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Milk consumption and acne in teenaged boys

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Abstract

Objective—We sought to examine the association between dietary dairy intake and teenaged acne among boys.

Methods—This was a prospective cohort study. We studied 4273 boys, members of a prospective cohort study of youths and of lifestyle factors, who reported dietary intake on up to 3 food frequency questionnaires from 1996 to 1998 and teenaged acne in 1999. We computed multivariate prevalence ratios and 95% confidence intervals for acne.

Results—After adjusting for age at baseline, height, and energy intake, the multivariate prevalence ratios (95% confidence interval; *P* value for test of trend) for acne comparing highest (>2 servings/d) with lowest (<1/wk) intake categories in 1996 were 1.16 (1.01, 1.34; 0.77) for total milk, 1.10 (0.94, 1.28; 0.83) for whole/2% milk, 1.17 (0.99, 1.39; 0.08) for low-fat (1%) milk, and 1.19 (1.01, 1.40; 0.02) for skim milk.

Limitations—Not all members of the cohort responded to the questionnaire. Acne assessment was by self-report and boys whose symptoms might have been part of an underlying disorder were not excluded. We did not adjust for steroid use and other lifestyle factors that may affect occurrence of acne.

Conclusion—We found a positive association between intake of skim milk and acne. This finding suggests that skim milk contains hormonal constituents, or factors that influence endogenous hormones, in sufficient quantities to have biological effects in consumers.

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Acne remains a substantial cause of morbidity and occasional mortality among adolescents and young adults.[1] It is a common, chronic, and self-limiting skin disease that causes physical and psychologic morbidity in up to 90% of adolescents and young adults.[2] In Western countries, it affects all ages, but its maximum prevalence peaks at 16 to 18 years when 75% to 98% of this age group is affected.[2] Even though acne is more common in girls, overall and below the age of 12 years, after 15 years of age it is slightly more common in boys.[3]

Acne results from androgen-stimulated hyperkeratinization and obstruction of the pilosebaceous follicles secondary to failure of normal desquamation of the follicular epithelium; androgen-stimulated sebum production; subsequent colonization of the follicles by *Propionibacterium* acnes and *Malassezia* species; and, variably, inflammation.[4]

Previous studies have shown an association between dietary intake of milk and prevalence of teenaged acne. Ecological studies suggest an association between Western diet and acne[5] whereas Robinson[6] reported that among 1925 patients who kept a food diary, the majority implicated milk in acne flares. In a previous study of US female nurses who reported their high-school diet and prevalence of physician-diagnosed severe teenaged acne, we found a positive association with intake of total and skim milk.[7] We also found a positive association between milk consumption and prevalence of acne among a prospective cohort[8] of US girls aged 9 to 15 years at baseline in 1996. However, these associations have not been examined in boys.

In this study, we examined data from a prospective study of US boys to evaluate the association between intake of dairy foods and occurrence of acne. The study was approved by our institutional review boards.

METHODS

Study population

The Growing Up Today Study (GUTS) is an ongoing cohort study of 9039 girls and 7843 boys, aged 9 to 15 years at baseline in 1996, followed up by a yearly questionnaire to ascertain lifestyle factors. They are offspring of the women in the Nurses Health Study II cohort and have been described in detail elsewhere.[9] In this article, we examined the association between milk consumption and occurrence of acne among male members of the cohort. After exclusion of those who had implausible values (<2092 and >20,920 kJ/d) for energy intake (n = 125), those who left more than 70 response items blank (n = 38), and those who did not respond to the 1999 questionnaire that contained the acne question (n = 3570), there were 4273 boys who completed a 126-item food frequency questionnaire (FFQ) in 1996 and a 125-item FFQ in 1997 or a 116-item FFQ in 1998.

Semiquantitative FFQs and calculation of nutrient intake

The development, reproducibility, and validation of the GUTS FFQ has been previously described.[10,11] In brief, participants were asked how frequently they used a typical portion size of specified foods on average during the past year. The dairy food group included total milk, chocolate milk, instant breakfast drink, ice cream, yogurt, cottage cheese, cream cheese, other (hard) cheese, frappe (milkshake), and butter. In addition they were asked, "What type of milk do you usually drink?" and the options were whole milk, 2% milk, 1% milk, skim/nonfat milk, soy milk, don't know, and don't drink milk. Consumption of the specific types of milk was derived from the cross-classification of the responses to the usual type of milk consumed and the frequency of total milk consumption. We grouped 2% milk with whole milk as it retains most of its fat. Other food items that were studied include French fries, pizza, and chocolate candy because these have often been perceived as causes of acne. The responses for some of the food items such as nonmilk dairy foods, pizza, French fries, and chocolate candy were collapsed because of small cell sizes.

Nutrient intakes were computed by multiplying the frequency of consumption of each unit of food and the nutrient content of the specified portions based on the nutrient values in foods obtained from US Department of Agriculture sources and food manufacturers.[12] In addition, portion sizes were determined by reviewing the US Department of Agriculture Handbook No. 8 serving sizes,[13] the Nationwide Food Consumption Survey Foods Commonly Eaten by Individuals (specifically for ages 9–18 years),[14] and the natural serving sizes for foods such as a slice of bread or one apple. Nutrients were energy-adjusted by using the residuals from the regression of nutrient intake on total caloric intake.[15] Total intake of vitamins A and D were calculated from all sources, combining diet and supplements. Intake of vitamins A and D from foods was calculated from all dietary sources without supplements. Dairy fat was computed from milk, butter, and cheese as a whole food and as ingredients in other foods reported in the FFQs.

Validation of the FFQ was done in a random sample of children of 399 participants in the Nurses Health Study II, of whom 305 agreed to participate.[11] Most (263, 86%) returned the two FFQs administered at an interval of 1 year apart, and completed 3 24-hour diet recalls during the same period. The mean of deattenuated Pearson correlation coefficients between the diet recalls and the FFQ was 0.54, which is similar to findings in adults.[11] To evaluate the reproducibility of milk intake during the period of the study, we computed the Spearman correlation coefficients for intake of types of milk at baseline in 1996 and in 1998. These correlations were 0.84 for total milk, 0.67 for whole milk, 0.57 for low-fat milk, and 0.69 for skim milk. We note that reported intake can reflect both true changes in intakes and error in reporting.

Assessment of nondietary factors

Age, Tanner stage, weight, and height were obtained from the yearly mailed questionnaires.

Identification of acne cases

In 1999, members of the GUTS cohort were asked, "Compared to other people your age, how would you describe your acne?" Possible responses were: I almost never have any pimples, I sometimes get a few pimples, I usually have a few pimples, I sometimes get a lot of pimples, and I usually get a lot of pimples.

Statistical analysis

To assess the potential for selection bias, we compared the boys who responded to the questionnaire that included the item on acne with those who did not using the Wilcoxon rank sum test for continuous variables and the χ^2 test for categorical variables. Age-adjusted Mantel-Haenszel prevalence ratio (PR) was used to identify variables that were significantly associated with acne at *P* value less than or equal to .10. These were then used in multivariate stratified models to identify statistically significant predictors at a *P* value of .05 or less and those variables that changed the odds ratio of the variables of primary interest by 10% or more using the frequency procedure with the Cochran-Mantel-Haenszel option in software (SAS/STAT, SAS Institute Inc, Cary, NC).[16]

In our primary analysis, to more clearly distinguish those respondents with substantial acne from those without, we excluded those who said they had "sometimes a few" pimples and dichotomized the responses between the "almost never" and "usually a few, sometimes a lot or usually a lot" levels leaving 2780 boys for analysis. Furthermore, we tested the robustness of our findings to our method of classifying acne by repeating the analysis with all respondents but dichotomizing the response to the acne question at different levels.

Because we did not know the exact onset of acne and we desired to best simulate a prospective study, we examined the association between diet reported in 1996 and history of acne reported in 1999. We also examined the association between diet responses in 1997 and 1998 separately and the cumulative average of diet responses from 1996 to 1998 and history of acne in 1999. To further reduce the possibility of reverse causation, we repeated the analysis among youths aged 11 years and younger in 1996, an age of low acne prevalence.

In multivariate analysis, we adjusted for age in months at baseline in 1996 (quintiles), energy intake (quintiles), height (quintiles), body mass index (quintiles), and Tanner stage (1 and 2, 3, 4, and 5). The food items were modeled as categories of servings per week or per day. The PR and 95% confidence interval (CI) were calculated for each category of intake and were compared with the lowest category of intake as the reference value. The lowest category of intake for types of milk included low intakes of all types of milk. In tests for linear trend, food intake was modeled as continuous variables of servings per day.

We categorized the energy-adjusted values of each nutrient into quintiles (except for vitamin D from supplements, which was categorized into quartiles) and modeled the PR for each quintile with the lowest quintile as the reference category. In tests for linear trend across quintiles of nutrient intake, we assigned the median measured value to each category and used these values as a continuous variable. Missing value indicators were created for those with missing covariates because we had few missing data.[17,18] We present two-sided 95% CI for all PR.

RESULTS

Boys who did not respond to the 1999 questionnaire that was used to define acne were slightly older (mean age = 144 compared with 141 months) than those who did, otherwise there was no notable difference between the two groups. Most of the boys (45%) drank whole or 2% milk, 23% drank low-fat milk, 29% drank skim milk, 0.4% drank soy milk, and 3% did not drink milk at baseline in 1996. Some 79% of the boys reported sometimes a few pimples or more whereas 44% reported usually a few or more pimples. Table I shows the age-standardized prevalence of the risk factors for acne according to categories of total milk intake in the cohort. Calcium, total vitamin D, vitamin D from foods, vitamin D from supplements, and energy intake increased with increasing intake of total milk.

The prevalence of acne according to intake of total milk was 0.57 for less than 1 serving/wk, 0.69 for 2 to 6 servings/wk, 0.73 for 1 serving/d, and 0.66 for 2 or more servings/d. Table II shows the multivariate PRs (95% CI; *P* value for test of trend), adjusted for age at baseline, height, and energy intake, comparing highest (≥2 servings/d) with lowest (<1 serving/wk) categories were 1.16 (1.01, 1.34; 0.77) for total milk, 1.10 (0.94, 1.28; 0.83) for whole milk, 1.17 (0.99, 1.39; 0.08) for low-fat milk, and 1.19 (1.01, 1.40; 0.02) for skim milk. The addition of body mass index or Tanner stage to the stratified models did not appreciably alter the PRs.

Intakes of calcium, total vitamin D, vitamin D from foods, total fat, types of fat including dairy fat, total vitamin A, and vitamin A from food were not associated with acne. There was a weak positive association with intakes of vitamin D from supplements; the multivariate PR (95% CI; *P* value for test of trend), adjusted for age at baseline, height, and energy intake, comparing the highest with the lowest quintiles of intakes in 1996 were 1.08 (1.01, 1.15; 0.04). There were no associations between acne and intakes of other dairy foods, chocolate candy, French fries, or pizza (data not shown).

Sensitivity analysis

The results for 1997, 1998, and cumulative averaged intake from 1996 to 1998 were similar (data not shown). We tested the robustness of the findings to our definition of acne by repeating the multivariate analysis, first by including the “sometimes a few” as cases of acne (they were omitted entirely initially) and secondly by including them among the non-cases. The findings were similar to what we reported above (data not shown). In addition, to reduce the likelihood of reverse causation, we examined these associations in a subcohort of the participants who were aged less than 11 years at baseline–a time of relatively low acne prevalence–and the results were similar to those reported (data not shown).

DISCUSSION

In this prospective study of US boys whose ages ranged from 9 to 15 years in 1996, the most consistent factors associated with prevalence of acne were age, Tanner stage, height, and intake of skim milk. We did not find any association with total fat, dairy fat, total vitamin A, and vitamin A from foods, suggesting that neither these nutrients nor the fat component of milk is important for comedogenicity. We found a weak positive association with vitamin D from supplements.

Milk intake may influence comedogenesis because it contains androgens, 5α-reduced steroids (direct precursors of dihydrotestosterone), and other nonsteroidal growth factors that affect the pilosebaceous unit.[19–22] Many of these bioactive molecules survive processing and, in the case of cheese, fermentation results in the production of more testosterone from precursors in milk.[19] The hormones in milk are carried by the whey protein fractions.[23] These proteins, including α-lactalbumin, also have intrinsic biological functions.[23] Animals fed α-lactalbumin–enriched whey protein show increased will and capacity to engage in physical activities, gains in lean body mass, improved efficiency of exercise training, and decreased percentage body fat mass; all of which are similar to the effect of androgens.[24–26] In addition, α-lactalbumin undergoes pressure-induced conformational alteration, possibly as a result of centrifugation stresses during processing, that leads to changes in biological function.[27]

Our finding of a definite but weak association between milk intake and acne in boys contrasts markedly with our findings in girls[7,8] but nonetheless provides support for this hypothesis. Girls at this age are at a far more advanced degree of maturation than boys. The insulin-like growth factor (IGF)-I levels in girls peak at age 15 years, and in boys not until 18 years. This cohort of boys was quite immature (average height only 5 ft). They had not yet entered their IGF-I–mediated growth spurt so the findings here are considered as fair representations of the influence of their exogenous (dairy) hormones, less influenced as they are, at this young age, by their endogenous hormones. This is supported by the data on height collected in the same study–the average height of the high milk consumers was 1.2 in (3.0 cm) greater than the nondairy consumers (data not shown).

The amount of androgens in milk has generally been considered low and first-pass metabolism in the liver may further reduce their bioavailability compared with the daily endogenous production in young children and adolescents. However, recent studies have questioned the methodology and assays on which estimates of daily production rates of endogenous steroid hormones in prepubertal children are based[28] and they suggest that dietary intake may be a more significant source of androgens than previously thought.[29] Milk also contains estrogens, some of which are produced in the lactating bovine mammary gland and are direct suppressors of sebaceous gland function.[30]

Milk intake may also affect comedogenicity through the IGF-I pathway, particularly the ability of IGF-I to increase levels of circulating androgens. In two large cross-sectional studies, milk consumption was positively associated with higher plasma IGF-I levels[31,32] and in both studies, this was predominantly an association with skim milk. Recent studies have suggested that this increase in the IGF-I stimulus to acnegenesis may be mediated by a hyperinsulinemic response to the ingestion of fluid milk.[33] In a randomized clinical trial of the effect of milk intake on bone remodeling, intakes of skim and low-fat milk were associated with increased serum IGF-I levels in both sexes.[34] Another randomized clinical trial showed that the whey component of milk contains insulin secretagogues.[35] Human and bovine IGF-I share the same amino acid sequences[36] and several milk proteins, including IGF-binding proteins, protect IGF-I from digestion in the gut.[37,38] Animal studies have shown that milk-borne IGF-I can be absorbed after oral intake.[38] Although both serum androgens and IGF-I levels increase at puberty, the period of maximum prevalence of acne, the course of the condition follows the levels of IGF-I more closely than it does androgens.[30]

Recent work has demonstrated the association of acne with the ingestion of a high glycemic load diet, with improvement occurring on a change to a higher protein, lower glycemic load diet.[4] The mechanism suggested for this relationship is through the induction of increased amounts of testosterone by elevated insulin and IGF-I levels secondary to dietary influences. This reinforces the likelihood that synergism of several influences impacting on increased levels of acnegenic androgens is at the root of acnegenesis.

The active metabolite of vitamin D, 1α, 25-dihydroxyvitamin D_3, plays an important role in epidermal differentiation by inhibiting the proliferation of keratinocytes while augmenting their differentiation.[39] In studies of hamster sebaceous gland cells in vivo, vitamin D increased the accumulation of wax esters in pilosebaceous units while decreasing the amount of triglycerides. In addition, there is positive biological interaction between the metabolic effects of testosterone and vitamin D in other organ systems, although this has not yet been shown in skin.[40] Our findings suggest that vitamin D intake from supplements may have an independent role in acne among boys.

Limitations

This study has several limitations. We studied only those boys who responded to the question on acne and provided information about their diet. Although this could have introduced selection bias, we think this is unlikely because the two groups were similar with respect to the key features of teenaged acne. Our study is also limited by the self-report of acne and lack of validation of the self-report of acne in this cohort. However, young people’s perception of acne severity has been shown to be closely related to objective clinical assessment.[41] The sensitivity analysis also shows that our results are robust to different ways of classifying acne in our study population. We did not exclude youths whose acne might have been part of the symptom complex for an underlying clinical disorder, which would likely result in an underestimation of the association with milk consumption. We did not adjust for use of steroids but our results remained essentially the same when we restricted the analyses to youths younger than 11 years at baseline, with presumably low prevalence of acne or use of steroids. Our questionnaire did not specify a body location for the acne. However, truncal acne with absence of a facial component occurs in less than 5% of those with the condition.[42] The dietary assessment used has been well validated and the use of energy-adjustment corrects for over-reporting or under-reporting of overall dietary intake.[15] We used the Mantel-Haenszel estimation of PR.[43–45] This method intrinsically controls for the main effects and higher order interactions of all confounders, whether significant or not and can lead to loss of statistical power.[44]

Conclusions

In conclusion, skim milk intake was associated with the prevalence of acne in adolescent boys. Our data support the concept that this may be a result of ingested milk’s effect on acnegenic androgen levels, possibly in part because of raised testosterone resulting from a hyperinsulinemic and IGF-I–mediated stimulus and in part caused by the dihydrotestoster-one precursors present in milk, which may have biological effects in the consumer. This raises the possibility that other hormonally sensitive glands may also be affected by the hormonal constituents of milk. Because of the potential importance of this finding for acne and possibly prostate cancer, these relationships should be evaluated further.

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Abbreviations used

CI	confidence interval
FFQ	food frequency questionnaire
GUTS	Growing Up Today Study
IGF	insulin-like growth factor
PR	prevalence ratio

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Table I

Age-standardized distribution of risk factors for acne by categories of total milk intake among male Growing Up Today Study participants at baseline, 1996, United States

Servings, glasses	≤1/wk	2–6/wk	1/d	≥2/d
No.	176	517	523	1543
Mean Tanner stage	2.4	2.4	2.4	2.4
BMI, kg/m^2	19.6	19.2	19.2	18.0
Height, in	59.1	59.8	60.3	60.0
Calorie intake, kcal	1897	2005	2167	2441
Calcium, mg	819	987	1110	1589
Total vitamin D, IU	240	312	353	517
Vitamin D from foods, IU	169	239	290	453
Vitamin D from supplements, IU	58.8	64.1	62.3	63.1

Four boys did not respond to the question on milk intake.

BMI, Body mass index.

Table II

Prevalence ratio and 95% confidence intervals for acne by categories of milk intake among boys in the Growing Up Today Study cohort at baseline, 1996, United States

Servings, glasses	≤1/wk	2–6/wk	1/d	≥2/d	*P* value for test of trend
Milk types					
Total milk					
Cases/total	102/176	356/517	379/523	1019/1543	
Age-adjusted PR	1.00	1.15	1.25	1.20	.69
95% CI		1.01, 1.32	1.09, 1.44	1.04, 1.38	
Multivariate PR	1.00	1.20	1.22	1.16	.77
95% CI		1.03, 1.39	1.06, 1.41	1.01, 1.34	
Whole milk					
Cases/total	99/172	166/242	172/247	389/618	
Age adjusted PR	1.00	1.20	1.21	1.09	.91
95% CI		1.03, 1.40	1.03, 1.40	0.95, 1.26	
Multivariate PR	1.00	1.23	1.19	1.10	.83
95% CI		1.04, 1.46	1.00, 1.42	0.94, 1.28	
Low-fat milk					
Cases/total	99/172	77/110	84/123	238/360	
Age adjusted PR	1.00	1.21	1.19	1.16	.11
95% CI		1.01, 1.45	1.00, 1.42	1.00, 1.34	
Multivariate PR		1.32	1.19	1.17	.08
95% CI		1.05, 1.67	0.94, 1.51	0.99, 1.39	
Skim milk					
Cases/total	99/172	97/147	110/136	381/551	
Age adjusted PR	1.00	1.15	1.37	1.21	.01
95% CI		0.97, 1.37	1.18, 1.60	1.05, 1.39	
Multivariate PR	1.00	1.12	1.29	1.19	.02
95% CI		0.90, 1.39	1.08, 1.54	1.01, 1.40	

Multivariate PR of acne for categories of intakes adjusted for age, height, and energy intake.

CI, Confidence interval; *PR*, prevalence ratio.