acne was significantly associated with irregular periods, menstruation and PCOS (Table 2). There was no significant difference in the anthropometric measurements between the groups with and without acne (Table 3).

Food frequency questionnaire-based assessment

Based on the recordings from the FFQ survey, the food intake was evaluated as either number of portions consumed or frequency of consumption of designated portions. There were significant differences in the number of portions of whole cereals ($p<0.05$), pulses ($p<0.01$), milk and milk products ($p<0.05$), omega-3 ($p<0.05$) and omega 6 fatty acid sources ($p<0.01$) between acne and control group. The individuals with acne seem to consume a higher portion of dairy products and relatively smaller portions of whole cereals, pulses

and sources of omega-3 fatty acids and omega-6 fatty acids than the non-acne group (Table 4). Regarding micronutrients, significant differences were observed in the number of portions of food containing zinc ($p<0.05$) with a lower ingestion among the acne individuals. Subgroup analysis of the acne group showed a significantly greater intake of green leafy vegetables in patients with grade 1 acne compared to those with grade 2 or grade 3 acne (Table 4). There was no discernible difference in the consumption of number of portions of other types of food tested between acne and non-acne individuals (Table 4). Patients with acne seem to more frequently consume refined cereals, dairy products and less frequently consume (9.3±6.6) pulses than the non-acne group (11.6±9.1) (Table 5). However, no significant difference was seen in the mean number of times of consumption of micronutrients, energy-dense foods, whole cereals, dietary fibre, animal proteins, trans fat foods sources, omega 3 fatty acids, omega-6 fatty acids, high fat, sugar and tea and coffee (Table 5). Moreover, ANOVA analysis showed no significant difference in the mean number of times of consumption of the food groups, within the different grades of acne (Table 5).

24-hour recall

24-hour food recall analysis showed significant differences ($p<0.05$) in the intake of energy, total carbohydrates, total protein, pulses, chicken, visible fat,

omega-6 fatty acid, α-linolenic acid. The acne group had a lower consumption of energy, total carbohydrate, total protein, pulses, chicken, visible fat, omega-6 fatty acids, α-linolenic acid than the non-acne group. There was significant difference indicating a lower consumption of micronutrients including zinc (p=0.012), thiamine (p<0.05), and niacin (p=0.01) among acne individuals (Table 6). Participants with the grade 1 acne had a greater mean significant intake of dietary fibre (21±11) in comparison to the participants with grade 2 (15±9), grade 3 (20±8) and grade 4 (14) acne. Participants with the grade 2 acne had a greater mean significant intake of α-linolenic acid (140.2±74.8) than the participants in grade 1 (138.9±61.0), grade 3 (125.8±38.1) and grade 4 (98) acne. ANOVA showed no significant difference in the consumption of micronutrients within the grades of acne (Table 6).

Table 2: Skin examination findings.

Characteristics	Overall	Group		P value
		With acne	Without acne	
	N (%)	N (%)	N (%)	0.001
On acne treatment	21 (10)	21 (16.0)	0 (0)	
Skin type				
Oily	66 (31.4)	55 (42.0)	11 (13.9)	
Dry	42 (20)	17 (13.0)	25 (31.6)	0
Combination	102 (48.6)	59 (45.0)	43 (54.4)	
If oily (n=66)				
Mild oily	41 (62.1)	31 (56.4)	10 (90.9)	
Moderate oily	24 (36.4)	23 (41.8)	1 (9.1)	0
Severe oily	1 (1.5)	1 (1.8)	0 (0)	
Presence of facial hair with its site (only females, n=140)	11 (7.9)	10 (7.6)	1 (1.3)	0.119
Site				
Chin	11 (100)	10 (11.1)	1 (2)	
Upper neck	0	0 (0)	0 (0)	0.096
Beard area	0	0 (0)	0 (0)	
Scalp type				
Oily	96 (45.7)	71 (54.2)	25 (31.6)	0.001
Dry	114 (54.3)	60 (45.8)	54 (68.4)	
If oily (n=96)				
Mild oily	77 (80.2)	56 (78.9)	21 (84.0)	
Moderate oily	18 (18.8)	14 (19.7)	4 (16.0)	0.025
Severe oily	1 (1.0)	1 (1.4)	0 (0)	
Hair thinning and site	21 (10)	18 (13.7)	3 (3.8)	0.02
Frontal	18 (85.7)	16 (88.8)	2 (66.7)	
Bitemporal	2 (9.5)	1 (5.6)	1 (33.3)	0.083
Both	1 (4.8)	1 (5.6)	0 (0)	
Characteristics evaluated for female population				
Regularity of periods	114 (81.4)	67 (74.4)	47 (94)	0.014
Acne flare during menstruation	67 (47.9)	54 (60)	13 (26)	0
Excess body hair	25 (17.9)	20 (22.2)	5 (10)	0.146
PCOS	23 (16.4)	20 (22.2)	3 (6)	0.035

Table 3: Anthropometric measurements of the participants

Anthropometric measurements and body composition parameters	Group			Grade of acne				F value	P value
	With acne	Without acne	P value	1 (n=85)	2 (n=35)	3 (n=10)	4 (n=1)		
	Mean±SD	Mean±SD		Mean±SD	Mean±SD	Mean±SD	Mean±SD		
				63.06±16.8	60.54±13.3	56.20±11.0	48	0.949	0.419
BMI (kg/m²)	23.4±5.6	23.2±5.2	0.847	23.7±5.8	23.4±5.6	20.8±3.0	19	1.023	0.385
Waist circumference (cm)	79.9±31.3	80.1±13.0	0.929	80.5±13.8	79.4±12.9	78.3±10.9	65	0.546	0.651
Hip circumference (cm)	96.7±17.5	94.7±11.5	0.378	97.2±20.3	96.0±10.7	96.3±9.9	83	0.242	0.867
WHR	0.8±0.09	0.8±0.09	0.118	0.8±0.1	0.8±.0.1	0.8±0.4	0.7	0.245	0.864
WHtR	0.4±0.07	0.5±0.08	0.447	0.4±0.1	0.4±0.1	0.4±0.1	0.4	0.454	0.715
Body fat (%)	27.9±8.3	27.9±8.6	0.991	28.3±8.2	27.2±8.4	29.1±8.1	11	1.586	0.196
Visceral fat (%)	6.5±5.7	5.7±4.6	0.41	6.7±6.0	5.9±5.3	5.9±3.3	2.5	0.339	0.797
Resting metabolism rate	1342±301	1297±229	0.261	1372.8±306.5	1337.0±218.8	1104.6±428.3	1287	2.456	0.066
Body age (years)	31.5±12.1	31.0±13.1	0.763	32.6±12.5	30.5±11.8	27.8±9.2	18	1.025	0.384
Subcutaneous fat (%)									
Whole body	23.4±8.7	23.2±8.7	0.912	23.4±8.1	23.5±10.6	24.1±7.1	8	1.045	0.375
Trunk	20.1±7.9	20.1±7.9	0.993	20.3±7.6	20.0±8.7	21.0±6.5	6	1.139	0.336
Arms	36.2±13.1	36.9±13.2	0.715	35.8±12.9	35.7±14.9	40.7±11.9	14	1.311	0.274
Legs	33.4±11.7	34.2±12.9	0.673	33.3±11.5	31.4±14.1	36.9±11.0	13	1.423	0.239
Skeletal muscle (%)									
Whole body	28.3±5.2	28.3±5.4	0.974	28.3±5.2	28.4±5.4	26.8±4.4	37	1.183	0.319
Trunk	24.4±22.4	22.5±5.2	0.465	25.2±27.6	23.0±5.2	21.8±4.1	32	0.162	0.922
Arms	31.3±7.8	31.4±7.9	0.896	31.2±7.7	31.4±8.4	29.9±6.6	43	0.84	0.474
Legs	41.3±7.6	41.0±7.7	0.764	41.3±7.6	41.4±7.7	39.6±6.7	54	1.105	0.35

Table 4: Outcomes of food frequency questionnaire (number of portions).

No. of portions of food groups	Overall	Groups		P value	Grades of acne				P value
		With acne	Without acne		1 (n=85)	2 (n=35)	3 (n=10)	4 (n=1)	
	Mean±SD	Mean±SD	Mean±SD		Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Energy									
Energy dense	54.3±51.8	56.8±52.4	50.3±51.0	0.387	57.8±54.1	48.9±35.2	77.2±83.2	43.4	0.497
Carbohydrates									
Refined cereals	38.5±37.5	42.4±38.6	32.0±34.9	0.052	42.4±38.4	37.8±24.8	61.2±70.3	23.1	0.379
Whole cereals	51.7±35.8	47.4±29.6	58.8±43.5	0.025	48.7±29.1	47.2±33.9	38.8±16.5	27.1	0.693
Total cereals	90.3±51.1	89.9±51.4	90.9±51.0	0.886	91.1±51.8	85.0±41.6	100.1±78.4	50.2	0.721
Dietary fibre	36.2±27.1	33.5±25.7	40.6±28.8	0.065	36.6±26.6	29.7±25.0	22.7±15.1	9.1	0.197

Continued.

	Groups			P value	Grades of acne				P value
		With acne	Without acne		1 (n=85)	2 (n=35)	3 (n=10)	4 (n=1)	
	Mean±SD	Mean±SD	Mean±SD		Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Protein									
Pulses	15.2±15.3	12.9±10.3	19.0±20.6	0.005	12.5±8.6	15.3±14.3	9.1±5.7	7.15	0.305
Total animal protein	6.5±6.2	6.8±5.7	6.0±6.9	0.398	6.6±5.9	8.1±5.6	4.9±4.3	0	0.234
Egg	2.6±4.4	2.7±4.5	2.3±4.4	0.564	2.8±4.6	2.9±4.7	1.8±2.1	0	0.843
Fish	6.4±6.1	6.7±5.7	5.8±6.8	0.355	6.4±5.9	8.0±5.6	4.6±3.8	0	0.186
Meat/chicken	3.2±3.7	3.4±3.6	2.8±3.9	0.245	3.1±3.1	4.5±4.6	2.5±2.8	0	0.145
Milk and milk products	13.3±13.0	14.7±12.0	11.0±14.0	0.048	15.2±11.9	13.9±12.0	13.9±14.5	9.2	0.914
Fat									
Omega 3	10.6±10.8	9.2±9.1	12.9±12.9	0.014	8.6±8.5	10.1±10.46	10.4±10.5	11.5	0.434
Omega 6	53.0±43.0	46.8±32.7	63.2±54.8	0.007	47.5±32.3	48.6±36.2	36.9±23.9	23.1	0.828
Trans fat	47.0±49.0	49.8±50.4	42.4±46.4	0.297	51.0±51.4	42.0±32.3	69.9±85.3	16.5	0.087
High fat	65.1±56.4	68.2±56.8	59.9±55.9	0.302	68.9±58.4	62.4±35.7	85.0±96.7	38.1	0.412
High sugar	8.3±9.0	14.0±20.2	14.2±22.1	0.953	14.9±23.3	11.3±11.3	15.8±17.9	15.5	0.681
High sugar and high fat	21.2±30.8	22.8±30.4	18.5±31.5	0.324	23.5±30.7	18.0±19.4	35.0±52.8	7.5	0.833
Tea and coffee	11.8±13.4	12.4±15.5	10.8±8.7	0.395	11.7±15.5	15.4±17.1	7.6±8.3	21	0.433
Micronutrients									
B-carotene	37.2±23.7	31.3±33.1	37.3±24.0	0.169	8.2±9.2	13.2±27.8	24.6±48.3	0.3	0.097
Retinol	2.4±4.7	2.9±4.5	2.4±4.4	0.449	31.9±38.7	31.8±19.8	26.4±18.9	17	0.933
Vitamin D	8.4±4.0	4.1±7.5	5.1±8.5	0.368	3.0±4.6	3.1±4.7	1.8±2.1	0	0.786
Vitamin E	12.3±11.2	9.9±10.6	12.3±11.5	0.124	22.8±17.3	24.3±15.3	22.5±16.4	20.2	0.968
Vitamin C	21.3±10.0	10.7±21.0	9.8±10.1	0.697	22.8±17.3	24.3±15.3	22.5±16.4	20.2	0.968
Calcium	23.8±16.5	23.1±16.6	23.7±17.8	0.816	24.0±10.8	23.5±12.5	21.6±11.5	14	0.326
Zinc	68.5±32.9	48.7±33.7	68.1±64.3	0.005	2.3±3.5	2.5±3.4	2.3±3.57	8	0.867
Selenium	23.7±43.5	39.0±26.5	43.2±23.9	0.254	7.1±6.2	6.7±5.8	7.4 ±5.8	8	0.597
Green leafy vegetables	5.70±1.67	5.60±2.65	2.06±1.904	0.131	18.5±48.3	9.63±30.7	2.48 ±2.5	0	0.007
Roots and tubers	15.70±8.30	10.10± 8.46	13.82±15.63	0.029	6.21± 4.9	5.86±5.0	7.8±4.9	5	0.304
Other vegetables	6.80±4.85	6.23±4.923	6.70±5.192	0.515	9.95±8.9	10.57±9.6	9.80±6.1	9	0.801
Fruits	21.2±16.10	20.23±16.63	21.32±16.23	0.625	19.3±15.0	22.9±20.2	18.6±16.7	11	0.764

Table 5: Outcomes of food frequency questionnaire (number of times).

No. of times of food groups	Overall	Groups		P value	Grades of acne				P value
		With acne	Without acne		1 (n=85)	2 (n=35)	3 (n=10)	4 (n=1)	
	Mean±SD	Mean±SD	Mean±SD		Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Energy dense	26.0±19.2	27.2±18.9	24.1±19.7	0.263	26.7±18.7	25.5±17.8	36.3±25.1	28.5	0.454
Carbohydrates									
Refined cereals	17.7±11.6	19.3±11.8	15.2±10.8	0.012	18.6±12.0	19.5±10.3	23.4±15.6	26.6	0.615
Whole cereals	24.3±11.2	24.3±11.9	24.3±9.9	0.986	25.3±12.3	22.6±12.0	22.2±7.6	16	0.555
Total cereals	42.1±18.1	43.6±18.8	39.5±16.6	0.112	44.0±19.4	42.2±17.8	45.6±19.3	42.6	0.952
Dietary fibre	19.5±12.1	18.3±11.8	21.6±12.5	0.054	19.4±12.0	16.5±11.5	16.2±10.8	8.5	0.483
Protein									
Pulses	10.2±7.7	9.3±6.6	11.6±9.1	0.043	9.4±6.6	10.1±7.3	6.3±3.8	7	0.439
Total animal protein	4.4±3.6	4.7±3.5	3.9±3.7	0.121	4.5±3.5	5.6±3.5	3.7±3.0	0	0.155
Egg	1.6±2.2	1.7±2.3	1.4±2.1	0.357	1.7±2.3	1.9±2.6	1.1±1.1	0	0.679
Fish	0.7±1.2	0.7±1.1	0.7±1.3	0.92	0.7±1.2	0.8±1.0	0.8±1.2	0	0.884
Meat/chicken	2.0±2.1	2.2±2.1	1.7±2.0	0.083	2.1±1.9	2.8±2.4	1.7±1.5	0	0.16
Milk and milk products	10.8±8.9	21.3±8.4	8.5±9.3	0.003	12.6±8.7	12.0±8.2	10.6±7.9	8.5	0.856
Fat									
Omega 3	7.1±6.1	6.9±6.0	7.5±6.2	0.498	6.7±6.2	7.1±5.0	8.2±7.7	5.5	0.44
Omega 6	25.9±13.6	25.2±13.5	27.0±13.8	0.355	25.4±14.2	25.3±12.7	23.8±10.3	14.5	0.868
Trans fat	29.1±28.7	30.9±28.9	26.1±28.1	0.245	31.2±31.0	28.5±21.0	38.7±36.3	11.5	0.881
High Fat	34.3±22.5	35.6±22.3	32.2±22.8	0.289	35.2±23.2	35.3±18.0	40.2±29.9	38	0.808
High sugar	8.3±9.0	8.8±10.1	7.4±6.7	0.281	8.8±10.1	7.8±8.5	11.8±15.4	11.5	0.709
High sugar and high fat	6.0±6.0	6.3±5.9	5.5±6.3	0.311	6.1±5.9	6.8±5.5	7.4±7.3	5.5	0.927
Tea and Coffee	6.3±4.0	6.3±4.3	6.2±3.6	0.859	6.3±4.2	6.9±4.8	4.3±3.8	7	0.739
Micronutrients									
Carotene	24.8±13.5	22.6±12.1	25.8±13.9	0.08	6.5±5.2	10.0±21.0	17.9±36.8	0.5	0.121
Retinol	2.4±1.3	1.8±2.3	1.4±2.1	0.257	6.5±5.2	10.0±21.0	17.9±36.8	0.5	0.12
Vitamin D	3.5±2.2	2.5±3.5	2.3±3.3	0.713	1.8±2.3	2.1±2.7	1.1±1.1	0	0.58
Vitamin E	7.2±6.1	6.9±5.7	7.1±6.2	0.811	19.6±12.6	19.2±10.0	17.6±11.0	13	0.906
Vitamin C	15.5±8.1	8.2±15.4	7.6±9.0	0.725	49.5±31.0	50.4 41.9	37.9 24.9	22.9	0.528
Calcium	11.1±19.1	19.3±11.7	16.6±12.0	0.117	23.5±12.5	21.6±11.3	30.3±16.1	14	0.528
Zinc	30.1±14.3	27.4±14.4	30.5±14.9	0.144	5.1± 8.5	3.9±6.7	4.2±9.0	8	0.96
Selenium	24.1±10.5	22.7±11.8	24.0±10.8	0.436	12.3±11.5	9.5±10.8	10.4±9.7	14	0.98
Green leafy vegetable	15.0±1.8	4.71±15.1	1.89± 2.0	0.1	2.56±2.53	7.17±2.00	14.8±37.05	0	0.06
Roots and tubers	10.45±5.0	10.40±5.1	10.47±5.4	0.924	7.07±5.64	7.20±6.74	8.50 ±5.75	4	0.9
Other vegetables	7.1±6.5	7.19±6.1	6.80±5.6	0.394	10.26±5.38	10.69±4.47	10.60±12.50	10	0.857
Fruits	19.2±14.5	18.0±14.6	19.25±16.1	0.564	17.58±13.7	19.89±17.3	15.7±12.97	11	0.85

Table 6: Outcomes of 24-hour recall questionnaire.

Nutrients	Overall	Groups		P value	Grades of acne				F value	P value
		With acne	Without acne		1 (n=85)	2 (n=35)	3 (n=10)	4 (n=1)		
	Mean±SD	Mean±SD	Mean±SD		Mean±SD	Mean±SD	Mean±SD	Mean±SD		
Macronutrients										
Energy										
Energy (kcal)	1601±707	1509±523	1754±919	0.015	1529±529	1499±568	1381±317	1476	1.601	0.175
Energy from total CHO (%)	48.83±9.37	48.76±8.67	48.95±10.49	0.886	47.8±7.6	50.4±11.4	50.9±4.5	49	0.624	0.646
Energy from refined CHO and added sugar (%)	13.56±8.91	48.92±8.95	12.33±8.76	0.121	13.7±8.7	15.7±10.2	14.4±6.1	13.1	0.914	0. 457
Energy from complex CHO (%)	40.52±13.11	39.67±12.47	41.94±14.07	0.224	39.7±12.5	38.6±13.8	42.4±6.9	39.6	0.531	0.713
Energy from total protein (%)	15.34±4.71	15.09±4.45	15.75±5.12	0.33	15.4±4.6	14.5±4.2	14.3±2.9	10.3	0.798	0.528
Energy from total fat (%)	34.87±7.26	35.08±7.06	34.52±7.60	0.59	35.8±6.6	33.7±8.2	32.8±5.2	39.7	0.97	0.425
CHO (g)										
Total carbohydrates	196±107	184±77	216±142	0.037	183±72	190±95	175±44	180	1.134	0.341
Carbohydrates from sugar	13.2±13.2	13±14	13±11	0.852	13±16	14±8	8±6	7	0.515	0.725
Refined carbohydrates	38±37	41±40	33±32	0.165	41±44	41±33	40±24	41	0.479	0.751
Dietary fibre	20±11	19±10	22±12	0.085	21±11	15±9	20±8	14	2.695	0.032
Protein (g)										
Total protein	61.9±36.0	57.3±26.7	69.5±46.7	0.017	59±28	54±24	49±14	38	1.735	0.144
Pulses	7.6±13.6	5.7±10.0	10.9±17.7	0.007	5.3±10.2	6.5±10.9	4.9±4	8.4	1.887	0.114
Milk	5.9±4.3	5.9±4.3	6.0±4.4	0.864	5.9±4.2	6.4±4.6	4.1±4.5	5.6	0.527	0.716
Curd	0.8±1.9	0.9±2.0	0.7±1.7	0.46	1.0±2.2	0.5±1.5	0.9±1.6	0	0.572	0.683
Paneer	0.6±2.8	0.8±3.4	0.3±1.3	0.211	1.0±4.1	0±0	0.7±2.4	9.5	1.659	0.177
Cheese	0.7±2.2	0.9±2.0	0.7±1.7	0.143	0.6±1.8	1.3±3.8	1.0±1.9	0	1.194	0.315
Buttermilk	0.0±0.1	0.0±0.1	0.0±0.0	0.439	0.0±0.1	0.0±0.0	0.0±0.0	0	0.363	0.835
Lassi	0.0±0.0	0.0±0.0	0.0±0.0	0	0.0±0.0	0.0±0.0	0.0±0.0	0	0	0
Whey protein	2.3±10.0	2.0±8.1	2.9±12.6	0.5	1.8±7.9	2.9±9.8	0.0±0.0	0	0.303	0.876
Protein from milk and milk products	10.3±7.5	10.5±10.5	10.0±13.9	0.759	10.6±10.3	11.1±12.2	6.9±4.5	15.1	0.311	0.87
Egg	3.3±6.2	3.6±6.7	3.0±5.3	0.528	3.6±.7.0	3.4±6.5	3.8±5.6	0	0.191	0.943
Chicken	10.5±19.6	8.4±14.4	14.0±25.7	0.045	8.9±15.6	8.5±11.6	4.2±13.5	0	1.179	0.321
Meat	3.4±12.3	3.2±8.0	3.8±17.9	0.729	3.2±8.6	3.9±7.1	1.4±4.5	0	0.128	0.972
Fish	3.7±11.5	4.3±12.6	2.7±9.4	0.343	5.4±14.9	1.4±5.7	5.6±8.0	0	1.017	0.4
Total animal protein	21.1±29.7	19.6±22.2	23.7±39.2	0.335	21.2±25.0	17.4±16.3	15.1±13.8	0	0.504	0.733

Continued.

Nutrients	Overall	Groups		P value	Grades of acne				F value	P value
		With acne	Without acne		1 (n=85)	2 (n=35)	3 (n=10)	4 (n=1)		
	Mean±SD	Mean±SD	Mean±SD		Mean±SD	Mean±SD	Mean±SD	Mean±SD		
Fat										
Total fat (g)	60.0±22.2	57.9±20.3	63.3±24.7	0.087	60.0±21.7	54.9±18.2	50.1±12.4	65.2	1.438	0.223
Visible fat (g)	27.8±13.2	26.3±12.1	30.4±14.6	0.027	27.0±13.0	24.6±10.4	24.5±9.9	42.6	1.869	0.117
Invisible fat (g)	32.1±16.6	31.6±15.0	32.9±19.0	0.602	33.0±15.9	30.3±13.7	25.5±9.4	22.6	0.684	0.604
Omega 6 (mg)	2064±1116	1922±935	2300±1338	0.017	1901±988	2023±884	1841±654	997	1.694	0.153
A-linolenic acid (mg)	151±80	137±63	174± 99	0.001	138.9±61.0	140.2±74.8	125.8±38.1	98	2.756	0.029
Epa (mg)	13.7±42.7	16±45	9.9±36.7	0.315	20.3±53.4	3.3±15.4	25.4±45.8	0	1.407	0.233
Dha (mg)	0.3±1.2	0.2±0.6	0.4±1.7	0.306	0.2±0.7	0.2±0.6	0.2±0.4	0	0.282	0.89
Omega 6: omega 3 ratio	14.5±6.0	14.7±5.9	14.3±6.2	0.6	14.2±5.7	15.6±5.2	16.0±8.9	10.1	0.655	0.624
Calcium	560 ±275	561±344	522±279	0.388	608.5±380.3	460.2±246.8	524.0±270.0	524	1.65	0.185
Zinc	7.5±2.8	6.1±2.9	7.6±5.8	0.012	6.4±2.9	5.6±3.3	5.78±1.99	3.7	1.758	0.102
Vitamin C	107.2± 75	86.7±76.5	91.7±108.5	0.695	98.7±86.4	59.8±49.3	81.7±37.0	62.2	1.403	0.296
Vitamin B6	67.6±1.0	1.0±.56	1.1±0.68	0.253	1.05± 0.57	0.89±0.58	0.91±0.34	0.83	1.01	0.497
Folate	263±130.1	222±131	264±205	0.07	243.0±131.7	177.7±125	212.5±124.4	131	1.823	0.108
Retinol	1435±450.5	454±519	696±1437	0.081	481.2±572.5	447.6±409	291.1±388.6	74	0.65	0.476
Thiamine	0.7±0.2	0.6±0.2	0.7±0.3	0.02	0.68±0.29	0.53±0.277	0.60±0.23	0.38	0.01	0.06
Riboflavin	0.7±0.25	0.7±0.3	0.7±0.3	0.286	0.75±0.34	0.63±0.26	0.65±0.30	0.398	0.282	0.275
Niacin	10.8±4.4	8.1±4.8	10.8±10.6	0.012	8.49±4.97	7.67±4.62	6.88±4.34	4.663	0.13	0.135

DISCUSSION

Diet seems to play an important role in the development and severity of acne, a skin condition attributable to chronic inflammation. This study conducted in a group of individuals of age 18 to 40 years observed an increased consumption of inflammation inducing foods and reduced consumption of certain foods with anti-inflammatory property among acne individuals. Participants with acne seemed to more frequently consume significantly higher portions of inflammatory food such as milk products, and refined cereals compared to non-acne group (Table 4). The link between diet, especially Western diet and acne has been demonstrated in various studies.[19,20] Studies have observed a higher number of servings of high GI food and sugars in individuals with moderate to severe acne and consuming relatively lower portions for about 12-weeks of intervention had a significant reduction in acne lesions.[21,22] Frequent intake of high glycaemic index foods exposes individuals to acute hyperinsulinemia which influences keratinisation and sebaceous secretion eventually leading to comedogenesis.[23-25]

Although milk has a low GI, milk and its constituents including whey protein are majorly considered as trigger factors of acne.[23,25] Several studies conducted on teenagers and young adults demonstrated a significant association of increased and frequent consumption of milk and associated proteins with exacerbated development of acne lesions.[26] Increased consumption of carbohydrates and dairy products could exacerbate the insulin mediated IGF-1 and mTOR signalling responses.[27,28]

India is home to a wide variety of pulses and legumes, low glycaemic index foods with well-demonstrated anti-inflammatory property with beneficial effects on acne.[19,23,29-31] In alignment with this, our study found a significant difference in the consumption of the number of portions per week, number of times per week as well as the total intake of pulses. Specifically, individuals in the acne group consumed lower portions of pulses. In the present study, compared to control group without acne, individuals with acne consumed significantly lower number of portions of the sources of omega-3 fatty acids and omega-6 fatty acids (Table 4). No significant differences were observed for these parameters with different grades of severity of acne (Tables 4 and 5). Acne development was shown to be negatively associated with frequent consumption of fish.[32,33] ω-3 polyunsaturated fatty acids have anti-inflammatory properties and may suppress inflammatory cytokine production, therefore, exerting a positive effect on acne.[34] Higher omega-6 to the omega-3 ratio characterises the western diet. Epidemiological studies suggest an absence of acne among non-westernized populations consuming a traditional diet, high in omega-3 fatty acids.[35] The results of our study also showed significant differences in the consumption of the number of portions of zinc. The acne group consumed less number of portions of zinc.

Additionally, results of 24-hour dietary recall of the present study showed that the consumption of zinc, thiamine and niacin was lower in the acne-group than the non-acne group. Recent meta-analysis has demonstrated an association between low serum zinc levels and acne and suggested zinc supplementations as a treatment option for reducing the number of inflammatory papules.[36] Studies have shown a probable association between zinc, niacin and acne may be due to the anti-inflammatory action of zinc together with its effects on androgen metabolism and niacin metabolism.[8,9,37] Although we did not find a significant difference in the consumption of green leafy vegetables between acne and non-acne groups, the difference was significant among the individuals with varying severity grades of acne. Some evidence suggests that the addition of antioxidants or vegetables in diet may limit or even reverse pro-inflammatory responses.[38,39] The 24-hour recall test results indicated that acne individuals consumed lesser portion of total protein, pulses, chicken, visible fat, ω-6 fatty acid and α-linolenic acid (ω-3 fatty acid) compared to those without acne. However, contrary to the FFQ observations, 24-hour dietary recall analysis observed that participants with acne consumed significantly lesser energy, total carbohydrates. The discrepancy in the results of 24-hour dietary may be due to difficulties in recalling or bias towards a single day 24-hour recall that may not be the actual representation of the usual food intake pattern of a person.

Overall, our study findings suggest an increased consumption of inflammation triggering foods and lower consumption of foods with anti-inflammatory and antioxidant property in the acne group of individuals. The results of this study showed that consumption of refined cereals and dairy was more in acne group whereas the consumption was low for pulses, whole cereals, ω-3 fatty acids and ω-6 fatty acids. However, there is still a need for more scientific evaluation of micronutrients, their synergistic interactions, toxicity, safety and efficacy evaluation to justify and further evaluate the role of micronutrients in the treatment of acne vulgaris.

Limitation and strengths

Our study employed semi-quantitative methods and relied on the recalling ability of the participants. Additionally, since the study is conducted for a narrow period of time, it does not take into accounts the wide variations in the diet and lifestyle habits of the individuals. Despite these limitations, our observations are valid representation of association of diet and acne.

CONCLUSION

The results of our study clearly demonstrate the role of dietary habits in acne patients residing in the Indian city of Mumbai. This is one of the primitive studies to demarcate the importance of a balanced diet, especially to exercise caution and build awareness among acne

individuals to prevent exacerbation of acne. This study lends scope for conducting more elaborate studies in individuals from different regions of the country.

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