SEMEN QUALITY AND REPRODUCTIVE HORMONE PROFILES IN MALE PATIENTS PRESENTING TO HANOI OBSTETRICS AND GYNECOLOGY HOSPITAL

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This retrospective cross-sectional study assessed the relationship between reproductive hormones and semen quality in 4,342 men attending the Andrology Clinic, Hanoi Obstetrics and Gynecology Hospital (2023 – 2024). Data included age, semen parameters (WHO 2021 criteria), and serum levels of luteinizing hormone (LH), follicle-stimulating hormone (FSH), testosterone, and prolactin. The mean age was 30.6 ± 5.0 years old. Elevated LH correlated negatively with sperm motility, viability, and morphology (ρ = –0.08 to –0.18; $p < 0.001$). Higher FSH mainly predicted reduced sperm concentration (ρ = –0.15; $p < 0.001$). Testosterone showed weak positive associations with semen volume, concentration, viability, and morphology, whereas prolactin within physiological levels had no significant effect. These findings confirm differential hormonal impacts on semen quality, particularly the detrimental roles of elevated LH and FSH. Endocrine assessment combined with semen analysis should be considered essential in evaluating male infertility to optimize diagnostic and therapeutic strategies.

Keywords: Semen parameters, male reproductive hormone, male infertility.

I. INTRODUCTION

Infertility affects approximately 10 – 15% of couples worldwide, with nearly half of cases attributable to male factors.[1,2] The initial evaluation of male infertility typically focuses on two principal domains: (1) reproductive hormone assessment and (2) semen analysis.[2,3] The key hormones include luteinizing hormone (LH), follicle-stimulating hormone (FSH), testosterone, and prolactin. LH, secreted by the pituitary gland, stimulates Leydig cells to produce testosterone; FSH acts on Sertoli cells to promote spermatogenesis; testosterone determines male sexual characteristics and maintains reproductive capacity; whereas prolactin, when elevated, may suppress the hypothalamic–pituitary–gonadal axis, resulting in impaired spermatogenesis and sexual dysfunction.[2,3] Quantification of these hormones enables differentiation between primary and secondary testicular dysfunction, thereby informing appropriate therapeutic strategies.[3]

Concurrently, semen analysis is the cornerstone test for evaluating male fertility potential. The World Health Organization (WHO) published the sixth edition of its laboratory manual in 2021, providing standardized protocols for semen collection, analysis, and reporting, together with reference values derived from fertile populations.[4] These guidelines serve as international standards,

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allowing consistency across laboratories, facilitating cross-study comparisons, and supporting treatment stratification.[4]

A central question of considerable research interest concerns the correlation between reproductive hormones and semen quality.[2,3] From a pathophysiological perspective, elevated FSH typically reflects impaired spermatogenesis; LH and testosterone indicate Leydig cell function; and hyperprolactinemia may indirectly influence sperm count and quality.[2,3] Thus, concurrent assessment of hormonal and semen parameters enhances understanding of disease mechanisms, supports early diagnosis, and informs treatment decisions-ranging from endocrine therapy to surgery or assisted reproductive technologies.[3,5]

Globally, numerous studies have demonstrated the value of combining hormonal testing with semen analysis in evaluating male infertility.[1-5] Recently, a cross-sectional study conducted in India between 2022 and 2023 reported that serum FSH and total testosterone were significantly associated with sperm count, concentration, and total motility, while total testosterone also showed significant correlations with progressive motility, normal morphology, and semen volume.[6] In Vietnam, however, only a limited number of fragmented reports exist, and systematic analyses of the relationship between reproductive hormones and semen quality remain scarce. Hanoi Obstetrics and Gynecology Hospital, as a tertiary referral center, receives a large volume of infertile male patients from northern Vietnam. Therefore, investigating semen and hormonal characteristics at this institution has substantial clinical relevance, contributes to the national evidence base, and supports improved strategies for managing male infertility.

Study objective: To determine the correlations between reproductive hormone levels of FSH, LH, testosterone, and prolactin and semen (volume, concentration, motility, viability, and morphology) in a cohort of Vietnamese men.

II. MATERIALS AND METHODS

1. Subjects

All male patients presenting for the first time at the Center for Reproductive Support (including both fertile controls and infertile patients) from January 1, 2023, to December 31, 2024**,** who underwent a standardized medical interview with complete clinical information recorded in the electronic medical record and had complete results for both semen analysis and reproductive hormone assays, were eligible for inclusion in the study

Inclusion criteria: Men aged ≥ 18 years old who were able to provide a semen sample by masturbation for semen analysis.

Exclusion criteria: incomplete laboratory data; ongoing hormonal therapy; confirmed obstructive azoospermia; malignancy; acute infection or genital tract conditions known to affect semen quality (e.g., orchitis, urethritis, testicular torsion, or testicular trauma).

2. Methods

Study design: this is a retrospective cross-sectional study.

Sample size: all eligible cases during the study period were included. A total of 4342 outpatients was recruited in this study.

Variables

Demographic data: age (rounded to the nearest year).

Semen analysis: Male patients with an abstinence period of 2 – 7 days were instructed to provide semen samples by masturbation into sterile containers. Samples were liquefied at 37^{o}C for 30 minutes, not exceeding 1 hour, and analyzed according to the WHO Laboratory

Manual, 6th edition (2021). Parameters assessed included semen volume, (mL), sperm concentration ($x10^6$/mL), total sperm count ($x 10^6$), progressive motility (%), viability (%), and normal morphology (%). Normal semen was defined as volume ≥ 1.4mL, concentration ≥ $16×10^6$/mL, total count ≥ $39×10^6$, progressive motility ≥ 30%, viability ≥ 54%, and normal morphology ≥ 4%. Oligospermia was diagnosed when concentration was < $16×10^6$/mL, asthenozoospermia when motility was below the cut-off, and teratozoospermia when morphology was < 4%. Azoospermia was defined as the complete absence of spermatozoa, including after centrifugation.

Hormonal assays: serum concentrations of luteinizing hormone (LH, IU/L), follicle-stimulating hormone (FSH, IU/L), testosterone (nmol/L), and prolactin (IU/L). In accordance with the recommendations of the hospital's Department of Biochemistry–Immunology, the reference ranges were standardized as follows: FSH, 2 – 12 IU/L; LH, 2 – 9 IU/L; prolactin, < 425 µg/L; and testosterone, 12.1 – 31.8 nmol/L.

All assays were conducted in the hospital's central laboratory using chemiluminescent immunoassay. Reference values were based on standardized ranges validated within the laboratory.

Statistical analysis

Data were cleaned and converted into numerical variables. Descriptive statistics were expressed as mean ± standard deviation (SD), interquartile range (Q1–Q3), and minimum–maximum values. Correlations between hormone concentrations and semen parameters were evaluated using age-adjusted Spearman correlation coefficients. A p-value < 0.05 was considered statistically significant. Analyses were performed using SPSS version 22.0.

3. Research ethics

This study was approved by the Institutional Ethics Committee of Hanoi Obstetrics and Gynecology Hospital (pursuant to Decision No. 1789/QD-PS of Hanoi Obstetrics and Gynecology Hospital dated December 13rd, 2024). All data were anonymized and used exclusively for research purposes.

III. RESULTS

1. Participant characteristics

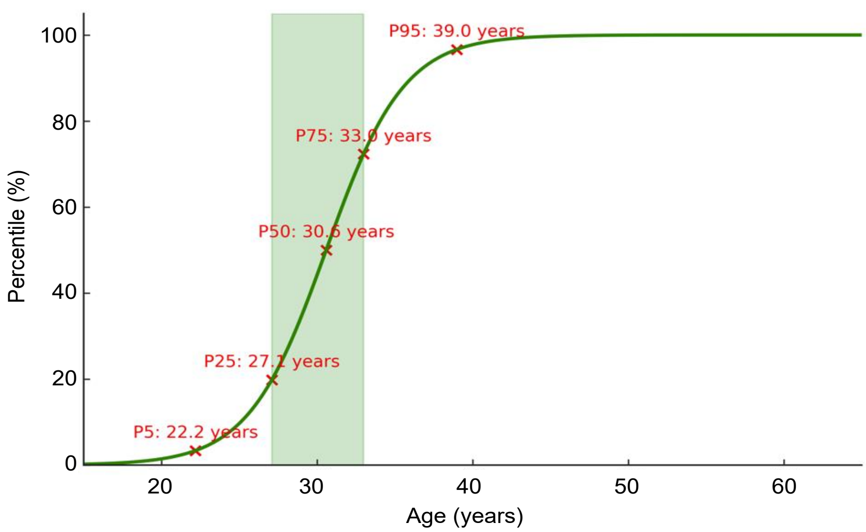

Chart 1. Percentile distribution of age among study participants

In total, 4,342 male patients were included, with ages ranging from 17 to 65 years old. The mean age was 30.56 ± 5 years old (95% confidence interval). The most common age group in the study population was 27.1 to 33 years old, with a relatively narrow range and only a small proportion of older individuals. This represents a typical reproductive-age cohort.

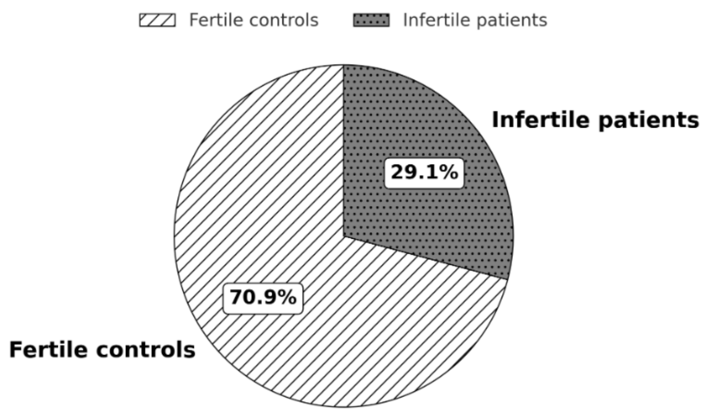

Chart 2. Study population distribution

This study included 4,342 men: 3,078 fertile controls (70.9%) and 1,264 infertile patients (29.1%). This distribution ensures a robust control group while allowing focused analysis of infertile cases, strengthening the study's comparative validity.

2. Semen analysis characteristics

Table 1. Semen analysis parameter

Parameter (n = 4,342)	Mean ± SD	Q1–Q3	Min–Max
Volume (mL)	2.28 ± 0.93	2.00 – 3.00	0.10 – 8.00
Sperm concentration (×10^6(/mL)	40.16 ± 22.63	24.00 – 50.00	1.00 – 120
Total sperm number (×10^6)	92.31 ± 62.05	46.00 – 120.00	0.50 – 400
Total motility (PR+NP)	0.63 ± 0.21	0.56 – 0.79	0.00 – 0.98
Progressive motility (PR)	0.57 ± 0.22	0.47 – 0.75	0.00 – 0.94
Viability	0.63 ± 0.21	0.56 – 0.79	0.00 – 0.92
Morphology (normal forms)	0.03 ± 0.01	0.02 – 0.04	0.00 – 0.06

(PR: progressive motility; NP: non-progressive motility)

In this cohort of 4,342 men, most semen parameters were within WHO reference thresholds. Mean semen volume (2.28mL), sperm concentration (31.16×10^6/mL), total count (92.31×10^6), motility (63%), and viability (63%) were satisfactory in the majority of cases, although a small proportion showed hypospermia, oligospermia, asthenozoospermia, or necrozoospermia. Morphology was the most impaired parameter, with a mean of only 3% normal forms and nearly half of patients falling below the 4% cut-off. These results highlight that while volume, concentration, motility, and viability were largely preserved, teratozoospermia was the predominant abnormality in this population.

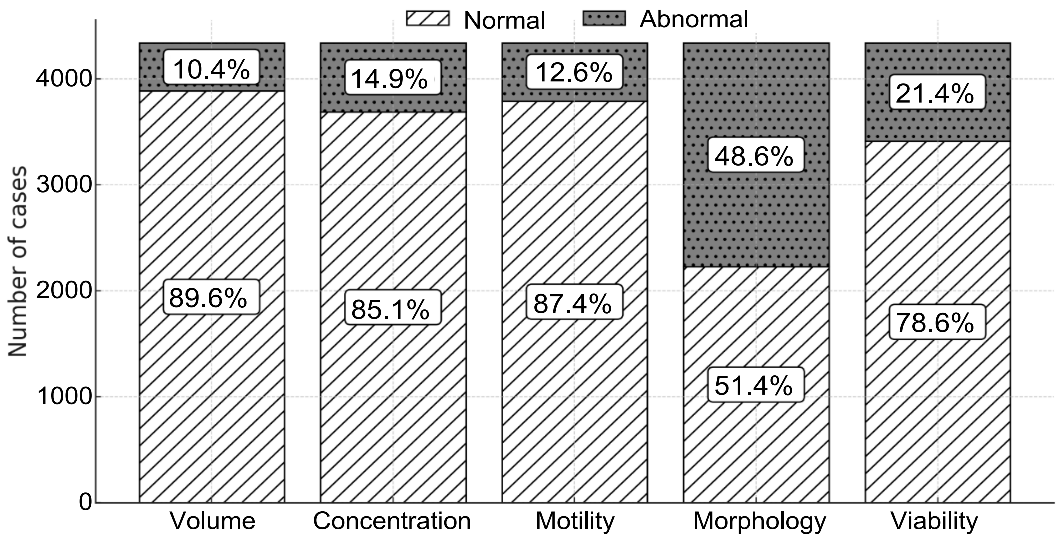

Chart 3. Distribution of Normal vs Abnormal Semen Parameters

Most patients exhibited normal semen volume, concentration, motility, and viability, whereas morphology was the most impaired parameter, with nearly half below the WHO threshold. This underscores teratozoospermia as the predominant abnormality in the cohort.

3. Reproductive hormone profiles

Table 2. Serum reproductive hormone concentrations

Hormone (n = 4,342)	Mean ± SD	Q1 – Q3	Min – Max
LH (IU/L)	3.32 ± 2.22	2.01 – 3.99	0.54 – 39.12
FSH (IU/L)	4.80 ± 4.55	2.77 – 5.25	0.77 – 72.31
Testosterone (nmol/L)	16.98 ± 6.40	12.47 – 20.54	1.32 – 99.56
Prolactin (IU/L)	268.6 ± 153.1	175.7 – 317.7	29.3 – 3,848.5

Serum reproductive hormone levels demonstrated wide distributions with large ranges within the study population, particularly for FSH and prolactin.

4. Correlations between serum reproductive hormones

Table 3. Correlations between serum reproductive hormones

Hormone pair	ρ (Spearman)	p-value	Observation
LH – Testosterone	+0.15	< 0.001	Weak but significant positive correlation
LH – FSH	+0.01	0.51	No correlation
FSH – Testosterone	+0.02	0.22	No correlation
Prolactin vs other hormones	–	> 0.05	No correlation

Except for the weak but physiologically significant positive association between LH and testosterone, the other serum reproductive hormones varied largely independently.

5. Hormones and total sperm motility

Table 4. Correlation between serum hormone concentrations and total sperm motility

Hormone	ρ (Spearman)	p-value	Adjusted mean, normal (95% CI)	Adjusted mean, abnormal (95% CI)
LH	–0.18	< 0.001	3.05 (2.97 – 3.13)	3.56 (3.44 – 3.68)
FSH	–0.01	0.54	3.21 (3.12 – 3.30)	3.28 (3.16 – 3.40)
Testosterone	+0.02	0.11	17.3 (17.0 – 17.6)	16.7 (16.4 – 17.0)
Prolactin	–0.005	0.75	246 (240 – 252)	244 (236 – 252)

LH demonstrated the strongest association with sperm motility, showing a significant negative correlation: adjusted mean values were considerably higher in the abnormal group compared with the normal group. Testosterone tended to be positively correlated with motility, though the difference was not statistically significant. Adjusted mean testosterone levels were lower in the abnormal group than in the normal group. Neither FSH nor prolactin showed significant associations with sperm motility.

6. Hormone and progressive sperm motility

Table 5. Correlation between serum hormone concentrations and progressive sperm motility

Hormone	ρ (Spearman)	p-value	Observation	Adjusted mean, normal (95% CI)	Adjusted mean, abnormal (95% CI)
LH	–0.18	< 0.001	Significant negative	3.08 (3.00 – 3.16)	3.59 (3.46 –3.72)
FSH	–0.01	0.46	Not significant	3.20 (3.11 – 3.29)	3.30 (3.18 – 3.42)
Testosterone	+0.02	> 0.10	Not significant	17.2 (16.9 – 17.5)	16.6 (16.3 – 16.9)
Prolactin	0.00	> 0.50	Not significant	248 (242 – 254)	245 (237 – 253)

LH was the only hormone to demonstrate a consistent and significant negative correlation with progressive motility. LH levels were markedly higher in the abnormal group (< 32% progressive motility). Testosterone was slightly lower in the abnormal group, though the difference was not statistically significant. FSH and prolactin showed no meaningful association.

7. Hormones and sperm morphology

Elevated LH and lower testosterone levels were associated with abnormal sperm morphology. Men with abnormal morphology (< 4% normal forms) had higher LH and lower testosterone compared with the normal morphology group. FSH and prolactin showed no statistically significant difference

Table 6. Correlation between serum hormone concentrations and normal sperm morphology

Hormone	ρ (Spearman)	p-value	Observation	Adjusted mean, normal (95% CI)	Adjusted mean, abnormal (95% CI)
LH	–0.08	< 0.001	Mild negative	3.11 (3.03 – 3.19)	3.36 (3.24 –3.48)
FSH	–0.01	0.49	Not significant	3.23 (3.14 – 3.32)	3.26 (3.14 – 3.38)
Testosterone	+0.03	~0.03	Mild positive	17.4 (17.1 – 17.7)	16.8 (16.5 – 17.1)
Prolactin	0.00	> 0.50	Not significant	247 (241 – 253)	246 (238 – 254)

8. Hormon and semen volume

Table 7. Correlation between serum hormone concentrations and semen volume

Hormone	ρ (Spearman)	p-value	Observation	Adjusted mean, normal (95% CI)	Adjusted mean, hypospermia (95% CI)
LH	–0.04	< 0.01	Mild negative	3.22 (3.14 – 3.30)	3.36 (3.22 – 3.50)
FSH	–0.02	> 0.05	Not significant	3.26 (3.18 – 3.34)	3.29 (3.15 – 3.43)
Testosterone	+0.05	< 0.01	Mild positive	17.2 (16.9 – 17.5)	16.5 (16.0 – 17.0)
Prolactin	0.00	> 0.05	Not significant	246 (240 – 252)	245 (234 – 256)

Semen volume < 1.5mL was associated with higher LH and lower testosterone levels.

9. Hormones and sperm concentration

Table 8. Correlation between serum hormone concentrations and sperm concentration

Hormone	ρ (Spearman)	p-value	Observation	Adjusted mean, normal (95% CI)	Adjusted mean, oligozoospermia (95% CI)
LH	–0.12	< 0.001	Significant negative	3.05 (2.97 – 3.13)	3.62 (3.48 – 3.76)
FSH	–0.15	< 0.001	Strong negative	3.02 (2.94 – 3.10)	3.95 (3.80 – 4.10)
Testosterone	+0.03	< 0.05	Mild positive	17.2 (16.9 – 17.5)	16.6 (16.1 – 17.1)
Prolactin	0.00	> 0.05	Not significant	247 (241 – 253)	245 (236 – 254)

Cases of oligozoospermia and azoospermia were associated with higher LH and FSH levels, while testosterone concentrations were lower compared with the normal group.

10. Hormones and sperm viability

Men with abnormal sperm viability exhibited higher LH and FSH levels and lower testosterone concentrations compared with the normal group. Elevated LH and FSH were associated with decreased viability, whereas higher testosterone levels corresponded to greater sperm survival.

Table 9. Correlation between serum hormone concentrations and sperm viability

Hormone	ρ (Spearman)	p-value	Observation	Adjusted mean, normal (95% CI)	Adjusted mean, abnormal (95% CI)
LH	–0.10	< 0.001	Moderate negative	3.07 (2.99 – 3.15)	3.49 (3.37 – 3.61)
FSH	–0.08	< 0.001	Mild negative	3.12 (3.04 – 3.20)	3.42 (3.30 – 3.54)
Testosterone	+0.04	< 0.01	Mild positive	17.3 (17.0 – 17.6)	16.7 (16.3 – 17.1)
Prolactin	0.00	> 0.05	Not significant	246 (240 – 252)	245 (236 – 254)

IV. DISCUSSION

This study, conducted on 4,342 infertile men at Hanoi Obstetrics and Gynecology Hospital, provides large-scale evidence regarding the relationships between serum reproductive hormones (LH, FSH, testosterone, prolactin) and semen quality parameters (according to WHO 2021 guidelines). The results highlighted LH as the hormone most strongly correlated with semen quality, particularly motility, viability, and morphology. FSH also played an important role but was primarilyassociated with sperm concentration. Testosterone demonstrated only a mild effect, while prolactin, within the physiological range, appeared unrelated to semen quality.

LH is secreted by the pituitary gland and stimulates Leydig cells to produce testosterone. Under physiological conditions, LH is maintained at stable levels through a negative feedback loop with testosterone. When testicular function declines, testosterone production decreases, leading to compensatory elevations in LH secretion. The findings of this study are consistent with this mechanism: elevated LH was associated with impaired semen quality (reduced motility, decreased viability, and abnormal morphology).

Comparison with international studies supports these observations. Zhao et al. (2020), in a Chinese cohort, reported that higher LH was negatively correlated with sperm motility and morphology. Similarly, a European study by Jørgensen et al. found that men with poor motility often had elevated LH and FSH. These results reinforce the hypothesis that elevated LH may represent a compensatory response to underlying testicular dysfunction, even when testosterone remains within the normal range.

In clinical practice, LH measurement is frequently used to support the diagnosis of suspected hypogonadism. However, our findings suggest that LH may also serve as a useful adjunct marker in evaluating semen quality. Men with elevated LH but normal testosterone should still be counseled regarding potential risks of impaired fertility.

FSH is a hormone that reflects Sertoli cell function and is regulated by inhibin-B. Elevated FSH typically indicates partial or complete impairment of spermatogenesis. In this study, FSH was significantly negatively correlated with sperm concentration but showed no meaningful association with motility or morphology. These results suggest that FSH is a stronger marker of sperm quantity than sperm quality.

Among men with severe oligozoospermia and azoospermia (< 15 million/mL), mean FSH concentrations were markedly elevated. Thus, FSH measurement is valuable for rapid screening in cases suspected of spermatogenic failure, particularly when semen analysis reveals severely abnormal or azoospermic samples. However, cases of mild oligozoospermia may still exhibit normal FSH levels, reflecting preserved Sertoli cell function. Therefore, FSH should always be interpreted in conjunction with LH, testosterone, and especially semen analysis findings.

Testosterone plays a central role in spermatogenesis, supporting the development of reproductive organs and maintaining secondary sexual characteristics. In this study, testosterone showed only weak positive associations with semen volume, concentration, and viability, and no significant relationship with motility. Clinically, severe testosterone deficiency (primary or secondary hypogonadism) is associated with impaired semen quality. However, most infertile men in this study still had testosterone levels within the normal range.

Elevated prolactin suppresses GnRH secretion, leading to decreased LH, FSH, and testosterone, thereby indirectly impairing spermatogenesis. Nevertheless, in this study, prolactin showed no significant association with semen parameters. These findings are consistent with other reports indicating that prolactin within the normal physiological range is not a decisive factor in male infertility. It is important to emphasize that only pathological hyperprolactinemia carries diagnostic and prognostic value. Therefore, prolactin testing should not be routinely performed in the evaluation of male infertility unless there are specific clinical indications (e.g., sexual dysfunction, galactorrhea, or secondary hypogonadism).

As this was a retrospective cross-sectional study, causal inference is limited. Potential confounders such as BMI, smoking, alcohol use, and comorbidities were not fully adjusted for, which should be addressed in future prospective research.

Our study demonstrated that each reproductive hormone exhibited distinct association with semen parameters. Sperm motility and viability were most strongly correlated with LH; sperm concentration was primarily related to FSH; sperm morphology was modestly influenced by both LH and testosterone; and semen volume showed a mild relationship with testosterone. Prolactin was not significantly associated with any semen parameter. These findings are consistent with Ghanti. et al. (India, 2024), who also reported significant associations of FSH and testosterone with sperm count, concentration, and motility, as well as additional links of testosterone with morphology and semen volume.[6] Taken together, our findings indicate that no single hormone fully reflects overall semen quality; instead, each provides complementary insights into specific aspects of semen characteristics. Moreover, according to Nguyen Hoai Bac et al., sperm concentration and progressive motility provide the highest prognostic value for male reproductive potential;[7] therefore, we particularly emphasize the role of LH and FSH.

These findings emphasize the importance of integrating hormonal assessment with semen analysis in Vietnamese clinical settings, even where resources for advanced genetic or molecular testing may be limited. Routine evaluation of LH and FSH can assist in stratifying patients for assisted reproductive interventions. Although correlation strengths in our analysis were modest, the large sample size enabled precise estimates and minimized random error. Nonetheless, limitations remain, including the cross-sectional design, lack of measurement of other hormones (e.g., SHBG), and absence of adjustment for confounders such as BMI, lifestyle factors (tobacco, alcohol, physical activity, stress), systemic comorbidities and the important role of ejaculation frequency[8]

V. CONCLUSION

In our large cohort study, elevated LH was generally associated with reduced motility, viability, and abnormal sperm morphology; higher FSH concentration correlated primarily with reduced sperm concentration; testosterone showed only weak association with semen volume, concentration, and viability, while prolactin demonstrated no meaningful relationship. Although effect sizes were modest, pairing semen analysis with a targeted reproductive-hormone panel can improve diagnostic yield and streamline care.

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