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The Impact of Age on Semen Parameters among Patients Referred from an Infertility Clinic: A Retrospective Cross-Sectional Study at a Tertiary Care Center

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Abstract

Background: Infertility affects a significant proportion of couples globally, with male factors contributing substantially to these cases. While the impact of female reproductive aging is well-documented, the influence of male age on fertility remains less thoroughly understood. Understanding age-related changes in male semen parameters is crucial for accurate diagnosis and effective counselling in clinical infertility settings.

Methods: This retrospective cross-sectional study analysed semen analysis reports in the Department of Pathology collected between 2022 and 2024 from 285 men aged 22 to 50 years referred from an infertility clinic at MIMS, Mandya. Participants were categorized into three age groups: 20–30 years (n=95), 31–40 years (n=120), and > 41 years (n=70). Parameters measured included semen volume, sperm concentration, total sperm count, progressive motility, non-progressive motility, normal morphology, and abnormal morphology. Statistical analysis was performed using ANOVA and Pearson's correlation tests with SPSS v26.0, with statistical significance set at $p < 0.05$.

Results: A statistically significant decline with increasing age was observed for semen volume ($p<0.001$), normal sperm morphology ($p=0.012$), progressive motility ($p=0.030$), and non-progressive motility ($p=0.032$). Specifically, semen volume decreased by 23.6% in the 41 years group compared to the 20-30 years group, while normal forms showed an 8.9% relative decrease in the oldest group. Progressive motility experienced a substantial 31.2% drop in the oldest group versus the youngest. Conversely, sperm concentration and total sperm count did not show statistically significant age-related changes. Abnormal sperm morphology significantly increased with age ($p = 0.006$).

Conclusion: Advancing paternal age negatively impacts semen volume, progressive motility, and normal sperm morphology, particularly in men aged 41 years and older. Sperm concentration and total count remained stable across age groups in this cohort. These findings underscore the importance of considering male age in clinical fertility evaluations and counselling for couples planning families.

Keywords: Male Fertility, Paternal Age, Semen Parameters, Sperm Motility, Sperm Morphology, Semen Volume, Infertility Clinic.

Introduction

Infertility, defined as the inability to conceive after a year of regular unprotected intercourse, remains a pervasive global health issue, affecting approximately 15% of couples worldwide. This complex condition can stem from female factors, male factors, or a combination of both. Recent epidemiological data indicate that male factors are solely or partially responsible for a significant proportion of infertility cases, accounting for 35-40% of diagnoses [1]. Despite this substantial contribution, research and clinical attention have historically disproportionately focused on female reproductive aging, leading to a prevalent misconception that male reproductive potential is largely unaffected by age. This oversight has created a gap in understanding the full spectrum of factors influencing male fertility across the lifespan, especially in Indian subcontinent [2,3].

However, a growing body of evidence challenges this traditional view, suggesting that the male reproductive system, much like its female counterpart, undergoes structural and functional transformations with advancing age that can adversely impact semen quality, characterized by changes in volume, motility, and morphology and consequently, fertility [4]. The aging process, an unavoidable biological phenomenon, is associated with a series of physiological changes within the male reproductive system. For instance, studies have shown a decline in testicular volume, typically observed after the age of 60, alongside reductions in the number and function of Leydig, Sertoli, and germ cells. These cellular changes are often accompanied by hormonal shifts, including a decrease in testosterone levels and a compensatory increase in gonadotropin levels, which can contribute to testicular fibrosis and impaired function of accessory glands essential for semen production. Collectively, these age-related alterations are linked to a reduction in crucial semen parameters such as semen volume, sperm count, motility, and morphology [5,6].

Furthermore, oxidative stress, a biological hallmark of aging, plays a critical role in compromising sperm quality. Increased oxidative stress can damage sperm DNA and impair its functionality, thereby heightening the risk of genetic mutations and contributing to fertility challenges. With contemporary societal trends showing an increasing number of men choosing to delay fatherhood until older ages, the implications of advanced paternal age on semen quality and reproductive outcomes have emerged as a significant public health concern. Advanced paternal age has been associated with various adverse reproductive and offspring outcomes, including longer time-to-pregnancy, higher rates of miscarriage, and an increased risk of genetic abnormalities and neurocognitive disorders in offspring [7-9]. Despite these compelling associations, the precise relationship between male aging and specific semen quality parameters remains a subject of ongoing investigation and, at times, controversy.

Given these uncertainties and the historical underrepresentation of male fertility in reproductive medicine, this study aims to contribute to a more comprehensive understanding of male reproductive aging. The specific objective is to evaluate age-related changes in key semen parameters, including semen volume, sperm concentration, motility (progressive and non-progressive), and morphology (normal and abnormal forms). By analysing these parameters across different age groups, this research seeks to provide insights into the specific effects of aging on male reproductive health in a tertiary care setting in South India, thereby aiding in more precise diagnosis and effective counselling for couples grappling with infertility.

Methodology

Study Design and Setting: This was a retrospective cross-sectional study conducted in the Department of Pathology at Mandya Institute of Medical Sciences (MIMS), a tertiary care teaching hospital serving the rural population of southern Karnataka, India. The study was conducted in accordance with the ethical guidelines of the Indian Council of Medical Research and the New Drugs & Clinical Trials Rules (2019), with Institutional Ethics Committee approval obtained prior to initiation.

Study Duration

Data from semen analysis reports collected between January 2022 and November 2024 were included.

Participants: The study population comprised 285 male patients aged between 22 and 50 years who were referred from the infertility clinic at MIMS, Mandya. The proposed study included semen analysis data from male participants aged between 21 and 50 years from January 2022 to November 2024.

Inclusion and Exclusion Criteria

Inclusion Criteria: Men aged 21-50 years with complete semen analysis data according to WHO guidelines, including data on semen volume, sperm concentration, motility, and morphology.

Exclusion Criteria: Patients with incomplete medical data, men with known infertility factors unrelated to age (e.g., genetic conditions, azoospermia), and men with a known history of chronic diseases such as cryptorchidism, orchitis, or genital trauma.

Sampling Method: Convenience sampling was employed. All eligible and complete cases that fulfilled the inclusion criteria during the specified study period were included for analysis.

Data Collection Procedure: Data were retrieved from the laboratory records maintained in the pathology department of MIMS, Mandya, after obtaining approval from the Institutional Ethics Committee. The variables collected included demographic details (age), date of semen analysis, medical history, and detailed semen analysis parameters as per WHO guidelines (2021). These parameters encompassed semen volume, sperm concentration, total sperm count, progressive motility, non-progressive motility, immotile sperm percentage, and normal and abnormal sperm morphology. All data were anonymized and handled with strict confidentiality, adhering to ethical standards.

Age Group Analysis: To comprehensively assess the impact of age on semen parameters, the 285 study participants were systematically categorized into three distinct age groups:

Group 1 (20–30 years): This group consisted of 95 participants and was considered the youngest cohort, representing what is often regarded as the peak reproductive years for males.

Group 2 (31–40 years): Comprising 120 participants, this group represented the mid-reproductive age.

Group 3 (>41 years): This oldest cohort included 70 participants and was hypothesized to potentially exhibit more pronounced age-related effects on semen parameters.

Statistical Analysis: All collected data were entered into a Microsoft Excel sheet. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) trial version V.20 software. Descriptive statistics, including percentages, means, and standard deviations, were used to summarize categorical and continuous variables, respectively. For inferential statistics, ANOVA (Analysis of Variance) was utilized to compare means across the three age groups, and Pearson's correlation tests were employed to identify relationships between age and various semen parameters. A p-value of < 0.05 was established as the threshold for statistical significance.

Results

The study analysed semen parameters from 285 male patients referred from an infertility clinic. The participants were divided into three age groups: 20–30 years (n=95), 31–40 years (n=120), and > 41 years (n=70). The analysis revealed significant age-related changes in several key semen quality parameters respectively (Table-1)

Table 1: Demographic and Semen Parameter Distribution by Age Group

Parameter	20–30 years (n=95) Group 1	31–40 years (n=120) Group 2	≥41 years (n=70) Group 3	p-value
Age (Mean ± SD)	26.4 ± 2.8	35.2 ± 2.9	45.6 ± 4.1	<0.001*
Semen Volume (ml)	2.16 ± 0.52	1.96 ± 0.48	1.65 ± 0.43	<0.001*
Sperm Concentration (million/ml)	68.3 ± 21.7	65.8 ± 20.4	63.1 ± 19.2	0.215
Progressive Motility (%)	48.1 ± 12.3	40.0 ± 11.5	33.1 ± 10.8	0.030*
Normal Morphology (%)	69.8 ± 8.4	66.7 ± 7.9	63.6 ± 7.2	0.012*

*Statistically significant ($p < 0.05$).

n= number of subjects

Table 2: Correlation Coefficients (r) Between Age and Semen Parameters

Semen Volume	-0.275	<0.001*
Progressive Motility	-0.128	0.030*
Normal Morphology	-0.183	0.012*
Sperm Concentration	-0.062	0.215

*Negative correlations indicate declining values with age.

Semen Volume: Semen volume exhibited a statistically significant decline with increasing age ($p<0.001$). The mean semen volume for Group 1 (20-30 years) was 2.16 ml. For Group 2 (31-40 years), the mean volume was 1.96 ml, and for Group 3 (>41 years), it was 1.65 ml. This represents a substantial 23.6% decrease in mean semen volume in the oldest age group (>41 years) when compared to the youngest age group (20-30 years). Pearson's correlation coefficient further indicated a

significant negative correlation between semen volume and age (r = -0.275).

Sperm Morphology

- **Normal Sperm Morphology:** A statistically significant decrease in normal sperm morphology was observed with advancing age (p=0.012). The mean percentage of normal forms was 69.81% for Group 1 (20-30 years), 66.72% for Group 2 (31-40 years), and 63.61% for Group 3 (>41 years). This translates to an 8.9% relative decrease in normal forms in the oldest age group compared to the youngest. A significant negative correlation (r = -0.183) was found between normal morphology and age.
- **Abnormal Sperm Morphology:** Conversely, abnormal sperm morphology significantly increased with age (p=0.006). The mean percentages of abnormal forms across the age groups were 29.80% (20-30 yrs), 33.40% (31-40 yrs), and 36.24% (>41 yrs).

Sperm Motility:

- **Progressive Motility:** Progressive motility showed a statistically significant decrease with advancing age (p=0.030). The mean progressive motility was 48.14% for Group 1, 40.00% for Group 2, and 33.12% for Group 3. This signifies a substantial 31.2% drop in forward-moving sperm in the oldest age group when compared to the youngest. A significant negative correlation (r = -0.128) was observed between progressive motility and age.
- **Non-Progressive Motility:** Non-progressive motility also demonstrated a significant negative correlation with age (p=0.032).

Parameters Not Significantly Affected by Age: While semen volume, motility, and morphology showed declines, some key parameters remained stable across the different age groups.

- **Sperm Concentration:** No statistically significant difference was observed in sperm concentration between the age groups (p > 0.05). The number of sperm per milliliter of semen remained relatively consistent regardless of age.
- **Total Sperm Count:** Similarly, total sperm count did not show a significant variation with increasing paternal age within this study cohort (p > 0.05).

These findings suggest that in the studied population, advancing paternal age primarily impacts semen quality, specifically sperm movement (motility) and shape (morphology), along with the fluid volume, rather than the overall sperm production density. This observation stands in contrast to some other studies that report age-related declines in sperm concentration and total count, highlighting potential population-specific differences.

Discussion

The findings of this retrospective cross-sectional study provide crucial insights into the impact of advancing paternal age on semen parameters among men referred from an infertility clinic in a South Indian tertiary care center. The observed declines in semen volume, progressive motility, and normal sperm morphology are consistent with previous research by Eskenazi et al. and Gunes et al., who also reported age-related deterioration in semen quality [6,10].

A particularly noteworthy finding is that the most significant adverse changes in semen quality were observed in men aged 41 years and older. This suggests a potential age threshold around 40 years where the decline in semen quality may accelerate, marking a critical period for male reproductive health. This accelerated decline highlights the importance of

considering male age as a significant factor in fertility evaluations, especially for older male partners. The progressive reduction in semen volume, for example, could be attributed to age-related changes in the accessory glands (e.g., prostate, seminal vesicles), which contribute a substantial portion of the seminal fluid. Reductions in Leydig, Sertoli, and germ cells, along with impaired accessory gland function, are known consequences of aging that directly influence semen volume and overall quality.

The decline in progressive motility is also a critical observation, as forward-moving sperm are essential for successful fertilization. A substantial 31.2% drop in progressive motility in the oldest group compared to the youngest underscores the functional impairment of sperm with age. This aligns with studies showing negative correlations between age and total motility, progressive motility, and total progressive motile count [2,10,11]. Similarly, the significant decrease in normal sperm morphology and the concomitant increase in abnormal forms directly impact the fertilizing capacity of sperm, as abnormally shaped sperm are less likely to achieve fertilization [1,3,12]. Oxidative stress, which intensifies with aging, is known to damage sperm DNA and impair its function, contributing to both reduced motility and increased morphological abnormalities. This age-related DNA damage in sperm can lead to increased risks of genetic mutations and fertility issues for offspring [6,7,11].

In contrast to the observed declines, a notable finding of this study was the stability of sperm concentration and total sperm count across all age groups. This suggests that in this specific population cohort, paternal age primarily impacts the functional aspects of semen (movement and shape) and the volume of seminal fluid, rather than the overall density of sperm production. This finding diverges from some other reports, such as those by Kumar et al or other studies [9,13] indicated age-related declines in sperm concentration. The reasons for this discrepancy could be multifaceted, potentially stemming from regional factors, genetic predispositions within the studied South Indian population, or methodological differences in participant selection and data collection. For example, some studies might include broader populations or different inclusion/exclusion criteria that capture more severe cases of age-related decline in sperm production. This highlights the importance of conducting region-specific studies to understand the nuances of male reproductive aging within diverse populations.

The study's findings reinforce the growing understanding that male age is a relevant and often underappreciated factor in the complex landscape of infertility. For clinicians, these results emphasize the necessity of including paternal age as a critical consideration during fertility evaluations and counselling sessions. Providing age-aware advice is paramount for couples who are planning families, especially when the male partner is of advanced age, as this information can influence treatment decisions and expectations. Understanding these specific age-related impacts allows for more targeted diagnostic approaches and potentially earlier interventions to mitigate the effects of aging on male fertility.

However, it is important to acknowledge certain limitations of this retrospective cross-sectional study. Being a hospital-based study, the sample may predominantly represent patients already presenting with infertility issues, potentially skewing the findings towards a population already experiencing some level of reproductive challenge. This could mean that the

observed declines might be more pronounced than in a general fertile male population. Furthermore, while the study controlled for known infertility factors unrelated to age in its exclusion criteria, it did not prospectively control for various lifestyle factors (e.g., diet, exercise, environmental exposures, smoking, alcohol use) which are known to influence semen quality [14,15,16]. These unmeasured variables could potentially confound the age-related effects. Future prospective studies that rigorously control for these lifestyle and environmental factors would be invaluable in confirming these findings and exploring potential interventions aimed at preserving male fertility with advancing age. Additionally, the reliance on collected reports means a lack of direct control over sample collection and processing nuances, which, while standardized by WHO guidelines, can still introduce minor variability.

Conclusion

In conclusion, advancing paternal age significantly and negatively impacts several key semen parameters, including semen volume, progressive motility, and normal sperm morphology, in men seeking fertility assistance at this tertiary care clinic. These adverse changes were particularly pronounced in men aged 41 years and older, suggesting a potential acceleration of decline around this age. Notably, sperm concentration and total sperm count remained stable and did not exhibit significant age-related changes in this specific study cohort.

These findings underscore that paternal age is a relevant and critical factor in male fertility assessment and should be thoroughly considered by clinicians. Incorporating age-related data into male fertility evaluations can lead to more accurate diagnoses and facilitate more informed and tailored counselling for couples planning families, particularly when the male partner is older. Future prospective studies are recommended to further confirm these observations, particularly those that can control for a broader range of lifestyle and environmental factors, and to investigate potential interventions aimed at ameliorating age-related declines in male reproductive health.

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