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Original Research Article

ASSOCIATION OF ALCOHOL CONSUMPTION AND CIGARETTE SMOKING WITH SEMEN QUALITY AMONG MEN ATTENDING AN INFERTILITY CLINIC: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Male infertility contributes to nearly half of infertility cases worldwide, with lifestyle-related risk factors increasingly recognized as modifiable determinants of semen quality. Among these, alcohol consumption and cigarette smoking have been implicated in oxidative stress, hormonal dysregulation, DNA damage, and impaired spermatogenesis. However, evidence from Indian populations remains limited and inconsistent. The present study evaluated the association of alcohol consumption and cigarette smoking with semen parameters among men undergoing infertility evaluation.

Materials and Methods: A descriptive cross-sectional study was conducted among 215 men attending the Fertility Clinic of the Department of Obstetrics and Gynaecology, Government Medical College, Kottayam. After obtaining informed consent, demographic details and detailed history regarding alcohol consumption and smoking habits were recorded. Semen samples were analyzed according to WHO 2010 guidelines. Associations between alcohol use, duration of alcohol consumption, smoking status, smoking chronicity, and semen parameters were analyzed using Pearson's Chi-square test with statistical significance set at $p<0.05$.

Results: Among the study participants, approximately half reported alcohol consumption, while nearly one-fourth were smokers. Alcohol consumption demonstrated significant associations with reduced sperm concentration, impaired motility, abnormal progressive motility, reduced vitality, and abnormal morphology. Longer duration of alcohol use showed a stronger adverse influence on semen quality. Cigarette smoking was significantly associated with oligospermia and abnormal sperm morphology, with greater impairment observed among men with higher cumulative smoking exposure.

Conclusion: Alcohol consumption and cigarette smoking were significantly associated with deterioration of multiple semen parameters, supporting the importance of behavioral modification during infertility management. Early counselling regarding cessation of alcohol and tobacco use may improve reproductive outcomes in infertile men.

Keywords: Male infertility; Alcohol; Cigarette smoking; Semen analysis; Lifestyle factors.

INTRODUCTION

Infertility has emerged as an important global public health issue affecting millions of couples worldwide. According to the World Health Organization (WHO), infertility is defined as the inability to achieve pregnancy after 12 months or more of regular unprotected sexual intercourse.[1] Approximately 15–20% of couples experience infertility during their reproductive years, and male-

related factors contribute to nearly half of these cases. In nearly 20–30% of infertile couples, the male partner is solely responsible for infertility, while an additional 20–30% have combined male and female factors. Consequently, evaluation of male reproductive health has become an integral component of infertility assessment.[2]

Semen analysis remains the cornerstone of male fertility evaluation because it provides objective information regarding sperm concentration, motility, morphology, vitality, semen volume, and liquefaction characteristics. Alterations in one or more of these parameters are strongly associated with reduced fertilizing potential. However, conventional semen analysis often identifies abnormalities without revealing their underlying causes. Increasing evidence suggests that modifiable lifestyle factors play an important role in determining semen quality, thereby providing opportunities for preventive interventions.[3]

Among lifestyle factors, alcohol consumption and cigarette smoking are the two most prevalent potentially reversible exposures affecting reproductive health. Both habits have become increasingly common among men of reproductive age due to changing social norms, urbanization, occupational stress, and changing lifestyle patterns. Although numerous epidemiological studies have evaluated their influence on male fertility, the reported findings remain inconsistent because of differences in study populations, exposure assessment, duration of addiction, and laboratory methodologies.[4]

Alcohol exerts its detrimental effects on male reproductive function through multiple biological mechanisms. Chronic alcohol intake interferes with the hypothalamic-pituitary-gonadal axis, resulting in suppression of gonadotropin secretion and reduced testosterone production by Leydig cells. Alcohol-induced oxidative stress increases reactive oxygen species within the testes, leading to lipid peroxidation, mitochondrial dysfunction, DNA fragmentation, and apoptosis of germ cells. Furthermore, chronic alcohol consumption impairs Sertoli cell function, disrupts spermatogenesis, and alters epididymal maturation of spermatozoa. These mechanisms collectively contribute to reductions in sperm concentration, impaired motility, abnormal morphology, and decreased sperm viability.[5]

Similarly, cigarette smoking has been consistently associated with impaired semen quality. Tobacco smoke contains thousands of toxic chemicals, including nicotine, cadmium, lead, carbon monoxide, and numerous carcinogenic compounds capable of crossing the blood-testis barrier. These substances increase oxidative stress, induce inflammatory responses, damage sperm DNA, and impair mitochondrial energy production necessary for normal sperm motility. Smoking has also been associated with hormonal alterations, increased sperm chromatin abnormalities, and reduced antioxidant capacity of seminal plasma. Several studies have demonstrated dose-dependent reductions in sperm count and progressive motility among smokers, although some investigations have failed to establish statistically significant associations, highlighting the need for further population-specific research.[5-,7]

The present study was undertaken to evaluate the association between alcohol consumption, cigarette smoking, and semen parameters among men attending an infertility clinic. By examining both current exposure and duration of these addictive habits, this study aims to provide clinically relevant evidence regarding their influence on sperm concentration, motility, morphology, vitality, and other semen characteristics in an Indian population.

MATERIALS AND METHODS

A hospital-based descriptive cross-sectional study was conducted over an 18-month period from 1 March 2018 to 31 August 2019 at the Fertility Unit, Department of Obstetrics and Gynaecology, Government Medical College, Kottayam, Kerala. The study evaluated the association between addictive lifestyle habits, specifically alcohol consumption and cigarette smoking, and semen quality among men presenting with infertility.

The study population comprised men aged 25–60 years attending the fertility clinic for evaluation of infertility. Eligible participants were recruited consecutively after confirming that they satisfied the predefined inclusion and exclusion criteria. Men with a history of testicular trauma or surgery, torsion, varicocele, orchitis, cryptorchidism and corrective surgery, mumps orchitis, chronic intake of medications known to affect spermatogenesis (including antidepressants, calcium channel blockers, alpha-adrenergic blockers, antiepileptic drugs, and antiretroviral therapy), use of indigenous medications, or those already receiving infertility treatment were excluded from the study.

Sample Size and Sampling Technique

The sample size was estimated for a descriptive cross-sectional study using the formula for estimating a population proportion with specified relative precision:

4PQ/L2

Based on a previous study,[2] reporting that approximately 33% of men with alcohol consumption or smoking habits exhibited poor semen quality, an anticipated prevalence of 33%, relative precision of 20%, and 95% confidence level were considered for sample size estimation. The minimum calculated sample size was 195 participants. After accounting for a 10% non-response rate, the final sample size was increased to 215 participants. Consecutive sampling was employed until the required sample size was achieved.

Data Collection: Following informed written consent, participants underwent a structured

interview conducted by the principal investigator using a predesigned questionnaire. Information regarding demographic characteristics and addictive lifestyle habits, including alcohol consumption, duration of alcohol use, cigarette smoking status, and duration of smoking, was recorded. Alcohol intake and smoking exposure constituted the principal independent variables evaluated in the present study.

Participants were instructed to maintain three days of sexual abstinence before semen collection. Semen samples were obtained by masturbation into sterile wide-mouthed plastic containers under standard laboratory conditions. Samples were allowed to liquefy completely at room temperature before analysis. Semen evaluation was performed according to the World Health Organization (WHO) 2010 guidelines, assessing semen volume, sperm concentration, total motility, progressive motility, vitality, and sperm morphology.

The primary outcome measures included abnormalities in semen parameters, namely oligospermia, asthenozoospermia, teratozoospermia, necrozoospermia, reduced progressive motility, and alterations in semen volume. These outcomes were compared between participants with and without alcohol consumption and cigarette smoking, as well as according to the duration of these habits.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 24. Categorical variables were summarized as frequencies and percentages. Associations between alcohol consumption, smoking characteristics, and semen abnormalities were evaluated using Pearson's Chi-square test. A two-sided p-value <0.05 was considered statistically significant.

Ethical Considerations: The study was conducted after obtaining approval from the Institutional Ethics Committee of Government Medical College, Kottayam. Written informed consent was obtained from all participants before enrolment. Confidentiality and anonymity of participant information were maintained throughout the study.

RESULTS

Table 1: Baseline characteristics of the study participants (N = 215)

Characteristic	Frequency (n)	Percentage (%)
Age (years)		
25–30	72	33.5
31–40	103	47.9
41–50	35	16.3
51–60	5	2.3
Alcohol consumption	109	50.7
Non-alcoholic	106	49.3
Smoking status	57	26.5
Non-smoker	158	73.5

Among the 215 participants, nearly half (47.9%) belonged to the 31–40-year age group. Alcohol consumption was reported by 109 (50.7%) participants, whereas 57 (26.5%) had a history of cigarette smoking.

Table 2: Distribution of abnormal semen parameters among the study population (N = 215)

Semen parameter	Abnormal, n (%)
Low semen volume	26 (12.1)
Abnormal liquefaction	5 (2.3)
Oligospermia	99 (46.0)
Asthenozoospermia	67 (31.2)
Reduced progressive motility	109 (50.7)
Reduced vitality	70 (32.6)
Teratozoospermia	12 (5.6)

Reduced progressive motility was the commonest abnormality (50.7%), followed by oligospermia (46.0%). Teratozoospermia (5.6%) and abnormal liquefaction (2.3%) were the least common abnormalities observed.

Table 3: Association between severity of alcohol consumption and semen parameters

Semen parameter	χ^2	P value	Significance
Sperm concentration	12.800	0.005	Significant
Total motility	10.275	0.016	Significant
Progressive motility	7.210	0.066	Not significant
Vitality	11.400	0.010	Significant
Morphology	39.784	<0.001	Significant

Alcohol consumption demonstrated a statistically significant association with sperm concentration, total motility, vitality and sperm morphology. Progressive motility showed a declining trend with

increasing alcohol intake; however, the association did not reach statistical significance (p=0.066). Heavy alcohol consumers exhibited the greatest proportion of abnormal semen parameters.

Table 4: Severity of alcohol consumption and distribution of abnormal semen parameters

Alcohol intake	Low concentration n (%)	Low motility n (%)	Reduced vitality n (%)	Abnormal morphology n (%)
Non-alcoholic	39 (36.8)	28 (26.4)	28 (26.4)	7 (6.6)
Mild	35 (47.3)	24 (32.4)	25 (33.8)	2 (2.7)
Moderate	22 (71.0)	11 (35.5)	13 (41.9)	0 (0.0)
Heavy	3 (75.0)	4 (100.0)	4 (100.0)	3 (75.0)

A dose-dependent deterioration in semen quality was observed with increasing alcohol intake. Heavy alcohol consumption was associated with the highest prevalence of oligospermia, impaired motility, reduced vitality and abnormal sperm morphology.

Table 5: Association between duration of alcohol consumption and semen parameters

Semen parameter	χ^2	P value	Significance
Sperm concentration	15.421	0.031	Significant
Total motility	26.001	0.001	Significant
Progressive motility	18.082	0.012	Significant
Vitality	21.870	0.003	Significant
Morphology	5.511	0.598	Not significant

Longer duration of alcohol consumption significantly influenced sperm concentration, motility, progressive motility and vitality. However, duration of alcohol exposure was not significantly associated with sperm morphology.

Table 6: Association between smoking status and semen parameters

Semen parameter	χ^2	P value	Significance
Sperm concentration	14.226	0.001	Significant
Total motility	2.374	0.305	Not significant
Progressive motility	3.134	0.209	Not significant
Vitality	1.624	0.444	Not significant
Morphology	22.900	<0.001	Significant

Smoking was significantly associated with reduced sperm concentration and abnormal sperm morphology. No statistically significant associations were observed with total motility, progressive motility or sperm vitality.

Table 7: Distribution of semen abnormalities according to smoking status

Smoking status	Low concentration n (%)	Low motility n (%)	Reduced vitality n (%)	Abnormal morphology n (%)
Non-smoker	63 (39.9)	47 (29.7)	51 (32.3)	2 (1.3)
Light smoker	36 (66.7)	20 (37.0)	19 (35.2)	10 (18.5)
Moderate smoker	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Light smokers demonstrated a markedly higher prevalence of oligospermia and abnormal sperm morphology compared with non-smokers. The small number of moderate smokers limited meaningful comparison within this category.

Table 8: Association between duration of smoking and semen parameters

Semen parameter	χ^2	P value	Significance
Sperm concentration	15.818	0.003	Significant
Total motility	21.325	<0.001	Significant
Progressive motility	11.457	0.022	Significant
Vitality	13.346	0.010	Significant
Morphology	31.666	<0.001	Significant

Increasing duration of cigarette smoking was significantly associated with deterioration in all evaluated semen parameters. Men with a longer smoking history exhibited a higher frequency of oligospermia, impaired motility, reduced vitality and abnormal sperm morphology.

DISCUSSION

Male factor infertility contributes to nearly half of all infertility cases, and modifiable behavioural factors have emerged as important determinants of male reproductive health. Alcohol consumption and

cigarette smoking are among the most common lifestyle exposures implicated in impaired spermatogenesis through mechanisms involving oxidative stress, endocrine disruption, mitochondrial dysfunction, and sperm DNA damage. The present study evaluated the influence of these addictive habits on semen quality among men undergoing infertility evaluation.

In the present study, 50.7% of participants reported alcohol consumption, while 26.5% had a history of cigarette smoking. These findings indicate that exposure to potentially modifiable behavioural risk factors is common among men attending infertility clinics. Although the prevalence of alcohol use was comparable to that reported in several Indian studies, the prevalence of smoking was lower than that observed by Aswal et al., who reported alcohol consumption in 82.4% and smoking in 80.4% of infertile men.[1] The differences may reflect regional variations in lifestyle habits, cultural practices, and study populations.

Alcohol consumption demonstrated a significant adverse association with sperm concentration, total motility, vitality, and sperm morphology. Furthermore, increasing severity of alcohol intake showed a progressive deterioration in semen quality, suggesting a dose-dependent effect. These findings support the hypothesis that chronic alcohol exposure interferes with the hypothalamic-pituitary-gonadal axis, suppresses testosterone synthesis, and increases oxidative stress within the testes, ultimately impairing spermatogenesis.

Our findings are consistent with those reported by Dushyant Singh Gaur et al,[8] who observed that alcohol consumption significantly reduced the proportion of normozoospermic men and increased the prevalence of teratozoospermia. The present study extends these observations by demonstrating significant deterioration in sperm vitality in addition to concentration and motility.

The duration of alcohol consumption also emerged as an important determinant of semen quality. Men with longer durations of alcohol exposure demonstrated significantly greater abnormalities in sperm concentration, motility, progressive motility, and vitality. This observation suggests that cumulative alcohol exposure may exert sustained toxic effects on the seminiferous epithelium, resulting in progressive deterioration of spermatogenesis. Interestingly, sperm morphology did not vary significantly with duration of alcohol use, indicating that structural sperm abnormalities may be influenced more by the quantity than the duration of alcohol consumption.

Smoking was another important behavioural factor evaluated in this study. Cigarette smoking showed significant associations with reduced sperm concentration and abnormal sperm morphology. Although total motility, progressive motility, and vitality did not differ significantly according to smoking status, increasing duration of smoking was associated with significant deterioration in all evaluated semen parameters. These findings suggest that cumulative tobacco exposure has a greater influence on semen quality than smoking status alone.

The present findings partially agree with those of Künzle et al,[9] who reported significant reductions in sperm density, total sperm count, motility, and vitality among smokers compared with non-smokers. In contrast, Saleh et al,[10] found no significant differences between smokers and non-smokers with respect to semen parameters. Such inconsistencies across studies may be attributed to differences in smoking intensity, cumulative exposure, study design, ethnic variation, and laboratory methodologies.

The biological mechanisms underlying smoking-related infertility are multifactorial. Cigarette smoke contains numerous toxic substances including nicotine, cadmium, lead, and reactive oxygen species that induce oxidative stress and DNA damage within spermatozoa. Increased oxidative stress decreases sperm membrane integrity, impairs mitochondrial energy production required for motility, and increases sperm apoptosis. Chronic smoking also alters antioxidant capacity within seminal plasma, thereby exacerbating oxidative injury.[11,12]

The findings of the present study emphasize that alcohol consumption and cigarette smoking represent modifiable risk factors for male infertility. Lifestyle modification, including alcohol reduction and smoking cessation, should therefore be incorporated into routine infertility counselling before initiating assisted reproductive techniques. Early behavioural intervention may improve semen quality and potentially enhance natural fertility as well as outcomes following fertility treatment.

CONCLUSION

The present study demonstrates that alcohol consumption and cigarette smoking are important modifiable risk factors adversely affecting semen quality among men undergoing infertility evaluation. Increasing alcohol intake was significantly associated with reduced sperm concentration, motility, vitality, and abnormal sperm morphology, while prolonged alcohol exposure further impaired progressive motility. Cigarette smoking was significantly associated with oligospermia and teratozoospermia, and longer duration of smoking resulted in progressive deterioration of all major semen parameters. These findings highlight the cumulative detrimental effects of addictive lifestyle habits on male reproductive function. Routine assessment of alcohol and tobacco use should form an integral part of infertility evaluation, and structured counselling aimed at alcohol reduction and smoking cessation should be incorporated into fertility management. Modification of these behavioural risk factors may

improve semen quality, enhance natural conception, and potentially increase the success of assisted reproductive techniques.

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