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Original Research Article

SEMEN QUALITY ALTERATIONS IN MEN WITH HYPERLIPIDEMIA AND DIABETES MELLITUS: A CROSS-SECTIONAL STUDY

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Abstract

Background: The impact of comorbid health conditions such as hyperlipidemia and diabetes mellitus on semen quality is not well understood. This study aims to assess the influence of these conditions on various semen parameters in men seeking infertility evaluation. **Materials and Methods:** A cross-sectional study was conducted involving 78 male patients aged 20-45 years, assessed for infertility. Participants provided informed consent and were categorized based on the presence of hyperlipidemia and diabetes mellitus. Semen analysis was performed according to WHO guidelines, measuring total sperm count, total motility, progressive motility, non-progressive motility, immotile sperm, and round cells. Statistical analysis included t-tests and chi-square tests to compare semen parameters between groups. **Results:** The study population had a mean age of 31.8 ± 4.5 years, a mean BMI of 27.7 ± 5.4 kg/m², and a mean duration of infertility of 3.5 ± 2.4 years. Among participants, 57.7% had diabetes mellitus and 67.9% had hyperlipidemia. The mean total sperm count was 25.6 ± 13.8 million/mL, and total motility was 78.2 ± 22.6%. Progressive motility was 42.8 ± 22.9%, non-progressive motility was 35.3 ± 22.4%, and immotile sperm was 19.4 ± 18.9%. Hyperlipidemia was associated with significantly lower progressive motility (37.9 ± 21.2%) compared to those without (53.3 ± 23.3%; $p = 0.005$). Diabetic individuals had significantly lower total motility (71.8 ± 26.3%) compared to non-diabetic individuals (87.0 ± 11.9%; $p = 0.003$) and higher immotile sperm percentages (24.1 ± 21.7% vs. 13.0 ± 11.9%; $p = 0.010$). Normozoospermia was significantly less prevalent in those with hyperlipidemia (28.3% vs. 64.0%; $p = 0.003$) and diabetes mellitus (22.2% vs. 63.6%; $p < 0.0001$). **Conclusion:** Hyperlipidemia and diabetes mellitus significantly impact semen quality, reducing motility and increasing the proportion of immotile sperm. These findings highlight the importance of managing metabolic health to improve reproductive outcomes. Further research is needed to explore the mechanisms and potential interventions to mitigate these adverse effects.

INTRODUCTION

Semen quality is a critical determinant of male fertility and is influenced by a multitude of factors, including genetic, environmental, and lifestyle variables. Over recent decades, research has increasingly highlighted the role of comorbid health conditions in affecting semen quality. These conditions, ranging from metabolic disorders to chronic illnesses, may significantly impair various semen parameters, such as sperm count, motility, morphology, and volume.[1]

Male infertility is a growing concern worldwide, with studies suggesting that it contributes to approximately 50% of all infertility cases. According to the World Health Organization (WHO), infertility affects an estimated 15% of couples globally, with male factors accounting for nearly half of these cases.[2] In recent years, there has been an alarming decline in semen quality, with a study published in Human Reproduction Update revealing a 50-60% reduction in sperm counts among men from North America, Europe, Australia, and New Zealand between 1973 and 2011.[2]

In India, infertility affects about 10-15% of couples, with male infertility contributing to around 40-50% of these cases.[3,4] The decline in semen quality has been observed in Indian men as well, with several studies reporting decreasing trends in sperm parameters over the past few decades. This decline

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is attributed to a range of factors, including lifestyle changes, environmental pollution, and increasing prevalence of comorbid health conditions.[4]

Several comorbid health conditions have been identified as significant contributors to this decline in semen quality. For instance, obesity, which has nearly tripled worldwide since 1975 according to the WHO, is linked to decreased sperm concentration and motility.[5] Diabetes mellitus, affecting over 400 million people globally, is associated with oxidative stress and inflammation, leading to impaired spermatogenesis. In India, around 77 million people are living with diabetes, making it a significant health concern.[6]

Cardiovascular diseases, which account for over 17 million deaths annually worldwide, are also implicated in poor semen quality due to vascular and endothelial dysfunction.[7] In India, cardiovascular diseases are responsible for nearly 28% of all deaths, highlighting the need to address this comorbidity in the context of male reproductive health.[8]

Furthermore, lifestyle-related conditions such as hypertension, hyperlipidemia, and metabolic syndrome are increasingly recognized for their detrimental effects on male reproductive health.[9] These conditions often coexist and create a compounding effect on semen quality, exacerbating the impact of each individual condition. Additionally, chronic infections, autoimmune diseases, and hormonal imbalances are crucial factors that cannot be overlooked.[10]

Understanding the intricate relationship between comorbid health conditions and semen quality is imperative for developing effective interventions and treatment strategies. So, the present study was conducted with an aim to evaluate the impact of various comorbidities on semen quality, providing a comprehensive analysis of the current evidence and identifying potential areas for further investigation.

MATERIALS AND METHODS

Study Design and Participants

This cross-sectional study was conducted in the infertility clinic of Obstetrics and Gynaecology department at tertiary care center of North India, a period of 1 year from July 2022 to June 2023 after obtaining the ethical approval from the institutional review board. The study included were male patients who were assessed for infertility (aged 20-45 years) after obtaining their informed consent. Participants were required to have abstained from ejaculation for 2-7 days prior to semen collection. Exclusion criteria included a history of genetic or congenital reproductive anomalies, chemotherapy or radiotherapy, medication known to affect sperm parameters, acute febrile illness or active infection at the time of semen collection, and a history of smoking, alcohol, or drug abuse.

Sample Size Calculation

The sample size calculation was based on the expected prevalence of abnormal semen parameters among men with comorbid health conditions. Using a confidence level of 95% and a margin of error of 10%, the initial sample size was calculated to be 96 participants. This was derived from the formula:$n=Z^2p(1-p)/e^2$, where Z is 1.96 for a 95% confidence level, p is 0.5 (estimated prevalence), and e is 0.1 (margin of error). After adjusting for potential dropouts and non-responses, a final sample size of 78 participants was determined to be sufficient for the study.

Data Collection and Study Questionnaire

Data were collected using a structured questionnaire that included sections on demographic information, medical history, lifestyle factors, and comorbid health conditions. Participants were also asked to provide details on their reproductive history and any previous diagnoses of infertility.

Semen Analysis

Semen samples were collected by masturbation into sterile containers after 2-7 days of sexual abstinence. The samples were allowed to liquefy at room temperature for 30-60 minutes before analysis. Semen analysis was performed according to the World Health Organization (WHO) guidelines (2010). The total sperm count was measured using a hemocytometer or automated sperm counter. Total motility, progressive motility, and non-progressive motility were assessed using computer-assisted semen analysis (CASA). Immotile sperm were identified using CASA, and round cells were quantified using light microscopy.

The WHO reference values used as cut-offs for semen parameters were as follows: total sperm count ≥15 million sperm/mL, total motility ≥40% motile sperm, progressive motility ≥32% sperm showing progressive motility, non-progressive motility included in the total motility ≥40%, immotile sperm ≤60% of the total sperm count, and round cells ≤1 million/mL. Sperm agglutination described as either mild (< 10 sperm/agglutinated with many free-swimming sperm), moderate (10-50 agglutinated with some free-swimming sperm), and severe (>50 agglutinated some sperm still free).

Participants were categorized into different semen quality conditions based on their semen analysis results, according to the World Health Organization (WHO) reference values and criteria. Normozoospermia was defined as having normal sperm parameters, including a total sperm count of ≥15 million/mL, total motility ≥40%, progressive motility ≥32%, and ≥4% normal forms. Azoospermia was defined as the complete absence of sperm in the ejaculate. Oligozoospermia referred to a reduced sperm count with a total sperm count of <15 million/mL. Asthenozoospermia was characterized by reduced sperm motility, with total motility <40% or progressive motility <32%. Teratozoospermia was defined by abnormal sperm morphology, with less than 4% normal forms.

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Oligoasthenozoospermia combined the conditions of oligozoospermia and asthenozoospermia, indicating a reduced sperm count and reduced sperm motility. Oligoteratozoospermia combined oligozoospermia and teratozoospermia, indicating a reduced sperm count and abnormal sperm morphology. Finally, asthenoteratozoospermia combined asthenozoospermia and teratozoospermia, indicating reduced sperm motility and abnormal sperm morphology.

Statistical Analysis

Data were analyzed using SPSS version 20.0. Descriptive statistics were used to summarize the data. Comparisons between groups were made using chi-square tests for categorical variables and independent t-test for continuous variables. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

The confidentiality of participant data was maintained throughout the research process, and participants were assured that their information would be used solely for research purposes. The study adhered to the ethical principles outlined in the Declaration of Helsinki.

RESULTS

The study included 78 male participants with a mean age of 31.8 ± 4.5 years and a body mass index (BMI) of 27.7 ± 5.4 kg/m². The average duration of infertility among participants was 3.5 ± 2.4 years. Comorbid health conditions were prevalent among the study population, with 45 participants (57.7%) having diabetes mellitus and 53 participants (67.9%) having hyperlipidemia. [Table 1]

The semen analysis revealed the following parameters: the mean total sperm count was 25.6 ± 13.8 million/mL, with a range of 0 to 68 million/mL. Total motility averaged 78.2 ± 22.6%, spanning from 0 to 98%. Progressive motility was 42.8 ± 22.9%, with values ranging from 0 to 85%. Non-progressive motility was 35.3 ± 22.4%, with a range of 0 to 80%. The percentage of immotile sperm averaged 19.4 ± 18.9%, with a range from 0 to 85%. The mean number of round cells was 4.1 ± 1.2 million/mL, ranging from 0 to 6 million/mL. Regarding agglutination, 48.7% of participants exhibited mild agglutination, 41.0% had moderate agglutination, and 10.3% experienced severe agglutination. [Table 2]

The categorization of semen quality revealed the following distribution: Normozoospermia was the most common category, with 31 participants (39.8%) falling into this group. Asthenozoospermia was observed in 23 participants (29.5%). Asthenoteratozoospermia was present in 7 participants (9.0%), while teratozoospermia was identified in 6 participants (7.7%). Oligoasthenozoospermia and oligoterozoospermia each accounted for 4 participants (5.1%). Azoospermia was found in 2 participants (2.6%), and oligozoospermia was the least common, with only 1 participant (1.3%). [Table 3]

The analysis of semen parameters revealed that total sperm count did not significantly differ between those with and without hyperlipidemia (25.1 ± 13.6 vs. 27.0 ± 14.8 million/mL) or diabetes mellitus (25.4 ± 16.5 vs. 26.0 ± 9.4 million/mL). Total motility was significantly lower in individuals with diabetes mellitus (71.8 ± 26.3%) compared to those without (87.0 ± 11.9%), with a p-value of 0.003. Hyperlipidemia also associated with reduced total motility (76.9 ± 23.5%), though not significantly (p = 0.466). Progressive motility was significantly decreased in both hyperlipidemia (37.9 ± 21.2%) and diabetes mellitus (35.0 ± 22.0%) compared to controls (53.3 ± 23.3% and 53.6 ± 19.8%), with p-values of 0.005 and <0.0001, respectively. Non-progressive motility was significantly higher in those with hyperlipidemia (39.0 ± 22.5%) versus those without (27.7 ± 20.8%), but not affected by diabetes status (p = 0.488). Immotile sperm percentages were higher in diabetes mellitus (24.1 ± 21.7%) compared to controls (13.0 ± 11.9%), with a p-value of 0.010. No significant differences were observed in round cell counts between any of the groups. [Table 4]

The distribution of normozoospermia among participants with and without hyperlipidemia and diabetes mellitus showed significant differences. Among those with hyperlipidemia, 28.3% had normozoospermia compared to 64.0% of those without hyperlipidemia, with a p-value of 0.003. For diabetes mellitus, only 22.2% of those with the condition had normozoospermia, whereas 63.6% of those without diabetes did, with a highly significant p-value of <0.0001. [Table 5]

Table 1: Baseline Characteristics of Study Participants (N=78)

Characteristic	Frequency (%)/ Mean ± SD
Age (years)	31.8 ± 4.5
BMI (kg/m²)	27.7 ± 5.4
Duration of Infertility (years)	3.5 ± 2.4
Comorbid Conditions	
Diabetes Mellitus	45 (57.7)
Hyperlipidemia	53 (67.9)

Table 2: Semen Parameters of Study Participants (N=78)

Parameter	Frequency (%)/ Mean ± SD	Range
Total Sperm Count (million/mL)	25.6 ± 13.8	0-68
Total Motility (%)	78.2 ± 22.6	0-98

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Progressive Motility (%)	42.8 ± 22.9	0-85
Non-Progressive Motility (%)	35.3 ± 22.4	0-80
Immotile (%)	19.4 ± 18.9	0-85
Round Cells (million/mL)	4.1 ± 1.2	0-6
Agglutination		
Mild	38 (48.7)	-
Moderate	32 (41.0)	-
Severe	8 (10.3)	-

Table 3: Categorization of Semen Quality (N=78)

Category	Frequency	%
Asthenoteratozoospermia	7	9
Asthenozoospermia	23	29.5
Azoospermia	2	2.6
Normozoospermia	31	39.8
Oligoasthenozoospermia	4	5.1
Oligoteratozoospermia	4	5.1
Oligozoospermia	1	1.3
Teratozoospermia	6	7.7

Table 4: Comparison of Semen Parameters by Comorbid Health Conditions (N=78)

Parameter	Hyperlipidemia		Diabetes Mellitus	
	Yes (n=53)	No (n=25)	Yes (n=45)	No (n=33)
	Mean ± SD		Mean ± SD	
Total Sperm Count (million/mL)	25.1 ± 13.6	27.0 ± 14.8	25.4 ± 16.5	26.0 ± 9.4
P value	0.568		0.863	
Total Motility (%)	76.9 ± 23.5	81.0 ± 20.9	71.8 ± 26.3	87.0 ± 11.9
P value	0.466		0.003	
Progressive Motility (%)	37.9 ± 21.2	53.3 ± 23.3	35.0 ± 22.0	53.6 ± 19.8
P value	0.005		<0.0001	
Non-Progressive Motility (%)	39.0 ± 22.5	27.7 ± 20.8	36.9 ± 23.8	33.3 ± 20.7
P value	0.037		0.488	
Immotile (%)	21.5 ± 21.0	15.0 ± 12.7	24.1 ± 21.7	13.0 ± 11.9
P value	0.164		0.010	
Round Cells (million/mL)	4.1 ± 1.2	4.2 ± 1.3	4.3 ± 1.3	3.9 ± 1.0
P value	0.876		0.123	

Table 5: Statistical Analysis of Semen Quality Differences (N=78)

Parameter	Normozoospermia		p-value
	Yes (n=31)	No (n=47)	
Hyperlipidemia			
Yes (n=53)	15 (28.3)	38 (71.7)	0.003
No (n=25)	16 (64.0)	9 (36.0)	
Diabetes Mellitus			
Yes (n=45)	10 (22.2)	35 (77.8)	<0.0001
No (n=33)	21 (63.6)	12 (36.4)	

DISCUSSION

The primary objective of this study was to assess the impact of comorbid health conditions, specifically hyperlipidemia and diabetes mellitus, on semen quality. Our findings indicate that these comorbidities are associated with significant alterations in several semen parameters, which could contribute to male infertility.

The study population had a mean age of 31.8 ± 4.5 years and a mean BMI of 27.7 ± 5.4 kg/m². The mean duration of infertility was 3.5 ± 2.4 years. Among the participants, 57.7% had diabetes mellitus, and 67.9% had hyperlipidemia. These characteristics reflect a population with a high prevalence of metabolic comorbidities, which are known to impact overall health and reproductive function.[11,12]

The semen analysis revealed a mean total sperm count of 25.6 ± 13.8 million/mL and total motility of 78.2 ± 22.6%. Progressive motility averaged 42.8 ± 22.9%, non-progressive motility 35.3 ± 22.4%, and immotile sperm 19.4 ± 18.9%. In a study by Jairajpuri et al., 42.5% of the cases had sperm counts in the range of 51-80 million/ml.[13] In a study by Koju et al., the mean sperm concentration for normazoospermic and oligozoospermic group was 46.6±21.7 and 7.0±3.8 respectively while the mean percentage of progressive motility is 47.2±23.5 in normozoospermia and 19.4±22.4 in oligozoospermia.[14]

The distribution of semen quality categories among participants revealed that 39.8% had normozoospermia, while the remaining 60.2% had various forms of abnormal semen parameters, including asthenozoospermia (29.5%), asthenoteratozoospermia (9%), azoospermia (2.6%), oligoasthenozoospermia (5.1%), oligoteratozoospermia (5.1%), oligozoospermia (1.3%), and teratozoospermia (7.7%). This

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distribution further underscores the significant impact of comorbid conditions on semen quality. A study by Tilahun et al., showed that majority participants, 84%, had one or more abnormal semen analysis parameters. Asthenozoospermia (43.5%), necrozoospermia (25.2%), oligozoospermia (24%), azoospermia (24%), and oligoasthenoteratozoospermia (25.2%) were the severe forms of abnormal semen analysis findings detected in this study.[15] In a study by Kurdukar et al., semen analysis was normal in 55% of cases. The dominant abnormality found was oligozoospermia (30%) followed by asthenozoospermia (27.5%). Azoospermia was found in 10% of cases.[16]

Our results show that individuals with hyperlipidemia had significantly lower progressive motility (37.9 ± 21.2%) compared to those without (53.3 ± 23.3%), with a p-value of 0.005. Non-progressive motility was also higher in the hyperlipidemic group (39.0 ± 22.5%) compared to those without hyperlipidemia (27.7 ± 20.8%), with a p-value of 0.037. These findings suggest that hyperlipidemia negatively impacts sperm motility, which is consistent with previous research.[17] Hyperlipidemia can lead to oxidative stress and inflammation, which in turn can damage sperm DNA and affect motility.[18]

Diabetes mellitus was associated with significantly lower total motility (71.8 ± 26.3%) and progressive motility (35.0 ± 22.0%) compared to non-diabetic individuals (87.0 ± 11.9% and 53.6 ± 19.8%, respectively), with p-values of 0.003 and <0.0001, respectively. The immotile sperm percentage was higher in diabetic individuals (24.1 ± 21.7%) compared to non-diabetic individuals (13.0 ± 11.9%), with a p-value of 0.010. These results are in line with those of studies by Zhong et al., and Kalaiselvi et al., who reported that diabetes adversely affects semen quality through mechanisms such as increased oxidative stress and glycation of sperm proteins.[19,20]

The prevalence of normozoospermia was significantly lower in individuals with hyperlipidemia and diabetes mellitus. Only 28.3% of those with hyperlipidemia had normozoospermia compared to 64.0% of those without ($p = 0.003$). For diabetes mellitus, only 22.2% of affected individuals had normozoospermia, versus 63.6% of non-diabetic individuals ($p < 0.0001$) (Table 3). This significant association highlights the impact of metabolic health on maintaining normal sperm parameters. These findings are supported by literatures that have shown systemic health conditions contribute to suboptimal sperm quality, often mediated through hormonal imbalances and metabolic disturbances.[21,22]

CONCLUSION

The present study underscores the significant impact of hyperlipidemia and diabetes mellitus on semen quality. These comorbid conditions are associated with reduced motility and an increased proportion of immotile sperm, which can contribute to infertility. These findings highlight the importance of managing metabolic health not only for general well-being but also for maintaining reproductive health. Future research should focus on elucidating the precise mechanisms by which these comorbidities affect sperm function and exploring potential therapeutic interventions to mitigate their adverse effects on male fertility.

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