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Analysis of risk factors for abnormal semen parameters of male partners of infertile couple: A descriptive study

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Abstract

Background: Infertility remains an ongoing reproductive problem and about half of infertile couples have a component of male factor infertility. Male factor infertility is seen as an alteration in sperm concentration and/or motility and/or morphology in sperm analysis. A wide variety of etiological factors are involved in the causation of those sperm abnormalities. This study was designed to determine the association between risk factors and different semen parameter abnormalities.

Methodology: A descriptive study was conducted amongst the male partners of infertile couples who presented to the Outpatient Department for infertility evaluation. All the men were advised for semen analysis as a part of routine infertility work-up. Those men who had abnormal semen parameters and consented to the study were enrolled. A detailed interview of each subject was conducted focusing on risk factors causing different semen parameter abnormalities. Analysis of data was conducted to evaluate the presence of risk factors and the association of risk factors to specific sperm abnormalities was determined.

Results: A total of 50 subjects with abnormal semen analysis reports were included in the study. The mean age was 32.14 years ± 5.95 years, and the mean BMI was 24.38 ± 2.07 kg/m^2. The mean duration of infertility was 5.94 ± 3.66 years. The median sperm concentration was calculated to be 6.75 million/ml (IQR 3-12). The mean sperm motility was 26.3% (SD ± 19.00). 30% of the subjects had oligozoospermia and 20% had asthenozoospermia whereas 50% had both oligozoospermia and asthenozoospermia. Men with a sedentary lifestyle and cigarette smokers were twice (OR 2.122) and four times (OR 4.133) more likely to have oligozoospermia respectively. Cigarette smokers were nearly seven times (OR 7.171) more likely to have asthenozoospermia. Similarly, driver men and laborer men were almost six times (OR 5.629) and eight times (OR 8.551) more likely to develop asthenozoospermia respectively. However, these observations were not statistically significant.

Conclusion: Cigarette smoking is seen to be associated with both oligozoospermia and asthenozoospermia. Driver and laborer men were more likely to have asthenozoospermia. However, further study with a larger sample size is required to analyze the statistical significance of these associations.

Keywords: male infertility, risk factors, oligozoospermia, asthenozoospermia

Introduction

Infertility is a disease of the reproductive system defined by the failure to achieve a clinical pregnancy after 12 months or more of regular unprotected sexual intercourse [1]. There are no reliable estimates of its global prevalence [2] but a global review of infertility from the World Fertility Survey and others estimated the infertility rates in South Asia as 4% in Bangladesh, 6% in Nepal, 5% in Pakistan, and 4% in Sri Lanka [3].

Male infertility refers to a male's inability to result in pregnancy in a fertile female [4]. Half of the infertile couples have a component of male factor infertility and almost 30% solely are caused by a male factor [5]. Males with sperm parameters below the WHO normal values are considered to have male factor infertility [6].

As male infertility is commonly due to semen abnormalities, semen analysis is the cornerstone of its assessment [7]. It is the initial and most essential step of infertility evaluation [8].

A variety of risk factors are involved in the genesis of sperm parameter abnormalities. Risk factors like tobacco use, alcohol consumption, obesity, history of varicocele, orchitis, scrotal trauma, and increased caffeine intake are associated with male infertility [9]. The adverse effects of environmental factors, such as toxic materials, pesticides, and radiation have also been studied. It has also been demonstrated that toxic materials and pesticides could cause a decrease in sperm concentration [10].

Some of these risk factors are identifiable and reversible whereas others are identifiable but not reversible. Therefore, it is important to identify the cause and correct them if possible [11].

This study aimed to identify the presence of risk factors associated with abnormal semen parameters and determine the association between risk factors and different semen parameter abnormalities.

Objectives

- To identify the different types of semen parameter abnormalities.
- To evaluate the presence of risk factors associated with semen parameter abnormalities.
- To determine the association of risk factors to different abnormal semen parameter abnormalities.

Materials and Methods

This descriptive study was conducted in the Department of Obstetrics and Gynecology, B.P. Koirala Institute of Health Sciences from April 2021 to March 2022 after obtaining

ethical clearance from the Institute Research Committee (IRC). This study involved the male partners of infertile couples who presented to the Outpatient Department for evaluation of infertility. Those male partners of the infertile couples were advised for a semen analysis test as a part of routine infertility investigations. The semen sample was collected after three days of sexual abstinence by masturbation into a sterile wide-mouth plastic container and analyzed within an hour of collection at the Central Laboratory of the institute by an automated semen analyzer according to the WHO criteria [12]. The semen analysis report was interpreted as per WHO sperm reference values 2010.

Abnormal semen parameters

- Oligozoospermia: Sperm concentration <15 million/ ml
- Asthenozoospermia: Sperm motitlity <40%
- Teratozoospermia: Sperm with normal morphology <4%

Based on the semen analysis report, those men who had any semen parameter abnormality and met the inclusion criteria were enrolled in the study. Informed written consent was taken before enrollment.

Inclusion Criteria

- Male partners of infertile couples with abnormal semen analysis parameters.

Exclusion Criteria

- Men who did not maintain abstinence for at least three days before testing.
- Men who incorrectly collected the semen.
- Men who refused to consent to the study.

Sample size calculation

This study considered a 95% confidence interval and 80% power to estimate the sample size. Due to its multiple negative effects on sperm quantity and quality, cigarette smoking is considered one of the major risk factors for semen parameter abnormalities. Therefore, sample size estimation for this study was done using the odd's ratio of smoking for semen parameter abnormalities, 1.17, reported by a study conducted in Nepal in 2019 [9]. After calculation, a total of 50 subjects with abnormal semen parameters on semen analysis were enrolled.

A detailed interview of each subject focused on the socio-demographic characteristics and various risk factors associated with different semen parameter abnormalities.

Statistical Analysis

The responses were recorded in a pre-designed proforma, entered into MS Excel 2010, and converted to SPSS 11.5 for further analysis. Mean (±SD), frequency and percentage were calculated for descriptive statistics. Categorical variables were analyzed using the Chi-square test, and a p-value ≤0.05 was considered statistically significant. Binary logistic regression was used to investigate the potential risk factors associated with abnormal semen parameters.

Results and Discussion

A total of 50 subjects with abnormal semen parameters meeting the inclusion criteria were enrolled in the study. These subjects had abnormal semen parameters in terms of either sperm concentration, sperm motility, or sperm morphology i.e., oligo/azoospermia, asthenozoospermia, and teratozoospermia respectively.

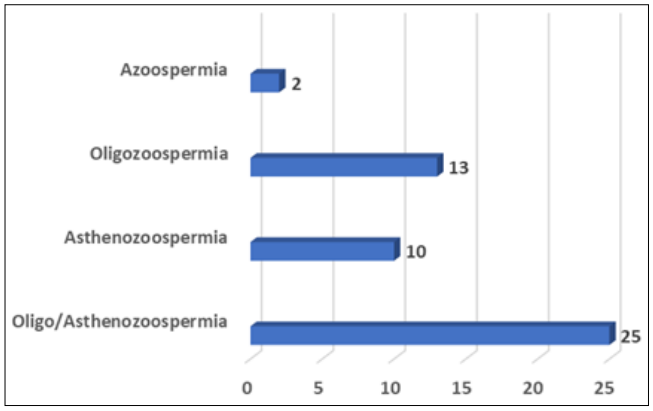

Fig 1: Type of semen parameter abnormalities

Amongst the enrolled subjects, 15 (30%) had oligozoospermia (of which 2 (4%) had azoospermia) and 10 (20%) had asthenozoospermia whereas 25 (50%) had both oligozoospermia as well as asthenozoospermia. The criteria for teratozoospermia were only fulfilled by the two subjects with azoospermia. Therefore, a total of 40 subjects with abnormal sperm concentration (oligo/azoospermia) and 36 subjects with abnormal sperm motility (asthenozoospermia) were collectively subjected to further risk factor analysis.

The median sperm concentration was calculated to be 6.75 million/ml IQR 3-12 (minimum 0 maximum 68). The mean sperm motility was 26.3% (SD ± 19.00).

Most of the subjects, 84%, presented with primary infertility. The mean duration of infertility was found to be 5.94 years (SD ± 3.66).

The mean age of the subjects was 32.14 years (SD ± 5.95). Most of the subjects, 24, were between 30-39 years of age, 20 were less than 30 years, and 6 subjects were ≥40 years old. Sharma A *et al* made similar observations that the most significant reduction in sperm parameters occurred after the age of 35 years [13].

The mean BMI was 24.38 (SD ± 2.07) kg/m^2. None of the subjects were underweight (BMI <18.5 kg/m^2). 19 subjects were overweight (23-24.9 kg/m^2), another 19 were in the pre-obese category (25-29.9 kg/m^2), 10 had normal BMI (18.5-22.9 kg/m^2) and only 2 subjects were obese (>30 kg/m^2). It has been studied that there is a trend of increased infertility with increased male BMI [14].

The testicular function is temperature dependent and requires a temperature of 2°C to 4°C below body temperature. Exposure to high temperatures is associated with impaired fertility parameters in men [15]. Also, toxic damage to the testes due to exposure to solvents and pesticides has been shown to result in many effects namely, reduced sperm production, the production of defective spermatozoa, and impaired androgen production [16].

Therefore, the occupation of the subjects was also analyzed where it was seen that most of the subjects were drivers (14) by occupation followed by laborers (10) and painters (7). Other subjects were service holders (6), carpenters (5), policemen (2,) and unemployed (6).

Jung A *et al* also concluded that the fertility parameters of professional drivers with long periods of sitting in vehicles were impaired [17].

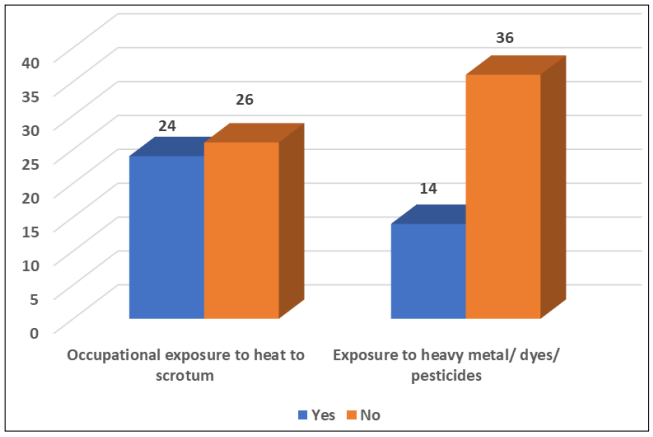

Fig 2: Distribution of subjects by occupational exposures

Nearly half of the subjects, 24, were found to be subjected to occupational exposure to heat to the scrotum whereas 14 of them were exposed to heavy metals/ dyes/ pesticides.

Increased physical activity has been seen to be associated with higher sperm count and vice versa. Here it was seen that 12 of the 50 subjects had a sedentary lifestyle. In a study by Gaskins AJ *et al*, higher moderate-to-vigorous activity was found to be significantly associated with higher total sperm count and sperm concentration [18]. The variations in observation could have been due to the relatively small sample size.

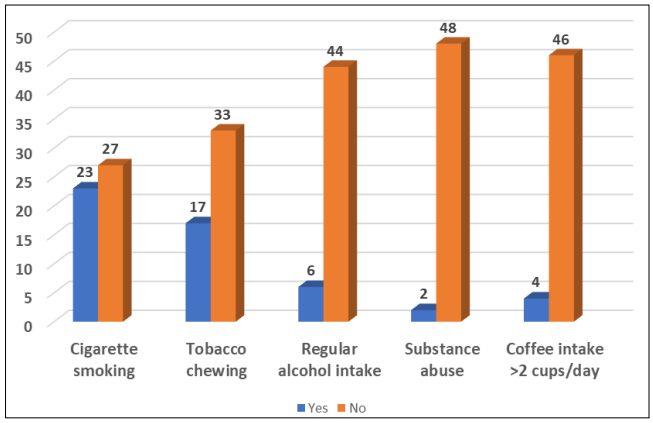

Fig 3: Distribution of subjects by risk factor associated with habits

Almost half of the subjects smoked cigarettes [23] regularly, 17 of them had a habit of chewing tobacco, 6 consumed alcohol regularly, and 2 had a habit of substance abuse. Only 4 subjects had a habit of drinking >2 cups of coffee per day.

The mean use duration for each was 11.56 ± 3.910 years, 12.47 ± 2.252 years, 13.33 ± 1.247 years, and 10 years respectively. The smokers smoked 10.47 ± 5.543 cigarette sticks per day. Also, the substances of abuse noted were marijuana and narcotics.

It has been noted that tobacco smoke contains harmful compounds and generates reactive intermediates, such as ROS and reactive nitrogen species, which can induce multiple genetic and epigenetic changes and affect sperm concentration, motility, and morphology [19].

Alcohol use in males has been found to affect spermatogenesis and/or sperm physiology and may even cause impotence [15]. Coffee consumption has also been hypothesized to influence semen parameters and sperm DNA integrity [20].

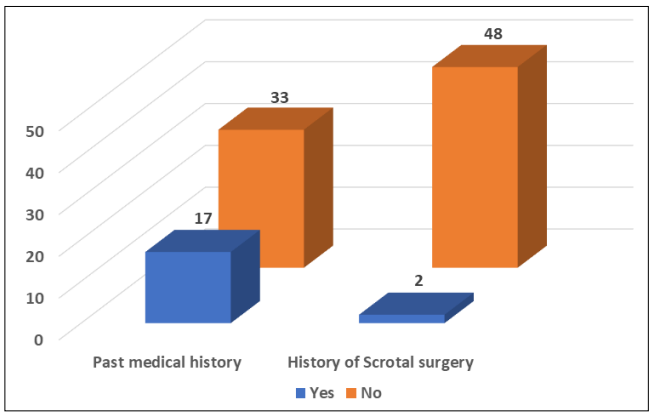

Fig 4: Distribution of subjects by past history

Of the 50 subjects, 17 had a significant past medical history and 2 had undergone scrotal surgery for hydrocele. Amongst those with a significant medical history, 13 had hypertension and 4 had diabetes mellitus. 4 of the hypertensive subjects were under anti-hypertensive medications.

Guo D *et al* concluded in 2017 that men diagnosed with hypertension have a lower semen volume, sperm motility, total sperm count, and motile sperm count [21]. Observations made by Long L *et al* suggested that chronic diseases like type 2 diabetes mellitus could cause testicular damage and induce male infertility [22]. The association of each of these diseases to sperm defects could not be studied due to the small sample size.

As the causative factors for abnormal semen parameters, this study also included regular hot baths, a history of chemotherapy/ radiotherapy, and a family history of infertility in first-degree male relatives as some of the risk factors. None of the subjects had the presence of any of these risk factors.

This study also analyzed the association of different risk factors with specific sperm abnormalities like oligozoospermia and asthenozoospermia amongst the 50 subjects with abnormal semen parameters. However, all the risk categories could not be analyzed individually for specific sperm parameter abnormalities due to the small sample size causing a lack of subjects in various groups.

Table 1: Comparison of age and BMI as risk factors for oligozoospermia and asthenozoospermia

Risk factors	Oligozoospermia		P value	Asthenozoospermia		P value
	Yes	No		Yes	No	
Age	31.7±6.2	33.8±4.7	0.329	33.1±6.1	29.6±4.9	0.056
BMI	24.3±1.8	24.5±3.1	0.838	24.5±2.1	24.0±1.9	0.416

Age and BMI were both found to be comparable between the subjects with normal sperm concentration and oligozoospermia.

Higher age was nearly significantly associated with asthenozoospermia (p-value 0.056). However, BMI was

comparable between subjects with normal sperm motility and those with asthenozoospermia.

Another study by Kidd SA *et al* in 2001 also concluded that the trend towards later fathering appears to be associated with diminished semen quality and fertility [23].

In men, excess weight may be linked with altered testosterone, estradiol levels, poor semen quality, and infertility [24]. Studies have indicated that high BMI affects sperm production and extreme levels of obesity negatively influence male reproductive potential [25].

Table 2: Risk factor analysis for oligozoospermia

Risk factors	Oligozoospermia (40)				
	N	P value	OR	95% CI	P value
Sedentary lifestyle	10 (25.0%)	0.741	2.122	0.089-50.811	0.642
Factors associated with habits					
Cigarette smoking	19 (47.5%)	0.670	4.133	0.140-122.190	0.411
Tobacco chewing	13 (32.5%)	0.654	0.335	0.029-3.933	0.384
Regular alcohol intake	4 (10.0%)	0.384	0.358	0.017-7.757	0.513
Occupation					
Service holders	4 (10.0%)	0.384	0.306	0.007-13.745	0.542
Driver	12(30.0%)	0.529	0.932	0.002-476.136	0.982
Laborer	8 (20.0%)	1.000	1.084	0.010-119.487	0.973
Unemployed	4 (10.0%)	0.384	0.268	0.004-16.604	0.532
Occupational exposure					
Heat	20(50.0%)	0.571	0.513	0.010-25.961	0.739
Dye/ Heavy metal/ Pesticides	12 (30.0%)	0.529	0.370	0.005-27.419	0.651

The analysis of different risk factor categories for oligozoospermia did not reveal a statistical association with any of the groups. However, men with a sedentary lifestyle and cigarette smokers were twice and four times more likely to have oligozoospermia respectively (no statistical significance).

As discussed earlier, similar conclusions were made by other studies which suggested that sperm concentration, motility, and morphology were significantly affected in smokers and tobacco chewers. A similar association with a sedentary lifestyle has also been discussed above.

Table 3: Risk factor analysis for asthenozoospermia

Risk factors	Asthenozoospermia (36)				
	N	P value	OR	95% CI	P value
Factors associated with habits					
Cigarette smoking	19 (52.8%)	0.123	7.171	0.625-82.294	0.114
Coffee (>2 cups/ day)	2 (5.6%)	0.307	0.056	0.002-1.967	0.112
Occupation					
Service holders	4 (11.1%)	0.756	2.362	0.041-136.049	0.678
Driver	12(33.3%)	0.178	5.629	0.149-212.280	0.351
Laborer	8 (22.2%)	0.529	8.551	0.483-151.504	0.143
Unemployed	4 (11.1%)	0.756	1.329	0.088-20.162	0.838
Occupational exposure					
Painter	5 (13.9%)	0.971	0.463	0.016-13.800	0.657
Heat	20 (55.6%)	0.086	1.082	0.058-20.266	0.958

Risk factor analysis for asthenozoospermia did not reveal a statistical association with any of the risk factor categories. However, cigarette smokers were nearly seven times more likely to have asthenozoospermia (no significant association). Similarly, driver men and laborer men were almost six times and eight times more likely to develop asthenozoospermia respectively (no significant association).

Similar observations have been made by other studies discussed above. The lack of statistical association in all these risk categories could be attributed to a small representative population.

Conclusion

This descriptive study identified the presence of risk factors in the subjects with abnormal semen parameters and the risk association of those factors with sperm parameter abnormalities was also calculated.

It was noted that most of the subjects with oligozoospermia and asthenozoospermia were cigarette smokers. Cigarette smokers were four times and seven times more likely to have oligozoospermia and asthenozoospermia respectively. Men with a sedentary lifestyle were more likely to develop oligozoospermia whereas driver and laborer men were more likely to have asthenozoospermia. However, these associations were not statistically significant.

Limitation

This study had a relatively small sample size due to which statistical association for all the risk factor categories could not be satisfactorily analyzed as there was a lack of samples in some of the categories. A larger sample size would have provided an opportunity to analyze each risk factor with specific sperm abnormalities as well.

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