

Effect of Vitamin D on Semen Parameters of Infertile Males

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ABSTRACT

Background: Male infertility affects almost 50% of infertile couples. Semen analysis remains the primary diagnostic tool, but evidence suggests a possible relationship between vitamin D status and male reproductive function. While vitamin D is established in metabolic and endocrine regulation, its role in semen quality is unclear. This study aimed to determine the relationship between serum vitamin D concentrations and semen parameters in infertile males. **Methods:** A cross-sectional observational study was conducted at the Department of Obstetrics & Gynaecology, Bangabandhu Sheikh Mujib Medical University (BSMMU) from July 2018 to June 2019. One hundred fifty infertile males were enrolled based on inclusion and exclusion criteria. Semen analysis followed WHO 2010 recommendations and serum vitamin D levels were assessed using ARCHITECT Plus ci4100 immunoassay. Data were analyzed using the SPSS 22 version. **Results:** The mean age of participants was 32.91±8.81 years. 42.66% lacked vitamin D (<20 ng/ml), 51.33% were deficient (21–29 ng/ml), and only 6% had adequate vitamin D status (≥30 ng/ml). Semen parameters showed abnormalities: asthenozoospermia (40%), oligozoospermia (34.33%), and azoospermia (12%). No significant association was found between vitamin D and semen parameters. **Conclusion:** Vitamin D deficiency prevalence was high in infertile males. No direct correlation was found between vitamin D levels and semen abnormalities. The exact role of vitamin D in male fertility should be further explored through more extensive interventional studies.

Keywords: Male infertility; Semen parameters; Vitamin D deficiency; Azoospermia; Oligozoospermia.

INTRODUCTION

Infertility is a common clinical problem affecting 13% to 15% of couples worldwide [1]. It is also considered a public problem, impacting healthcare services and social environment [2]. Males are solely responsible for 20–30% of infertility cases and contribute to 50% of cases overall. Male infertility is almost always defined by an abnormal semen analysis, although other factors may play a role even with a normal analysis. Clinicians usually rely on semen analysis results for assessing male fertility [3]. Standard semen analysis is widely considered part of the routine assessment in evaluating male fertility and the surrogate measure of male fecundity in clinical practice [4].

Male infertility can stem from various conditions. Some are identifiable and reversible, like ductal obstruction and hypogonadotropic hypogonadism [5]. Others are identifiable but irreversible, such as bilateral testicular atrophy from viral orchitis [6]. When the etiology of an abnormal semen analysis is unidentifiable, it's termed idiopathic. Unexplained infertility occurs when the reason is unclear, with normal semen analysis and partner evaluation [7]. Rarely, patients with normal semen analyses have sperm that don't function properly for fertility. The male evaluation aims to identify these conditions. Identifying and treating reversible conditions may improve fertility and allow conception through intercourse [8]. Even azoospermia patients may have active sperm production or could have it induced with treatment. There is little consensus on which parameter within a conventional semen analysis best predicts male fertility [9]. A correlation between sperm counts and pregnancy has been reported, showing evidence of a predictive value of sperm count [10]. WHO adopted the threshold of $20 \times 10^6/\text{mL}$ as reference for minimal value of sperm count [11, 12]. Routine semen analysis also includes evaluating sperm morphology and motility, both considered related to male fertility [13].

Since WHO reference values were adopted, it's become evident that basic semen analysis is insufficient to determine male fertility status, as these values were based on healthy men, not those with proven fertility [14]. This raises concerns about conceiving with semen parameters below WHO cutoff values [15]. Additional sperm function tests don't provide further information to traditional semen parameters in assessing infertile male patients' fertility status [16].

Studies show environmental factors like toxic substances, pesticides, and radiation harm male reproductive function. Tobacco, alcohol, and caffeine abuse are also linked to male infertility. Risk factors vary by country, so developing nations should identify key influences. Cellular abnormalities affect semen parameters at molecular and biochemical levels [17]. Vitamin D, essential for calcium-phosphorus metabolism and bone mineralization, is a fat-soluble vitamin and steroid hormone. Sunlight induces its synthesis in the skin, converting cholesterol to cholecalciferol (inactive Vitamin D₃) via ultraviolet-B rays, then hydroxylated by hepatic 25-hydroxylase and renal 1 alpha-hydroxylase to form 1,25(OH)₂VD₃ (active VD₃-calcitriol). A small amount of Vitamin D comes from diet or supplements. Recent studies highlight Vitamin D's role in reproductive functions, with receptors and metabolizing enzymes in the male genital tract and germ cells [18]. An inactivating enzyme in spermatozoa differentiates normal and infertile men, serving as a marker for semen quality and Vitamin D responsiveness [19]. No consensus exists on optimal serum VD levels. Vitamin D deficiency is below 20 ng/ml, insufficiency is 21–29 ng/ml, and levels above 30 ng/mL are sufficient [20]. This study aimed to evaluate serum Vitamin D levels of infertile males and determine whether there is an association with semen parameters.

Objective

The objective of this study was to explore the association between vitamin D levels (25OHD), with various semen parameters in infertile male.

METHODOLOGY & MATERIALS

This cross-sectional observational study was conducted at the Department of Obstetrics & Gynaecology, Bangabandhu Sheikh Mujib Medical University (BSMMU), from July 2018 to June 2019. The study included 150 male patients with clinically diagnosed infertility who attended outpatient and indoor departments at BSMMU, Dhaka, and who met inclusion and exclusion criteria.

Selection criteria:

Inclusion criteria:

- Male partners of women who will present in the infertility clinic
- Male partners of women who will give the history of inability to conceive to his spouse after a period of 12 months or more despite regular and adequate unprotected coital exposure
- Give the consent to participate in the study

Exclusion criteria

- Male partners of women with less than 12-month history of infertility
- Couples married less than one year before presentation
- Couples not living together
- Couples not having regular intercourse
- Genital tract infections
- Associated varicocele
- Chronic severe debilitating medical illness (cerebrovascular, cardiovascular, hypertension, diabetes, hereditary hyperlipidemia, thromboembolic events)
- Use of systemic medication (steroids, antihyperlipidemic)
- Anabolic steroid intake, some supplementation of Vitamin D, obstructive azoospermia

Data collection:

Data were collected from male patients clinically diagnosed with infertility attending the outpatient and indoor departments of Gynecology and Obstetrics at Bangabandhu Sheikh Mujib Medical University, Dhaka. A semi-structured questionnaire gathered socio-demographic data, infertility history, and lifestyle factors. Semen samples were collected following WHO (2010) guidelines, ensuring abstinence for 3–5 days, hygienic collection via masturbation, and delivery within 15–20 minutes. Semen analysis assessed volume, concentration, motility, morphology, and bacterial culture. Venous blood was drawn, centrifuged, and analyzed for serum 25(OH) D using the ARCHITECT Plus ci4100 immunoassay. Standardized protocols ensured sample integrity and minimized inter-laboratory variations.

Ethical consideration:

Ethical approval was obtained before initiating the study. After explaining the study's purpose and procedures, written informed consent was secured from all participants. Participation was voluntary, with the right to refuse or withdraw at any time without affecting medical care. Patient privacy and data confidentiality were maintained strictly. The study posed no harm, and potential risks associated with blood collection were disclosed. Experienced physicians promptly managed any complications, ensuring participant safety throughout the study.

Statistical data analysis:

Statistical analysis was performed using SPSS version 22. Descriptive statistics were used to summarize sociodemographic characteristics, duration of infertility, semen parameters, and vitamin D levels. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as mean ± standard deviation. Associations between semen abnormalities and vitamin D levels were analyzed using appropriate statistical tests.

RESULTS

Table 1: Sociodemographic Characteristics (n=150)

Characteristics		Frequency (n=150)	Percentage (%)
Age in Years	24 - 30	31	20.6
	31 - 40	86	57.3
	41 - 48	33	22.1
Mean±SD		32.91±8.81	
Education	Illiterate	11	7.3
	Primary	46	30.6
	SSC	67	44.6
	HSC	16	10.6
	Graduate or above	10	6.6
Occupation	Daily worker	17	11.3
	Service	76	50.6
	Self employed	57	38.1
Residence	Urban	102	68
	Rural	48	32

The mean age of the maximum participant was 32.91±8.81. Educational level was SSC in most participants (44.6%). Maximum women were service holder (50.6%) and came from urban areas (68.0%).

Table 2: Duration of Infertility (n=150)

Duration of infertility (years)	Number of patients (n=150)	Percentage (%)
2-7	112	74.66
8-12	38	25.33
Mean±SD	5.91±2.81	

Duration of infertility of the participants was 2-12 years (Mean 5.91±2.81).

Table 3: Semen Parameters of Infertile Men (n=150)

Abnormality	Frequency (n=150)	Percentage (%)
Azoospermia	18	12
Oligozoospermia	52	34.33
Asthenozoospermia	60	40
Teratozoospermia	3	2
Oligoteratozoospermia	11	7.33
Oligoasthenoteratozoospermia	6	4

In terms of semen parameters, Azoospermia seen in about 18 (12%), Oligospermia in 52 (34.33) and Asthenozoospermia in 60 (40%) infertile males, on the other hand Teratozoospermia, Oligoteratozoospermia, Oligoteratozoospermia were seen in 3 (2%), 11 (7.33), 6 (4%) males respectively. There is no significant relation to the type of abnormal semen parameters with vitamin D level.

Table 4: Distribution of the study patients by vitamin D level ng/ml (n=150)

Vitamin D level ng/ml	Frequency (n=150)	Percentage (%)
Sufficiency ≥ 30 ng/ml	9	6
Insufficiency 21-29 ng/ml	77	51.33
Deficiency < 20 ng/ml	64	42.66
Mean \pm SD	22.42 \pm 3.96	

Vitamin D insufficiency was seen in maximum (77) participants (51.33). Deficiency was seen in 42.66% cases. Only 9 (6%) participants showed to have optimum vitamin D level.

DISCUSSION

This research examined how vitamin D affects the semen measurements of infertile adult men. The study results demonstrate that sufficient vitamin D levels existed in less than 6% of the sample group, but insufficiency reached 51.33%, and deficiency affected 42.66% of participants. Researchers evaluated the link between vitamin D levels and three specified semen defects, including azoospermia, oligospermia, and asthenozoospermia, but failed to establish any significant statistical relation. These results contribute to the ongoing debate regarding the role of vitamin D in male fertility and raise essential questions about its broader implications in reproductive health.

Studies have demonstrated the complexity of male infertility by showing that vitamin D plays a role in spermatogenesis and sperm function. Research conducted by Corbett et al. [17] confirmed the presence of vitamin D receptors in human sperm therefore validating that vitamin D affects male fertility. Research indicates that individuals with better vitamin D concentrations tend to have enhanced sperm motility and better shape accuracy, which shows possible regulatory effects on sperm cell functions (Du Plessis et al., [3]. Systematic and non-systematic research indicates that vitamin D supplements do not show substantial effects on semen quality and fertility success rates (Ross et al.,) [9]. The European Association of Urology guidelines identify multiple factors involved in male infertility yet do not regard vitamin D deficiency as a main influencing factor (Jungwirth et al.,) [7].

Various conditions with existing literature show different results because of differing approaches, research populations, and environmental factors. The evidence suggests that metabolic disorders like obesity and insulin resistance affect the regulation of vitamin D and semen quantity (Osei,) [19]. The relationship between vitamin D and fertility might operate through broad physiological mechanisms since obesity affects sperm function (Du Plessis et al.,) [3] and vitamin D regulates metabolic processes (Faserl et al.,) [18].

The substantial rate of vitamin D deficiency in infertile males remains an essential clinical observation, even though this study did not establish direct links. The vital role of vitamin D in calcium homeostasis and immune regulation, together with endocrine function, provides fundamental influence over reproductive wellness (Ross et al.,) [20]. Vitamin D deficiency can lead to impaired endocrine capabilities, which potentially affects the development of sperm together with testicular dysfunction throughout time. The relationship between vitamin D and semen abnormalities remains ambiguous because vitamin D deficiency indicates multiple health risks which need medical evaluation.

Extensive research explores the link between oxidative stress and male infertility, showing that vitamin D potentially controls sperm oxidative damage, according to Shamsi et al. [8]. Research suggests vitamin D plays a protective role in sperm integrity through antioxidant effects after the discovery revealed its anti-damage potential for sperm DNA (Schulte et al.,) [10]. The research shows no concrete evidence to establish whether vitamin D supplements would enhance fertility outcomes. Research indicates that vitamin D supplementation delivers

helpful outcomes in vitamin D-deficient subjects. Yet, conflicting reports demonstrate that vitamin D influence remains secondary, assuming other metabolic and environmental elements (Whitman-Elia & Baxley) [2]. The data indicates that vitamin D correction alone should not be the primary infertility management strategy because a comprehensive approach is necessary.

In summary, this study highlights the widespread prevalence of vitamin D deficiency among infertile males but does not establish a significant association between vitamin D levels and semen abnormalities. While vitamin D alone may not be a decisive factor in male fertility, its potential role in broader metabolic and endocrine functions necessitates further investigation. Future studies should explore larger cohorts and interventional designs to determine whether correcting vitamin D deficiency can positively influence male reproductive outcomes.

CONCLUSION

Vitamin D deficiency probably has a direct effect on sperm abnormality in infertile men. Our data have shown that almost all infertile males due to abnormal semen parameters are suffering from Vitamin D deficiency or insufficiency. There may be a role of vitamin D deficiency as a marker of poor reproductive health or the underlying etiological problems. It seems that impaired reproductive function can be corrected by vitamin D and calcium supplements, and fortification. The prevalence of low vitamin D levels among our infertile men is considerable, considering our lifestyle and geographical zones.

Limitations and recommendations

This study was limited by its cross-sectional design, small sample size, and lack of longitudinal follow-up, preventing causal inferences. Potential confounding factors such as lifestyle, diet, and genetic influences were not fully controlled. Additionally, the study did not assess the impact of vitamin D supplementation on fertility outcomes. Future large-scale, randomized clinical trials are recommended to explore the role of vitamin D in male infertility, determine optimal serum levels, and assess the effectiveness of supplementation in improving semen parameters.

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