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Sperm Parameters and Reproductive Hormones Among Male Sudanese Worker Exposed to High Occupational Heat

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Abstract:

Introduction: The hormonal function of the human testicle is temperature dependant. It requires a temperature 2 – 4 C˚ below body temperature. The frequency and time of heat exposure are capable of producing reversible or irreversible changes in human spermatogensis.
Objective: the aim of this study is to reconfirm or refute the previously tested hypothesis that the occupational heat exposure reduces both sperm output and quality in fertile men due to increases of scrotal and testicular temperature.
Materials and methods: Sperm quality was examined in 216 Sudanese workers in sugar factories, Bakeries and Khartoum Foundry center, their ages between 18-54 years old. A scrotal temperature ranged between 38.9-41 C˚ and heat exposure for 1 to 24 years were recorded. A 102 age and place-matched unexposed workers who had scrotal temperature range between 32-34 C˚ was used as a control group. Venous blood (5-10 ml) and semen samples by masturbation were collected from them. Serum was prepared and analyzed for reproductive hormones by RIA techniques. Semen samples were analyzed by Computer Assisted Sperm Analysis (CASA) method.
Results: The results of this study indicated that sperms (count, motility and morphology) were assessed in both groups. The sperm density, motility and morphology were significantly affected in the test group P.value (000).
In the test group it was found that the longer the duration of exposure the more significant is the decline in all sperm parameters, and those who were exposed for more than 10 years may develop azoospermia. 20 volunteers were found to have primary infertility and 8 to have secondary infertility. FSH significantly increased in the azoospermic and oligospermic groups, while the other hormones, LH, Testosterone and Prolactin, remained within the normal range levels. High testicular temperature impaired spermatogenesis leading to oligozoospermia, asthenozoospermia, teratzoospermia and azoospermia.

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Therefor, the long term effects of hyperthermia adversely affect the sperm quantity and quality.
Long term testicular hyperthermia may lead to primary and secondary infertility.
The fasting baseline of FSH levels is negatively proportional with the sperm density.
Conclusion: These results support the hypothesis that increases in heat exposure are associated with reduced semen quality.

Introduction:

In humans, as in most mammals, testicular function is temperature dependent. Normal testicular function requires a temperature 2-4 °C below body temperature. [1-3] The negative effect of exogenous scrotal heat exposure on spermatogenesis has been demonstrated by numerous experimental human and animal studies. Recently, scrotal hyperthermia has been linked to certain lifestyle factors including use of disposable plastic lined nappies in children, prolonged car driving and sedentary work. [4-6] The frequency and time of heat exposure capable of producing reversible or irreversible changes in human spermatogenesis are not known. Studies of frequency of heat exposure and durability of inhibition of spermatogenesis revealed significant but reversible (within weeks or months) changes after single or multiple short-term scrotal heating [7] and total body heating.[8] It is an established fact that active sperm production is dependent on an environment that is 3–4°C lower than the normal body temperature. There is growing evidence of the adverse effect of heat on sperm production in animals [9, 10] as well as in humans.[8, 11]
Sudan is one of the African countries characterized by long summer season with a temperature ranging between 35-45 degrees, thus those people who are working in high occupational heat are expected to be suffering from reduction in active sperm production and quality as well. Since no study was done in Sudan regarding this issue, the **aim** of this study is to investigate for the sperm quality as well as reproductive hormones among Sudanese workers exposed to high occupational heat.

Materials and Methods:

The study was conducted on 216 Sudanese subjects working in sugar factories (El-Genaid, Sinnar and Asalaia), Barkers and Khartoum foundry center(KFC) who were exposed to high thermal testiculo–epididymal temperature 8 hours daily, for a minimum duration of one year and a maximum of 24 years. Their scrotal temperature ranged between 38.9-41.0 C°. Another 102 age and place-matched workers who were working in normal environment and with a scrotal temperature range between 32-34 C° were termed unexposed workers and are used as control group. Patients with childhood illness such as testicular torsion, post pubertal mumps, developmental delay, and precocious puberty or patients with surgical or urological disorder like unilateral or bilateral cryptorchidism were excluded from the study.
Routine medical examinations were conducted and symptoms based questionnaires regarding reproductive function were administered and recorded. The instructions for

sample collection and delivery were achieved according to WHO (1996) recommendation. They were asked to clean the reproductive organ with tap water before semen collection. Semen samples were collected by masturbation. The appearance and physical characteristics of semen were noted. Blood specimens (5 ml) were collected intravenously using sterile syringes. Serum was separated at room temperature and kept at -40 C° until hormone analysis was carried out using radioimmunometric assay kits (Ares Serono Diagnostici, Milano, Italy).

The semen sample was processed for various parameters such as sperm concentration, sperm motility, and morphology by using Computer Assisted Sperm Analysis (CASA) Method. Serum samples were brought to room temperature before analysis of LH, FSH, Testosterone and Prolactin using RIA technique. The RIA kits were obtained from Ares Serono Diagnostici, Milano, Italy. The counts were taken on RIA gamma counter (Packard, USA). Results on sperm characteristic and hormonal levels were compared with the control group used in this study and the normal range reported in the diagnostic kit.

The difference between means was calculated using student t-test. The distribution of the mean values tested for normality between groups differences were tested by one way ANOVA using the SPSS program. P-value less than 0.05 were considered significant.

Results:

The semen physical properties including appearance, pH, volume, color, coagulation and viscosity were normal in all study subjects. The results indicated that the sperm concentration for the test group (13%) 28 subjects azoospermic , 35 subjects (16%) oligozoospermic and 135 subjects (71%) normospermic while for the control group 0% azoospermic, 4 subjects (3.9%) oligozoospermic and 98 subjects (96.1%) normospermic **(Table 1)**.

The sperm motility data indicated that a significant high percentage of grade (C+D) among the exposed group (67%) compared with the unexposed (14%). Deterioration of sperm morphology was observed in 32.9% of the exposed subjects compared with only one percent in unexposed workers **(Table 2)**.

The data on reproductive hormones in the study subjects were presented in (**Table 3**). The mean FSH showed significant ($P<0.00$) high level in exposed workers (7.0±6.4 μ/L) compared with unexposed workers (3.5±2.4 μ/L), however LH, Testosterone and prolactin showed no significant differences.

FSH was also found higher in exposed workers with abnormal sperm concentration (azoospermic and oligospermic) compared with those with normal sperm concentration (**Table 4**).

There is no significant difference in the mean levels of the reproductive hormones and prolactin in exposed subjects with abnormal sperm morphology and motility compared with the exposed normal subjects**.** Sperm count, morphology and motility

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were inversely correlated with duration of exposure to occupational temperature **(Table 5)**.

Table 1: The percentage of sperm density for the test group and the control group.

Sperm count	Test group n=216	Control group n=102
Azoospermia	**28 (13%)**	**-**
Oligozoospermia	**35 (16%)**	**04 (3.9%)**
Normospermia	**153 (71%)**	**98 (96.1%)**

Table 2: Comparison of reproductive hormones between the exposed and unexposed group

Hormones	Exposed workers n=216 mean±SD	Unexposed workers n=102 mean±SD	P-value
FSH (μ/L)	**7.0±6.4**	**3.5±2.4**	**0.00**
LH (μ/L)	**5.0±2.2**	**4.6±1.8**	**0.31**
Testosterone (μ /L)	**13.3±4.6**	**15.7±3.9**	**0.49**
PRL (mμ /L)	**180.0±75.3**	**149.0±37.4**	**0.07**

Table 3: Comparison of male reproductive hormones and the sperm concentration among the exposed group.

Hormones	Normospermic n=153 Mean±SD	Azoospermic n=28 Mean±SD	Oligospermic n=35 Mean±SD	P-value
FSH (µ/L)	4.8±2.2	16.9±9.4	8.3±5.8	0.00
LH (µ/L)	4.7±2.0	5.8±2.8	5.4±2.5	0.08
Testosterone (µ/L)	13.4±4.3	12.7±4.7	13.1±5.5	0.71
PRL (mµ /L)	174.9±69.1	195.7±68.9	187.9±102.6	0.37

Table 4: Mean levels of male reproductive hormones among exposed workers in relation to sperm morphology and motility.

Hormones	Sperm Morphology N=188		Sperm Motility n=188	
	Normal n=126	Abnormal n=62	Normal n=63	Abnormal n=125
FSH (µ/L)	5.5±4.5	5.0±2.5	5.1±4.6	5.6±3.9
LH (µ/L)	4.7±2.1	5.0±2.1	4.7±2.3	4.9±2.1
Testosterone (µ/L)	14.8±3.9	15.1±5.8	13.6±3.9	13.3±4.8
PRL (mµ /L)	181.1±82.4	156.7±51.5	175.6±83.9	177.9±73.4

Table 5: Comparison between sperm parameters according to duration of exposure to high occupational heat.

Sperm parameters	Duration < 5yrs n=68	Duration 5-10 yrs n=51	Duration >10 yrs n=97	P-value

Count (Mean±SD)	57.7±39.1	57.3±41.4	37.1±19.9	0.002
Motility (Mean±SD)	45.5±22.2	37±20.1	26.7±24.2	0.00
Morphology (Mean±SD)	71.1±14.4	66.2±25.7	52.9±34.9	0.00

Discussion:

This study suggests that exposure to high occupational temperature is related to decrease in sperm count per ejaculation, proportion of normal sperm form, motility and a significant increase of FSH in serum. The semen parameters decreased and FSH concentration increased with increasing exposure to high temperature. In this study, sperm concentration was found below the normal value in 29% of the exposed workers compared with workers exposed to normal temperature 3.9%. We infer this to prolonged or regular exposure to higher temperatures which can override the body's ability to keep the testes cool. Parameters such as motility and morphology clearly suggest that regular occupational heat exposure may have some role in the deterioration of sperm quality. Our study reported a significant decrease in the degree of sperm motility (67%) grade (C+D), and high percentage of sperm morphology deterioration among exposed group. Bedford in 1991[12] proposed that cauda epididymis is sensitive to high temperature, high scrotal temperature causes absorptive and secretary function of disruption of cauda epithelium which impaired sperm motility lead to asthenozoospermia. Many studies had reported abnormal sperm morphology among workers exposed to high temperature on their works [13, 14] and this abnormality in sperms was found correlated with increasing exposure to heat overtime.[15] These data indicated that sperm function is strictly correlated with sperm morphology and that sperm motility is the best predictor of fertility potential in man. In the present study, the serum concentration of FSH was significantly higher in heat exposure groups especially those with azoospermia; however other hormones (LH, Testosterone and Prolactin) showed no significant effect. This result may indicate abnormality in initial sperm production. Since, when the sperm producing capacity of the testis is diminished, the pituitary makes more FSH in an attempt to make the testes do its job. Therefore, if a man's FSH is significantly elevated there is a strong indication that his testes are not producing sperm optimally. Our result was similar to the findings reported high FSH in azoospermic men.[16, 17]

This study indicated that the effect of testicular hyperthermia for more than 10 years is highly aggressive on sperm parameters including sperm count, morphology and motility and it may lead to azoospermia and sterility.

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Our finding was similar to studies reported that males exposed to very high temperature at their work place for a period more than ten years were probably develop azoospermia.[16, 18]

Conclusion:

We found, in conclusion, that exposure to high occupational temperature is related to decrease in sperm count per ejaculation, proportion of normal sperm morphology, motility and a significant increase of FSH in serum

Also the results support the hypothesis that increases in heat exposure is associated with reduced semen quality

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