Short Research Article

Effect of environmental factors, lifestyle, lipid profile and previous medical conditions on semen quality in male partners of infertile couples; evidence from Kumasi metropolis

Abstract

Introduction: Infertility among men is a major public health problem that has mainly been linked to semen abnormalities due to certain background or environmental characteristics, disease and surgical conditions as well as lifestyle. The purpose of this study was to assess the effects of environmental factors, lifestyle, lipid profile and previous medical conditions on semen quality of male infertile couples in the Kumasi metropolis.

Methods: The study was a cross-sectional study conducted between February 2012 and May 2013. The study involved 150 men whose female partners reported to the Obstetrics and Gynaecology Department of Komfo Teaching Hospital (KATH) in Ashanti Region of Ghana for infertility treatment. Semen of the respondents were examined for various characteristics including sperm viability, motility and concentration. The demographic, behavioral and anthropometric data of clients were also taken with the use of structured questionnaires. Associations between the various explanatory factors and semen quality were tested using correlation and regression at significant levels of $p<0.05$.

Results: About half of the respondents had very low sperm counts (oligospermia), 36.7% had normal sperm concentration whereas 10.7% had no sperm in the semen. The mean sperm motility among the males of infertile couples was 51.0 (SD=30.12). Mumps had significant association with Log of sperm concentration (p=0.025) but not with motility (p=0.333). Extensive use of marijuana was associated with $1.69X10^6$ increase in the log sperm concentration (p=0.020). Extensive use of heroine also had a significant association sperm concentration (p=0.05). Lipid levels had no significant association with sperm quality.

Conclusion: Although the lipid profile showed no significant association with semen quality, positive lifestyles targeted at improving lipid profile might help improve semen concentration since BMI and triglyceride negatively affected sperm concentration and motility though the effects were not significant. The effects of marijuana and heroin use may arise may be due the small number of users in the study group.

Keywords: Infertility; semen; lipid; sperm; oligospermia; mumps

Introduction

Infertility has been described as a major reproductive health problem that affects 10% to 15% of couples, with approximately equal contributions (Singh and Jaiswal, 2011). Infertility is defined as the inability to achieve pregnancy after one year of unprotected intercourse. An estimated 15% of couples meet this criterion and are considered infertile, with approximately 35% due to female factors alone, 30% due to male factors alone, 20% due to a combination of female and male factors, and 15% unexplained. Male infertility is commonly due to deficiencies in the semen, and semen quality is normally used as a surrogate measure of male fecundity (Cooper *et al.*, 2010). Adeniji *et al.*, (2003) suggested abnormal semen quality remains a significant contribution to overall infertility and said Asthenozoospermia is the most common seminal quality abnormality.

However, apart from seminal fluid abnormalities, several studies have looked at other factors including medical history and lifestyle that influence male infertility. Dawson (2012) mentioned systemic diseases, endocrine abnormalities, iatrogenic injuries, congenital abnormalities, acquired testicular damage, vericocele, immunological factors, male accessory gland infection as possible causes of male infertility. It has been suggested that inflammatory conditions contribute more to male infertility in Africa (Yeboah *et al*., 1992). Exposure to many environmental agents may be hazardous to the reproductive capacity in humans. Male reproductive function is known to be highly sensitive to many chemical and physical agents generated by industrial or agricultural activities (Bonde, 1996; Spira and Multigner, 1998). Such agents are commonly present in some occupational activities and in the general environment. People's life styles also play extremely significant roles in their marital time and in successful pregnancies. Lifestyle habits have long-term impacts on male potency (Serdar, 2010). In their study, Zinaman *et al*., (2000) found that couples who did not achieve clinical pregnancies had a significantly higher proportion of men who smoked. Again Serdar (2010) said alcoholics are more likely to have upper levels of estrogen in their organism, which is able to severely repress sperm. Furthermore, alcohol abuse has been linked with damaging sperm and decreased sperm counts (Muthusami and Chinnaswamy, 2005; Donnelly, *et al.*, 1999).

MATERIAL AND METHODS

The study took place between February 2012 and May 2013.

The study was conducted in the Kumasi metropolis in the Ashanti region of Ghana. A total of one hundred and fifty (150) men whose female partners reported to the Obstetric and Gynaecology Department of Komfo Anokye Teaching Hospital (KATH) for infertility treatment were selected for the study. The male partners were contacted and details of the study were explained to them. Those who agreed to be part of the study were gave informed consent.

Respondents' socio-demographic data, information of medication and drug usage, lifestyle and other quantitative data were taken with the use of open ended semi-structured questionnaires. Information on respondents' exposures to environmental and other chemical hazards was also collected with the questionnaires.

The body weight was measured without shoes using an electronic measuring scale, and height to the nearest cm was taken. Waist circumference (WC) in cm was measured midway between the lower costal margin and iliac crest during the end-expiratory phase (World Health Organisation, 1995). Hip circumference (HC) in cm was measured at the level of the greater trochanters (World Health Organisation 1995). The waist-to-hip (W/H) ratio was defined as the waist circumference divided by the hip circumference, while the waist/height (W/Ht) ratio was defined as the waist circumference divided by the height in cm.

The body mass index (BMI) was calculated as weight in kg divided by the height (in m^2)

$$\text{BMI} = \frac{\text{Weight in kilograms}}{(\text{Height in meters})^2}$$ (Eknoyan, 2007)

The following **(BMI)** definitions were adopted for this study:

Underweight: BMI = Below 18.5

Normal: BMI = 18.5 to 24.9

Overweight: BMI = 25 to 29.9

Obese: BMI = Over 30
(WHO, 2006)

The participants were instructed to fast for 12 to 14 hours after eating a low fat diet before the test and not to take alcohol 24 hours before the test to ensure accuracy of the result (Mosby's Diagnostic and Laboratory Test Reference, 2005). Blood samples were taken at the same time the participant presented their semen samples for the study. The blood was mixed thoroughly and analyzed within five hours of collection. The blood was allowed to stand for at least 30 minutes after which serum was separated by centrifugation at 3000 rpm for 10 minutes. The separated serum and the sample from the fluoride tubes were analysed using a BT3000 auto analyser, manufactured by Biotechnical Instruments S.p.A. Rome, Italy. Total cholesterol (TC), high density lipoprotein cholesterol (HDL), triglycerides (TG) and low-density lipoprotein cholesterol (LDL) were measured.

The following normal serum lipids levels in millimoles (mmol) were adopted for the study:
Total cholesterol = 3.90 -5.20
Triglyceride = 0.30 - 2.26
HDL cholesterol = 0.00 -2.59
LDL cholesterol = 0.0 - 3.99

Sperm concentration was determined using the haemocytometer method on two separate preparations of the semen samples, one on each side of the counting chamber. Wet mount slides were then prepared for microscopy to determine sperm motility, while the dye exclusion method was employed to determine sperm vitality (WHO, 2010).

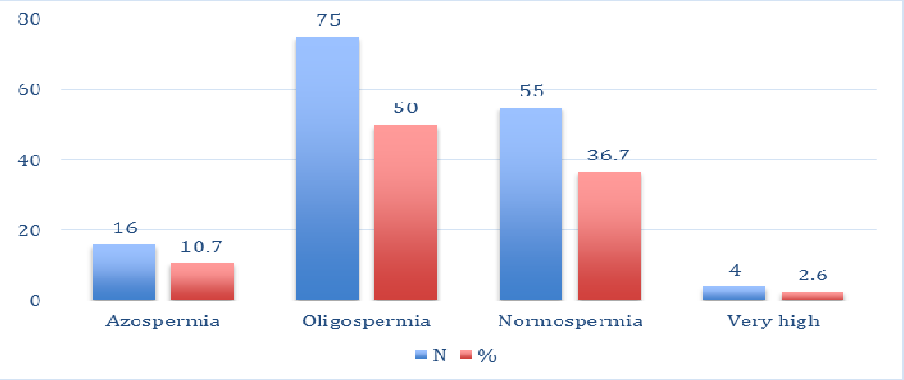
All questionnaires and interview results from the field were checked for completeness and internal errors during data collection. Questionnaires were sorted, numbered and kept in files and kept confidentially. Data were coded and entered using SPSS software. Data were analyzed using STATA 11. Descriptive statistics were done using frequencies and percentages and results presented using graphs and tables. Binary independent variables were coded "1=yes" and "0=no" and their associations with sperm concentration and motility were tested using linear regression. Sperm concentration was however log transformed because it was non-linear. Associations between continuous independent variables (lipid profiles) and sperm concentration and sperm motility were tested using Spearman correlation and Pearson correlation respectively. All analysis were conducted at significant levels of $p<0.05$.

Ethical clearance for the study was obtained from the Committee on Human Research, Publications and Ethics (CHPRE) of the Kwame Nkrumah University of Science and Technology (KNUST) and Komfo Anokye Teaching Hospital (KATH). The CHRPE clearance, with reference number of CHRPE/21/11 was given on 11th April 2011, and the KATH clearance with reference number RD/CR 145 was given on the 28th January 2010. Participation in the study was strictly voluntary with the informed consent of participants that guaranteed their right to privacy. Information obtained was treated with the strictest confidentiality. The IRB approved that the informed consent be read and signed by each patient involved in the study.

RESULTS

Figure 1 shows the classification of the number of sperms in semen of the male partners involved in the study. As shown, half of the respondents had very low sperm counts (oligospermia) whereas 36.7% had normal spermatozoa concentration in the semen. Only 2.6% had very high sperm counts and 10.7% had no sperm in the semen. The mean semen motility among the infertile couples was 51.0 (SD=30.12) and it was 48.52 (SD=3.10) among primary infertile couples and 54.51 (SD=3.99) among the secondary infertile couples.

Figure 1: Percentage of azoospermia, normospermia and oligospermia



Effects of some medical conditions on semen quality

Most of the medical conditions studied had no significant relationship with semen quality of the male partners studied (Table 1). Most of the respondents had also never experienced any of the medical conditions studied. 31% and 21.3% had experienced mumps and high blood pressure respectively. Mumps had significant association with Log of sperm concentration (p=0.025) but not with motility (p=0.333). Having experienced mumps was associated with 0.55 decrease log sperm concentration.

Table 1 Relationship between semen quality and some medical conditions

Medical conditions	% Prevalence	Ln (Sperm concentration)			Motile sperms		
		Beta	t	p-value	Beta	t	p-value
Diabetes mellitus	10.7	-2.09	-0.52	0.606	-11.95	-1.49	0.139
High BP	21.3	0.03	0.11	0.920	1.89	0.31	0.760
Hepatitis	6.0	-0.75	-1.53	0.128	-12.34	-1.18	0.239
Mumps	38.0	-0.55	-0.25	0.025	5.01	0.97	0.333
Heart problems	4.0	-0.61	-0.90	0.372	-13.75	-1.07	0.288
Allergy	23.3	0.01	0.02	0.987	-9.32	-1.57	0.118
Arthritis	12.0	0.15	0.44	0.663	5.88	0.75	0.454
Cancer	8.0	0.09	0.19	0.851	2.15	0.19	0.846

Beta=regression coefficient

Semen Quality And Surgical History

22.7% and 23.3% of the respondents had undergone hernia repair and biopsy of the testis respectively, and a few others had undergone other surgical procedures. None of these surgical procedures had any significant effects on sperm concentration and motility (Table 2).

Table 2: Relationship between semen quality and surgical history

Medical conditions	% Prevalence	Ln (Sperm counts)			Motile sperms		
		Beta	t	p-value	Beta	t	p-value
Operations on urinary tract	4.7	-0.01	-0.02	0.982	-0.94	-0.75	0.941
Vasectomy	1.3	2.14	1.38	0.172	-5.77	-0.25	0.804
Hernia repair	22.7	-0.02	-0.07	0.944	-1.77	-0.28	0.777
Varicocelectomy	3.3	-0.35	-0.44	0.663	-1.09	-0.07	0.942
Hydrocele repair	2.7	0.37	0.42	0.677	7.55	0.87	0.389
Biopsy of the testis	23.3	-0.21	0.19	0.851	11.84	-0.46	0.648
Operation on the penis	1.3	-0.95	-0.09	0.372	0.96	0.04	0.970

Beta=regression coefficient

The relationship between semen quality and lipid profile and BMI

Results presented in Table 3 shows no significant association between lipid profile and sperm characteristics. The mean (SD) BMI was 23.83 (3.01) Kg/m^2 and majority (75%) of respondents were overweight whereas 7% were underweight. The mean (SD) HDL and LDL were 2.37 (1.05) and 2.79 (0.88) mmol/L respectively. Cholesterol levels had positive correlation with sperm concentration whereas negative correlations were observed between triglycerides and BMI and sperm characteristics, although they were not significant. BMI and triglycerides were also negatively correlated with sperm motility.

Table 3 Results of relationship between lipid profile and semen quality

Lipid profile	Mean (SD)	Sperm concentration*		Sperm motility§	
		r	p-value	r	p-value
Total cholesterol	5.13 (3.75)	0.06	0.478	0.06	0.433
HDL cholesterol	2.37 (1.05)	0.02	0.811	0.04	0.638
LDL cholesterol	2.79 (0.88)	0.02	0.814	-0.03	0.694
Triglyceride	1.66 (1.50)	-0.08	0.356	-0.05	0.544
BMI	23.83 (3.01)	-0.02	0.792	-0.34	0.681

Test=spearman correlation; §Test=Pearson correlation; r- correlation coefficient

The relationship between environmental and behavioural factors and semen quality

Results of analysis of the relationship between environmental and behavioral factors on semen quality are presented in Table 4. With the exception of marijuana usage, none of the factors considered had significant association with sperm count. Only 3% of the respondents used marijuana extensively. Majority, 66% however drank alcohol and 27% smoked cigarettes. Extensive use of marijuana was associated with $1.69X10^6$ increase in the log sperm concentration (p=0.020). 1% of the respondents used heroine extensively. Extensive use of heroine negatively affected sperm concentration (p=0.05).

Table 4: Results of relationship between environmental and behavorial factors and semen quality

Variables	% Prevalence	Sperm concentration (Ln) Beta	t	p-value
Smoking	27.0	0.11	0.42	0.675
Alcohol	66.0	0.08	0.33	0.743
Extensively use cocaine	6.0	-0.23	-0.41	0.686
Extensively use marijuana	3.0	1.69	2.36	0.020
Extensively use amphetamines	1.0	-0.52	-0.46	0.645
Extensively use heroin	1.0	-1.83	-1.98	0.050
Thermal	12.0	0.20	0.75	0.457
Chemical	26.0	0.15	0.40	0.691
Radiation therapy	4.0	-0.27	-0.97	0.335
Chemotherapy	4.0	-0.14	-0.68	0.497
Use of any medication	33.0	0.41	0.67	0.503

Beta=regression coefficient

DISCUSSION

Sperm quality and lipid profile

Results of this study showed no significant association between semen quality and lipid profile. The findings of this study is consistent with the finding of Khalili *et al.*, (2009). They concluded in their study that, the concentrations of serum lipids are not related with quality of semen parameters in infertile men. This findings are however is contrary to the study by Kulka *et al.*, (1984) where alterations in phospholipids concentrations were noticed with abnormal semen analysis. In another study, high level of lipids was shown to be common in azoospermic males (Padron *et al*., 1989). Vignon *et al* (1989) also found that increased triglyceride have deleterious effects on spermatogenesis.

An important lifestyle-dependent factor that adversely affects spermatogenesis is obesity. Obesity has been associated with a variety of problems including male and female infertility (Cabler *et al.*, 2010) and semen samples of obese males are likely to have reduced sperm counts and also abnormal sperm morphology (Male Infertility Cure.com, 2011). Obesity/overweight may result in hypogonadism, increased scrotal temperatures, impaired

spermatogenesis, decreased sperm concentration and motility, and increased sperm DNA damage (Kasturi *et al*., 2008). An inverse relationship between BMI and the total number of normal-motile sperm has been reported in subjects and men presenting with a BMI greater than 25 kg/m^2 have fewer chromatin-intact normal-motile sperm cells per ejaculate and therefore, to ensure maximum fertility potential, patients may be advised to reduce body weight (Hilton *et al*., 2006).

In this study, 75% of respondents were overweight whereas 7% were underweight. The BMI of respondents however had no significant association with the sperm concentration and motility. This was however inconsistent with results from study by Ayers *et al*., (1985) which concluded that men with low BMI (20 kg/m2) may present with an abnormal semen analysis and may show abnormal motility. Again, several studies have shown inconsistent results where, up to a threefold higher incidence of obesity in infertile men than in those with normal semen quality (Magnusdottir *et al*., 2005; Hammoud *et al*., 2008) and a BMI of more than 25 is associated with an average 25 per cent reduction in sperm count and sperm motility (Jensen *et al*., 2004; Kort *et al*., 2006).

Semen quality and some medical conditions and surgical history

Various studies have established the influence of certain medical conditions on male infertility. This study however reported no significant association with most of the medical conditions studied and most of the respondents had also never experienced any of the medical conditions studied. Mumps, however, had significant association with sperm counts but not with motility. The influence of mumps on male infertility has been attributed to the inflammation of the testicle, either in one or in rare cases, both. This results in the testicle shrinking, and sperm production is lowered (Smith, 2010). According to Smith (2010), in 25 to 35% of cases, mumps affects the testicles (orchitis), causing swelling, pain and soreness in the affected testis, with a high temperature. It may cause infertility in some.

Diabetes mellitus had no significant influence on semen quality in this study and this was inconsistent with previous studies that established a significant association between the two. For instance, Sexton and Jarow (1997) indicated that DM might affect male reproductive function at multiple levels as a result of its effects on the endocrine control of spermatogenesis, spermatogenesis itself or by impairing penile erection and ejaculation. Sexual dysfunction, in all its forms (reduced erection, impotence, and other libido dissociations) has also been described as an accompanying phenomenon of the diabetes (Dinulovi and Radonjic, 1990). They related this to the regulation of carbohydrate metabolism and to the duration of disease. Surgical histories of the male partners of infertile couples did not influence semen quality in this study. Varicocelectomy has however been reported to result in a warmer environment for the testis and that this impairs spermatogenesis and fertility and an interesting recent observation is that varicocele is more associated with secondary than primary infertility and so it may be responsible for a premature decline in sperm count (Gorelick *et al*., 1993).

Effects of exposure to environmental factors and behavioural patterns as well as medication on semen quality

Some studies have reported positive influence of occupational exposures including exposure to chemicals and pesticides to semen quality (Schrag *et al*., 1985); occupational exposure to glycol ethers (Multigner *et al*., 2007; Cherry *et al*., 2008); exposure to pesticides (Abell *et al*., 2000; Ayotte *et al*., 2001; Hossain *et al*., 2010); inorganic lead and other heavy metals

(cadmium, mercury), metal welding fumes and carbon disulphide (Bonde & Storgaard, 2002; Benoff *et al*., 2009).

The study however, found no significant effect of exposure to environmental factors as well as chemicals on semen quality. This was consistent with several large prospective studies, which found no evidence for any major impact in Western countries (Larsen *et al*., 1999; Thonneau *et al*., 1999; Bonde & Storgaard, 2002). The study by Gracia *et al*., (2004) also found no clear, clinically important associations between occupational exposures and male infertili,ty. Other consistent results included studies in North America (Hauser *et al*., 2003), and the highly exposed Inuit population in Europe (Bonefeld-Jorgensen *et al*., 2006; Elzanaty *et al*., 2006; Toft *et al*., 2006, 2007; Krüger *et al*., 2007) which have also shown no evidence for major effects of occupational exposures on semen parameters or on fertility.

Semen quality, in terms of motility and sperm concentration was not significantly influenced by cigarette smoking in this study. Inconsistently, cigarette smoking has been associated with decreased sperm count, alterations in motility, and an overall increase in the number of abnormal sperm (Kulikauskas *et al*., 1985). A study by Said *et al*., (2005) on the use of chewing tobacco by a group of Indian men who were undergoing infertility evaluation was strongly associated with a decrease in sperm quality and to a lesser extent with oligoasthenozoospermia or azoospermia. The contribution of cigarette smoking to male infertility has been linked with seminal cadmium levels which are significantly increased, especially in those smoking more than one pack per day (Oldereid *et al*., 1994).

The influence of frequency of alcohol consumption on male infertility has also been explored in previous studies. According to Serdar (2010) men who frequently drink great amounts of alcohol can have severe troubles with their productiveness. This study however reported no significant association between alcohol consumption and semen quality and this is consistent with most studies that included alcohol as a point of investigation and failed to show a significant impact on sperm counts, at least among those with moderate alcohol consumption (Marinelli *et al*., 2004; Martini *et al*., 2004). Previous studies by Pajarinen *et al*., (1996), Muthusami & Chinnaswamy, (2005) and Serdar (2010) have reported moderate consumption of alcohol may affect semen quality more often than previously thought, whereas high alcohol consumption may even be associated with serious disorders of spermatogenesis. Also in chronic alcoholics, there is good evidence for impairment of spermatogenesis and reductions in sperm counts and testosterone levels (Muthusami & Chinnaswamy, 2005).

This study showed evidence of influence of marijuana on semen quality. This was however inconsistent with the study by Brown and Dobs (2002), where no major effect of cannabis use on spermatogenesis in humans was observed. Some animal studies have however demonstrated adverse effects of cannabinoids on testicular steroidogenesis (Brown & Dobs 2002), sperm maturation and motility (Ricci *et al*., 2007) and in some studies on sperm production (Abel, 1981; Patra & Wadsworth, 1991). These effects work via endogenous cannabinoid-type receptors (CB1, CB2) (Brown & Dobs, 2002; Ricci *et al*., 2007) that are expressed also in humans (Brown & Dobs, 2002), including on sperm (Rossato *et al*., 2005).

Finally, the effect of medications on male infertility was not evident in this study. However this has been reported in other studies. This includes the effect of use of antiepileptics (carbamazepine, oxcarbazepine, valproate) which were associated with adverse effects on sperm number, morphology or motility (Isojarvi *et al*., 2004); H2-receptor antagonist (cimetidine) that affect spermatogenesis (Van Thiel *et al.*, 1979); antimalaria drugs such as

Pyrimethamine, Artemether, Quinine ($C_{20}H_{24}N_2O_2$) which are used to treat forms of malaria (Trager & Polonsky 2005); sulfasalazine, which has been widely used for the chronic treatment of irritable bowel disorders (Feagins & Kane, 2009); chemotherapeutic agents (anti-mitotics such as cyclophosphamide) used for treatment of cancers or of some kidney diseases (Nudell *et al*., 2002) and nifedipine for hypertension (Hershlag *et al*., 1995).

CONCLUSIONS

The study documented influences of certain lifestyles characteristics such as smoking marijuana on semen quality of male partners of infertile couples. Mumps increased the likelihood of having low sperm concentration. The effects of the extensive use of marijuana and heroin might have arisen from the small number of users in the study group. Lipid levels had no influence on sperm characteristics in this setting. Engaging in positive lifestyles that minimize these risks could therefore help in improving sperm quality.

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