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ORIGINAL ARTICLE

Acne prevalence and associations with lifestyle: a cross-sectional online survey of adolescents/young adults in 7 European countries

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Abstract

Background Although acne vulgaris is a common skin disorder, limited epidemiological data exist specifically for European populations.

Objective To determine the prevalence of self-reported acne among young people in Europe and evaluate the effect of lifestyle on acne.

Methods We conducted a cross-sectional population-based online survey in representative samples of individuals aged 15–24 years in Belgium, Czech and Slovak Republics, France, Italy, Poland and Spain (n = 10 521), identified by a quota sampling method based on age, geographic location and socio-professional category.

Results The overall adjusted prevalence of self-reported acne was 57.8% (95% confidence interval 56.9% to 58.7%). The rates per country ranged from 42.2% in Poland to 73.5% in the Czech and Slovak Republics. The prevalence of acne was highest at age 15–17 years and decreased with age. On multivariate analysis, a history of maternal or paternal acne was associated with an increased probability of having acne (odds ratio 3.077, 95% CI 2.743 to 3.451, and 2.700, 95% CI 2.391 to 3.049, respectively; both $P < 0.0001$), as was the consumption of chocolate (OR 1.276, 95% CI 1.094 to 1.488, for quartile 4 vs. quartile 1). Increasing age (OR 0.728, 95% CI 0.639 to 0.830 for age 21–24 years vs. 15–17 years) and smoking tobacco (OR 0.705, 95% CI 0.616 to 0.807) were associated with a reduced probability of acne.

Conclusion The overall prevalence of self-reported acne was high in adolescents/young adults in the European countries investigated. Heredity was the main risk factor for developing acne.

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Conflicts of interest

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Introduction

Acne vulgaris is one of the most common skin conditions. It predominantly affects adolescents and young adults[1] and can have a negative effect on their self-esteem, mood and quality of life.[2] The reported prevalence of acne among adolescents ranges from approximately 40% to 90%, depending on the study methodology and definitions used.[3–7] Although the prevalence tends to decrease with age, a substantial number of adults, particularly women, have acne.[8]

A number of risk factors for acne have been proposed, including genetic, hormonal and lifestyle factors such as diet and smoking.[1,9] With respect to lifestyle, there is evidence of an association between a Western diet, in particular high glycaemic index foods, and acne.[10–16] However, the relationship between acne and smoking remains unclear.[17–22]

Relatively few studies have specifically evaluated the effect of lifestyle factors on acne in European populations.[11,17,20,21,23,24] Surveys are useful tools to collect data easily in a large

population on a self-reported basis. The online collection of data via the Internet is a well-accepted method, especially in the young population in European countries.[25,26] The aim of this survey was to determine the prevalence of self-reported acne in young people aged 15–24 years in various European countries and evaluate factors associated with acne, particularly those related to lifestyle.

Methods

A representative sample of people aged 15–24 years living in Belgium, Czech and Slovak Republics, France, Italy, Poland and Spain were invited to complete an online questionnaire. All study participants belonged to a panel of individuals who had previously agreed to respond to online questionnaires. A polling organization, CSA Market Research Consultancy (Health Sector), conducted the specifically designed survey. CSA recruited the study sample from a database of Internet users. Individuals agreed to participate in the acne survey. A quota sampling method based on age, sex, geographical location and socio-professional category ensured accurate representation of the population of each country.

A specific survey, in native language, was adapted by CSA to be understood in the target population. The survey covered sociodemographic characteristics, lifestyle (e.g. dietary habits, use of tobacco, cannabis and alcohol), family history and the presence/absence of acne based on self-declaration by the respondent.

The overall target sample size was 10 500 participants, to include 2000 from each of France, Spain, Italy and Poland, 1000 from the Czech Republic 500 from the Slovak Republic (results were evaluated together) and 1000 from Belgium. Based on a previous study showing a 40%–60% prevalence of acne in the 15- to 24-year population,[21] a sample size of more than 500 individuals per country was considered sufficient to give an evaluation of the percentage of acne in the target population.

Statistical analysis

The prevalence rate of acne was calculated for age classes 15–17 years, 18–20 years and 21–24 years, as well as for all ages combined.

We summarized variables for the groups of participants with and without acne, using descriptive statistics, including mean ± standard deviation for quantitative variables and frequencies and percentages for qualitative variables.

We used logistic regression analysis to identify potential risk factors for acne. Variables that were associated with acne at the 10% level (Wald chi-square test) on univariate analysis were included in the multivariate analysis. The multivariate model used backward variable selection (descending order method) to identify those variables that were independently associated with acne at the 5% significance level. Odds ratios with 95% confidence interval (CI) were generated. The model was created using a training set corresponding to 70% of the population and then validated using the remaining 30% (validation set). We assessed the balance of the model using the Hosmer and Lemeshow test (for which a *P*-value above 0.05 indicates good balance), and the discriminatory power of the model using receiver operating characteristic (ROC) curve analysis. Positive and negative predictive values were calculated. We used SAS version 9.4 for analyses.

Results

Description of targeted population

A total of 10 521 surveys were completed by participants, including 2003 from France, 2006 from Spain, 2009 from Italy, 2003 from Poland, 1500 from the Czech and Slovak Republics and 1000 from Belgium. The proportion of completed/completed + screened questionnaires was: France (27%), Italy (29%), Spain (23%), Poland (45%), Belgium (44%), Czech Republic (49%) and Slovak Republic (81%). Survey withdrawal rates were 8%, 4%, 8%, 10%, 10%, 10% and 8% in France, Italy, Spain, Poland, Belgium Czech Republic and Slovak Republic, respectively. The distribution of age and sex among participants from the Czech and Slovak Republics and Belgium differed from that expected from the quota recruitment method, and consequently, the prevalence rates for these countries were adjusted by weighting the results based on the difference between the actual and anticipated frequencies for each age/sex stratum.

The sociodemographic characteristics of the study population are presented in Table 1. There were approximately equal numbers of male and female participants, and the mean age of the study population was 19.9 years. Mean BMI was 22.2 kg/m^2, and most participants (69.51%) were in the 'normal weight' BMI category. The majority reported having fair skin and frequent sunburn or light skin and occasional sunburn (combined total 71.25%).

Prevalence of acne

Among a total of 10 521 participants across all countries, 6063 reported having had or currently having acne, giving an adjusted overall prevalence of 57.8% (95% CI 56.9% to 58.7%). The prevalence rate per country ranged from 42.2% in Poland to 73.5% in the Czech and Slovak Republics (Table 2). The prevalence of acne was highest in the 15- to 17-year-old age class and decreased with increasing age (Table 3).

Variables associated with acne

Sociodemographic characteristics, family history, dietary habits, and use of tobacco and mood-altering substances are summarized for participants with and without acne in Table 1 and Tables 4–6. On univariate analysis, participants with acne were more likely to have a family history of acne (Table 4), have severe/morbid obesity (Table 1), and consume greater amounts of milk, dairy products, chocolate, sweets and ice cream (Table 6),

Table 1 Sociodemographic characteristics of participants with and without acne

Parameter	Total (*N* = 10 521)	Acne (*N* = 6063)	No acne (*N* = 4458)	Univariate analysis† Odds ratio (95% CI)	*P*-value
Age (years), mean ± SD	19.9 ± 2.8	19.6 ± 2.8	20.3 ± 2.7	0.920 (0.907 to 0.933)	<0.0001
Age class, *n* (%)					<0.0001
15–17 years	2729 (25.94)	1791 (29.54)	938 (21.04)	reference	
18–20 years	3201 (30.42)	1850 (30.51)	1351 (30.31)	0.717 (0.645 to 0.797)	
21–24 years	4591 (43.64)	2422 (39.95)	2169 (48.65)	0.585 (0.530 to 0.645)	
Sex, *n* (%)					0.1743
Male	5245 (49.85)	3057 (50.42)	2188 (49.08)	reference	
Female	5276 (50.15)	3006 (49.58)	2270 (50.92)	0.948 (0.877 to 1.024)	
Body mass index, kg/m^2, mean ± SD	22.2 ± 3.6	22.1 ± 3.7	22.3 ± 3.6	0.989 (0.979 to 1.000)	0.0497
Body mass class, *n* (%)					0.0167
Underweight	1294 (12.45)	776 (12.94)	518 (11.78)	1.102 (0.977 to 1.244)	
Normal weight	7226 (69.51)	4163 (69.41)	3063 (69.65)	reference	
Overweight	1501 (14.44)	827 (13.79)	674 (15.33)	0.903 (0.807 to 1.010)	
Moderate obesity	304 (2.92)	182 (3.03)	122 (2.77)	1.098 (0.869 to 1.387)	
Severe obesity	55 (0.53)	41 (0.68)	14 (0.32)	1.751 (1.050 to 2.922)‡	
Morbid obesity	16 (0.15)	9 (0.15)	7 (0.16)		
Country, *n* (%)					<0.001
France	2003 (19.04)	1299	704	1.209 (1.063 to 1.374)	
Spain	2006 (19.07)	1212	794	reference	
Italy	2009 (19.1)	1062	947	0.735 (0.648 to 0.833)	
Poland	2003 (19.04)	845	1158	0.478 (0.421 to 0.542)	
Czech and Slovak Republics	1500 (14.26)	1100	400	1.802 (1.558 to 2.083)	
Belgium	1000 (9.5)	545	455	0.785 (0.673 to 0.915)	

†Comparison of participants with acne vs. those without acne.
‡Severe and morbid obesity classes combined.
CI, confidence interval; reference, reference value for odds ratio; SD, standard deviation.

Table 2 Prevalence of self-reported acne by country

	France (*N* = 2003)	Spain (*N* = 2006)	Italy (*N* = 2009)	Poland (*N* = 2003)	Czech + Slovak Republics (*N* = 1500)	Belgium (*N* = 1000)	Total (*N* = 10.521)
Number with acne	1299	1212	1062	845	1100	545	6063
Adjusted prevalence, % (95% CI)†	64.9 (62.7 to 66.9)	60.4 (58.2 to 62.6)	52.9 (50.7 to 55.1)	42.2 (40.0 to 44.4)	73.5 (71.2 to 75.7)	56.1 (53.0 to 59.1)	57.8 (56.9 to 58.7)

†Prevalence rates for Belgium and the Czech Republic/Slovakia were weighted to take account of differences in the actual age and sex distribution vs. the expected distribution from the quota-based recruitment method.
CI, confidence interval.

Table 3 Prevalence of self-reported acne by age (all countries)

	15–17 years (*N* = 2729)	18–20 years (*N* = 3201)	21–24 years (*N* = 4591)	Total (*N* = 10 521)
Number with acne	1791	1850	2422	6063
Adjusted prevalence, % (95% CI)†	65.8 (64.1 to 67.5)	57.8 (56.1 to 59.6)	52.6 (51.1 to 54.1)	57.8 (56.9 to 58.7)

†Prevalence rates for Belgium and the Czech Republic/Slovakia were weighted to take account of differences in the actual age and sex distribution vs. the expected distribution from the quota-based recruitment method.
CI, confidence interval.

compared with those without acne. In addition, residents of the Czech and Slovak Republics and France appeared to have an increased likelihood of acne (Table 1). In contrast, people without acne were more likely than those with acne to be in older age classes (Table 1), use tobacco or cannabis, and consume alcohol (Table 5).

Table 4 Family history of acne in participants with and without acne

Parameter	Acne (*N* = 6063)	No acne (*N* = 4458)	Univariate analysis Odds ratio (95% CI)	*P*-value
Father has (or had) acne				<0.0001
Yes	2556 (42.16)	719 (16.13)	3.790 (3.448 to 4.167)	
No	3507 (57.84)	3739 (83.87)	reference	
Mother has (or had) acne				<0.0001
Yes	3003 (49.53)	867 (19.45)	4.065 (3.716 to 4.446)	
No	3060 (50.47)	3591 (80.55)	reference	
Father and/or mother has (or had) acne				<0.0001
Father alone	964 (15.9)	413 (9.26)	3.539 (3.115 to 4.021)	
Mother alone	1411 (23.27)	561 (12.58)	3.814 (3.408 to 4.267)	
Both parents	1592 (26.26)	306 (6.86)	7.887 (6.897 to 9.020)	
Neither parent	2096 (34.57)	3178 (71.29)	reference	
Sibling has (or had) acne				<0.0001
Yes	3872 (63.86)	1741 (39.05)	3.397 (3.108 to 3.713)	
No	1355 (22.35)	2070 (46.43)	reference	
No siblings	836 (13.79)	647 (14.51)	1.974 (1.745 to 2.233)	

CI, confidence interval; reference, reference value for odds ratio.

Table 5 Use of tobacco, cannabis and alcohol among participants with or without acne

Parameter	Acne (*N* = 6063)	No acne (*N* = 4458)	Univariate analysis Odds ratio (95% CI)	*P*-value
Tobacco smoking				<0.0001
Current smoker	1018 (16.79)	921 (20.66)	0.759 (0.686 to 0.840)	
Ex-smoker	778 (12.83)	606 (13.59)	0.882 (0.785 to 0.990)	
Never smoked	4267 (70.38)	2931 (65.75)	reference	
Number of cigarettes†per day, mean ± SD	1.5 ± 4.3	1.9 ± 4.7	0.979 (0.971 to 0.987)‡	<0.0001
Cannabis use				0.0081
≥once/month	249 (4.11)	235 (5.27)	0.757 (0.630 to 0.909)	
<once/month	248 (4.09)	201 (4.51)	0.881 (0.728 to 1.066)	
Ex-user	625 (10.31)	494 (11.08)	0.903 (0.797 to 1.024)	
Never used	4941 (81.49)	3528 (79.14)	reference	
Number of joints per month, mean ± SD	0.1 ± 0.6	0.2 ± 0.8	0.920 (0.869 to 0.974)	0.0039
Alcohol consumption				<0.0001
≥twice/week	621 (10.24)	600 (13.46)	0.663 (0.578 to 0.761)	
≤once/week	3058 (50.44)	2245 (50.36)	0.873 (0.793 to 0.961)	
Ex-drinker	803 (13.24)	600 (13.46)	0.858 (0.752 to 0.978)	
Never consumed alcohol	1581 (26.08)	1013 (22.72)	reference	
Number of glasses per week, mean ± SD	1.6 ± 2.4	1.6 ± 2.3	0.993 (0.977 to 1.009)	0.4040
Consumption in quartiles				0.0019
Quartile 1	2384 (39.32)	1613 (36.18)	reference	
Quartile 2	1603 (26.44)	1307 (29.32)	0.830 (0.753 to 0.914)	
Quartile 3	912 (15.04)	693 (15.55)	0.890 (0.792 to 1.001)	
Quartile 4	1164 (19.2)	845 (18.95)	0.932 (0.836 to 1.039)	

Data are number (%) of participants unless indicated otherwise.
†Including cigarettes, cigars, cigarillos and rolling tobacco.
‡Based on number of cigarettes per week.
CI, confidence interval; reference, reference value for odds ratio.

Table 6 Consumption of different foods by participants with or without acne

Parameter	Acne (*N* = 6063)	No acne (*N* = 4458)	Univariate analysis Odds ratio (95% CI)	*P*-value
Type of milk				<0.0001
Whole	1133 (20.14%)	940 (22.97%)	1.007 (0.855 to 1.186)†	
Semi-skimmed	3850 (68.43%)	2627 (64.18%)	1.224 (1.056 to 1.419)†	
Skimmed	556 (9.88%)	445 (10.87%)	1.044 (0.866 to 1.258)†	
Not known	87 (1.55%)	81 (1.98%)	0.897 (0.643 to 1.252)†	
Milk				0.0002
Quartile 1	1666 (27.48%)	1362 (30.55%)	reference	
Quartile 2	1648 (27.18%)	1246 (27.95%)	1.081 (0.976 to 1.198)	
Quartile 3	1253 (20.67%)	885 (19.85%)	1.157 (1.035 to 1.295)	
Quartile 4	1496 (24.67%)	965 (21.65%)	1.267 (1.138 to 1.412)	
Dairy products				0.0003
Quartile 1	1451 (23.93%)	1163 (26.09%)	reference	
Quartile 2	1502 (24.77%)	1174 (26.33%)	1.025 (0.920 to 1.143)	
Quartile 3	1716 (28.3%)	1105 (24.79%)	1.245 (1.117 to 1.387)	
Quartile 4	1394 (22.99%)	1016 (22.79%)	1.100 (0.983 to 1.230)	
Fruit juice				0.9767
Quartile 1	1264 (20.85%)	938 (21.04%)	reference	
Quartile 2	1659 (27.36%)	1227 (27.52%)	1.003 (0.897 to 1.122)	
Quartile 3	1496 (24.67%)	1101 (24.7%)	1.008 (0.899 to 1.131)	
Quartile 4	1644 (27.12%)	1192 (26.74%)	1.023 (0.914 to 1.146)	
Sweetened sodas				0.2642
Quartile 1	1628 (26.85%)	1249 (28.02%)	reference	
Quartile 2	1656 (27.31%)	1252 (28.08%)	1.015 (0.915 to 1.126)	
Quartile 3	1237 (20.4%)	874 (19.61%)	1.086 (0.969 to 1.217)	
Quartile 4	1542 (25.43%)	1083 (24.29%)	1.092 (0.981 to 1.216)	
Chocolate				<0.0001
Quartile 1	1168 (19.26%)	1036 (23.24%)	reference	
Quartile 2	1392 (22.96%)	1108 (24.85%)	1.114 (0.993 to 1.250)	
Quartile 3	1804 (29.75%)	1282 (28.76%)	1.248 (1.118 to 1.393)	
Quartile 4	1699 (28.02%)	1032 (23.15%)	1.460 (1.303 to 1.636)	
Sweets				<0.0001
Quartile 1	1623 (26.77%)	1414 (31.72%)	reference	
Quartile 2	1447 (23.87%)	1172 (26.29%)	1.076 (0.968 to 1.195)	
Quartile 3	1424 (23.49%)	992 (22.25%)	1.251 (1.123 to 1.393)	
Quartile 4	1569 (25.88%)	880 (19.74%)	1.553 (1.393 to 1.742)	
Ice cream/sorbet				0.0824
Quartile 1	1284 (21.18%)	1018 (22.84%)	reference	
Quartile 2	2098 (34.6%)	1444 (32.39%)	1.130 (1.023 to 1.248)	
Quartile 3	1245 (20.53%)	952 (21.35%)	1.107 (0.988 to 1.241)	
Quartile 4	1436 (23.68%)	1044 (23.42%)	1.102 (0.987 to 1.231)	
Pasta/rice/semolina				0.0019
Quartile 1	1742 (28.73%)	1383 (31.02%)	reference	
Quartile 2	1906 (31.44%)	1339 (30.04%)	0.830 (0.753 to 0.914)	
Quartile 3	1146 (18.9%)	822 (18.44%)	0.890 (0.792 to 1.001)	
Quartile 4	1269 (20.93%)	914 (20.5%)	0.932 (0.836 to 1.039)	

Data are number (%) of participants who consumed each type of food (per quartile). Quartile 1 = lowest; quartile 4 = highest.
†Versus participants who do not drink milk.
CI, confidence interval; reference, reference value for odds ratio.

Consequently, the following variables were entered into the multivariate model: age class, sex, body mass index (BMI) class, country, heredity (dichotomous variables for mother and father), tobacco use, cannabis use, consumption of alcohol, dairy products, chocolate, sweets, ice cream and pasta (in quartiles) and type of milk consumed. Although sex was not significantly associated with acne on univariate analysis, it was included in the multivariate analysis because it is known that there is a difference in rates between men and women.[9]

On multivariate regression analysis, only six factors were found to be independently associated with acne (Table 7). Country of residence affected the risk of having acne: taking Spain as the reference (because of its median prevalence value), the reporting of acne was significantly higher in the Czech and Slovak Republics and lower in Poland and Belgium. A history of acne in one parent was associated with a 2.7- to threefold increased risk of having acne, almost eightfold increased risk if both parents had acne (OR = 7.887 in univariate analysis). Consumption of chocolate increased the probability of having acne by up to 30%. The probability of having acne decreased with increasing age, and smoking tobacco reduced the probability of acne by approximately 30%.

Table 7 Factors independently associated with the probability of having acne: results of multivariate regression analysis

Factor	Odds ratio (95% CI)	*P*-value
Age class (reference: 15–17 years)		<0.0001
18–20 years	0.806 (0.700 to 0.928)	
21–24 years	0.728 (0.639 to 0.830)	
Country (reference: Spain)		<0.0001
France	1.153 (0.972 to 1.366)	
Italy	0.888 (0.753 to 1.047)	
Poland	0.456 (0.384 to 0.540)	
Czech and Slovak Republics	1.963 (1.620 to 2.379)	
Belgium	0.780 (0.638 to 0.953)	
Heredity (reference: No)		
Father has (or had) acne		<0.0001
Yes	2.700 (2.391 to 3.049)	
Mother has (or had) acne		<0.0001
Yes	3.077 (2.743 to 3.451)	
Tobacco smoking (reference: Never smoked)		<0.0001
Current smoker	0.705 (0.616 to 0.807)	
Ex-smoker	0.910 (0.780 to 1.062)	
Chocolate consumption (reference: Quartile 1)		0.0017
Quartile 2	1.302 (1.117 to 1.518)	
Quartile 3	1.286 (1.108 to 1.493)	
Quartile 4	1.276 (1.094 to 1.488)	

Parameters with a *P*-value of <0.1 on univariate analysis were included in multivariate analysis (descending order method). The significance level was set at $P < 0.05$ for multivariate analysis.
CI, confidence interval; reference, reference value for odds ratio.

The potential usefulness of the multivariate model as a predictive tool was assessed. The model had good balance, as indicated by a value of 11.6678 ($P = 0.1667$) for the Hosmer and Lemeshow test. The model also had good discriminatory power, as indicated by an area under the ROC curve of 0.7414 for the training set (Fig. 1). Using a cut-off limit of 0.5 to discriminate between acne prone (probability from the model for that subject >0.5) and nonacne prone (probability <0.5), 68.67% of subjects in the training set were correctly classified. The positive predictive value of the model (i.e. the probability of actually having acne if the prediction of the model is positive) was 73%, and the negative predictive value (i.e. the probability of not having acne if the prediction of the model is negative) was 63%. Results were consistent for the validation set, with an area under the ROC curve of 0.7457, a total of 69.41% of subjects correctly classified, and positive and negative predictive values of 63% and 73%, respectively.

Discussion

This unique, large, international survey, involving more than 10 000 members of the general population from seven European countries, found that more than half of young adults aged 15–24 years reported having acne. The prevalence was highest among those aged 15–17 years, with two-thirds of this age group affected, and then decreased with increasing age. Analysis of sociodemographic and lifestyle characteristics identified several factors that were independently associated with acne. A family

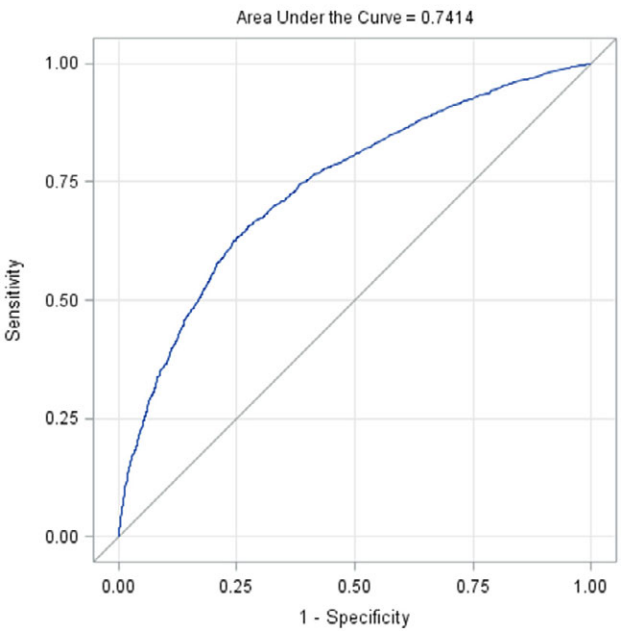

Figure 1 Receiver operating characteristic curve for the multivariate model.

history of acne in either parent, and higher levels of chocolate consumption, was associated with an increased probability of having acne. Increasing age, and tobacco smoking, were associated with a reduced likelihood of having acne. There was also evidence of geographical variation, with a greater probability of having acne in the Czech and Slovak Republics, and a lower probability in Belgium and Poland.

The overall prevalence of acne among people aged 15–24 years in the current study (57.8%) is consistent with the results of other studies of self-reported acne in adolescents and young adults, in which the prevalence ranged from 61% to 93%.[3,5,27–32] In those studies conducted in European countries, reported prevalence rates were 61% for people aged 15–24 years in France,[27] 62% for fifth-year medical students in Portugal,[28] and 83% for adolescents aged 15–18 years in Scotland.[5]

In the current study, a history of acne in a parent was associated with a marked increase in the risk of a respondent having acne, whereas increasing age was found to be associated with a lower risk. The association with family history is consistent with other studies, which have demonstrated a strong element of heritability for acne.[23,33–35] A large study of twins found that 81% of the variance of the disease could be attributed to additive genetic effects.[36] In the current study, 65% of respondents reported that one or both of their parents had (or had had) acne, which is similar to the 63% of patients with mild-to-moderate acne who had a family history of acne in a study conducted in France, Switzerland, Italy and Portugal.[37] Although acne can persist into adulthood,[8] the prevalence tends to peak in teenage years and decrease thereafter.[38,39] The inverse relationship between age and acne in the current study is consistent with this pattern.

Among the lifestyle factors investigated in the study, chocolate consumption was associated with an increased probability of having acne, whereas tobacco smoking was associated with a reduced likelihood of having acne. Previous studies have demonstrated an association between high glycaemic index foods and acne,[10,12,14] although in our study, only chocolate, and not pasta or sweets, was independently associated in multivariate analysis. Relatively few studies have reported on the relationship between chocolate and acne, and the results are conflicting. Some have found that eating chocolate can exacerbate the condition in acne prone people,[40,41] whereas, previously, others have not.[42,43] A randomized, placebo-controlled study that found that unsweetened 100% cocoa was associated with a worsening of acne also found evidence of a dose-dependent relationship between the quantity of chocolate consumed and the number of acneiform lesions that developed.[40] Analysis of data from a survey of people aged 15–24 years in France found that daily consumption of chocolate was independently associated with the presence of self-reported acne, as indicated by an odds ratio of 1.99 vs. people with no acne (95% CI 1.30 to 3.03).[21] Our data, which cover a similar age group across multiple European countries, are consistent with the finding from the French study. Chocolate consumed in daily life will contain other substances such as sugar and milk, so it is possible that this relationship is due to a combination of ingredients. Previous studies have suggested there may be an association between dairy products and acne,[10,23] in particular skimmed milk,[44–46] although randomized trials have not been performed. We found an association between increased consumption of milk and acne on univariate analysis, as well as a relationship with the type of milk (i.e. semi-skimmed); however, these associations were not significant on multivariate analysis. Similarly, consumption of sweets was not independently associated with acne in our study.

The relationship between smoking and acne is not clear. Some observational studies have found that smoking increases the prevalence of acne,[17,18,47] others have found a negative association,[19,20] and some have found no relationship.[22,23,48] A large cross-sectional study of people of any age with dermatologist-diagnosed acne found a significant correlation between being an active smoker and an increased prevalence of acne.[17] In contrast, a large cross-sectional analysis of young men with dermatologist-diagnosed acne found an inverse relationship between cigarette consumption and the prevalence of severe acne.[19] A survey study in France found that smoking more than 10 cigarettes per day was independently associated with a reduced probability of having self-reported acne (odds ratio 0.44, 95% CI 0.30 to 0.66),[21] which is consistent with the finding in our study. The French study found that regular use of cannabis was associated with an increased probability of having self-reported acne,[21] whereas we did not find an independent association between acne and cannabis use.

The results of the current study should be interpreted with an element of caution because the study gathered information on self-reported acne, rather than acne diagnosed by a physician, and may be subject to bias. However, because acne is relatively common, one can presume that false-positive or false-negative diagnoses are probably rare, thus minimizing any bias associated with self-reported information. Several other limitations should also be considered. A validated instrument covering relevant parameters for this study was not available, and therefore, a newly developed questionnaire was used. The study sample was not selected randomly and is therefore potentially subject to sampling bias. The quota sampling method used for the recruitment process ensures that the study sample is representative of the population with respect to specific criteria or strata, but does not guarantee that it is fully representative of the general population with respect to other criteria. The cross-sectional design of the study means that although associations can be identified, causality cannot be demonstrated.

Additional studies are needed to clarify the nature of the relationship between smoking and acne, although such studies would also have to be observational in nature and would therefore potentially be limited by confounding and bias issues similar to those associated with previous studies. Additional

controlled studies evaluating whether chocolate consumption is associated with the development of acne would be helpful, to enable physicians to provide appropriate advice to their patients. Work to elucidate the reasons underlying the variation in the prevalence of acne between different European countries could also be of interest.

In conclusion, the self-reported prevalence of acne is high in European adolescents and young adults. The data suggest the main risk factor for developing acne is heredity. An association between self-reported acne and chocolate consumption, and an apparent inverse relationship with smoking, need to be confirmed by additional studies. As in other exploratory survey studies, these findings should help to indicate directions for future research and should be of benefit to clinicians when counselling patients.

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Contributors

All authors had full access to all of the data (including the statistical report and tables) and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Ethical approval

Ethical approval was not needed for this survey study.

Transparency statement

The lead author (PW, the manuscript's guarantor) affirms that the manuscript is an honest, accurate and transparent account of the study being reported; and no important aspects of the study have been omitted; and that discrepancies from the study as planned have been explained.

References

1 Bhate K, Williams HC. Epidemiology of acne vulgaris. *Br J Dermatol* 2013; **168**: 474–485.
2 Dunn LK, O'Neill JL, Feldman SR. Acne in adolescents: quality of life, self-esteem, mood, and psychological disorders. *Dermatol Online J* 2011; **17**: 1.
3 Ghodsi SZ, Orawa H, Zouboulis CC. Prevalence, severity, and severity risk factors of acne in high school pupils: a community-based study. *J Invest Dermatol* 2009; **129**: 2136–2141.
4 Karciauskiene J, Valiukeviciene S, Gollnick H, Stang A. The prevalence and risk factors of adolescent acne among schoolchildren in Lithuania: across-sectional study. *J Eur Acad Dermatol Venereol* 2014; **28**: 733–740.
5 Walker N, Lewis-Jones MS. Quality of life and acne in Scottish adolescent schoolchildren: use of the Children's Dermatology Life Quality Index (CDLQI) and the Cardiff Acne Disability Index (CADI). *J Eur Acad Dermatol Venereol* 2006; **20**: 45–50.
6 Wu TQ, Mei SQ, Zhang JX *et al.* Prevalence and risk factors of facial acne vulgaris among Chinese adolescents. *Int J Adolesc Med Health* 2007; **19**: 407–412.
7 Hanisah A, Omar K, Shah SA. Prevalence of acne and its impact on the quality of life in school-aged adolescents in Malaysia. *J Prim Health Care* 2009; **1**: 20–25.
8 Poli F, Dreno B, Verschoore M. An epidemiological study of acne in female adults: results of a survey conducted in France. *J Eur Acad Dermatol Venereol* 2001; **15**: 541–545.
9 Lynn DD, Umari T, Dunnick CA, Dellavalle RP. The epidemiology of acne vulgaris in late adolescence. *Adolesc Health Med Ther* 2016; **7**: 13–25.
10 Ismail NH, Manaf ZA, Azizan NZ. High glycemic load diet, milk and ice cream consumption are related to acne vulgaris in Malaysian young adults: a case control study. *BMC Dermatol* 2012; **12**: 13.
11 Grossi E, Cazzaniga S, Crotti S, *et al.* ; GISED Acne Study Group. The constellation of dietary factors in adolescent acne: a semantic connectivity map approach. *J Eur Acad Dermatol Venereol* 2016; **30**: 96–100.
12 Aksu AE, Metintas S, Saracoglu ZN *et al.* Acne: prevalence and relationship with dietary habits in Eskisehir, Turkey. *J Eur Acad Dermatol Venereol* 2012; **26**: 1503–1509.
13 Jung JY, Yoon MY, Min SU, Hong JS, Choi YS, Suh DH. The influence of dietary patterns on acne vulgaris in Koreans. *Eur J Dermatol* 2010; **20**: 768–772.
14 Mahmood SN, Bowe WP. Diet and acne update: carbohydrates emerge as the main culprit. *J Drugs Dermatol* 2014; **13**: 428–435.
15 Smith RN, Mann NJ, Braue A, Mäkeläinen H, Varigos GA. A low-glycemic-load diet improves symptoms in acne vulgaris patients: a randomized controlled trial. *Am J Clin Nutr* 2007; **86**: 107–115.
16 Kwon HH, Yoon JY, Hong JS, Jung JY, Park MS, Suh DH. Clinical and histological effect of a low glycaemic load diet in treatment of acne vulgaris in Korean patients: a randomized, controlled trial. *Acta Derm Venereol* 2012; **92**: 241–246.
17 Schäfer T, Nienhaus A, Vieluf D, Berger J, Ring J. Epidemiology of acne in the general population: the risk of smoking. *Br J Dermatol* 2001; **145**: 100–104.
18 Chuh AA, Zawar V, Wong WC, Lee A. The association of smoking and acne in men in Hong Kong and in India: a retrospective case-control study in primary care settings. *Clin Exp Dermatol* 2004; **29**: 597–599.
19 Klaz I, Kochba I, Shohat T, Zarka S, Brenner S. Severe acne vulgaris and tobacco smoking in young men. *J Invest Dermatol* 2006; **126**: 1749–1752.
20 Rombouts S, Nijsten T, Lambert J. Cigarette smoking and acne in adolescents: results from a cross-sectional study. *J Eur Acad Dermatol Venereol* 2007; **21**: 326–333.
21 Wolkenstein P, Misery L, Amici JM *et al.* Smoking and dietary factors associated with moderate-to-severe acne in French adolescents and young adults: results of a survey using a representative sample. *Dermatology* 2015; **230**: 34–39.
22 Firooz A, Sarhangnejad R, Davoudi SM, Nassiri-Kashani M. Acne and smoking: is there a relationship? *BMC Dermatol* 2005; **5**: 2.
23 Di Landro A, Cazzaniga S, Parazzini F, *et al.* ; GISED Acne Study Group. Family history, body mass index, selected dietary factors, menstrual history, and risk of moderate to severe acne in adolescents and young adults. *J Am Acad Dermatol* 2012; **67**: 1129–1135.
24 Skroza N, Tolino E, Semyonov L *et al.* Mediterranean diet and familial dysmetabolism as factors influencing the development of acne. *Scand J Public Health* 2012; **40**: 466–474.
25 Skarupova K. Technical report: Computer-assisted and online data collection in general population surveys. European Monitoring Centre for Drugs and Drug Addiction. September 2014. http://www.emcdda.europa.eu/system/files/publications/808/Technical_report_Computer_assisted_and_online_data_collection_in_GPS_480810.pdf (last accessed 2 March 2017).
26 Flanagan SM, Greenfield S, Coad J, Neilson S. An exploration of the data collection methods utilised with children, teenagers and young people (CTYPs). *BMC Res Notes* 2015; **8**: 61.
27 Misery L, Wolkenstein P, Amici JM *et al.* Consequences of acne on stress, fatigue, sleep disorders and sexual activity: a population-based study. *Acta Derm Venereol* 2015; **95**: 485–488.

28 Gonçalves G, Amado JM, Matos ME, Massa A. The prevalence of acne among a group of Portuguese medical students. *J Eur Acad Dermatol Venereol* 2012; **26**: 514–517.
29 Purvis D, Robinson E, Watson P. Acne prevalence in secondary school students and their perceived difficulty in accessing acne treatment. *N Z Med J* 2004; **117**: U1018.
30 Cheng CE, Irwin B, Mauriello D, Liang L, Pappert A, Kimball AB. Self-reported acne severity, treatment, and belief patterns across multiple racial and ethnic groups in adolescent students. *Pediatr Dermatol* 2010; **27**: 446–452.
31 Tan HH, Tan AW, Barkham T, Yan XY, Zhu M. Community-based study of acne vulgaris in adolescents in Singapore. *Br J Dermatol* 2007; **157**: 547–551.
32 Yeung CK, Teo LH, Xiang LH, Chan HH. A community-based epidemiological study of acne vulgaris in Hong Kong adolescents. *Acta Derm Venereol* 2002; **82**: 104–107.
33 Xu SX, Wang HL, Fan X *et al.* The familial risk of acne vulgaris in Chinese Hans – a case-control study. *J Eur Acad Dermatol Venereol* 2007; **21**: 602–605.
34 Ballanger F, Baudry P, N'Guyen JM, Khammari A, Dréno B. Heredity: a prognostic factor for acne. *Dermatology* 2006; **212**: 145–149.
35 Cho EB, Ha JM, Park EJ, Kim KH, Kim KJ. Heredity of acne in Korean patients. *J Dermatol* 2014; **41**: 915–917.
36 Bataille V, Snieder H, MacGregor AJ, Sasieni P, Spector TD. The influence of genetics and environmental factors in the pathogenesis of acne: a twin study of acne in women. *J Invest Dermatol* 2002; **119**: 1317–1322.
37 Dréno B, Jean-Decoster C, Georgescu V. Profile of patients with mild-to-moderate acne in Europe: a survey. *Eur J Dermatol* 2016; **26**: 177–184.
38 Collier CN, Harper JC, Cafardi JA *et al.* The prevalence of acne in adults 20 years and older. *J Am Acad Dermatol* 2008; **58**: 56–59.
39 Perkins AC, Maglione J, Hillebrand GG, Miyamoto K, Kimball AB. Acne vulgaris in women: prevalence across the life span. *J Womens Health (Larchmt)* 2012; **21**: 223–230.
40 Caperton C, Block S, Viera M, Keri J, Berman B. Double-blind, placebo-controlled study assessing the effect of chocolate consumption in subjects with a history of acne vulgaris. *J Clin Aesthet Dermatol* 2014; **7**: 19–23.
41 Vongraviopap S, Asawanonda P. Dark chocolate exacerbates acne. *Int J Dermatol* 2016; **55**: 587–591.
42 Fulton JE Jr, Plewig G, Kligman AM. Effect of chocolate on acne vulgaris. *JAMA* 1969; **210**: 2071–2074.
43 Anderson PC. Foods as the cause of acne. *Am Fam Physician* 1971; **3**: 102–103.
44 Adebamowo CA, Spiegelman D, Berkey CS *et al.* Milk consumption and acne in teenaged boys. *J Am Acad Dermatol* 2008; **58**: 787–793.
45 LaRosa CL, Quach KA, Koons K *et al.* Consumption of dairy in teenagers with and without acne. *J Am Acad Dermatol* 2016; **75**: 318–322.
46 Adebamowo CA, Spiegelman D, Danby FW, Frazier AL, Willett WC, Holmes MD. High school dietary dairy intake and teenage acne. *J Am Acad Dermatol* 2005; **52**: 207–214.
47 Capitanio B, Sinagra JL, Ottaviani M, Bordignon V, Amantea A, Picardo M. Acne and smoking. *Dermato Endocrinol* 2009; **1**: 129–135.
48 Jemec GB, Linneberg A, Nielsen NH, Frølund L, Madsen F, Jørgensen T. Have oral contraceptives reduced the prevalence of acne? A population-based study of acne vulgaris, tobacco smoking and oral contraceptives. *Dermatology* 2002; **204**: 179–184.

