

Serum Ghrelin Levels and Their Association With Demographic and Clinical Characteristics Among Patients With Moderate Acne Vulgaris: An Analytical Cross-Sectional Study

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Abstract

Background: Acne vulgaris is a chronic inflammatory disorder of the pilosebaceous unit, and serum ghrelin may have a potential role in its metabolic and inflammatory pathways.

Objective: To assess serum ghrelin levels among patients with moderate acne vulgaris and to evaluate their association with demographic and clinical characteristics.

Methods: This single-centre, hospital-based, analytical cross-sectional study was conducted in the Sree Balaji Medical College & Hospital, Chennai, Tamil Nadu, from June 2024 to April 2026. A total of 55 consenting patients with moderate acne vulgaris, graded using GAGS, were enrolled; demographic, anthropometric, and clinical acne-related data were recorded, and fasting morning serum ghrelin levels were estimated using a Human GHRL ELISA kit.

Results: The study included 55 acne cases with a mean age of 23.0 ± 3.7 years; most participants were aged 20–25 years (60.0%) and females were slightly predominant (52.7%). The mean BMI was 23.3 ± 2.9 kg/m², and 41.8% had acne for more than 12 months. Face with trunk involvement was observed in 70.9%, and the right cheek (100.0%), left cheek (98.2%), and forehead (94.5%) were commonly affected. Comedones and papules were present in all cases, while pustules occurred in 96.4%. The mean serum ghrelin level was 2758.0 ± 959.6 pg/mL. Ghrelin levels differed significantly by residence, being higher in urban participants (3186.8 ± 958.3 pg/mL; $p=0.012$), but not by other variables.

Conclusion: Serum ghrelin levels were not significantly associated with most demographic or clinical acne characteristics, although significantly higher levels were observed among urban participants.

Keywords: Acne vulgaris, serum ghrelin, Global Acne Grading System, inflammatory acne, urban residence, ELISA.

Introduction

Acne vulgaris is a chronic inflammatory disorder of the pilosebaceous unit and is one of the most frequent dermatological conditions affecting adolescents and young adults. Bhate and Williams reported that moderate-to-severe acne affected approximately 20% of young people, while acne persisted into the 20s and 30s in nearly 64% and 43% of individuals, respectively.(1) Lynn et al. also noted that, according to the Global Burden of Disease study, acne vulgaris affected approximately 85% of young adults aged 12–25 years, emphasizing its high burden during the most socially and psychologically active years of life.(2) The pathogenesis of acne is multifactorial and involves sebaceous gland hyperactivity, follicular hyperkeratinization, Cutibacterium acnes colonization, and inflammation. Vasam et al. described these four mechanisms as the central pathogenic events leading to comedonal and inflammatory acne lesions.(3) In addition to these classical pathways, current evidence suggests that acne is closely linked to endocrine and metabolic signalling. Melnik reported that insulin, insulin-like growth factor-1, branched-chain amino acids, and high-glycaemic dietary patterns may activate mammalian target of rapamycin complex 1 signalling, thereby promoting sebaceous lipogenesis, follicular inflammation, and comedogenesis.(4) This metabolic perspective is clinically relevant because acne commonly peaks during puberty and early adulthood, when hormonal activity, insulin sensitivity, diet, stress, and lifestyle patterns may interact with sebaceous gland function. The sebaceous gland is now regarded as an active neuroendocrine and immunological organ rather than a passive sebum-producing structure. Makrantonaki and Zouboulis described sebocytes as cells capable of participating in inflammatory and endocrine signalling within acne pathogenesis.(5) Zouboulis further reported that human sebocytes express receptors for peptide hormones, neurotransmitters, steroid hormones, thyroid hormones, and other regulatory molecules, supporting the concept that systemic hormonal mediators may influence sebaceous gland biology.(6)

Ghrelin is a peptide hormone originally identified by Kojima et al. as a growth-hormone-releasing acylated peptide

from the stomach and the endogenous ligand for the growth hormone secretagogue receptor.(7) Although ghrelin is best known for regulating appetite, energy balance, and growth hormone secretion, Pradhan et al. highlighted that its biological actions extend beyond hunger signalling and include effects on glucose metabolism, adiposity, and broader neuroendocrine regulation.(8) Ghrelin also has immunomodulatory relevance; Dixit et al. demonstrated that ghrelin inhibited leptin- and activation-induced expression of pro-inflammatory cytokines such as interleukin-1 β , interleukin-6, and tumour necrosis factor- α in human monocytes and T cells.(9) Considering the inflammatory, endocrine, and metabolic components of acne vulgaris, serum ghrelin may provide useful insight into the systemic biological milieu associated with acne. The objective of the present study was to assess serum ghrelin levels among patients with moderate acne vulgaris and to evaluate their association with demographic and clinical characteristics.

Materials and Methods

This was a single-centre, hospital-based, analytical cross-sectional study conducted in the outpatient department (OPD) and/or inpatient wards of the Department of Dermatology, Venereology and Leprosy, and the Central Laboratory, Department of Biochemistry, Sree Balaji Medical College & Hospital (SBMCH), Chennai, Tamil Nadu over a period of two years (June 2024–April 2026). The study was approved by the Institutional Human Ethics Committee (IHEC). Each participant was provided with a Participant Information Sheet (PIS) translated into their local language. The information was also explained verbally to ensure clear understanding and voluntary agreement. Patients with moderate acne vulgaris, graded according to the Global Acne Grading System (GAGS), were included irrespective of gender, provided they were willing to give written informed consent for participation. Patients were excluded if they had other skin disorders, pregnancy, malignancy, history of drug or alcohol abuse, or were receiving chronic medications for pre-existing diseases or disorders.

The sample size was calculated for estimating the mean serum ghrelin level among patients with acne vulgaris. Ozuguz et al. reported 30 patients with moderate acne vulgaris assessed by GAGS; the mean serum ghrelin level was 13.2 ± 3.1 pg/mL.(10) Using the formula $n = Z^2\sigma^2/d^2$, with 95% confidence level ($Z=1.96$), standard deviation (σ) of 3.1, and allowable absolute precision (d) of 0.82, the required sample size was calculated as 55 acne cases; enrolled using nonprobability sampling technique – purposive sampling/consecutive enumeration/convenience sampling. Data were collected using a predesigned study proforma. Demographic details, including age, gender, education, socioeconomic status, and residence, were recorded. Anthropometric assessment was performed, and body mass index was calculated in kg/m². Clinical history related to acne was documented, including the duration of acne in months. Each participant underwent a detailed dermatological examination to assess the distribution and morphology of acne lesions. The site of involvement was recorded as face only, face with trunk, or trunk only, and the specific regions involved, including forehead, right cheek, left cheek, nose, chin/beard area, and chest/upper back, were noted. Lesion types, including comedones, papules, pustules, and nodules, were assessed clinically. Acne severity was graded using the Global Acne Grading System, and only patients with moderate acne vulgaris were included.

For biochemical assessment, participants were instructed to report after an overnight fast. Approximately 5 mL of venous blood was collected in the morning between 7:00 AM and 9:00 AM to minimize pre-analytical variation related to meal-associated changes in circulating ghrelin levels. Blood was collected in a serum separator tube, allowed to clot, and centrifuged for serum separation. The separated serum was aliquoted to avoid repeated freeze–thaw cycles. Samples were analysed immediately when feasible or stored at -20°C to -80°C until batched analysis. Serum ghrelin concentration was estimated using a commercial Human GHRL ELISA kit (Cat. No. ELK1943). The assay was performed according to the manufacturer’s protocol based on the competitive inhibition enzyme immunoassay principle. Standards and serum samples were added to pre-coated microplate wells, followed by the biotinylated antibody and streptavidin–horseradish peroxidase reagents. After substrate reaction with tetramethylbenzidine and addition of stop solution, absorbance was read at 450 nm. Serum ghrelin concentrations were derived from the standard curve and expressed as pg/mL.

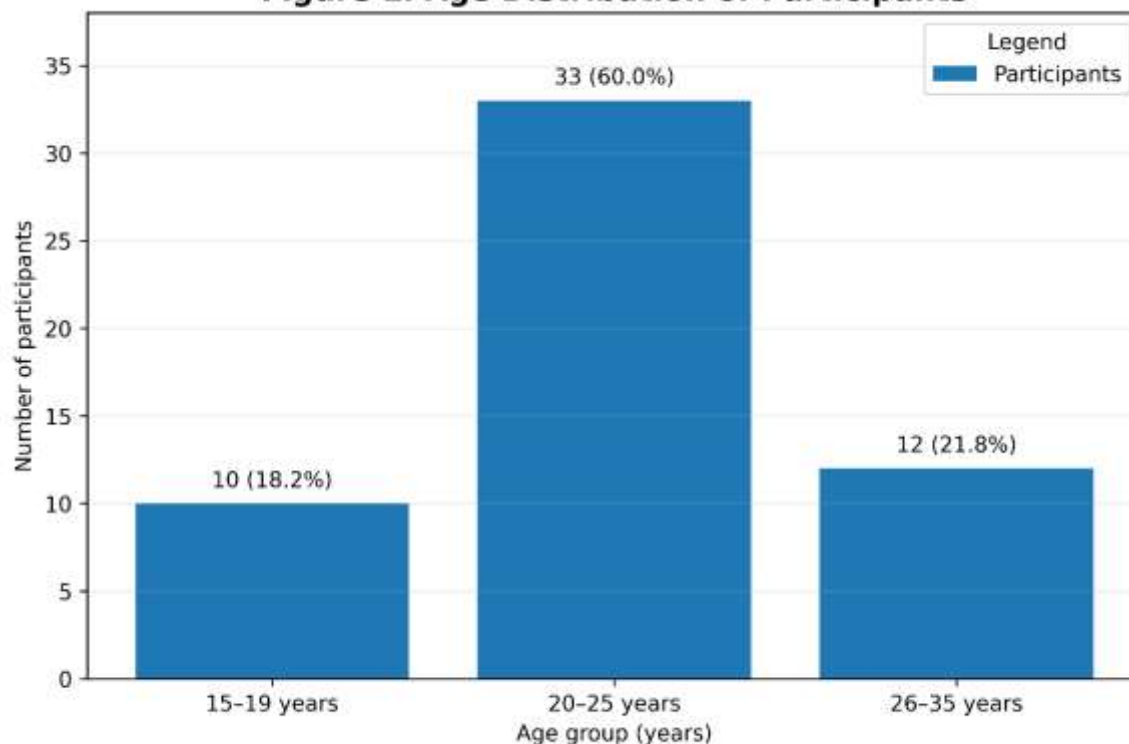
Statistical analysis: Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics for Windows, Version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean and standard deviation, while categorical variables were summarized as frequencies and percentages. Serum ghrelin levels were compared across demographic and clinical categories using an independent samples t-test or one-way analysis of variance, as appropriate. A p value of <0.05 was considered statistically significant.

Results

The study included 55 acne cases with a mean age of 23.0 ± 3.7 years, with most participants aged 20–25 years (60.0%). Females constituted a slightly higher proportion than males (52.7% vs. 47.3%), and the mean body mass index was 23.3 ± 2.9 kg/m². Most participants had intermediate/diploma-level education (41.8%) and belonged to the lower-middle socioeconomic class (49.1%). The mean duration of acne was 11.4 ± 6.6 months, with 41.8% reporting symptoms for more than 12 months. Face with trunk involvement was observed in 70.9% of cases, while the right cheek (100.0%), left cheek (98.2%), and forehead (94.5%) were the most commonly affected regions. Comedones and papules were present in all cases, followed by pustules in 96.4% and nodules in 30.9%.

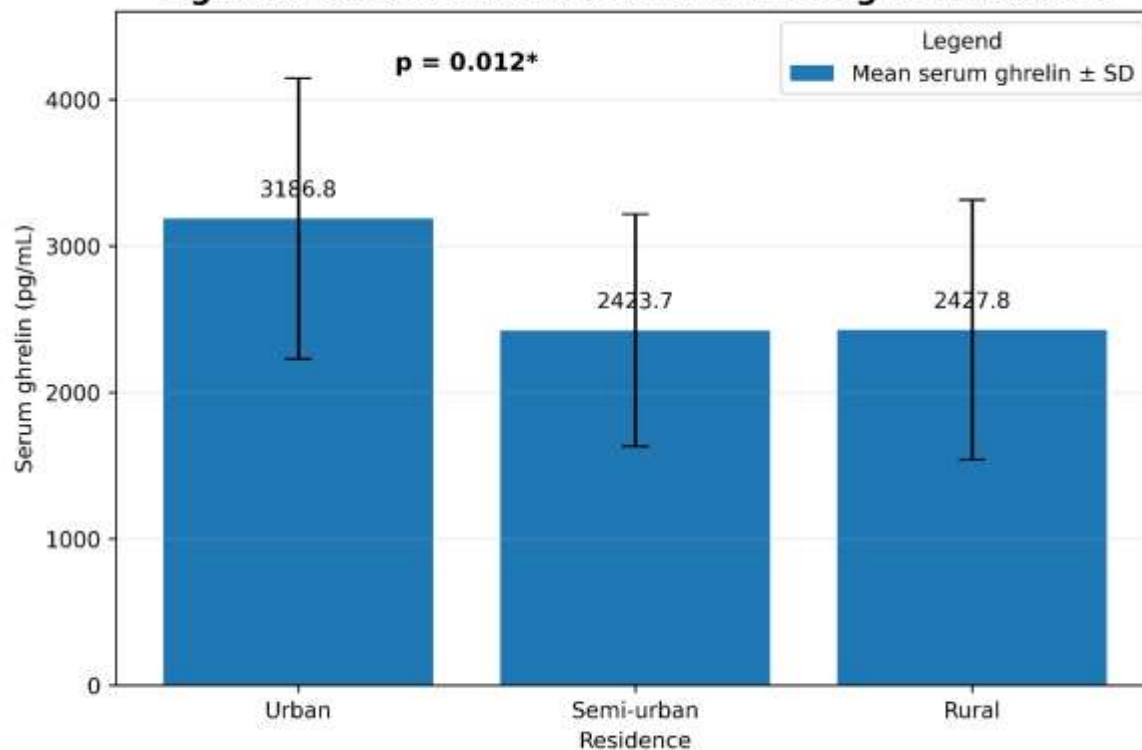
The mean serum ghrelin level among acne cases was 2758.0 ± 959.6 pg/mL. It was slightly higher in the 20–25-year age group (2890.9 ± 1031.0 pg/mL) than in the 15–19-year group (2459.2 ± 938.4 pg/mL) and 26–35-year group (2652.6 ± 849.1 pg/mL), but this difference was not statistically significant ($p=0.488$). Ghrelin levels were also comparable between females and males (2732.9 ± 854.9 vs. 2783.9 ± 1073.4 pg/mL; $p=0.847$). Among socioeconomic groups, the upper-lower/lower class showed a relatively higher mean ghrelin level (3128.6 ± 1049.2 pg/mL), although the association was not significant ($p=0.126$). Residence showed a statistically significant association with serum ghrelin levels, with urban participants having higher levels (3186.8 ± 958.3 pg/mL) than semi-urban (2423.7 ± 792.8 pg/mL) and rural participants (2427.8 ± 887.3 pg/mL; $p=0.012$). No significant differences were observed with acne duration, site distribution, trunk involvement, nodules, or pustules.

Figure 1. Age Distribution of Participants



Legend: Bars represent the number of acne cases; percentages are shown above each bar.

Figure 2. Serum Ghrelin Levels According to Residence



Legend: Bars show mean serum ghrelin; error bars represent SD. *Statistically significant at $p < 0.05$.

Discussion

The present study evaluated serum ghrelin levels among 55 patients with moderate acne vulgaris and demonstrated that acne was predominantly observed in young adults, with a mean age of 23.0 ± 3.7 years and 60.0% of participants belonging to the 20–25-year age group. This age distribution was consistent with the recognized epidemiology of acne, which commonly affected adolescents and young adults and may persist into early adulthood. Liu et al. reported a mean age of 23.2 years among 552 acne patients and observed that acne onset most commonly occurred between 13 and 25 years, with peak onset between 18 and 25 years.(11) The young adult predominance in the present study therefore reflected the age at which sebaceous gland activity, androgen responsiveness, lifestyle factors, and cosmetic concerns were clinically prominent. Females constituted a slightly higher proportion than males in the present study (52.7% vs. 47.3%). Although adolescent acne has often been reported to be more common or more severe among males, post-adolescent acne showed a female predominance. Liu et al. observed a male-to-female ratio of approximately 1:2.3 among acne patients,(11) while Khunger and Kumar reported that 82.1% of 280 adult acne patients were women.(12) The mean body mass index was $23.3 \pm 2.9 \text{ kg/m}^2$, suggesting that most participants were in the normal to mildly elevated BMI range. This was relevant because BMI and acne have shown inconsistent relationships; Liu et al. noted that 58.5% of acne patients had normal BMI and emphasized that the association between BMI and acne remained controversial.(11)

The clinical profile showed a mean acne duration of 11.4 ± 6.6 months, and 41.8% of cases had symptoms for more than 12 months, indicating that acne had a chronic course in a substantial proportion of participants. Acne vulgaris is a chronic inflammatory disorder of the pilosebaceous unit, and its pathogenesis involves excess sebum production, follicular hyperkeratinization, Cutibacterium acnes proliferation, and inflammation.(3) In the present study, face with trunk involvement was documented in 70.9% of cases, whereas isolated facial involvement was present in 29.1%, and no participant had trunk-only involvement. This pattern was clinically important because truncal involvement often accompanies facial acne rather than occurring alone. Tan et al. reported that isolated truncal acne was uncommon, ranging from <1% to 14%, while approximately 30% to 60% of individuals with facial acne had truncal acne, depending on the population studied.(13) The higher proportion of combined face and trunk

involvement in the present cohort suggested a clinically active moderate acne phenotype requiring careful assessment beyond the face. Regional involvement was most frequent over the right cheek (100.0%), left cheek (98.2%), and forehead (94.5%), followed by the nose (85.5%), chin/beard area (83.6%), and chest/upper back (70.9%). This pattern was compatible with the distribution assessed in the Global Acne Grading System, which included the forehead, right cheek, left cheek, nose, chin, and chest/back as anatomical regions for severity assessment.(14) Khunger and Kumar similarly reported cheek involvement as the most common site in adult acne, affecting 81% of cases, followed by the chin in 67% and mandibular area in 58.3%.(12) The universal presence of comedones and papules in the present study, along with pustules in 96.4% and nodules in 30.9%, indicated a mixed comedonal and inflammatory lesion profile. This was pathophysiologically appropriate because microcomedones are considered the precursor lesions,(15) while inflammatory papules, pustules, and nodules develop through immune activation, follicular rupture, and perifollicular inflammation.(16)

The mean serum ghrelin level among acne cases was 2758.0 ± 959.6 pg/mL. Ghrelin has attracted interest in acne because it is an adipokine and gastric peptide involved in energy homeostasis, appetite regulation, and metabolic signalling.(17) Ozuguz et al. specifically evaluated leptin, adiponectin, and ghrelin in non-obese patients with moderate acne vulgaris aged 18–25 years and reported that all acne cases had GAGS scores of 19–30.(10) In that study, ghrelin levels did not differ significantly between acne patients and controls (13.2 ± 3.1 vs. 12.9 ± 3.4), suggesting that ghrelin was not independently altered in non-obese moderate acne. The absolute ghrelin values in the present study should be interpreted within the context of assay-specific measurement, because reported ghrelin concentrations may vary substantially according to sample processing, analytical method, and assay manufacturer. In the present study, serum ghrelin levels did not differ significantly across age groups, although the highest mean value was observed among participants aged 20–25 years (2890.9 ± 1031.0 pg/mL). Ghrelin levels were also comparable between females and males (2732.9 ± 854.9 vs. 2783.9 ± 1073.4 pg/mL), indicating that sex-related variation was not evident in this cohort. This finding paralleled the broader observation by Ozuguz et al., in which ghrelin was not significantly different between acne patients and controls despite matching for age and sex.(10) The absence of significant differences with acne duration, site distribution, trunk involvement, nodules, and pustules suggested that circulating ghrelin was not directly related to the clinical extent or inflammatory morphology of moderate acne in the present dataset.

Residence was the only variable that showed a statistically significant association with serum ghrelin levels. Urban participants had higher serum ghrelin levels (3186.8 ± 958.3 pg/mL) than semi-urban (2423.7 ± 792.8 pg/mL) and rural participants (2427.8 ± 887.3 pg/mL). This finding was notable because residence may represent a composite marker of diet, sleep, stress, sedentary behaviour, cosmetic exposure, and other environmental factors. Liu et al. observed that acne patients reported aggravation with staying up late, emotional stress, milk and dessert intake, and prolonged screen exposure, and also noted that acne affected several areas including cheeks, forehead, chin, nose, chest, and back.(11) Ghrelin itself is sensitive to nutritional state: Cummings et al. demonstrated that plasma ghrelin increased nearly twofold before meals and declined to trough levels within one hour after eating,(18) while Koliaki et al. reported that ghrelin levels rose before feeding and were strongly suppressed by food ingestion.(19) Therefore, the higher ghrelin level among urban participants in the present study may have reflected differences in meal timing, dietary pattern, metabolic signalling, or lifestyle-related neuroendocrine regulation rather than acne morphology alone. The biological plausibility of examining ghrelin in acne was further supported by its immunometabolic properties. Acne is now understood not only as a disorder of sebum and follicular occlusion but also as an inflammatory condition involving cellular immune responses and inflammatory mediators.(20) Ghrelin has been reported to attenuate inflammatory cytokine release, including interleukin-6 and tumour necrosis factor- α , and has been discussed as a regulator of inflammatory responses. In this context, the present finding that ghrelin was not significantly associated with pustules or nodules suggested that systemic ghrelin concentration may not directly mirror visible inflammatory lesion burden in moderate acne. Instead, ghrelin may represent a broader metabolic and environmental biomarker, with its strongest signal in this cohort emerging in relation to residence.

The present study had certain limitations. It included a relatively small sample size of 55 acne cases from a single centre, which may limit the generalizability of the findings. As the study did not include a healthy control group, serum ghrelin levels could not be compared with those of individuals without acne. The cross-sectional nature of assessment also limited the ability to establish a temporal or causal relationship between serum ghrelin levels and acne characteristics. In addition, dietary pattern, fasting duration, sleep, stress, physical activity, and hormonal factors, which may influence circulating ghrelin levels, were not analysed in detail.

Conclusion

The present study showed that moderate acne vulgaris predominantly affected young adults, with a slight female preponderance and frequent involvement of both the face and trunk. The cheeks and forehead were the most commonly affected facial regions, and comedones and papules were present in all cases, with pustules also being highly frequent. The mean serum ghrelin level among acne cases was 2758.0 ± 959.6 pg/mL. Serum ghrelin levels did not differ significantly according to age, gender, education, socioeconomic status, acne duration, site distribution, trunk involvement, or lesion morphology. However, residence showed a significant association, with higher ghrelin levels observed among urban participants compared with semi-urban and rural participants. These findings suggested that serum ghrelin may not be directly related to the clinical pattern or inflammatory severity of moderate acne, although its association with residence may reflect the influence of lifestyle or environmental factors.

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Table 1: Baseline demographic and clinical characteristics of acne cases

		Acne cases (N = 55)
Age (years), Mean (SD)		23.0 (3.7)
Age (years), n (%)	15 to 19	10 (18.2)
	20 to 25	33 (60.0)
	26 to 35	12 (21.8)
Gender, n (%)	Female	29 (52.7)
	Male	26 (47.3)
Body mass index (kg/m ²), Mean (SD)		23.3 (2.9)
Education, n (%)	Primary/middle/high school	19 (34.5)
	Intermediate/diploma	23 (41.8)
	Graduate/postgraduate	13 (23.6)
Socioeconomic status, n (%)	Upper/upper-middle	8 (14.5)
	Lower middle	27 (49.1)
	Upper lower/lower	20 (36.4)
Residence, n (%)	Urban	25 (45.5)
	Semi-urban	16 (29.1)
	Rural	14 (25.5)
Duration of acne (months), Mean (SD)		11.4 (6.6)
Duration of acne (months), n (%)	<6	11 (20.0)
	6 to 12	21 (38.2)
	>12	23 (41.8)
Site distribution, n (%)	Face only	16 (29.1)
	Face + trunk	39 (70.9)
	Trunk only	0 (0.0)
Region involved, n (%)	Forehead	52 (94.5)
	Right cheek	55 (100.0)
	Left cheek	54 (98.2)
	Nose	47 (85.5)
	Chin/Beard	46 (83.6)
	Chest/Upper back	39 (70.9)
Lesion grade, n (%)	Comedones	55 (100.0)
	Papules	55 (100.0)
	Pustules	53 (96.4)
	Nodules	17 (30.9)
Serum ghrelin (pg/mL), Mean (SD)		2758.0 (959.6)

Table 2: Association of serum ghrelin levels with demographic and clinical characteristics among acne cases

		Serum ghrelin (pg/mL)	P value
		Mean (SD)	
Age (years)	15 to 19	2459.2 (938.4)	0.488
	20 to 25	2890.9 (1031.0)	
	26 to 35	2652.6 (849.1)	
Gender	Female	2732.9 (854.9)	0.847
	Male	2783.9 (1073.4)	
Education	Primary/middle/high school	2563.1 (1101.5)	0.394
	Intermediate/diploma	2971.5 (643.1)	
	Graduate/postgraduate	2759.1 (1104.5)	

Socioeconomic status	Upper/upper-middle	2692.8 (801.8)	0.126
	Lower middle	2545.9 (900.3)	
	Upper lower/lower	3128.6 (1049.2)	
Residence	Urban	3186.8 (958.3)	0.012*
	Semi-urban	2423.7 (792.8)	
	Rural	2427.8 (887.3)	
Duration of acne (months)	<6	2401.4 (1047.2)	0.190
	6 to 12	2479.0 (687.8)	
	>12	2928.9 (961.7)	
Site distribution	Face only	2669.4 (891.8)	0.652
	Face + trunk	2794.3 (994.9)	
	Trunk only	–	
Trunk involvement	No	2669.4 (891.8)	0.652
	Yes	2794.3 (994.9)	
Nodules	Absent	2905.3 (903.2)	0.110
	Present	2428.7 (1026.9)	
Pustules	Absent	2836.7 (671.2)	0.892
	Present	2755.0 (973.3)	
Comedones	Absent	–	–
	Present	2758.0 (959.6)	
Papules	Absent	–	–
	Present	2758.0 (959.6)	
*Statistically significant at p<0.05			