

## The Relations between Cadmium, Zinc and Oxidative stress in Oligoasthenozoospermic Men

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### ABSTRACT

**Background:** Cadmium (Cd) has been found to accumulate in male reproductive organs and induce male reproductive toxicity in several animal species. **Objective:** To study the levels of Cadmium and Zinc in blood and seminal plasma of oligoasthenozoospermic men and to investigate their possible role and their relation to oxidative stress in pathophysiology of oligoasthenozoospermia. **Study Design:** Blood and seminal plasma were collected from thirty primary infertile males with oligoasthenozoospermic, and 30 control subjects. Cadmium (Cd), zinc (Zn), malondialdehyde (MDA) and superoxide dismutase (SOD) activity were estimated in all samples. **Results:** The serum and seminal concentrations of Cd and MDA of oligoasthenozoospermic group were significantly higher than those of control groups. Levels of blood and seminal plasma of Zn and SOD activity of infertile men were significantly lower than those of control group. The seminal plasma levels of Cd of oligoasthenozoospermic group were correlated positively and significantly with MDA levels in seminal plasma. However, there were significant negative correlations between seminal plasma levels of Cd and seminal levels of Zn and seminal SOD activity, sperm count and sperm motility. There were inverse correlations between seminal plasma levels of MDA and SOD activity, sperm count and sperm motility in oligoasthenozoospermic group. The results also shows that there was a positive and significant correlation between the seminal SOD activity and sperm motility in infertile men. Seminal plasma levels of Zinc were negatively and significantly correlated with sperm motility of oligoasthenozoospermic group. **Conclusion:** Cadmium may have adverse impacts on semen quality and male reproductive health. The pathophysiological mechanism of high Cadmium levels in oligoasthenozoospermic men is probably through induction of oxidative stress. Lowered levels of zinc may contribute to infertility through its significant effects on semen motility. There is competitive mechanism of interaction between Zn in relation to Cd in oligoasthenozoospermic men

### INTRODUCTION

The general population is exposed to metals at low concentrations either voluntarily through supplementation or

involuntarily through intake of contaminated food and water or contact with contaminated soil, dust, or air. Some metals, such as cadmium (Cd), lead, arsenic, and mercury, are nonessential xenobiotics that can be measured in most of the general

population<sup>(1)</sup>. Because widespread human exposure have been demonstrated, there is growing concern for adverse health effects associated with low-level exposures encountered in the environment. Human and animal evidence suggests that these metals may have adverse impacts on male reproductive health at relatively low levels. For example, Cadmium (Cd) has been linked to poor human semen quality and DNA damage<sup>(2)</sup>. Pb and Cd are highly toxic metals for humans and other mammals. Both are pervasive in the human environment and accumulate in the human body over a lifetime, including prenatal life (especially Pb)<sup>(3)</sup>.

Several trace elements have been shown to be essential for testicular development and spermatogenesis. Zinc (Zn) in human semen seems to play an important role in the physiology of spermatozoa. Zn deficiency leads to gonadal dysfunction, decreases testicular weight, and causes shrinkage of seminiferous tubules<sup>(4)</sup>. It has been noted that Zn has a relationship with many enzymes in the body and can prevent cell damage through activation of the antioxidant system<sup>(5)</sup>. Zinc is an essential component of the oxidant defense system and functions at many levels<sup>(6)</sup>. One study has shown that Zn deficiency in the diet paves the way for cell damage in the rat testis<sup>(7)</sup>.

The imbalance between reactive oxygen species (ROS) production and total antioxidant capacity (TAC) corresponding to oxidative stress is correlated with male infertility and the exposure of the spermatozoa to

reactive oxygen species has been associated with cellular injury that includes DNA damage and lipid peroxidation (LP)<sup>(8)</sup>. In fact, the excess of LP as represented by high levels of malondialdehyde (MDA) product may cause changes in the sperm characters, decreased fluidity and flexibility of the sperm membrane, and diminishing of the fertilization potential. This indicates that LP could be harmful to male sperm and reproductive system<sup>(9)</sup>.

#### **Aim of the work:**

To study the levels of Cadmium and Zinc in blood and seminal plasma of oligoasthenozoospermic men and to investigate their possible role and their relation to oxidative stress in pathophysiology of oligoasthenozoospermia.

## **PATIENTS, MATERIALS & METHODS**

#### **Patients:**

This study included 60 non smoker males aged 20 - 40 years. It was carried in Department of Dermatology and Andrology and Physiology Department, Faculty of Medicine, Assiut University from December 2007 until October 2008. The protocol was approved by the Faculty of Medicine, Assiut University ethical committee, and informed consent was obtained from each patient before the collection of samples. The participants were classified into: Group A: included 30 oligoasthenozoospermic male partners with sperm count less than 20 millions /ml, total motility <50%), Group B: included 30 normozoospermic healthy fertile control males selected from

general population (whose partners had conceived within a year and have sperm count greater than 20 million/ml, total motility > 50%.

**Selection Criteria:**

All patients had regular unprotected intercourse for at least 12 months without conception and had normal hormonal profile. Their partners were having normal and regular menstrual cycles without any uterine pathology or hormonal disturbance. A detailed background history and physical examination were taken from both husband and wife.

The exclusion criteria were as follows: 1- Factors in the individual's history that have a possible influence on male infertility, as suggested by the World Health Organization (WHO)(10) (eg, history of diabetes mellitus, long-term medication, urinary tract infection, sexually transmitted disease, or testicular injury), 2- Clinically detected abnormalities (small testicular volume or varicocele ). 3- Patients with previous groin/scrotal surgery or chronic alcohol intake were also excluded.

**Semen collection:**

Semen samples were obtained by masturbation into 50 ml sterile polystyrene jars after an abstinence period of 3 to 5 days. After liquefaction, samples were processed by conventional analysis to determine the volume, sperm count, and sperm motility. Motility was assessed at room temperature according to WHO criteria<sup>(10)</sup>.

After semen analysis, spermatozoa were immediately separated from seminal plasma by centrifugation (100x g for 10min at

room temperature). Supernatants were collected and stored at  $-70^{\circ}\text{C}$ .

**Blood collection:**

Blood samples (6 ml) were collected from controls and patients. The samples were taken from an antecubital vein and were transferred to chilled sterile disposable tubes. 3ml was heparinized and separated as plasma and the rest was separated as serum after centrifugation at 3,000 *r.p.m.* for 20 min. Plasma and serum were stored immediately at  $-20^{\circ}\text{C}$  until assay.

**Methodology:****Determination of Cadmium and Zinc:**

Serum and seminal plasma cadmium (Cd) and zinc (Zn) levels were estimated by atomic absorption spectrometry. Determinations of the concentrations of Cd were performed by graphite furnace atomic absorption spectrometry (Perkin-Elmer 5100 PC AAS, Zeeman furnace module, Furnace cooling System and Autosampler AS-70, Norwalk, USA) using pyrolytic transverse heated graphite atomizer tubes. Cadmium at 228.8 nm with hollow cathode lamps.

**Determination of Malondialdehyde (MDA) and Superoxide dismutase (SOD) activity:**

Levels of MDA in seminal plasma were assessed using thiobarbituric acid reactivity. The product of reaction between malondialdehyde and thiobarbituric acid was measured according to Ohkawa(11). Determination of SOD activity in the seminal plasma was done according to Misra and Fridovich (12).

**Statistical Analysis:**

In the present study, the data were statistically analyzed using computer database (Prism program, Graph pad version 3.0). Data comparisons were performed by using two tailed unpaired student t-test and the correlations between the biochemical parameters were performed using (ANOVA) with a statistical significance of  $P < 0.05$  was used (spearman's rank correlation coefficient). Levels of significance (P) were considered as following: (1)  $P > 0.05$ , not significant; (2)  $P < 0.05$ , significant; (3)  $P \leq 0.01$ , highly significant and the results are presented as mean  $\pm$  SD (13).

## RESULTS

Data concerned with semen volume, sperm count and motility of both studied groups are presented in table (1).

In this study, it was found that there was a significant difference among the mean Cd levels in the examined groups, as the mean serum and seminal plasma Cd levels of control group were significantly lower than oligoathenozoospermic ( $P < 0.001$ ). Generally, the mean serum levels of Cd were significantly higher than the mean seminal plasma levels in both examined groups ( $P < 0.001$ ), Table (2).

It was found that serum and seminal plasma levels of Zn of control group were significantly higher than those of oligoathenozoospermic group ( $p < 0.001$ ). The MDA concentrations in plasma and seminal plasma of oligoathenozoospermic group were significantly higher compared with control group ( $P < 0.001$ ). The mean

of plasma and seminal SOD activity were significantly higher in control group, compared with the oligoathenozoospermic group ( $P < 0.001$ ) (Table 2).

Table (3) shows that serum Cd levels have positive correlations with seminal Cd levels ( $r = 0.384, P < 0.05$ ) and plasma concentrations of MDA ( $r = 0.74, P < 0.001$ ) and have negative correlations with plasma levels of SOD ( $r = -0.624, P < 0.001$ ) and sperm motility ( $r = -0.424, P < 0.05$ ).

The seminal plasma levels of Cd of oligoathenozoospermic group were correlated positively and significantly with MDA levels in seminal plasma ( $r = 0.964, P < 0.001$ ). However, there were negative significant correlations between seminal plasma levels of Cd and seminal levels of Zn ( $r = -0.873, P < 0.001$ ) and seminal SOD activity ( $r = -0.827, P < 0.001$ ), sperm count ( $r = -0.912, P < 0.001$ ) and sperm motility ( $r = -0.888, P < 0.001$ ). Table (3).

There were inverse correlations between seminal plasma levels of MDA and SOD activity ( $r = -0.676, P < 0.001$ ), sperm count ( $r = -0.78, P < 0.001$ ) sperm motility ( $r = -0.747, P < 0.001$ ) in oligoathenozoospermic group.

In all samples of infertile men, positive and significant correlation between the seminal SOD activity and sperm motility was established ( $r = 0.941, P < 0.001$ ). Seminal plasma levels of Zinc were significantly and positively correlated with sperm motility of oligoathenozoospermic group ( $r = 0.915, p < 0.001$ ) Table (4).

Figure (1A) shows that there was inverse correlation between plasma levels of MDA and of SOD activity of

oligoathenozoospermic group ( $r = -0.605$ ,  $P < 0.001$ ). There was an inverse correlation between plasma levels of MDA and sperm motility of oligoathenozoospermic group ( $r = -0.0459$ ,  $P < 0.05$ ) Figure (1B).

Furthermore, as shown in Figure (1C), plasma levels of SOD activity were positively correlated with sperm motility ( $r = 0.555$ ,  $P < 0.01$ ) in oligoathenozoospermic group.

**Table (1):** Semen biophysical characteristics in both studied groups

Characteristic	Control group	Oligoathenozoospermic group
Number	30	30
Volume of ejaculate (ml)	3.83±0.021	3.9± 0.02
Sperm count (X 10 <sup>6</sup> /ml)	94.92±1.03	11.53±1.14
Motility (%)	93.27±0.51	44.78±1.4

Data are presented as mean ± SE

**Table (2):** Levels of different parameters in both studied groups

Parameter	Control group	Oligoathenozoospermic group
Serum Cd (ug/l)	1.1±0.09	1.42± 0.014 <sup>a</sup>
Seminal plasma Cd (ug/l)	0.86±0.01	1.18±0.015 <sup>a</sup>
Serum Zn (ug/l)	141.3±1.7 <sup>b</sup>	116.5±2.27
Seminal plasma Zn(ug/l)	271.7±4.1 <sup>b</sup>	192.9±4.54
Seminal MDA(nmol/l)	1.23±0.01	3.36 ±0.02 <sup>a</sup>
Plasma MDA(nmol/l)	14.2±0.08	16±0.15 <sup>a</sup>
Seminal SOD activity(U/ml)	22.08±0.22 <sup>b</sup>	13.47±0.12
Plasma SOD activity(U/ml)	137.6±1.53 <sup>b</sup>	79.5±0.68

Data are presented as mean ± SE, Cd: Cadmium, Zn: Zinc, MDA :malondialdehyde, SOD: superoxide dismutase.

a:  $P < 0.001$  as compared to the control group , b :  $P < 0.001$  as compared to the oligoathenozoospermic group.

**Table (3):** Multiple correlations analysis between Cd levels (in serum and SP) and Zn levels, MDA, SOD activity and the semen parameters in oligoathenozoospermic group.

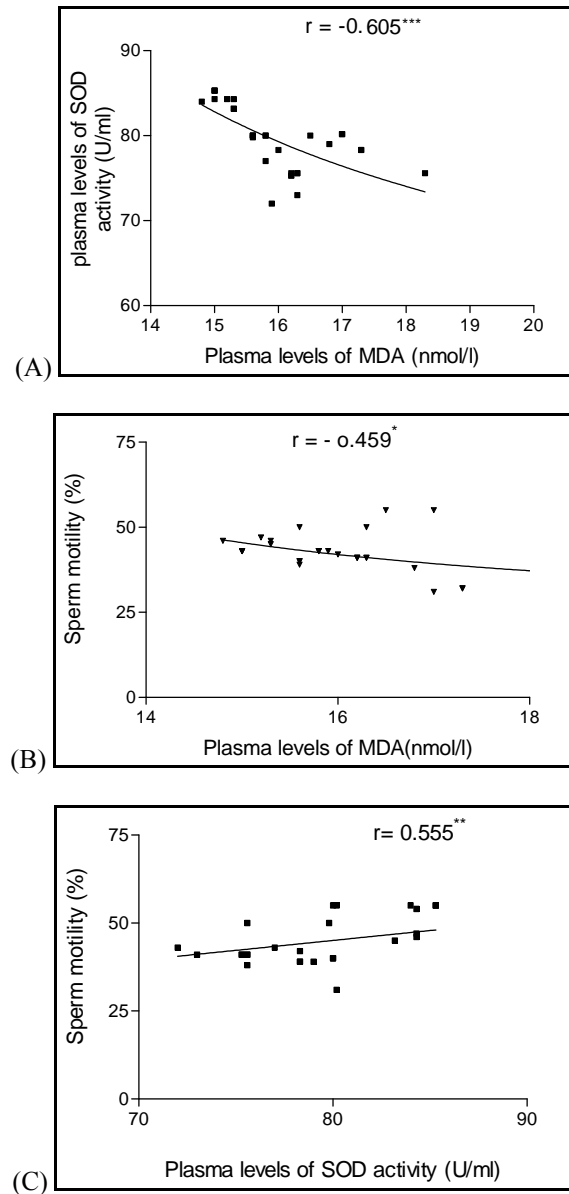
Parameters	Serum Cd		SP Cd	
	Coefficient (r)	P	Coefficient (r)	P
Serum Zn	0.007	NS	-0.019	NS
SP Zn	0.0141	NS	-0.873	<0.001***
SP Cd	0.384	< 0.05*	-	-
SP MDA	0.312	NS	0.964	<0.001***
Plasma MDA	0.740	<0.001***	0.037	NS
SP SOD	-0.304	NS	-0.827	<0.001***
Plasma SOD	-0.624	<0.001***	-0.333	NS
Sperm count	-0.083	NS	- 0.912	<0.001***
Sperm motility	-0.424	< 0.05*	-0.888	<0.001***

SP: Seminal plasma, Cd: Cadmium, Zn: Zinc, MDA: malondialdehyde,  
SOD: superoxide dismutase.  
NS: non significant

**Table (4):** Multiple correlations analysis between semen parameters (sperm count and motility) and seminal plasma of MDA, SOD activity and Zinc in oligoathenozoospermic group

Parameters	Sperm count		Sperm motility	
	r	P	r	P
MDA	-0.780	<0.001	-0.747	<0.001
SOD activity	0.126	NS	0.941	<0.001
Zinc	0.049	NS	0.915	<0.001

MDA: malondialdehyde, SOD: superoxide dismutase, NS: non significant



**Figure (1):** Multiple correlations analysis between plasma levels of MDA and SOD activity and Sperm count in oligoathenozoospermic (A) Inverse correlations between levels of MDA and SOD activity in plasma. (B): Inverse correlation between plasma levels of MDA and sperm count. (C): Positive correlation between plasma levels of SOD activity and sperm count . MDA: malondialdehyde, SOD: superoxide dismutase, \*\*\*= 0.001, \*\*=0.01 and \* = 0.05.

## DISCUSSION

It has long been established that agents such as cadmium, which are known reproductive toxicants, implicated in occupational hazards are found to accumulate in human semen<sup>(14)</sup>. However, the subjects in this study were recruited from occupationally unexposed population.

A high level of cadmium in serum of oligoathenozoospermic patients were significantly higher than control subjects, this was explained by Omu et al<sup>(15)</sup> who reported that a high level of cadmium was the possible cause of asthenozoospermia in smokers. Cigarette smoking is an important variable when considering the effect of both lead and cadmium exposure on human health. Cigarette smoke is a major source of airborne environmental lead and cadmium exposure. A single cigarette has been reported to contain 1.5 µg of cadmium<sup>(16)</sup>. Although smoking was excluded in the subjects investigated in our study, the incidence of unwilling exposure to second-hand cigarette smoke is very high in Egypt. Unlike in the most developed countries, there are no smoking restrictions in public places in Egypt except hazardous areas such as petrochemical filling stations. Another explanation of high levels of Cd in infertile patients is that environmental discharge of cadmium due to the use of petroleum products, combination of fossil fuels (petroleum and coal) and municipal refuse contribute to airborne cadmium pollution and possibly introduce high concentrations of this potential reproductive toxicant into the environment<sup>(17)</sup>.

The seminal plasma levels of Cd in oligoathenozoospermic patients were significantly higher than control group indicating that there is systemic and cellular Cd toxicity in oligoathenozoospermic patients. Since the testes is known to serve as one of the important targets of Cd<sup>(18)</sup>, it is likely that cadmium elicits its toxic effect, probably expressed as infertility<sup>(19)</sup>.

Zinc, a critical element in male reproductive function, is normally secreted in enormous amounts by the prostate gland. Zinc and copper are bound to a small cysteine-rich metal-binding protein, metallothionein (MT), which has been identified in the male mammalian reproductive organs such as testis, epididymis, prostate and seminal vesicles. In general, MT is important in the homeostasis of essential metals, like zinc and copper, and provides protection from toxic metals such as cadmium<sup>(20)</sup>.

In this study, there were significant low serum and seminal plasma zinc levels in oligoathenozoospermic patients than the control group. This was explained by Amara et al.<sup>(18)</sup> who reported that there is competitive mechanism of interaction of Zn in relation to Cd toxicity.

The lowered levels of zinc of oligoathenozoospermic men may also be explained by that Cd appears to mainly affect the distribution of Zn in the body. Because Zn is required for optimum activity of > 200 enzymes including those involved in the synthesis and repair of DNA and RNA, and thus related protein synthesis and tissue repair response, this may have multiple adverse



consequences. However, alterations in the amount and/or biologic availability of Zn in certain body compartments (e.g., through Cd-related decrease in the capacity of MT to provide optimum supply of Zn to the cell) may influence sperm proliferation, maturation, and viability<sup>(21)</sup>. Moreover, dietary Cd probably produced testicular lesions indirectly by decreasing testicular Zn; this decrease seems to be due to sequestration of Zn by Cd-induced hepatic and renal metallothioneins<sup>(22)</sup>.

Seminal plasma levels of zinc were positively correlated with sperm motility and this positive correlation may be explained by that Zinc in seminal plasma stabilizes the cell membrane and nuclear chromatin of spermatozoa. It may play a regulatory role in the process of capacitation and acrosome reaction<sup>(23)</sup>.

Normally, a balance is maintained between the amount of ROS produced and antioxidants. Cellular damage arises when this equilibrium is disturbed, especially when the cellular scavenging systems cannot eliminate the increase in ROS. The scavenging potential in gonads and seminal fluid is normally maintained by adequate levels of SOD, catalase, and probably glutathione peroxidase and reductase which are mainly produced by the male accessory sex glands<sup>(24)</sup>.

In this study the oxidative stress (OS) status was evaluated in infertile men by assessing the levels of LP product (MDA) in semen. MDA concentrations in plasma and seminal plasma of oligoasthenozoospermic group were significantly greater compared with control group. In contrast, the mean of plasma and

seminal SOD activity was significantly lower in oligoasthenozoospermic group compared with the control group. This was explained by that Cd is highly toxic metal in humans and other mammals. This heavy metal can induce OS through its capacity to interact with ROS, increasing its oxidant activity or by affecting membrane integrity<sup>(25)</sup>.

The seminal plasma levels of Cd of oligoasthenozoospermic group were correlated positively and significantly with MDA levels in seminal plasma. However, there were significant negative correlation between seminal plasma levels of Cd and seminal SOD activity, sperm count and sperm motility. The explanation is that spermatozoa are particularly susceptible to OS-induced damage, because their plasma membranes contain high concentration of polyunsaturated fatty acids (PUFA) and their cytoplasm contains low concentrations of scavenging enzymes<sup>(26)</sup>. Lipid hydroperoxides are stable under physiological conditions until they contact transition metals such as cadmium or copper salts. These metals or their complexes cause lipid hydroperoxides to generate alkoxyl and peroxy radicals, which then continue the chain reaction within the membrane and propagate the damage throughout the cell. Propagation of LPO depends on the antioxidant strategies employed by spermatozoa. One of the by-products of lipid peroxide decomposition is malondialdehyde<sup>(27)</sup>.

This explanation was supported by Amara et al.<sup>(18)</sup> who reported that there was concomitant increase in

generation of free radicals, such as  $H_2O_2$  and OH, in the testes of the Cd-treated rats and the interaction between Cd and essential trace elements could be one of the reasons for decreased antioxidant enzymes in the rat testis.

Both levels of seminal plasma of Cd and MDA in the present study have significant negative correlations with sperm count and motility, these results were in accordance with Fatma et al.<sup>(26)</sup> who reported that MDA concentration in semen of all patients was also positively correlated with acrosome abnormality and cytoplasmic retention and the high levels of OS were correlated with impairment of the acrosome reaction owing to protein cross-linking and LP.

These results can be explained by that  $H_2O_2$  diffuses across the membranes into the cells and inhibits the activity of some vital enzymes such as glucose-6-phosphate dehydrogenase (G6PD) via the hexose monophosphate shunt controls the intracellular availability of NADPH, which is then used as a source of electrons by spermatozoa to fuel the generation of ROS by an enzyme system known as NADPH oxidase.

Another hypothesis involves a series of interrelated events resulting in a decrease in axonemal protein phosphorylation and sperm immobilization, both of which are associated with a reduction in membrane fluidity that is necessary for sperm-oocyte fusion<sup>(28)</sup>. On the other hand, the low seminal  $O_2$  scavenging capacity could support an inadequate seminal defense against free radical toxicity, which, in turn, could affect sperm motility<sup>(18)</sup>.

### Conclusion:

Cadmium may have adverse impacts on semen quality and male reproductive health. The pathophysiological mechanism of high Cadmium levels in oligoathenozoospermic men is probably through induction of oxidative stress. The evaluation of oxidative status might have an indicative value on the diagnosis of male infertility.

Lowered levels of zinc may contribute to infertility through its significant effects on semen motility. There is competitive mechanism of interaction between Zn in relation to Cd in oligoathenozoospermic men.

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## العلاقة بين الكاديوم والزنك و التوتّر الناتج عن الأكسدة في الرجال ذوي قلة وضعف حركة الحيوانات المنوية

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يعد الكاديوم و الزنك من العناصر الأثرية التي تؤثّر علي الجهاز التناسلي لدي الذكور نتيجة التلوث البيئي. كما وجد أن الكاديوم يتراكم في الأعضاء التناسلية الذكرية و يسبب خلل في الوظائف التناسلية الذكرية.

وتهدف هذه الدراسة الي دراسة مستويات الكاديوم و الزنك في السائل المنوي و مصل الدم في الرجال ذوي قلة وضعف حركة الحيوانات المنوية دراسة دورهم و علاقتهم بالتوتّر الناتج عن الأكسدة كاسباب لمرض قلة وضعف حركة الحيوانات المنوية .

وشملت هذه الدراسة علي ٦٠ شخص مقسمين الي مجموعتين :

١- مجموعة الرجال ذوي قلة وضعف حركة الحيوانات المنوية: وضمت ٣٠ رجل لديهم عدد

الحيوانات المنوية أقل من ٢٠ مليون/ملي و حركتهم الكلية  $> ٥٠\%$  .

٢- المجموعة الضابطة : وشملت ٣٠ رجل لديهم عدد الحيوانات المنوية أكبر من ٢٠

مليون/ملي و حركتهم الكلية  $< ٥٠\%$  .

و تم جمع السائل المنوي و عينة دم من كل رجل من المجموعتين. كما تم قياس مستويات الكاديوم و الزنك باستخدام طريقة الأمتصاص الذري باستخدام جهاز السبكتروفوتومتر. وقياس مستويات الدهيدات حمض المالونيك و سوبر اوكسيد ديسميوتيز في كل العينات.

و لقد أوضحت نتائج هذه الدراسة إن مستويات الكاديوم والدهيدات حمض المالونيك في السائل المنوي و دم الرجال ذوي قلة وضعف حركة الحيوانات المنوية عالية و ذات دلالة إحصائية عن مستوياتها في المجموعة الضابطة. وكانت مستويات الزنك و سوبر اوكسيد ديسميوتيز في السائل المنوي و الدم في الرجال عالية و ذات دلالة إحصائية في المجموعة الضابطة عن مستوياتها في مجموعة الرجال ذوي قلة وضعف حركة الحيوانات المنوية.

كان هناك علاقات ذات دلالات إحصائية موجبة بين مستويات الكاديوم في المصل و مستويات الكاديوم في السائل المنوي و الدهيدات حمض المالونيك في بلازما الرجال ذوي قلة وضعف حركة الحيوانات المنوية. كما كان هناك علاقات ذات دلالات إحصائية سالبة بين مستويات الكاديوم في المصل و مستويات سوبر اوكسيد ديسميوتيز في البلازما و حركة الحيوانات المنوية في مجموعة الرجال ذوي قلة وضعف حركة الحيوانات المنوية.

هناك علاقات ذات دلالات إحصائية موجبة بين مستويات الكاديوم والدهيدات حمض المالونيك في السائل المنوي للرجال ذوي قلة وضعف حركة الحيوانات المنوية. كما كان هناك علاقات ذات دلالات إحصائية سالبة بين مستويات السائل المنوي من الكاديوم و مستويات الزنك و سوبر اوكسيد ديسميوتيز و عدد و حركة الحيوانات المنوية في مجموعة الرجال ذوي قلة وضعف حركة الحيوانات المنوية.

وفي كل العينات كان هناك علاقات ذات دلالات إحصائية موجبة بين حركة الحيوانات المنوية و مستويات الزنك و سوبر اوكسيد ديسميوتيز في السائل المنوي في مجموعة الرجال ذوي قلة وضعف حركة الحيوانات المنوية.

و لقد أوضحت نتائج هذه الدراسة إن في مجموعة الرجال ذوي قلة وضعف حركة الحيوانات المنوية هناك علاقات ذات دلالات إحصائية سالبة بين مستويات الدهيدات حمض المالونيك

في السائل المنوي و مستويات ا لسوبر اوكسيد ديسميوتيز و عدد و حركة الحيوانات المنوية كما كان هناك علاقات ذات دلالات إحصائية موجبة بين مستويات ا لسوبر اوكسيد ديسميوتيز في السائل المنوي وحركة الحيوانات المنوية .  
و في مجموعة الرجال ذوي قلة وضعف حركة الحيوانات المنوية كان هناك أيضا علاقات ذات دلالات إحصائية سالبة بين مستويات الدهيدات حمض المالمونيك في البلازما و مستويات ا لسوبر اوكسيد ديسميوتيز في البلازما و حركة الحيوانات المنوية كما وجدت علاقة موجبة بين مستويات ا لسوبر اوكسيد ديسميوتيز في البلازما وحركة الحيوانات المنوية .  
ونستنتج من هذه الدراسة أن الكادميوم له تأثير عكسي علي نوعية السائل المنوي و صحة الجهاز التناسلي الذكري وأن مستوياته العالية لها دور كمسببات لمرض قلة وضعف حركة الحيوانات المنوية من خلال تخليق التوتر الناتج عن الأوكسدة . كما أن مستويات الزنك القليلة تساهم في العقم من خلال تأثيرها علي حركة الحيوانات المنوية .