Assessment of serum testosterone, estradiol, and progesterone levels in female patients with acne vulgaris

Previously titled: Assessment of serum hormone levels in female patients with acne vulgaris

Phu Cuong Nguyen1, Hoang Van Nguyen1, Van Tien Vu1, Van Tran Pham2, Dang Quyet Tran1, Thanh Tung Nguyen3

1Department of Dermatology and Venereology, 103 Military Hospital, Vietnam Military Medical University, HaNoi, Ha Dong, 100000, Vietnam
2Department of Biochemistry, 103 Military Hospital, Vietnam Military Medical University, Hanoi, Ha Dong, 100000, Vietnam
3Military Institute of Clinical Embryology and Histology, Vietnam Military Medical University, Hanoi, Ha Dong, 100000, Vietnam

Abstract
Introduction: Acne is a chronic inflammatory disorder of the pilosebaceous unit with differential pathogenesis. To elucidate the roles of hormones in acne pathogenesis, we conducted a study to evaluate the serum testosterone, estradiol, progesterone levels in women with acne vulgaris.

Methods: We conducted a cross-sectional descriptive study, and 175 women with acne vulgaris were examined; their serum estradiol, progesterone, testosterone were analyzed by chemiluminescence technique and compared with the healthy control group.

Results: Increased serum hormone levels in women with acne vulgaris were accounted for 29.7%, and hyperandrogenism was accounted for 16.0% of cases. We found significant differences in testosterone levels (mean value, 55.67±25.56 versus 38.37±10.16 ng/dL, p<0.05) respectively in the acne group and the control group. However, the estradiol level of the acne group (323.15±93.31 pmol/L) was lower than the control group (370.94±58.88 pmol/L) with p<0.05). No statistically significant differences were found for progesterone (0.60±0.38 versus 0.50±0.15 ng/mL, p>0.05) levels. Moreover, we did not find the relationship between serum hormone levels and the severity of acne vulgaris.

Conclusion: This study showed that the female acne vulgaris patients may have high serum testosterone levels and low serum estradiol levels compared with those of female controls. However, hormone alterations had no correlation with the acne grades.

Keywords
Acne vulgaris, hormone
Corresponding author: Thanh Tung Nguyen (bstungvmp@gmail.com)

Author roles: Nguyen PC: Data Curation, Formal Analysis, Investigation, Software, Writing – Review & Editing; Nguyen HV: Data Curation, Investigation, Writing – Original Draft Preparation; Vu VT: Data Curation, Investigation, Visualization, Writing – Original Draft Preparation; Pham VT: Data Curation, Methodology, Resources, Supervision; Tran DQ: Project Administration, Resources, Supervision, Visualization; Nguyen TT: Investigation, Supervision, Visualization

Competing interests: No competing interests were disclosed.

Grant information: The author(s) declared that no grants were involved in supporting this work.

Copyright: © 2022 Nguyen PC et al. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

How to cite this article: Nguyen PC, Nguyen HV, Vu VT et al. Assessment of serum testosterone, estradiol, and progesterone levels in female patients with acne vulgaris [version 2; peer review: 1 approved] F1000Research 2022, 11:23 https://doi.org/10.12688/f1000research.75617.2

First published: 11 Jan 2022, 11:23 https://doi.org/10.12688/f1000research.75617.1
Introduction
Acne is a chronic inflammatory disorder of the pilosebaceous unit with various manifestations, including non-inflammation and inflammation lesions. Collier et al. (2008) investigated 1013 Americans aged 20 years and older; 73.3% (744) reported ever having acne, more women suffer from acne than men. Four major factors involved in acne pathogenesis are excessive sebum production, follicular hyperkeratinization, hyper-colonization of the duct by Cutibacterium acnes (formerly Propionibacterium acnes), and the production of inflammation. Moreover, the hormone plays a crucial role in the pathogenesis of acne. Some studies found that acne had a relationship with hyperandrogenemia in female patients. Estradiol, the primary female sex hormone is known as the major active estrogen, forms in absolute serum levels and estrogenic activity during human female reproductive years. Supplying sufficient amounts of estrogens will decrease sebum production and may act by suppressing androgen production by inhibiting the pituitary from secreting gonadotropin. The effect of progesterone on sebaceous glands was still disputed. Some authors have blamed progesterone for the change of sebum production in females during the menstrual cycle. However, this theory has not been proved experimentally. Therefore, we conducted this study to evaluate the serum testosterone, estradiol, and progesterone levels and the correlation of hormonal alterations with the severity of acne in women with acne vulgaris.

Methods
Study design
A cross-sectional study was conducted from January to October 2019 to concentrate serum estradiol, progesterone, testosterone levels in female acne patients at the Dermatology department of 103 military hospital, Vietnam.

Inclusion criteria
The inclusion criteria for acne patients were females aged 16 to 25 years and diagnosed with acne vulgaris. The control group’s criteria were healthy females without pregnancy or lactation.

Exclusion criteria
Exclusion criteria were: diagnosis with (1) other types of acne; (2) patients with polycystic ovary syndrome; (3) using hormone contraceptives or other hormones; (4) a history of ovarian or pelvic surgery; (5) pregnant or breastfeeding women.

Methodology
This was a prospective, cross-sectional descriptive study with control samples.

The sample size was based on the below formula and the research result of da Cunha (2013), we got n = 148.

\[
 n = \frac{Z_{1-\alpha/2}^2 (1-p)p}{d^2}
\]

Techniques of the research
All patients for each group were asked about risk factors, clinically examined, were performed tests (control group, acne group), and registered to study records.

The acne grading score, according to Karen McKoy (2008), is as follows:

- Mild: less than 20 noninflammatory lesions or less than 15 inflammatory lesions or less than 30 total kinds of lesions.
- Moderate: 20–100 noninflammatory lesions or 15–50 inflammatory lesions or 30–125 total kinds of lesions.
- Severe: more than 05 papules/cysts or more than 100 noninflammatory lesions/more than 50 inflammatory lesions or more than 125 total kinds of lesions.

REVISED

Amendments from Version 1
The study’s title was changed to “Assessment of serum testosterone, estradiol, and progesterone levels in female patients with acne vulgaris.” And for the inclusion criteria, we choose acne patients from 16 to 25 years old.

Any further responses from the reviewers can be found at the end of the article.
Assessment technique of plasma hormone levels: 4 mL of venous blood was collected at 08:00 h and during the follicular phase of the menstrual cycle (2nd to 4th day of menses). Blood samples are contained in a tube with EDTA anticoagulant solution. After being incubated at room temperature for 10–20 minutes, samples are centrifuged for about 20 minutes at 2000–3000 rpm. After centrifuging, taking the plasma part for testing, we used direct chemiluminescent technology for measuring hormone levels in the Unicel® DXI800 machine. Units: testosterone for ng/dL, estradiol for pmol/L, progesterone for ng/mL.

Data analysis
The data were analyzed by SPSS software version 22.0. Mean SD are in the form: X±SD, comparing two means using the student t-test. The research results were compared by the Chi-squared test, and a p-value <0.05 was considered to be of statistical significance.

Results
210 female participants were enrolled in the study and divided into 175 female patients with acne vulgaris and 35 healthy controls.

The mean age of patients and BMI showed no statistically significant difference between the study group and the control group with p>0.05 (Table 1).

The plasma testosterone level of the acne vulgaris patients was higher than the control group, respectively 55.67±25.56 ng/dL, 38.37±10.16 ng/dL. The difference was statistically significant with p<0.05. On the other hand, plasma estradiol level in acne vulgaris patients was lower than the control group with a statistically significant difference (p <0.05), respectively 323.15±93.31 pmol/L and 370.94±58.88 pmol/l. However, plasma progesterone levels were not different between both groups (Table 2).

52 patients (29.7%) out of 175 acne patients had hormonal alterations, including 28 patients (16%) with hyperandrogenism; 20 patients (11.43%) had increased serum progesterone level, only four patients (2.29%) had increased serum estradiol level, no patient had low hormonal levels (Table 3).

Table 1. Age and BMI features of acne vulgaris group and control group.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Acne group (n=175)</th>
<th>Control group (n=35)</th>
<th>p-value</th>
<th>Normal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average age (years)</td>
<td>20.82±2.53</td>
<td>19.91±2.57</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>19.33±1.51</td>
<td>18.90±1.62</td>
<td>&gt;0.05</td>
<td>18.5–24.9</td>
</tr>
</tbody>
</table>

Table 2. Plasma hormone levels of acne vulgaris group and control group.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Acne group (n=175)</th>
<th>Control group (n=35)</th>
<th>p-value</th>
<th>Normal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testosterone (ng/dL)</td>
<td>55.67±25.56</td>
<td>38.37±10.16</td>
<td>&lt;0.05</td>
<td>6–86</td>
</tr>
<tr>
<td>Estradiol (pmol/L)</td>
<td>323.15±93.31</td>
<td>370.94±58.88</td>
<td>&lt;0.05</td>
<td>74–532</td>
</tr>
<tr>
<td>Progesterone (ng/mL)</td>
<td>0.60±0.38</td>
<td>0.50±0.15</td>
<td>&gt;0.05</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

Table 3. Hormonal alterations in acne female patients.

<table>
<thead>
<tr>
<th>Value</th>
<th>Testosterone</th>
<th>Estradiol</th>
<th>Progesterone</th>
<th>Total (n=175)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>147 (84.0%)</td>
<td>171 (97.71%)</td>
<td>155 (88.57%)</td>
<td>124</td>
</tr>
<tr>
<td>Increase</td>
<td>28 (16.0%)</td>
<td>4 (2.29%)</td>
<td>20 (11.43%)</td>
<td>52 (29.7%)</td>
</tr>
<tr>
<td>Decrease</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>
There were no different hormone levels between the grades of the acne vulgaris group and there were no different testosterone levels between the mild acne and control groups with \( p > 0.05 \). However, testosterone levels in moderate and severe groups were statistically significantly higher than in the control group (\( p < 0.05 \)). Estradiol levels in the moderate and severe groups were statistically significantly lower than the control group with \( p < 0.05 \). However, the estradiol level in the mild group was not significantly lower when compared with the control group. Progesterone levels in the mild and moderate groups were similar to the control group, except the severe group was higher than the control group; the difference was statistically significant with \( p < 0.05 \) (Table 4).

### Discussion

The gonads and the adrenal gland produce the majority of circulating androgens. However, androgens can also be produced locally within the sebaceous gland from the adrenal precursor hormone DHEAS (dehydroepiandrosterone sulfate). The major androgens interacting with the androgen receptor are testosterone and DHT (dihydrotestosterone). In addition, androgen receptors have been localized to the basal layer of the sebaceous gland and the outer root sheath keratinocytes.7

In 2013, da Cunha et al. investigated androgen levels in 835 female patients with acne vulgaris and found that the rate of androgenism was 10.77%.5 In 2014, Wei et al. studied endocrine disorders in 242 acne patients. The authors showed that serum testosterone levels were significantly increased in the acne patient group compared with controls.8 In this study, we found that the testosterone level of the acne group was higher than controls and the hyperandrogenism rate was 16%. We hypothesize that estrogens might impact sebum secretion by three different mechanisms: the opposition of androgens within the sebaceous glands, inhibition of gonadal androgen production via a negative feedback mechanism on gonadotropin release, and has an effect on genes which play a role in sebaceous gland and lipid production.9

In 2014, Wei et al. surveyed 118 female acne patients compared with 90 sex-matched controls. The results showed that the estradiol level in the acne group decreased significantly compared with the control group with a \( p \)-value less than 0.001, respectively 263.81±14.83 pmol/L; 398.71±26.24 pmol/L.8 This result was also consistent with our result.

Testosterone is converted into a more potent form DHT by 5-ARD (5α-reductase) enzyme causing an excess sebum production, whereas progesterone inhibits the activity of this enzyme and prevents turning testosterone into DHT. So, progesterone itself might be expected to reduce sebaceous gland activity. However, the progesterone effect on acne remains unclear. Although some studies show that progesterone can reduce androgen effects by inhibiting the 5-ARD enzyme or androgen receptors,10 the fluctuation of sebum production in women during the menstrual cycle and premenstrual cyclic flare has partly been associated with progesterone, and some progestins lead to an exacerbation of acne by interacting with androgen receptors.10,11 In our study, there was no statically significant difference between the acne group and controls in terms of serum progesterone levels. However, the progesterone level of the severe acne was higher than the control group; the difference was statically significant with \( p < 0.05 \).

### Conclusion

This study showed that the female acne vulgaris patients might have high serum testosterone levels and low serum estradiol levels compared with those of female controls. However, hormone levels differences had no correlation with acne grade.
Data availability
Underlying data

The project contains the following underlying data:

- DATA.xlsx

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

Ethics approval
Approval was obtained from the ethics committee of Hanoi Department of Science and Technology with the code: 01C-08/14-2017-3. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Consent to participate
Written informed consent for publication of the patients’ details was obtained from the patients.

Acknowledgments
The authors would like to thank the Department of Dermatology and Venereology of 103 Military hospital, Military Medical University, for their support during the study and to the patients for their voluntary participation in this research.

References
Open Peer Review

Current Peer Review Status: ✅

Version 2

Reviewer Report 16 February 2022

https://doi.org/10.5256/f1000research.121108.r122986

© 2022 Aksoy B. This is an open access peer review report distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Berna Aksoy
Department of Dermatology, Faculty of Medicine, Bahcesehir University, Istanbul, Turkey

The article is satisfactory in its revised form: approved.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 02 February 2022

https://doi.org/10.5256/f1000research.79509.r119712

© 2022 Aksoy B. This is an open access peer review report distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Berna Aksoy
Department of Dermatology, Faculty of Medicine, Bahcesehir University, Istanbul, Turkey

This manuscript evaluates serum hormone levels in women, comparing with a control group. The manuscript evaluated 3 hormones at menstruation period. However, the manuscript needs revision as:

Progesterone 0,5 vs 0,6 may be better analysed by increasing control size, which is too small (175 vs 35). Additionally severe acne vs control group progesterone levels are significantly different. For
a better statistical analysis the control group should be nearly half, and I think, therefore, that increasing control size will be meaningful statistically. The same is applicable to progesterone levels.

Acne vulgaris is a term up to age 25, what is the rationale that you choose 30 years? Acne adultorum is supposed to be related to hormonal disturbances. Many acne adultorum patients are stressful working women, there is an increased rate of stress hormones such as prolactin and cortisol. It is better you exclude women over 25.

Estradiol, progesterone and testosterone levels are in fact not enough for hormonal evaluation in women.

Is the work clearly and accurately presented and does it cite the current literature? Yes

Is the study design appropriate and is the work technically sound? No

Are sufficient details of methods and analysis provided to allow replication by others? Yes

If applicable, is the statistical analysis and its interpretation appropriate? Partly

Are all the source data underlying the results available to ensure full reproducibility? No source data required

Are the conclusions drawn adequately supported by the results? No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Acne

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 07 Feb 2022

NGUYEN CUONG, Vietnam Military Medical University, HaNoi, Vietnam

1. Progesterone 0,5 vs 0,6 may be better analysed by increasing control size, which is too small (175 vs 35). Additionally severe acne vs control group progesterone levels are significantly different. For a better statistical analysis the control group should be nearly half, and I think, therefore, that increasing control size will be meaningful statistically. The same is applicable to progesterone levels.
- This article studied the relationship between acne vulgaris with three degrees of disease and hormone levels. And mild acne was found not in relation to sex hormone disorders. This study tried to find this relationship in the moderate and severe groups, with 35 patients in each group. So we decided to choose the control group of around 35 patients. To be more meaningful statistically, we will increase the number of patients in the control group.

2. Acne vulgaris is a term up to age 25, what is the rationale that you choose 30 years? Acne adultorum is supposed to be related to hormonal disturbances. Many acne adultorum patients are stressful working women, there is an increased rate of stress hormones such as prolactin and cortisol. It is better you exclude women over 25.

Acne that occurs in patients over 25 years old is called post-adolescent acne, and the hormone levels in these patients will be affected by external factors such as stress. And Our study first chooses female acne patients ranging from 16 to 30. When we checked our data and found that patients over 25 years old had no change in my statistical data, we could replace the inclusive criteria field that we chose the patients from 16 to 25 years old.

3. Estradiol, progesterone, and testosterone levels are in fact not enough for hormonal evaluation in women.

- Thank you for your comment. We will consider changing the article to “Assessment of serum testosterone, estradiol, and progesterone levels in female patients with acne”.

**Competing Interests:** Author