Health Science Reports

WILEY

Health Science Reports
Open Access

ORIGINAL RESEARCH OPEN ACCESS

Prevalence of Acne and Its Association With Increased Body Mass Index Among Adolescent Schoolchildren in Northern Sudan: A Cross-Sectional Study

Moteb K. Alotaibi[1] | Ishag Adam[2]

[1]Department of Dermatology, College of Medicine, Qassim University, Buraidah, Saudi Arabia | [2]Faculty of Medicine, University of Khartoum, Khartoum, Sudan

Correspondence: Ishag Adam (ishagadam@hotmail.com)

Received: 25 January 2024 | **Revised:** 28 March 2025 | **Accepted:** 2 April 2025

Funding: The authors received no specific funding for this work.

Keywords: acne | adolescent | age | associated factors | prevalence | Sudan

ABSTRACT

Background and Aims: Acne is a major health problem among adolescents. There is little published epidemiological data on the association between acne and body mass index (BMI) among adolescents, and no study has been conducted in Sudan. We aimed to assess the prevalence of acne and the possible associated factors (including body mass index [BMI]) among adolescent schoolchildren in the River Nile in Sudan.

Methods: A cross-sectional survey was conducted among adolescents (males and females) during the 3-month period (July–September 2022). A questionnaire was used to collect sociodemographic information, and their BMIs were computed from their weights and heights, which were measured using a standard procedure. Multivariate binary regression analysis was conducted.

Results: Of the 384 enrolled adolescents, 177 (46.1%) were males and 297 (53.9%) were females. The median (interquartile) of the age and BMI were 15.1 (14.0–16.3) years and 18.4 (16.4–21.5) kg/m^2, respectively. One hundred and forty adolescents (36.5%) had acne, which was mild in 109 (28.4%), moderate in 28 (7.3%), and severe in three (0.8%) adolescents. After adjusting, age (adjusted odds ratio (AOR) = 1.21, 95% confidence interval, CI = 1.04–1.41) and BMI (AOR = 1.10, 95% CI = 1.01–1.14) were positively associated with acne. Females were at a higher risk of having acne (AOR = 2.59, 95% CI = 1.64–4.08).

Conclusion: Our results showed a high prevalence of acne among Sudanese adolescents, especially females, and its prevalence increased with age and BMI.

1 | Introduction

Acne vulgaris is considered one of the main international health problems among adolescents [1, 2]. In spite of all measures, there is still a constant increase in the incidence rates of acne over the past three decades [3]. Moreover, it has been reported that the prevalence of acne varies widely in countries/populations and among different age groups and ethnicities within the same country/population [4].

Infections and immunity dysregulation are the main factors behind the pathogenesis of acne, which can lead to or are results of sebum overproduction and hyperkeratinization of the follicles [1, 5]. The observed lesions, namely papules, nodules, pustules, and cysts, are the features of the inflammatory process of acne; on the other hand, open and closed comedones present the noninflammatory process/type of acne [6]. The site of the acne lesion varies according to age, for example, the face is the affected area in adolescents, while the chest or upper back is affected at a later age [6].

Several previous studies have reported different prevalence rates of acne in different African countries [7–14]. Likewise, several factors, such as a family history of acne [15] or being female [16–18], were reported as risk factors for acne. The contribution of body mass index (BMI) as a risk factor for acne was investigated with no conclusive results. While some studies showed an increased risk of acne with increased BMI or obesity [15, 18, 19], other studies showed that being overweight and obese are inversely associated with acne [20, 21].

Unfortunately, acne is commonly considered of little clinical importance and a transient problem that would resolve spontaneously. This is not the case because acne, especially the severe form, may significantly affect adolescents' lives, especially in social and psychological-emotional domains. The acne-attributed effects among adolescents may be equal or not less than problems-detected among adolescents with chronic disabling illnesses such as asthma, arthritis, epilepsy, and diabetes mellitus [22]. Not only psychological-emotional problems but also other problems such as anxiety, depression, stress, low attachment to friends, and struggle at school were also reported among adolescents with acne [23, 24]. To the best of our knowledge, no study reports the prevalence and associated factors, including the BMI, of adolescents with acne in Sudan. However, we extrapolated it from studies on the frequency of skin diseases in different urban and rural Sudanese areas, which showed a 5% prevalence of acne, with a female predominance [25]. There were no studies with adequate sample size reporting the prevalence and clinical patterns of acne lesions and their severity in Sudanese adolescents, which led to the commencement of this study.

2 | Methods

2.1 | Study Design, Sitting, and Eligibility Criteria

A cross-sectional survey was conducted in the Almatamah locality on the River Nile in Sudan from July to September 2022. The details of the methods have been mentioned in our previous study, and part (sociodemographic) of the data sets are from the previous study [26]. In summary, the participants were Sudanese adolescents whose ages ranged between 11 and 19 years old who were studying in public primary and secondary schools [27]. Almatamah locality is about 112 km from Khartoum, the capital of Sudan. Four schools were randomly selected from villages in the Wad Hamid area of the Almatamah locality. Then, from the primary and secondary-level public school lists, adolescents were selected randomly regardless of sex. The Strengthening of the Reporting of Observational Studies in Epidemiology (STROBE) was strictly followed [28].

Following the student's parents (or guardians) signing an informed written consent form, they were interviewed using a questionnaire containing information on socio-demographics (e.g., age, sex, mother's and father's education and occupation, and family history of acne).

2.2 | Outcomes and Definition

Then, each student was examined in privacy, looking for the presence or absence of acne using the Global Acne Grading System (GAGS). This system was used to assess the severity of acne and its points depending on the site and type of lesion of the acne itself [29]. In summary, "the sites/points that included and were examined were the face, chest, and upper back and were divided into six areas: the forehead, cheeks, nose, chin, and torso (chest and upper back combined). Then, each acne lesion (comedo, papule, pustule, and nodule) was considered as having points. When there was no acne lesion in an area, a 0 score was given". Thereafter, depending on the score, the acne severity is graded as none (no acne) for 0 points; a mild form of acne was considered if the points were between 1 and 18, moderate form of the disease (acne) was considered when the score was between 19 and 30 points, severe and very severe form for acne was considered for 31–38 points and > 38 points, respectively. Adolescents with acne were asked about their age at the onset of acne.

2.2.1 | Ethical Approval and Informed Consent

This study was conducted according to the Declaration of Helsinki. The study received ethical clearance from the Faculty of Medicine, University of Khartoum, Sudan. The reference number is #9, 2021. The adolescents' parents or legal guardians signed a witnessed informed consent form. The adolescents' privacy and confidentiality were strictly followed, and personal identifiers were excluded during the analysis.

2.2.2 | Sample Size

As mentioned in our previous work [26], the sample size of 384 adolescents (both male and female) was estimated using a single proportional formula ($n = Z^2pq/d^2$). $Q = (1-p)$, $Z1-\alpha =$ confidence interval of $95\% = 1.96$, $d =$ margin of error of $5\% = 0.05$. We assumed a maximum (50%) prevalence of acne among adolescents within the range of prevalence of acne in Egypt (34.7%) [7] and Nigeria (64.4%) [19]. The maximum prevalence (50.0%) of acne was assumed because there is no data on the prevalence of acne among children in Sudan.

2.3 | Data Management and Statistical Analysis

Data were analyzed using the IBM Statistical Package for the Social Sciences (SPSS) for Windows, version 22.0 (SPSS Inc., New York, United States). Adolescents' sex and parents' education (categorized variables)were expressed as numbers and proportion/percentages and were compared using the χ^2 test. Age and BMI, which were continuous variables, were assessed for normality using the Shapiro–Wilk test. They were found to be non-normally distributed and expressed as a median and interquartile range (IQR). Univariate analysis was performed with acne as the dependent variable, while adolescents' age, sex, BMI, and parents' educational level were independent variables. Thereafter, variables with $p < 0.20$ in univariate analysis were entered to build up multivariate binary regression with backward elimination. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were calculated. A two-sided p-value of < 0.05 was considered statistically significant.

3 | Results

Three hundred and eighty-four adolescents were enrolled. The median (IQR) of adolescents was 15.1 (14.0–16.3) years, while the median (IQR) of their BMI was 18.4 (16.4 21.5) kg/m^2. Thirty-seven (9.6%), 295 (76.8%), and 52 (13.5%) adolescents were in the age group ≤ 13 years, 14–17, and > 17 years, respectively. Of the 384 adolescents, 177 (46.1%) were male and 297 (53.9%) were female. Two hundred and fifty-three (65.9%) of the adolescents' fathers had an education past the secondary level, and 238 (62.0%) of the adolescents' mothers had an education past the secondary level (Table 1). Ninety-two (24.0%) adolescents had a family history of acne.

One hundred and forty adolescents (36.5%) had acne, which was mild in 109 (28.4%), moderate in 28 (7.3%), and severe in three (0.8%) adolescents. Age and BMI were significantly higher in adolescents with acne. The prevalence of acne was significantly higher in the adolescents in the age group 14–17 (39.3%) years compared with the age group ≤ 13 years (13.5%) and > 17 years (36.5%), $p = 0.009$. The median (IQR) of the adolescents' age at the onset of acne was 14.0 years (13–15) years. A higher number of females was detected among adolescents with acne compared to adolescents without acne [98/140 (70.0%) vs. 109/244 (44.7%), $p < 0.001$]. There was no significant difference in the fathers' and mothers' education levels. In the adjusted multivariate analysis, increasing age (AOR = 1.21, 95% CI = 1.04–1.41) and BMI (AOR = 1.10, 95% CI = 1.01–1.14) were positively associated with acne. Females were at a higher risk of having acne (AOR = 2.59, 95% CI = 1.64–4.08) (Table 2).

A significantly higher number of females had severe and moderately severe acne. All three severe and 24/28 (85.7%) moderately severe acne were females. None of the males had severe acne, and 4/28 (14.3%) of the moderately severe acne were males, $p = 0.028$.

4 | Discussion

The main finding of this study was that 36.5% of the adolescents had acne. The prevalence of acne in the study was almost within the prevalence range of acne in Africa [4]. After taking a closer look at the reported prevalence in African countries, one can see that the prevalence in Sudan is higher than in these countries. The prevalence of acne in the current study is higher than the reported prevalence in Egypt (34.7%) [7], Mali (23.0%) [8], Ethiopia (19.4) [9], Tanzania (26.0%) [30], Kenya (11.2%) [10], Ghana (5%) [11], Cameroon (7.7%) [12], and Angola (23.6%) [13]. On the other hand, the prevalence of acne in our study was lower than that reported among adolescents in Ibadan, Nigeria (64.4%) [19]. Differences in sociodemographic factors among the participants, their nutritional status, genetic background, environmental factors in the different regions, and hormonal and immunological differences in the different populations could explain the difference in the prevalence of acne among African countries [31].

Most adolescents with acne have mild acne (28.4%), similar to what has been found in the literature [31]. Acne lesions during early adolescence are predominantly noninflammatory, but inflammatory lesions become more prevalent after the age of 13

TABLE 1 | Univariate analysis of the factors associated with acne among adolescent schoolchildren in Sudan, 2022.

Variable		Total (number = 384)	Adolescents with acne (number = 140)	Adolescents without acne (number = 244)	OR	95% CI	p
	Median (interquartile range)						
Age, years		15.1 (14.0–16.3)	15.3 (14.1–16.7)	15.0 (13.9–15.9)	1.33	1.15–1.53	< 0.001
Body mass index, kg/m^2		18.6 (16.6–21.4)	19.0 (17.5–21.8)	18.1 (16.0–21.3)	1.10	1.03–1.16	0.002
	Frequency (proportion)						
Sex	Male	177 (46.1)	42 (30.0)	135 (55.3)		Reference	
	Female	207 (53.9)	98 (70.0)	109 (44.7)	2.89	1.86–4.49	< 0.001
Mother's education	≥ Secondary level	241 (62.8)	85 (60.7)	153 (62.7)		Reference	
	< Secondary level	146 (38.0)	55 (39.9)	91 (37.3)	1.08	0.71–1.66	0.699
Mother's occupation	Housewife	350 (90.9)	105 (89.0)	244 (91.7)		Reference	
	Employed	34 (9.1)	13 (11.0)	22 (8.3)	1.24	0.60–2.54	0.550
Father's education	≥ Secondary level	254 (66.1)	70 (59.3)	184 (69.2)		Reference	
	< Secondary level	130 (33.9)	48 (40.7)	82 (30.8)	0.96	0.62–1.49	0. 865

TABLE 2 | Adjusted multivariate binary regression analysis of the factors associated with acne among adolescent schoolchildren in Sudan, 2022.

Variable		OR	95% CI	*p*
Median (interquartile range)				
Age, years		1.21	1.04–1.41	0.010
Body mass index, kg/m^2		1.10	1.01–1.14	0.038
Frequency (proportion)				
Sex	Male		Reference	
	Female	2.59	1.64–4.08	< 0.001

[31, 32]. This could be explained by increased sebum production under the influence of androgens and, subsequently, increased colonization with *Cutibacterium acnes* that trigger an inflammatory response [31].

Female adolescents are at a 2.59% higher risk of acne than males. This aligns with previous studies [16, 17, 33]. Recent systemic reviews of the epidemiology of acne suggest that the influence of sex is controversial due to differences in sampling methods. However, the estimated pooled odds ratio (OR) of 1.07 and the borderline of the 95% CI, which was 0.42–2.71, suggest that the male sex is only associated with a slight/borderline increase in odds of acne [15]. On the other hand, a previous study reported that males (compared with females) were at a higher risk of having severe acne [34]. Perkins et al. compared acne among females of different ethnicities and found that acne was more prevalent in African and Hispanic women compared with Indian, Caucasian, and Asian women [35]. Our study and previous studies have shown that age is positively associated with acne risk [15, 18]. Perhaps the inflammatory process becomes more prevalent by increasing the age [31, 32]. Moreover, sebum production increases with age under the influence of hormones [31].

The contribution of BMI as a risk factor for acne was investigated. The results revealed that increased BMI was positively associated with acne. In Ibadan, Nigeria, adolescents with a high BMI were at higher risk of facial acne vulgaris. However, the severity of their acne was not associated with BMI [19]. Previous studies in this regard have revealed discordant results. Rodriguez et al. found that the median BMI percentile was higher among acne cases when compared to control groups [18]. In a nationwide study, Snast et al. found that being overweight and obese were significantly associated with acne [21]. A recent systematic review estimated the pooled odds ratio of the association between BMI and acne risk. The pooled OR, 2.36, and the 95% CI of 1.97–2.83 suggest that BMI significantly influences acne presentation [15]. On the other hand, as mentioned above, other studies have shown that being overweight or obese is inversely associated with acne [20, 21]. A recent study showed that, although the prevalence of acne among teenagers did not differ significantly between different BMI groups, overweight or obese participants had inflammatory acne, and the severity of their acne was positively associated with their BMI [36]. There was no obvious explanation for the association between increasing BMI and acne; however, inflammatory and immunological factors could explain the process [37]. Several hormones and peptides, such as androgens, growth hormones, insulin, and insulin-like growth factor-1, which are essential for sebaceous gland growth and differentiation, are disturbed by obesity and can lead to the development of acne [38, 39]. Although parents' education was not associated with acne in the current study, parents' education could be a useful tool in preventing acne by preventing other factors, such as nutritional factors, that were reported to be associated with acne [19–21].

4.1 | Limitations

Due to the study's cross-sectional nature, cause and effect could not be assured. A larger longitudinal study is needed. Several hormones and peptides are associated with acne [38, 39]. However, we did not assess these peptides and hormones due to funding constraints.

5 | Conclusion

Our results showed a high prevalence of acne among Sudanese adolescents, especially females, and its prevalence increased with age and BMI.

Author Contributions

Moteb K. Alotaibi: conceptualization, data curation, formal analysis, methodology, writing – original draft, writing – review and editing. **Ishag Adam:** conceptualization, data curation, writing – original draft, writing – review and editing.

Acknowledgments

The authors would like to thank all the participants in this study. The authors received no specific funding for this work.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data sets generated and/or analyzed during this study are not publicly available (because the manuscript is still under peer review). However, they are available from the corresponding author upon reasonable request.

Transparency Statement

The lead author Ishag Adam affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

References

1. S. M. Tuchayi, E. Makrantonaki, R. Ganceviciene, C. Dessinioti, S. R. Feldman, and C. C. Zouboulis, "Acne Vulgaris," *Nature Reviews Disease Primers* 1 (2015): 15029, https://doi.org/10.1038/nrdp.2015.29.

2. C. Karimkhani, R. P. Dellavalle, L. E. Coffeng, et al., "Global Skin Disease Morbidity and Mortality: An Update From the Global Burden of Disease Study 2013," *JAMA Dermatology* 153, no. 5 (2017): 406–412, https://doi.org/10.1001/jamadermatol.2016.5538.

3. H. Chen, T. C. Zhang, X. L. Yin, J. Y. Man, X. R. Yang, and M. Lu, "Magnitude and Temporal Trend of Acne Vulgaris Burden in 204 Countries and Territories From 1990 to 2019: An Analysis From the Global Burden of Disease Study 2019," *British Journal of Dermatology* 186, no. 4 (2022): 673–683, https://doi.org/10.1111/bjd.20882.

4. J. K. L. Tan and K. Bhate, "A Global Perspective on the Epidemiology of Acne," supplement, *British Journal of Dermatology* 172, no. S1 (2015): S3–S12, https://doi.org/10.1111/bjd.13462.

5. T. X. Cong, D. Hao, X. Wen, X. H. Li, G. He, and X. Jiang, "From Pathogenesis of Acne Vulgaris to Anti-Acne Agents," *Archives of Dermatological Research* 311, no. 5 (2019): 337–349, https://doi.org/10.1007/s00403-019-01908-x.

6. L. K. Ogé, A. Broussard, and M. D. Marshall, "Acne Vulgaris: Diagnosis and Treatment," *American Family Physician* 100, no. 8 (2019): 475–484.

7. K. Tayel, M. Attia, N. Agamia, and N. Fadl, "Acne Vulgaris: Prevalence, Severity, and Impact on Quality of Life and Self-Esteem Among Egyptian Adolescents," *Journal of the Egyptian Public Health Association* 95, no. 1 (2020): 30, https://doi.org/10.1186/s42506-020-00056-9.

8. C. E. Campbell and B. I. Strassmann, "The Blemishes of Modern Society? Acne Prevalence in the Dogon of Mali," *Evolution, Medicine, and Public Health* 2016, no. 1 (2016): 325–337, https://doi.org/10.1093/emph/eow027.

9. E. A. Bogino, "Acne at Ayder Referral Hospital Among Patients Attending Dermatologic Clinic, Mekelle, Northern Ethiopia, September 2014," *Science Journal of Clinical Medicine* 3, no. 6 (2014): 129–134, https://doi.org/10.11648/j.sjcm.20140306.16.

10. S. K. Kiprono and G. Wamburu, "Acne Vulgaris in General Population of Rural Western Kenya: Cross-Sectional Community Survey," *International Journal of Dermatology* 55, no. 4 (2016): e212–e214, https://doi.org/10.1111/ijd.13105.

11. B. E. Rosenbaum, R. Klein, P. G. Hagan, et al., "Dermatology in Ghana: A Retrospective Review of Skin Disease at the Korle Bu Teaching Hospital Dermatology Clinic," *Pan African Medical Journal* 26 (2017): 125, https://doi.org/10.11604/pamj.2017.26.125.10954.

12. E. A. Kouotou, H. Adegbidi, R. Bene Belembe, et al., "Acné Au Cameroun: Qualité De vie Et Comorbidités Psychiatriques," *Annales de dermatologie et de vénéréologie* 143, no. 10 (2016): 601–606, https://doi.org/10.1016/j.annder.2016.05.011.

13. D. A. De Luca, Z. Maianski, and M. Averbukh, "A Study of Skin Disease Spectrum Occurring in Angola Phototype V–VI Population in Luanda," *International Journal of Dermatology* 57, no. 7 (2018): 849–855, https://doi.org/10.1111/ijd.13958.

14. E. Anab, A. Ogunbiyi, and A. George, "Community Based Study of the Influence of Social Class on the Prevalence and Clinical Profile of Adolescent Facial Acne Vulgaris," *Medical Journal* 24, no. 1 (2015): 17–27, https://doi.org/10.4103/NJM.NJM.

15. A. H. S. Heng and F. T. Chew, "Systematic Review of the Epidemiology of Acne Vulgaris," *Scientific Reports* 10, no. 1 (2020): 5754, https://doi.org/10.1038/s41598-020-62715-3.

16. A. M. Layton, D. Thiboutot, and J. Tan, "Reviewing the Global Burden of Acne: How Could We Improve Care to Reduce the Burden?," *British Journal of Dermatology* 184, no. 2 (2021): 219–225, https://doi.org/10.1111/bjd.19477.

17. T. Vos, A. D. Flaxman, M. Naghavi, et al., "Years Lived With Disability (YLDs) for 1160 Sequelae of 289 Diseases and Injuries 1990–2010: A Systematic Analysis for the Global Burden of Disease Study 2010," *Lancet* 380, no. 9859 (2012): 2163–2196, https://doi.org/10.1016/S0140-6736(12)61729-2.

18. K. E. Rodriguez Baisi, A. L. Weaver, H. Shakshouk, and M. M. Tollefson, "Acne Incidence in Preadolescents and Association With Increased Body Mass Index: A Population-Based Retrospective Cohort Study of 643 Cases With Age- and Sex-Matched Community Controls," *Pediatric Dermatology* 40, no. 3 (2023): 428–433.

19. E. O. Okoro, A. O. Ogunbiyi, A. O. George, and M. O. Subulade, "Association of Diet With Acne Vulgaris Among Adolescents in Ibadan, Southwest Nigeria," *International Journal of Dermatology* 55, no. 9 (2016): 982–988, https://doi.org/10.1111/ijd.13166.

20. I. Snast, A. Dalal, G. Twig, et al., "Acne and Obesity: A Nationwide Study of 600,404 Adolescents," *Journal of the American Academy of Dermatology* 81, no. 3 (2019): 723–729, https://doi.org/10.1016/J.JAAD.2019.04.009.

21. I. Snast, A. Dalal, G. Twig, et al., "Acne and Obesity: A Nationwide Study of 600,404 Adolescents," *Journal of the American Academy of Dermatology* 81, no. 3 (2019): 723–729, https://doi.org/10.1016/j.jaad.2019.04.009.

22. E. Mallon, J. N. Newton, A. Klassen, S. L. Stewart-Brown, T. J. Ryan, and A. Y. Finlay, "The Quality of Life in Acne: A Comparison With General Medical Conditions Using Generic Questionnaires," *British Journal of Dermatology* 140, no. 4 (1999): 672–676, https://doi.org/10.1046/j.1365-2133.1999.02768.x.

23. J. A. Halvorsen, R. S. Stern, F. Dalgard, M. Thoresen, E. Bjertness, and L. Lien, "Suicidal Ideation, Mental Health Problems, and Social Impairment Are Increased in Adolescents With Acne: A Population-Based Study," *Journal of Investigative Dermatology* 131, no. 2 (2011): 363–370, https://doi.org/10.1038/jid.2010.264.

24. Y. M. Almutawa, E. Bhattarai, M. AlGhareeb, and J. Zhao, "Evaluation of Psychiatric Comorbidities and Quality of Life as Well as Brain-Derived Neurotrophic Factor (BDNF) Concentrations Among Patients Suffering From Acne Vulgaris: A Systematic Review and Meta-Analysis," *Cureus* 15, no. 1 (2023): e33357, https://doi.org/10.7759/cureus.33357.

25. M. Kibar Öztürk, "Skin Diseases in Rural Nyala, Sudan (in a Rural Hospital, in 12 Orphanages, and in Two Refugee Camps)," *International Journal of Dermatology* 58, no. 11 (2019): 1341–1349, https://doi.org/10.1111/ijd.14619.

26. M. A. Ahmed, A. Al-Nafeesah, A. AlEed, and I. Adam, "Prevalence and Associated Factors of Symptoms of Pica Among Adolescent Schoolchildren in Northern Sudan: A Cross-Sectional Study," *Journal of Eating Disorders* 11, no. 1 (2023): 49, https://doi.org/10.1186/S40337-023-00777-0.

27. "5th Sudan Population and Housing Census—2008." Published 2009, https://microdata.worldbank.org/index.php/catalog/1014.

28. E. von Elm, D. G. Altman, M. Egger, S. J. Pocock, P. C. Gøtzsche, and J. P. Vandenbroucke, "The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for Reporting Observational Studies," *Journal of Clinical Epidemiology* 61, no. 4 (2008): 344–349, https://doi.org/10.1016/j.jclinepi.2007.11.008.

29. A. Doshi, A. Zaheer, and M. J. Stiller, "A Comparison of Current Acne Grading Systems and Proposal of a Novel System," *International Journal of Dermatology* 36, no. 6 (1997): 416–418, https://doi.org/10.1046/j.1365-4362.1997.00099.x.

30. F. T. Satimia, S. R. McBride, and B. Leppard, "Prevalence of Skin Disease in Rural Tanzania and Factors Influencing the Choice of Health Care, Modern or Traditional," *Archives of Dermatology* 134, no. 11 (1998): 1363–1366, https://doi.org/10.1001/archderm.134.11.1363.

31. E. Bagatin, D. L. Timpano, L. R. S. Guadanhim, et al., "Acne Vulgaris: Prevalence and Clinical Forms in Adolescents From São Paulo, Brazil," *Anais Brasileiros de Dermatologia* 89, no. 3 (2014): 428–435, https://doi.org/10.1590/abd1806-4841.20142100.

32. A. H. S. Heng, Y. H. Say, Y. Y. Sio, Y. T. Ng, and F. T. Chew, "Epidemiological Risk Factors Associated With Acne Vulgaris Presentation, Severity, and Scarring in a Singapore Chinese Population: A

Cross-Sectional Study," *Dermatology* 238, no. 2 (2022): 226–235, https://doi.org/10.1159/000516232.

33. S. K. Janani and R. Sureshkumar, "A Comprehensive Review on Acne, Its Pathogenesis, Treatment, In-Vitro and In-Vivo Models for Induction and Evaluation Methods," *International Journal of Pharmaceutical Sciences and Research* 10, no. 7 (2019): 3155–3177, https://doi.org/10.13040/IJPSR.0975-8232.10(7).3155-77.

34. Ö. Kutlu, A. S. Karadağ, and U. Wollina, "Adult Acne Versus Adolescent Acne: A Narrative Review With a Focus on Epidemiology to Treatment," *Anais Brasileiros de Dermatologia* 98, no. 1 (2023): 75–83, https://doi.org/10.1016/j.abd.2022.01.006.

35. A. C. Perkins, C. E. Cheng, G. G. Hillebrand, K. Miyamoto, and A. B. Kimball, "Comparison of the Epidemiology of Acne Vulgaris Among Caucasian, Asian, Continental Indian and African American Women," *Journal of the European Academy of Dermatology and Venereology* 25, no. 9 (2011): 1054–1060, https://doi.org/10.1111/j.1468-3083.2010.03919.x.

36. K. Sas and A. Reich, "High Body Mass Index Is a Risk Factor for Acne Severity in Adolescents: A Preliminary Report," *Acta Dermatovenerologica Croatica: ADC* 27, no. 2 (2019): 81–85.

37. I. Kurokawa, F. W. Danby, Q. Ju, et al., "New Developments in Our Understanding of Acne Pathogenesis and Treatment," *Experimental Dermatology* 18, no. 10 (2009): 821–832, https://doi.org/10.1111/J.1600-0625.2009.00890.X.

38. M. Picardo, L. F. Eichenfield, and J. Tan, "Acne and Rosacea," supplement, *Dermatology and Therapy* 7, no. S1 (2017): S43–S52, https://doi.org/10.1007/S13555-016-0168-8.

39. X. Liu, H. Y. Tang, and Z. C. Luo, "Insulin Resistance and Skin Diseases," *Zhongguo Yi Xue Ke Xue Yuan Xue Bao* 42, no. 2 (2020): 247–250, https://doi.org/10.3881/J.ISSN.1000-503X.11609.