Dermatology Practical & Conceptual

Risk Factors and Epidemiology of Acne Severity and Acne Scar Development: A Comprehensive Clinical Study

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ABSTRACT

Introduction: Acne vulgaris, affecting around 9.4% of the global population, is a common disorder of the pilosebaceous unit. Approximately 95% of affected individuals develop some degree of scarring, which, along with active acne, contributes significantly to psychosocial morbidity.

Objectives: This study aimed to evaluate the factors influencing acne severity, the development of acne scars, and the severity of scarring in patients with acne vulgaris.

Methods: A cross-sectional study was conducted between May and November 2024 at the dermatology outpatient clinic of Ordu University, Turkey. Demographic data, characteristics of acne lesions, treatment history, and various potential risk factors for acne and scarring were recorded. Acne severity and scar severity were evaluated using standardized grading systems.

Results: A total of 269 patients (175 females, 94 males) were included, with acne scars observed in 71.3%. Younger age, earlier, and adolescent-onset acne were significantly associated with greater acne severity and scarring. Male sex and severe acne further increased the risk and severity of scars. Patients with scarring reported higher emotional stress. Post-lesional hyperpigmentation and erythema predicted more severe scarring. Prior use of topical agents and systemic antibiotics was linked to increased scar risk, while systemic isotretinoin had a protective effect.

Conclusions: Early identification of risk factors and timely intervention may help reduce the burden of acne scarring and improve patients' quality of life. Recognizing predictors of acne severity and scarring can guide clinicians in implementing preventive strategies and optimizing long-term outcomes.

Introduction

Acne vulgaris is a chronic inflammatory disorder of the pilosebaceous unit characterized by the presence of comedones, papules, pustules, and cysts. Its lifetime prevalence approaches 100%, and it affects individuals globally [1,3]. With a reported prevalence of 9.4%, acne ranks as the eighth most prevalent disease worldwide [2]. It affects approximately 85% of adolescents and often persists into adulthood, particularly in females over the age of 25 [1,2].

Several factors have been implicated in acne severity, including female sex, older adolescent age, parental education, positive family history, oily skin type, and higher body mass index (BMI) [4]. The relationship between acne and dietary factors or smoking remains less clearly defined. Further studies are necessary to elucidate these associations [4].

Acne scarring occurs in up to 95% of patients with acne [5,7], although the prevalence in the general population ranges from 1% to 11% [7]. Even mild-to-moderate acne can result in clinically significant scarring [5]. Given that acne lesions commonly occur on visible areas, scarring can lead to considerable psychosocial burden. Currently, there is no universal consensus on optimal treatment modalities for acne scars [6,7], and many patients present with multiple scar types, complicating management strategies [6]. Consequently, early identification of high-risk patients is essential to implementing timely and effective interventions to prevent scarring [5].

This study aimed to evaluate the risk factors associated with acne severity, acne scar development, and acne scar severity in individuals with acne vulgaris.

Materials and Methods

Study Population, Setting, and Ethics

This cross-sectional study was conducted between May 2024 and November 2024 in the dermatology outpatient clinic of Ordu University, Ordu, Türkiye. Ethical approval was obtained from the university's Ethics Committee (Approval No: 2024/34). Sample size calculations indicated a minimum of 104 participants for a 95% confidence interval. Participants aged 18–65 years with a diagnosis of acne vulgaris who consented to participate were included. Patients with other dermatological conditions affecting acne-prone areas were excluded. Informed consent was obtained from all participants. The study adhered to the Declaration of Helsinki and the Guidelines for Good Clinical Practice. This study was reported in accordance with the STROBE guidelines (see Table S1).

Study Design

Two senior dermatologists evaluated each participant for diagnosis, classification, and severity assessment of both acne and acne scarring. Demographic and clinical data, including age, marital status, employment, disease duration, age at onset, history of adolescent acne, skin type, family history, lesion location and type, post-lesional hyperpigmentation and erythema, and scar morphology, were recorded. Scar types included icepick, rolling, and boxcar scars. Additional data included prior acne treatments, smoking/alcohol use, cosmetic usage, use of potential triggering medications, emotional stress level (0–10 Likert scale), seasonal acne variation, and dietary habits, including dairy consumption. In female patients, menstrual irregularities and clinical signs of hyperandrogenism were also documented.

Acne Severity: Global Acne Grading System (GAGS)

The Global Acne Grading System (GAGS), developed by Doshi et al. in 1997, evaluates acne severity across six anatomical regions with assigned multipliers. Lesions are graded from 0 (none) to 4 (nodules), and the region score is calculated by multiplying the lesion grade by the region multiplier. The final score classifies acne as: 1–18 (mild), 19–30 (moderate), 31–38 (severe), and >39 (very severe) [8].

Acne Scar Classification

According to Jennings et al., acne scars are categorized as atrophic, hypertrophic, keloidal, or papular. Atrophic scars are further divided into icepick, rolling, and boxcar subtypes [6].

Acne Scar Severity

A 4-point scale was used to assess scar severity: Grade 1 (macular changes), Grade 2 (mild), Grade 3 (moderate), and Grade 4 (severe) [9]. Clinical grading of acne scars was performed using the Goodman and Baron qualitative scar grading scale, a widely accepted and validated method. Two senior dermatologists calibrated their scoring before the study to ensure consistency. Blinding was not feasible as dermatologists performed direct patient examinations and collected clinical data, including acne type and lesion characteristics. The calibration and standardized assessment procedures aimed to minimize inter-rater variability and improve scoring reliability.

Assessment of Clinical Signs of Hyperandrogenism

Hyperandrogenism is a clinical condition caused by excess androgen production from the ovaries and adrenal glands or increased peripheral conversion. Its manifestations include seborrhea, acne, infertility, hirsutism, and virilization [10]. In this study, only clinical signs relevant to dermatology, such as adult female acne, hirsutism, and female pattern hair loss, were assessed, without biochemical evaluation.

Statistical Analysis

MedCalc version 20.009 (Ostend, Belgium) was used for statistical analyses. Normality of continuous variables was assessed using the Kolmogorov-Smirnov test and Q-Q plots. Mean, standard deviation (SD), median, and interquartile ranges (IQR), are reported for continuous variables; categorical data are summarized using frequency and percentage. Independent t-tests and Mann-Whitney U tests were used for group comparisons. Logistic regression analysis was performed to identify risk factors associated with acne severity and scarring. Univariable odds ratios (uORs), multivariable odds ratios (mORs), and their 95% confidence intervals (CIs) are reported. To evaluate factors associated with the presence and severity of acne scarring, a multivariable logistic regression model was applied. A p-value of <0.05 was considered statistically significant.

Power Analysis

The power (1-β) of the study was calculated using G*Power version 3.1.2 software. The test family was specified as z tests, and the statistical test used was logistic regression. The type of power analysis was set to "Post hoc; Compute achieved power—given α, sample size, and effect size." Based on previous studies, a two-tailed test was applied, with α = 0.05, H_0 = 0.59, X distribution = Binomial, and a sample size of N=269. The calculated power (1-β) value was 0.87, indicating that the study had sufficient power to detect the observed effect size.

Results

The study included 269 patients, of whom 75 (65.1%) were females and 94 (34.9%) were males. The mean age of the participants was 25 ± 6.6 years, with an average acne onset age of 19.5 ± 6.2 years. The average duration of acne was 5.7 ± 5.6 years. Stress levels were measured with a mean score of 6.2 ± 2.7, and the mean GAGS score was 23.4 ± 7.9.

Based on the GAGS score, acne severity was classified as mild in 26.4%, moderate in 59.1%, severe in 12.3%, and very severe in 2.2% of participants. Acne scarring was present in 71.3% of patients, with severity graded as Grade 1 in 23.8%, Grade 2 in 36.8%, Grade 3 in 22.8%, and Grade 4 in 16.6%. Detailed demographic information is shown in Table 1.

Risk Factors Associated with Acne Severity

Patients with severe acne were significantly younger (mean age 23 ± 5.5 vs. 25 ± 9; *P*=0.000) and had an earlier onset of acne (16.5 ± 6 vs. 19 ± 10; *P*=0.001). A history of adolescent acne increased the likelihood of severe acne, with patients having a 1.87 times higher odds of developing severe acne

Table 1. Demographic Characteristics of the Study Group.

Variables		N	%
Adolescent acne	**No**	153	56.9
	Yes	116	43.1
Skin type	**Dry**	122	45.4
	Oily	147	54.6
Family history of acne	**No**	126	46.8
	Yes	143	53.2
Family history for acne scar	**No**	198	73.6
	Yes	71	26.4
Forehead	**No**	54	20.1
	Yes	215	79.9
Cheek	**No**	19	7.1
	Yes	250	92.9
Nose	**No**	205	76.2
	Yes	64	23.8
Chin	**No**	93	34.6
	Yes	176	65.4
Submandibular area	**No**	175	65.1
	Yes	94	34.9
Back	**No**	148	55.0
	Yes	121	45.0
Chest	**No**	198	73.6
	Yes	71	26.4
Postlesional hyperpigmentation	**No**	106	39.4
	Yes	163	60.4
Erythema	**No**	65	24.2
	Yes	204	75.8
Previous treatment	**No**	100	37.2
	Topical	120	44.6
	Antibiotic (Oral)	40	14.9
	İsotretinoin(Oral)	9	3.3
Smoking	**No**	221	82.2
	Yes	48	17.8
Alcohol	**No**	258	95.9
	Yes	11	4.1
Regular use of cosmetics	**No**	96	35.7
	Yes	173	64.3
Triggering medication	**No**	226	84.0
	Yes	43	16.0
Dairy consumption	**No**	164	61.0
	Yes	105	39.0
Menstruation history	**Regular**	142	52.8
	Irregular	32	12.3
	Not applicable	94	34.9
Hyperandrogenism	**No**	154	57.2
	Yes	21	7.8
	İNot applicable	94	34.9

(odds ratio (OR)=1.87; 95% CI: 1.14–3.08; *P*=0.013). Acne lesions located on the forehead (OR=0.0001) were significantly linked with higher acne severity. Table 2 presents a detailed univariable analysis of the factors associated with acne severity. These findings emphasize the multifactorial nature of acne severity and highlight the importance of lesion localization in predicting severity.

Risk Factors Associated with Acne Scarring

Previous treatments played a significant role; patients who received topical treatments had an increased risk of scarring (OR2.02; 95% CI: 1.12–3.65; *P*=0.019), and those treated with oral antibiotics had an even higher risk (OR=4.11; 95% CI: 1.48–11.4; *P*=0.006). Conversely, oral isotretinoin was associated with a significantly reduced risk of acne scarring (OR=0.16; 95% CI: 0.03–0.85; *P*=.031), suggesting a protective effect. These findings underline the importance of appropriate treatment choices and their potential to prevent scarring. Table 3 provides a detailed univariable analysis of the clinical and demographic factors associated with the development of acne scars.

Risk Factors for Acne Scar Severity

Several factors were identified as significant predictors of acne scar severity. Patients with a history of adolescent acne had a significantly higher likelihood of severe scarring (OR2.66; 95% CI: 1.41–5.01; *P*=0.002). Additionally, involvement of specific anatomical areas such as the forehead (OR=4.46; 95% CI: 1.64–12.2; *P*=0.003), cheek (OR=7.00; 95% CI: 0.87–55.9; P=0.034), and back (=2.32; 95% CI: 1.28–4.18; P=0.005) were all strongly related to more severe scarring.

Post-inflammatory changes such as hyperpigmentation (OR = 1.88; 95% CI: 1.01–3.51; P = 0.045) and erythema (OR = 2.22; 95% CI: 1.04–4.74; P = 0.038) also contributed to increased scar severity. Nasal involvement did not significantly impact scar severity (OR = 0.302; 95% CI: 0.1–0.88; P = 0.028). Table 2 provides a detailed univariable analysis of the clinical and demographic factors associated with the severity of acne scarring.

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Risk Factors for Acne Scarring: Multivariable Analysis

A multivariable logistic regression analysis was performed to identify factors associated with acne scarring. Stress levels (OR = 1.453; P < 0.0001) and global acne severity (OR = 1.079; P = 0.033) were significant risk factors for scarring. Topical treatments (OR = 3.158; P = 0.007) and oral antibiotics (OR = 4.263; P = 0.026) increased the odds of scarring, while oral isotretinoin was protective (OR = 0.088; P = 0.037).

Postlesional hyperpigmentation (OR = 2.436; P = 0.031) was also significantly associated with scarring, but erythema did not show a significant impact (P = 0.365). Other factors such as age, sex, acne onset, and family history did not significantly affect scarring risk.

Risk Factors for Acne Scar Severity: Multivariable Analysis

A multivariable logistic regression analysis identified key factors associated with the severity of acne scarring. Higher global acne severity (OR = 1.195; P = 0.000) and postlesional hyperpigmentation (OR = 4.751; P = 0.001) were significantly linked to more severe scarring. Regular cosmetic use had a protective effect (OR = 0.413; P = 0.041). Scarring on the nose was less severe compared to other regions (OR = 0.302; P = 0.028). Other factors, such as stress, acne duration, and prior treatments, were not significantly associated

Table 4 summarizes the factors contributing to acne severity, the development of acne scarring, and the severity of acne scars. The factors associated with acne severity are derived from the univariable analysis, while those related to acne scarring and acne scar severity are based on the multivariaable analysis results.

Discussion

This study assessed the factors influencing acne severity, scar formation, and scar severity. Younger age, adolescent acne history, and earlier onset were significantly associated with more severe acne and scarring. Male sex and high acne severity emerged as risk factors for scar development and severity.

It is well established that patients with acne vulgaris experience a reduced quality of life, diminished psychological well-being, lower satisfaction with their appearance, greater social impairment, and a higher tendency toward depressive temperament. Therefore, identifying and effectively managing the factors associated with acne is crucial for the appropriate treatment of this prevalent chronic dermatological condition [11].

Several studies have examined factors affecting acne frequency and severity. A systematic review of 35 articles found that older adolescents are more frequently affected than were younger adolescents and adults [4]. Similarly, our study showed greater severity in those with adolescent-onset acne. While acne is generally more common in females—consistent with our findings—it has been reported as more severe in

Table 2. Univariable Analysis of Factors Associated with Acne Severity and Acne Scar Severity (N=269).

		GAGS (≤25) (n = 153)		GAGS>25 (n = 116)		Acne Severity			Acne scarring (Grade 1-2) (n = 117)		Acne scarring (Grade 3-4) (n = 76)		Acne Scar Severity		
		N	%	N	%	uOR	95% CI	p-value	N	%	N	%	uOR	95% CI	p-value
Sex	Female	101	66.0	74	63.8	1.00	Reference		75	64.1	40	52.6	1.00	Reference	
	Male	52	34.0	42	36.2	1.10	0.66-1.82	0.705	42	35.9	36	47.4	1.60	0.89-2.89	0.113
Adolescent acne	No	76	49.7	40	34.5	1.00	Reference		55	47.0	19	25.0	1.00	Reference	
	Yes	77	50.3	76	65.5	1.87	1.14-3.08	0.013*	62	53.0	57	75.0	2.66	1.41-5.01	0.002*
Skin type	Dry	68	44.4	54	46.6	1.00	Reference		52	44.4	34	44.7	1.00	Reference	
	Oily	85	55.6	62	53.4	0.91	0.56-1.49	0.731	65	55.6	42	55.3	0.98	0.55-1.76	0.968
Family history of acne	No	71	46.4	55	47.5	1.00	Reference		52	44.4	36	47.4	1.00	Reference	
	Yes	82	53.6	61	52.6	0.96	0.59-1.55	0.869	65	55.6	40	52.6	0.88	0.49-1.58	0.690
Family history of	No	112	73.2	86	74.1	1.00	Reference		85	72.6	56	73.7	1.00	Reference	
	Yes	41	26.8	30	25.9	0.95	0.55-1.65	0.863	32	27.4	20	26.3	0.94	0.49-1.82	0.874
Forehead	No	50	32.7	4	3.4	1.00	Reference		28	23.9	5	6.6	1.00	Reference	
	Yes	103	67.3	112	96.6	13.50	4.74-38.95	<0.0001*	89	76.1	71	93.4	4.46	1.64-12.2	0.003*
Cheek	No	18	11.8	1	0.9	1.00	Reference		10	8.5	1	1.3	1.00	Reference	
	Yes	135	88.2	115	99.1	15.33	2.01-116.6	0.000*	107	91.5	75	98.7	7.00	0.87-55.9	0.034*
Nose	No	123	80.4	82	70.7	1.00	Reference		91	77.8	58	76.3	1.00	Reference	
	Yes	30	19.6	34	29.3	1.70	0.96-2.99	0.065	26	22.2	18	23.7	1.08	0.54-2.15	0.813
Chin	No	70	45.8	23	19.8	1.00	Reference		39	33.3	15	19.7	1.00	Reference	
	Yes	83	54.2	93	80.2	3.41	1.95-5.94	<0.0001*	78	66.7	61	80.3	2.03	1.02-4.02	0.041*
Submandibular area	No	109	71.2	66	56.9	1.00	Reference		81	69.2	40	52.6	1.00	Reference	
	Yes	44	28.8	50	43.1	1.87	1.13-3.11	0.014*	36	30.8	36	47.4	2.02	1.11-3.68	0.020*
Back	No	113	73.9	35	30.2	1.00	Reference		72	61.5	31	40.8	1.00	Reference	
	Yes	40	26.1	81	69.8	6.53	3.82-11.17	<0.0001*	45	38.5	45	59.2	2.32	1.28-4.18	0.005*
Chest	No	133	86.9	65	56.0	1.00	Reference		92	78.6	46	60.5	1.00	Reference	
	Yes	20	13.1	51	44.0	5.21	2.87-9.47	<0.0001*	25	21.4	30	39.5	2.40	1.26-4.54	0.007*
Postlesional hyperpigmentation	No	64	41.8	42	36.2	1.00	Reference		49	41.9	21	27.6	1.00	Reference	
	Yes	89	58.2	74	63.8	1.26	0.77-2.08	0.350	68	58.1	55	72.4	1.88	1.01-3.51	0.045*

Table 2 continues

Table 2. Univariable Analysis of Factors Associated with Acne Severity and Acne Scar Severity (N=269). *(continued)*

		GAGS (≤25) (n = 153)		GAGS>25 (n = 116)		Acne Severity			Acne scarring (Grade 1-2) (n = 117)		Acne scarring (Grade 3-4) (n = 76)		Acne Scar Severity		
		N	%	N	%	uOR	95% CI	p-value	N	%	N	%	uOR	95% CI	p-value
Erythema	No	41	26.8	24	20.7	1.00	Reference		32	27.4	11	14.5	1.00	Reference	
	Yes	112	73.2	92	79.3	1.40	0.79-2.49	0.247	85	72.6	65	85.5	2.22	1.04-4.74	0.038*
Smoking	No	122	79.7	99	85.3	1.00	Reference		92	78.6	63	82.9	1.00	Reference	
	Yes	31	20.3	17	14.7	0.67	0.35-1.29	0.235	25	21.4	13	17.1	0.75	0.36-1.59	0.467
Alcohol	No	148	96.7	110	94.8	1.00	Reference		112	95.7	74	97.4	1.00	Reference	
	Yes	5	3.3	6	5.2	1.61	0.48-5.42	0.435	5	4.3	2	2.6	0.60	0.11-3.20	0.554
Regular use of cosmetics	No	58	37.9	38	32.8	1.00	Reference		40	34.2	33	43.4	1.00	Reference	
	Yes	95	62.1	78	67.2	1.25	0.75-2.08	0.383	77	65.8	43	56.6	0.67	0.37-1.22	0.197
Triggering medication	No	132	86.3	94	81.0	1.00	Reference		100	85.5	64	84.2	1.00	Reference	
	Yes	21	13.7	22	19.0	1.47	0.76-2.82	0.247	17	14.5	12	15.8	1.10	0.49-2.46	0.810
Dairy	No	95	62.1	69	59.5	1.00	Reference		73	62.4	46	60.5	1.00	Reference	
	Yes	58	37.9	47	40.5	1.11	0.68-1.82	0.664	44	37.6	30	39.5	1.08	0.59-1.95	0.794

*Significant difference at <0.05 level according to logistic regression. uOR: univariable odds ratio. CI: confidence interval.

Table 3. Clinical Characteristics and Univariable Analysis of Factors Associated with Acne Scar.

Variables		acne scarring (+) (N=193)		acne scar (-) (N=76)		p-value		
		N	%	N	%	OR	95% CI	p-Value
Gender	Female	115	59.6	60	78.9	1.00	Reference	
	Male	78	40.4	16	21.1	2.54	1.36-4.73	0.003**
Adolescent acne	No	74	38.3	42	55.3	1.00	Reference	
	Yes	119	61.7	34	44.7	1.98	1.16-3.39	0.012**
Skin type	Dry	86	44.6	36	47.4	1.00	Reference	
	Oily	107	55.4	40	52.6	1.12	0.65-1.90	0.677
Family history of acne	No	88	45.6	38	50.0	1.00	Reference	
	Yes	105	54.4	38	50.0	1.19	0.70-2.03	0.515
Family history of acne scar	No	141	73.1	57	75.0	1.00	Reference	
	Yes	52	26.9	19	25.0	1.10	0.60-2.03	0.745
Forehead	No	33	17.1	21	27.6	1.00	Reference	
	Yes	160	82.9	55	72.4	1.85	0.98-3.46	0.054
Cheek	No	11	5.7	8	10.5	1.00	Reference	
	Yes	182	94.3	68	89.5	1.94	0.75-5.04	0.170
Nose	No	149	77.2	56	73.7	1.00	Reference	
	Yes	44	22.8	20	26.3	0.82	0.44-1.52	0.542
Chin	No	54	28.0	39	51.3	1.00	Reference	
	Yes	139	72.0	37	48.7	2.71	1.56-4.69	0.000**
Submandibular area	No	121	62.7	54	71.1	1.00	Reference	
	Yes	72	37.3	22	28.9	1.46	0.82-2.59	0.196
Back	No	103	53.4	45	59.2	1.00	Reference	
	Yes	90	46.6	31	40.8	1.26	0.74-2.17	0.386
Chest	No	138	71.5	60	78.9	1.00	Reference	
	Yes	55	28.5	16	21.1	1.49	0.79-2.81	0.214
Postlesional hyperpigmentation	No	70	36.3	36	47.4	1.00	Reference	
	Yes	123	63.7	40	52.6	1.58	0.92-2.71	0.094
Erythema	No	43	22.3	22	28.9	1.00	Reference	
	Yes	150	77.7	54	71.1	1.42	0.78-2.59	0.251
Previous treatment	No	63	32.6	37	48.7	1.00	Reference	
	Topical	93	48.2	27	35.5	2.02	1.12-3.65	0.019**
	Antibiotic (Oral)	35	18.1	5	6.6	4.11	1.48-11.4	0.006**
	İsotretinoin (Oral)	2	1.0	7	9.2	0.16	0.03-0.85	0.031**
Smoking	No	155	80.3	66	86.8	1.00	Reference	
	Yes	38	19.7	10	13.2	1.61	0.76-3.43	0.210
Alcohol	No	186	96.4	72	94.7	1.00	Reference	
	Yes	7	3.6	4	5.3	0.67	0.19-2.38	0.544
Regular use of cosmetics	No	73	37.8	23	30.3	1.00	Reference	
	Yes	120	62.2	53	69.7	0.71	0.40-1.26	0.245
Triggering medication	No	164	85.0	62	81.6	1.00	Reference	
	Yes	29	15.0	14	18.4	0.78	0.38-1.57	0.494
Dairy consumption	No	119	61.7	45	59.2	1.00	Reference	
	Yes	74	38.3	31	40.8	0.90	0.52-1.55	0.711

*Significant difference at <0.05 level according to logistic regression. uOR: Univariable dds ratio. CI: confidence interval.

Table 4. Summary of Factors Affecting Acne Severity, Scarring, and Scar Severity.

Factor	Associated with	Effect	uOr/ mOR	p-value	Comment
Younger age	Acne severity ↑ Acne Scar ↑	Increased risk	—	0.000/ 0.001	Severe acne is more common in younger individuals
Earlier acne onset	Acne severity ↑ Acne Scar	Increased risk	—	0.001/ 0.003	Early onset is linked to higher severity
History of adolescent acne	Acne Severity ↑ Acne Scar ↑	Increased risk	1.87 / 1.98	0.013 / 0.012	Increases both severity and scarring risk
Stress levels	Acne Scar ↑	Increased risk	1.453	< 0.0001	Strong predictor of scarring
Global acne severity (GAGS)	Acne Scar ↑ / Scar severity ↑	Increased risk	1.079 / 1.195	0.033 / 0.000	Both scar presence and severity increase with acne severity
Postlesional hyperpigmentation	Acne Scar ↑ / Scar severity ↑	Increased risk	2.436 / 4.751	0.031 / 0.001	Strongest marker for scar risk and severity
Topical treatment	Acne Scar ↑	Increased risk	3.158	0.007	May indicate insufficient control in moderate/severe cases
Oral antibiotic	Acne Scar ↑	Increased risk	4.263	0.026	Linked to delayed or inadequate treatment
Oral isotretinoin	Acne Scar ↓	Protective	0.088	0.037	Strongly protective against scarring
Regular cosmetic use	Scar severity ↓	Protective	0.413	0.041	May reduce scar severity
Nasal acne	Scar severity ↓	Less severe	0.302	0.028	Scars on the nose tend to be milder

Significant difference at <0.05 level according to logistic regression., Unadjusted odds ratios (uOR) are reported for acne severity, while adjusted odds ratios (mOR) are reported for acne scarring and acne scarring risk

males [4, 11]; however, we found no sex-based difference in severity. Although a positive family history has been linked to both acne risk and severity in some studies [12–15], others reported no such association [4]. In our study, family history was not related to acne severity or scarring.

Previous studies have associated oily and mixed skin types with increased acne severity [4]; however, in our study, skin type was not linked to acne severity or scarring. Although hormonal factors are known to influence acne in females, Heng et al. reported in a systematic review no association between menstrual history and severe acne [4]. Similarly, we found no relationship between acne severity, scarring, and menstrual irregularity or hyperandrogenism.

Dietary factors, particularly milk consumption, remain a debated topic. While milk has been frequently implicated in acne pathogenesis due to its hormonal and IGF-1 content [10,14,15], some studies have reported protective effects [4,11] A systematic review found this association primarily in Western populations [3], and some studies have linked milk intake to the presence of acne and the severity of acne scars [12,13]. In contrast, our study did not identify any association between milk consumption and acne severity or scarring.

Studies on smoking and alcohol have shown inconsistent results regarding their effects on acne and scarring. While some linked living with a smoker or alcohol use to greater acne severity, others found no association [4,12,13]. In line with Yan et al. [16], our study found no relationship between smoking or alcohol intake and acne severity or scarring.

In our study, 71.3% of patients had acne scarring, consistent with Yan et al.'s finding of 61.3%, and most of the scars were mild, similar to previous reports [5,13,14,16]. Studies have identified male sex, younger age, family or sibling history, and behaviors like squeezing as risk factors for scarring [13,14,16]. While milk consumption appeared protective, butter intake was linked to more severe scars, and smoking showed no clear association [13,14]. In our study, acne scars were more severe in males and in those with earlier acne onset and younger age, consistent with previous findings [5,13–15]. Unlike some reports [13,14,16], we found no link

between family history and scar severity. Scar severity correlated with acne severity [5,15], but showed no association with cosmetic use, medications, acne duration, or stress.

In our study, topical and systemic antibiotic treatments were associated with an increased risk of acne scarring, consistent with Yan et al. [15], while systemic isotretinoin reduced this risk. Previous research supports early low-dose oral isotretinoin as effective for managing and preventing acne scars [17,18]. We also identified postlesional hyperpigmentation and erythema as risk factors for scar severity. Acne scars can significantly impact mental well-being, increasing risks of depression, suicide, and reduced quality of life [6]. Emotional stress was more prevalent among patients with acne scars, underscoring the psychosocial burden of this condition. These findings reinforce the importance of early, aggressive acne management.

Limitations of the Study

This study has several limitations that should be acknowledged. First, the cross-sectional design precludes the establishment of causal relationships. Additionally, there is a potential for recall bias, as participants may not have accurately remembered or reported relevant information, including family history of acne or scarring, cosmetic use, dairy consumption, and the use of acne-triggering medications. Specifically, the consumption of milk and dairy products was assessed through self-reported frequency-based measures, which may introduce reporting bias and represent a limitation of the study. This limitation may have influenced the strength or direction of the associations observed and should be taken into account when interpreting the results. Furthermore, as the study was conducted in a tertiary care setting, the findings may not be generalizable to the broader population. This setting also introduces the possibility of selection bias, as patients with more severe acne and scarring may have been overrepresented. While the sample size was adequate for the study's aims, future research with larger and more diverse populations would help strengthen the generalizability of the findings.

A notable strength of this study is that all participants were evaluated in person by experienced dermatologists, rather than participants' providing self-reported data, thereby enhancing the accuracy and reliability of clinical assessments.

Conclusion

This study demonstrates that acne severity and scarring are influenced by multiple factors, including age, age at onset, stress levels, lesion location, and treatment history. Younger patients with earlier acne onset and higher stress levels were more likely to experience severe acne and scarring. Topical treatments and oral antibiotics increased scarring risk, while oral isotretinoin had a protective effect. Post-inflammatory hyperpigmentation was a key factor in scar severity. These findings underline the importance of early, appropriate treatment and highlight the role of both physical and psychological factors in acne management.

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