Impact of major life style factors on male fertility in rural based population

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Abstract

Background: Infertility is the inability of the couples to conceive after 12 months of unprotected intercourse. There are innumerable causes of infertility including lifestyle factors. This study was to determine the specific impact of major lifestyle factors on semen quality of couples with infertility problem in rural based population.

Materials and Methods: This was a retrospective study on 250 male partners with infertility problem, conducted at Pathology department from August 2014 to May 2016. Semen analysis was carried out using WHO criteria and subjects were categorized based on history of lifestyle factors like alcohol, smoking, obesity, psychological stress and occupational exposure. Individuals in the age group of 15 to 45 years with exposure to a single lifestyle factor were included while those exposed to combined lifestyle factors with secondary infertility and chronic infections were excluded from the study. The data was analyzed using chi-square test.

Results: The proportion of abnormal sperms were higher in individuals who were exposed to different lifestyle factors compared to unexposed ones with a p value of <0.00001. Oligozoospermia followed by asthenozoospermia was the most common sperm variable in alcoholics (86%), obese (68%) and those with occupational exposure (58%) and stress (60%). While asthenozoospermia was the most common variable in smokers (70%).

Conclusion: The above findings showed that various lifestyle factors might be attributed to the risk of declining semen quality. The impact of environmental factors, alcohol and smoking on male infertility rates especially in rural population was a highlight in this study.

Keywords: Infertility, Lifestyle factors, Environmental factors, Oligozoospermia, Asthenozoospermia.

Introduction

Infertility is a disease of the reproductive system that impairs the body's ability to perform the basic function of reproduction. Infertility, defined as the inability to conceive after 12 months of unprotected intercourse, affects 10-15% of all couples.(1)

Male infertility plays a key role in conception difficulties of up to 40% infertile couples. Although in some men a specific disorder may be present, in majority no apparent reason for infertility could be found. This has drawn attention to the impact of lifestyle and environmental factors, on male reproductive health of such men.(1)

The cause of deterioration in reproductive health may be attributed to direct or indirect exposure of various lifestyle factors like smoking, alcohol, caffeine, high temperature, diet, stress which have shown to adversely affect male reproduction. These factors may impair male fertility by interfering with spermatogenesis, spermiogenesis, motility, sperm DNA and chromatin integrity, hormonal regulation or by reducing fertilizing capacity of spermatozoa.(2)

Hence, here is an attempt to compile the data pertaining to male reproductive health with reference to the different lifestyle factors and to emphasize the impact of these factors in rural based population.

Material and Methods

The present study was done to highlight the role of lifestyle factors on male fertility with a special emphasize on the rural based population.

Source of Data: This Retrospective study was conducted at laboratory of Department of Pathology, K.V.G. M.C.H, Sullia, D. K. over a period of 21 months from August 2014 to May 2016. A total of 250 subjects were included in ourstudy who were male partners of infertile couples seeking treatment for primary infertility at our institute.

Selection Criteria: Since we aimed to study the impact of different lifestyle factors on specific aspects of sperm characteristics, very stringent case selection criteria were laid down. 250 subjects were segregated into five groups of 50 subjects each based on the self-reported history of exposure to lifestyle factors like alcohol, cigarette smoking, obesity, psychological stress and environmental exposure.(1,3,4,5,6)

Inclusion Criteria: All the male patients who visited our OPD with infertility complaints in the age group of 15 to 45 years.

Exclusion Criteria:

1. Those suffering from secondary infertility.
2. Those with history of prolonged medications or exposed to excessive heat.

3. Males above 45 years of age.
4. Those with history of injury to testes, varicocele, hydrocele, undescended testis or its corrective surgery.
5. Those with history of exposure to combined lifestyle factors (exposed to more than 1 selected lifestyle factor in the study).
6. Those with history of chronic illness like tuberculosis, mumps etc.

The five study groups, each comprising of 50 males were:

Group A: Strict non-alcoholics, non-smokers, non-obese, no history of stress and no occupational exposure who all acted as controls.

Group B: Alcohol users with no other lifestyle factor exposure, were divided into three subgroups according to the average daily alcohol consumption:

a) Mild: those consuming 40g or less,
b) Moderate: those consuming 40-80-g and
c) Heavy: those consuming more than 80g per day.[3]

Group C: Smokers with no other lifestyle factor exposure were sub-grouped based on the Smoking Index (SI). Smoking index is a parameter used to quantitate cumulative smoking exposure. It can be defined as the product of number of cigarettes/day × years of smoking; accordingly they were divided into:

a) Light Smokers: <200 SI,
b) Moderate Smokers: 200-600 SI and
c) Heavy Smokers:>600 SI.[4]

Group D: Includes 2 lifestyle factors namely, Psychological stress and Obesity in two subgroups of 25 each; with no other life style factors in the background.

a) Psychological Stress (Includes emotional, financial and occupational stress)
b) Obesity(those with high Body Mass Index $\geq 25 kg/m^2$).[5]

Group E: Males with history of occupational exposure with no other lifestyle factors implication were sub-grouped into:

a) Exposure to Pesticides
b) Exposure to Solvents
c) Exposure to Mixed[6]

Informed consent was taken, as a routine from all the cases and ethical committee clearance was obtained.

Sample Collection: Following strict abstinence of four to six days, samples were collected in sterile wide mouthed containers in the laboratory. Only one sample per patient was included in the study. All the samples were kept at 37 plus/minus two degrees centigrade temperature and processed immediately after complete liquefaction.

All the semen samples were analyzed for 10 primary semen parameters: Liquefaction Time, Volume, Viscosity, Color, Agglutination, Sperm concentration, Sperm count, Motility, Viability, Sperm Morphology (normal forms) and abnormal spermatozoa; as per the recommended guidelines according to the WHO manual[7]. These parameters when taken together indicated the presence or absence of the three main semen variables: asthenozoospermia (A), teratozoospermia (T) and oligozoospermia (O), which acted as pointers to the specific need for further evaluation of their infertility.

The three variables were present either individually or in various combinations such as asthenozoospermia and teratozoospermia (A+T), asthenozoospermia and oligozoospermia (A+O), oligozoospermia and teratozoospermia (O+T), and asthenozoospermia with oligozoospermia and teratozoospermia (A+O+T). Samples with normozoospermia (N) were those which had all the parameters within the recommended ranges and were thus categorized separately.

Microscopy: Semen samples were examined for sperm count, sperm concentration, sperm motility, sperm vitality, sperm morphology, presence of agglutination and particulate matter. Sperm morphology was studied on Leishmann and Papanicolaou stained smears. Sperm vitality was assessed in wet mount smears after supravital staining with aqueous eosin.

Statistics: The data was analyzed by Chi-square Test. A P value less than 0.05 was considered statistically significant and values lesser than 0.0001 were considered highly statistically significant.

Results

A total 250 cases were selected and were categorized into five groups based on their independent lifestyle factors, each comprising of 50 cases. The distribution of the cases has been depicted in the table 1. Also the definitions for each sperm variable has been considered as per WHO manual (2010). Asthenozoospermia defined as percentage of progressively motile (PR) spermatozoa below the lower reference limit (31%-34%). Oligozoospermia defined as total number (or concentration, depending on outcome reported) of spermatozoa below the lower reference limit (33-46 million sperms per ejaculate). Teratozoospermia defined as percentage of morphologically normal spermatozoa below the lower reference limit (3-4%).[7]

Table 1: Distribution of cases included in the study based on life style factors

Lifestyle Status	Characteristics	Number of Cases (n)
A. Controls	Non-alcoholics, Non-smokers, Non-obese, No stress, No occupational exposure.	50
B. Alcohol consumers	**Daily alcohol intake**	**50**
Mild alcoholics	Less than 4o grams	19
Moderate alcoholics	40-80grams	17
Heavy alcoholics	More than 80 grams	14
C. Smokers	**Smoking Index**	**50**
Light smokers	SI<200	18
Moderate smokers	SI 200-600	23
Heavy smokers	SI>600	09
D. Obese and stress	**Obese(BMI>25Kg/m^2 Psychological Stress**	**50**
Stress with no Obesity	Emotional, Financial, Occupational	25
Obese with no Stress	BMI >25kg/m^2	25
E. Occupational exposure	**Exposure to Pesticides , Solvents and Mixed**	**50**
Pesticides	Farmers, animal husbandry, fumigators	22
Solvents	Mechanics, painters, woodworkers, printers	17
Mixed	Combination of both the above groups	11

To determine the contribution of each of the three main semen variables, viz, asthenozoospermia (A), oligozoospermia (O) and Teratozoospermia (T), the controls (Group A), the alcoholics (Group B), the smokers (Group C), those with obesity and psychological stress (Group D) and those with occupational exposure (Group E), were distributed according to the presence of individual semen variables or their various combinations, as observed during semen analysis. (Table 2-5)

Group A: Controls

Out of 250 subjects studied, 50 were considered as "controls" who had no history of exposure to alcohol, smoking, obesity, stress and occupational factors. It was observed that among controls, normozoospermia was present in 45 cases. Amongst the remaining controls, varying proportions of semen variables were observed, but within permissible range.

Table 2: Semen Variables amongst alcohol consumers (Group B) and controls

Diagnosis	Alcohol Consumers				Controls
	Mild (n=19)	Moderate (n=17)	Heavy (n=14)	Total (n=50)	(n=50)
N	5	0	0	5	45
A	0	0	0	0	00
A+O	4	10	1	15	2
A+T	0	0	2	02	00
A+O+T	0	5	8	13	01
O	10	2	2	14	2
O+T	00	00	01	01	00
T	00	00	00	00	00

(N- normozoospermia, A-asthenozoospermia, A+O-astheno and oligospermia, A+T-astheno and teratozoospermia, A+O+T-astheno,oligo and teratozoospermia, O-oligospermia, O+T-oligo and teratozoospermia, T-teratozoospermia).

Group B: Alcohol Consumers

Amongst 50 alcoholics, only five samples had semen parameters consistent with normozoospermia, of which all were mild alcoholics. No moderate or heavy alcoholic showed normozoospermia. The most common semen variable observed amongst mild, moderate and heavy alcoholics was "O", "A+O", and "A+O+T" respectively. Overall, oligospermia (mild: n=14, moderate:n=17, heavy:n=12) followed by asthenospermia (mild:n=4, moderate:n=15, heavy:n=11) was found to be the most common semen variable in all the subgroups with significant statistical difference having p <0.05. (Table 2, 6) Thus alcohol appeared to contribute mostly towards developmental defects of sperm morphology and sperm production, which rose steadily with the increasing quantity of alcohol consumption.

Group C: Cigarette Smokers

Only 6 cases of smokers showed normozoospermia, of which 5 were light smokers and 1 of moderate category. No heavy smoker showed normozoospermia. The most common sperm variable observed in light, moderate and heavy smokers was "O" and "A+O" respectively. Overall asthenozoospermia (A) individually (n=10) or in combination with other variables (n=35) was found to be the most common sperm variable in all subgroups. A progressive rise in defects of sperm motility, count and morphology were seen from light to moderate to heavy smokers with significant statistical difference (p <0.05). Hence cigarette smoke appeared to contribute significantly towards impairment of sperm motility with asthenozoospermia being the earliest defect of sperm quality in smokers. (Table 3,6)

Table 3: Semen Variables amongst smokers (Group C) and controls (Group A)

Diagnosis	Smokers				Controls
	Light (n=18)	Moderate (n=23)	Heavy (n=9)	Total (n=50)	(n=50)
N	5	1	0	6	45
A	5	4	1	10	00
A+O	3	9	4	16	2
A+T	0	3	2	5	00
A+O+T	0	3	1	4	01
O	5	3	0	8	2
O+T	0	0	1	1	00
T	0	0	0	0	00

(N-normozoospermia, A-asthenozoospermia, A+O-astheno and oligospermia, A+T-astheno and teratozoospermia, A+O+T-astheno,oligo and teratozoospermia, O-oligospermia, O+T-oligo and teratozoospermia, T-teratozoospermia).

Group D: Obese and Stress

Stress: Only 4 out of 25 subjects showed normozoospermia, while the rest were distributed with varying sperm variables. Oligospermia being the most common variable seen alone (n=5) while oligo (n=15) and asthenospermia (n=15) shared the same standard in combination.

Obese: Amongst the obese subjects, 5 showed normozoospermia, the rest had varying numbers of sperm variables. The most common sperm variable observed here was oligospermia both alone (n=6) and in combination (n=17). Thus stress and obesity appeared to contribute mostly towards the developmental defects of sperm (count) predominantly followed by motility with a significant statistical difference among the controls and the group D having p value less than 0.05 (Table 4 and 6).

Table 4: Semen variables amongst obese and those with psychological stress (Group D) and controls (Group A)

Diagnosis	Group D		Controls
	Stress (n=25)	Obese (n=25)	(n=50)
N	4	5	45
A	3	1	00
A+O	9	9	2
A+T	2	2	00
A+O+T	1	2	01
O	5	6	2
O+T	0	0	00
T	1	0	00

(N- normozoospermia, A-asthenozoospermia, A+O-astheno and oligospermia, A+T-astheno and teratozoospermia, A+O+T-astheno,oligo and teratozoospermia, O-oligospermia, O+T-oligo and teratozoospermia, T-teratozoospermia).

Group E: Occupational Exposure

Amongst the subjects with occupational exposure history, 10 showed normozoospermia, of which 4 were exposed to pesticides, 5 to solvents and the remaining one to both. The most common sperm variable observed in all the subgroups was oligozoospermia , both alone (pesticides:n=6, solvents:n=8, mixed:n=4) and in combination (pesticides:n=13, solvents:n=8, mixed:n=8) with increase in number of combination sperm variables (A+0) among the pesticide(n=6) subgroup than the other two, illustrating the strong impact of pesticides on sperm quality compared to solvents exposure with a highly significant statistical difference of p value less than 0.00001.(Table 5,6).

Table 5: Semen variables amongst those with occupational exposure (Group E) and controls (Group A)

Diagnosis	Group E				Controls
	Pesticides (n=22)	Solvents (n=17)	Mixed (n=11)	Total (n=50)	(n=50)
N	4	5	1	10	45
A	3	4	1	8	00
A+O	6	0	2	8	2
A+T	2	0	1	3	00
A+O+T	1	0	1	2	01
O	6	8	4	18	2
O+T	0	0	1	1	00
T	0	0	0	0	00

(N- normozoospermia, A-asthenozoospermia, A+O-astheno and oligospermia, A+T-astheno and teratozoospermia, A+O+T-astheno,oligo and teratozoospermia, O-oligospermia, O+T-oligo and teratozoospermia, T-teratozoospermia).

Table 6: Distribution of semen variables amongst cases (Group B/C/D/E)

Cases	Semen Variables		
Groups	**Asthenospermia**	**Oligozoospermia**	**Teratozoospermia**
Group B (Alcoholics)			
Mild	04	14	00
Moderate	15	17	05
Heavy	11	12	11
Total	**30**	**43**	**16**
P-value	P= 0.02060		
Group E (Occupational Exposure)			
Pesticides	12	13	03
Solvents	04	08	00
Mixed exposure	05	08	03
Total	**21**	**29**	**06**
P-value	P<0.00001		

The proportion of sperm variables in people exposed to all the above considered lifestyle factors viz alcohol, smoking, stress, obesity, pesticides, solvents and mixed ones were found to be 90%, 88%, 84%, 80%, 82%, 71% and 91% respectively which is higher than the unexposed control group with a statistical difference being proved by a p value less than 0.05, hence significant.

Discussion

Lifestyle factors play an important role in the etiology of various diseases and have also been implicated to cause reproductive impairment. This may be due to the direct or indirect adverse effect of toxicants on spermatogenesis and hormonal regulation. Lifestyle factors as toxicants can damage directly the testicular tissues, which can result in various adverse effects, namely reduced sperm count, the production of

defective spermatozoa, and impaired androgen production.[8] Study of semen parameters like sperm motility, sperm count and sperm morphology have conventionally been used to assess the semen quality of an individual. However none of these measures, alone or in combination, can be considered diagnostic of infertility. In our study, we have tried explaining the impact of lifestyle factors on semen analysis considering the three main variables; asthenozoospermia (A), teratozoospermia (T) and oligozoospermia (O). The various lifestyle factors considered here are alcoholism, smoking, obesity, psychological stress and occupational exposure.

Alcohol consumers: Alcohol abuse in men has been reported to cause impaired testosterone production, and atrophy of testes, which can result in impotence, infertility and reduced male secondary sexual characteristics. Alcohol interferes in the feedback mechanisms of hypothalamus-pituitary gonadal axis resulting in the impairment of production and secretion of adequate quantity and potency, of leutinizing hormone and follicle stimulating hormone leading to deterioration of sertoli cells. However dose dependant effects of alcohol on human spermatogenesis are not well established.[1]

In our study, of all the 50 alcoholics, only 5 showed normozoospermia of which all the 5 were mild alcoholics, while none of the moderate or heavy alcoholics showed normal semen parameters. Thus alcoholism did reduce the number of normozoospermic cases. Of the 3 semen variables, oligospermia, asthenozoospermia and their combined presence, amongst alcoholics was more than that found in controls, while teratozoospermia was less frequent amongst alcoholics. A positive correlation with the alcohol intake was observed amongst alcoholics, with percentage of cases increasing from mild to heavy alcoholic sub-groups for all the three variables. The results were consistent with the study done by Gaur D S et al, where oligo and asthenozoospermia were maximum followed by teratozoospermia stating that alcohol abuse targets the sperm production.[1]

The categories (A+O) and (A+O+T) showed higher number of cases with increase in the dosage of alcohol from mild to moderate to heavy (Table 2). In our study, Oligospermia being the overall most common sperm variable, showed a significant statistical relation with the dose related subgroups of alcoholics. While teratozoospermia, did not show a strong correlation amongst mild alcoholics, but appeared probably as an additive feature amongst moderate and heavy alcoholics.

Smokers: Smoking is known to have a detrimental effect on sperm quality, in particular concentration, motility and morphology. It is related to a decrease in semen volume in a population of fertile men. It has also been associated with increased levels of aneuploidy in human sperm, lower seminal plasma antioxidant levels and increased oxidative damage to sperm DNA.[9,10]

Toxins in the smoke reach the male reproductive system and their effects are mainly due to their direct interaction with seminal fluid components and the accessory glands, leading to increased viscosity, reduced seminal volume and delayed liquefaction time, reducing the forward linear progression of spermatozoa, manifesting as asthenozoospermia. Also direct exposure of sperms to the toxins in the smoke tilts the delicate balance of reactive oxygen species that are produced by sperms for their special functions like decapitation etc., but increased levels of ROS have been shown to be detrimental to the DNA of spermatozoa, thus producing the negative effect on the viability and morphology of spermatozoa.[11]

In our study, only 6 showed normozoospermia, illustrating the fact that smoking certainly has a definite influence on the semen quality. Asthenozoospermia was the most dominant semen variable contributing to the semen quality of smokers, individually or in combination with other sperm variables. Hence asthenozoospermia appeared to be a premier factor contributing to the infertile status of a male. Oligozoospermia appeared to be the next anomaly to develop in smokers reducing the sperm count. Our results were consistent with a similar study done by Gaur D S et al stating smoke-induced toxins primarily hamper sperm motility and seminal fluid quality with asthenozoospermia being the most common sperm variable observed in smokers.[1]

In heavy and moderate smokers, presence of all the three variables, astheno, oligo as well as teratozoospermia, indicated that heavy smoking apparently had a significant contribution in the impairment of sperm counts besides motility defects. A study on voluntary males of reproductive age showed that after ejaculation, sperm motility deteriorated much more rapidly in heavy smokers in comparison to controls.[12]

Obesity: Obesity is another lifestyle factor gaining attention in the decline of semen quality and male reproductive potential over the past 50 years. According to Carlsen et al.[3] the quality of semen has substantially declined, with the consequent negative effect of poor semen quality on male fertility conceivably contributing to an overall decrease in male reproductive potential.[13]

The mechanisms responsible for effects on male infertility are ambiguous and undefined. Most of these mechanisms might contribute to the Hypothalamic-pituitary gonadal axis. Total body fat has been associated with low levels of free and total testosterone in men, and most of them present with a decreased ratio of testosterone to estrogen, which is explained by over activity of the aromatase cytochrome P-450 enzyme, which is expressed at high levels in white adipose tissue

and is responsible for a key step in the biosynthesis of estrogens .Such dysregulated hormonal levels and elevated leptons contribute to the detrimental effects. A study by Hofny et al. also found that testosterone replacement therapy decreased leptin levels. By decreasing elevated leptin levels in obese patients, it might be possible to reverse some of the potential suppressive effects of excess leptin on the HPG axis and restore normal spermatogenesis.[13]

In our study, only 5 out of 25 showed normozoospermia. Oligozoospermia being the dominant sperm variable observed followed by asthenozoospermia serves as a potential early indicator of the effect of obesity on male fertility with a significant statistical relationship. Hence the importance of diet for optimum male reproductive health.

Psychological stress: Occupational stress and burn-out have been related to male infertility and reduced semen quality. Case-control studies have shown higher stress levels among infertile men than among fertile controls. The direction of causality is uncertain, because infertile men may be more distressed or especially vulnerable to the stress.

In our study, a questionnaire pertaining to emotional, financial and occupational stress was subjected to the individuals and accordingly the semen variables were compared. Only 4 out of 25 cases showed normal semen parameters. Oligozoospermia was the most common sperm variable followed by asthenozoospermia indicating that the stress due to unknown causes mainly targets on the sperm count followed by sperm motility and rarely the sperm morphology.

Occupational exposure: Chemical substances such as pesticides and solvents have the capacity to interfere in the functioning of the endocrine system, in the hormones' mechanism of action, and are called endocrine deregulators or endocrine disruptors. Alterations caused by endocrine disruptors can be temporary or permanent. Endocrine disruptors can cause reproductive anomalies and congenital malformations .The principal effects of exposure to endocrine disruptors on male fertility are temporal reduction in sperm concentration and quality, high incidence of cryptorchidism and hypospadias and altered sex ratio.[14]

This study showed that in an infertility consultation population, environmental exposure particularly to pesticides and solvents is associated with dramatic changes in sperm variables which are consistent with the previous studies. In a study by Alenjandro et al, 225 male partners with occupational exposure were studied and showed that the exposure to pesticides and solvents is significantly associated with sperm threshold values well below the lower limit of the normal range and also stated that those exposed to pesticides had higher serum estradiol and those exposed to solvents had lower LH levels, probably the mechanisms for deteriorating the male reproductive health.[6]

In our study, amongst those exposed to pesticides (n=22), only 4 had normozoospermia. While those exposed to solvents (n=17), only 5 showed normal semen variables and those exposed to mixed combination (n=11), only 1 showed normozoospermia indicating that the chronic exposure to the occupational hazards can definitely delimit the normal male fertility rates. Among all the subgroups, oligozoospermia was found to be the most dominant sperm variable followed by asthenozoospermia. Hence oligozoospermia serves as an early predictor of decline in male fertility rates amongst those exposed to the occupational hazards.

Conclusion

The present study suggested the role of various lifestyle factors and reproductive toxicants in deterioration of semen quality. Oligozoospermia being the most common anomaly of semen, its presence can be subtle as an early indicator in the reduction of the semen quality.

In our study; oligozoospermia followed by asthenozoospermia was the most common sperm variable in alcoholics (86%), obese (68%) and those with occupational exposure (58%) and stress (60%). While asthenozoospermia was the most common variable in smokers (70%). Also deterioration in semen quality appeared in direct proportion to the quantity of alcohol and cigarettes smoked as is evident from our study. Obesity and psychological stress , being the uncommon parameters to have an impact on male infertility, also showed significant association (68% and 60% respectively), with a p less than 0.05 enhancing their importance among the list of risk factors to decline semen quality.

Hence, a higher level of attention towards lifestyle factors in infertility settings might unravel clinical cases that are seldom identified today. The data might be useful in advocating for adopting the healthy lifestyle in order to reduce the male reproductive health problems.

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