Comparing the Effectiveness of Dietary Vitamin C and Exercise Interventions on Fertility Parameters in Normal Obese Men

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Purpose: Comparing the effectiveness of dietary vitamin C and weight loss exercises interventions for weight loss on semen characteristics in normal obese man.

Materials and Methods: A total number of 200 men were randomly allocated into two groups based on body mass index, exercise and vitamin C groups. Also, 50 men with normal spermogram were placed in a control group. In exercise group, a 6 months intensive exercise program was designed under a coach's supervision to reduce the body weight. In vitamin C group, 1,000 mg of vitamin C were given every other day as supplement.

Results: Weight loss increased the volume of semen in participants with 25-30 (P = .02) and more than 30 body mass index (P = .001). The increased concentration of sperm per mL of semen in body mass index (BMI) 25-30 group (P = .01) and more than 30 (P = .003) BMI was significant. Improving sperm motility after two hours in participants with more than 30 (P = .01) BMI was significant. In vitamin C group, the improvement of sperm concentration in participants who had less than 25 (P = .01), between 25 and 30 (P = .01), more than 30 (P = .02) BMI was significant. Sperm motility improved in all three groups (P = .001, P = .02 and P = .003, respectively).

Conclusion: Weight loss can significantly increase semen volume, its concentration, its mobility and percentage of normal morphology. Consuming vitamin C significantly improves sperm concentration and mobility, but the semen volume and the percentage of normal morphology will not change significantly.

Keywords: ascorbic acid; administration; fertility; physiology; humans; nutritional requirements; population control; fertility; drug effects; infertility; male.

INTRODUCTION

International Committee for Monitoring Assisted Reproductive Technology (ICMART) and the World Health Organization (WHO) guidelines, have defined the infertility as not becoming pregnant after one year sexual intercourse without protection due to the reproductive systems disease.[1] The regular rate of fecundity is 85-80% after 12 months.[2] About 15% of couples suffer infertility of which 25-50% is contributed to male factor.[3]

Pathology of male factors can be categorized into three groups. First are the pre-testicular factors. They include hypogonadism; hypothyroidism; follicle-stimulating hormone reducing drugs including spironolactone and cimetidine, and nitrofurantoin that decreases sperm motility; aberrant life style (cigarette smoking, chronic alcoholism, marijuana); and vigorous activities like energetic bicycle riding.[4,5] Second are testicular factors. They include age, neoplasm e.g. seminoma, cryptorchidism, varicocele which account for 14%, mumps viral infection, Klinefelter syndrome and idiopathic factors which account for 30 % of male infertility.[6,7] Third are the post-testicular factors, including: impotence, vas deferens obstruction, lack of vas deferens, infection such as prostatitis, ejaculatory duct obstruction and hypospadias.[8]

WHO has depicted the normal semen analysis chart, according to which the semen volume is the total amount of fluid ejaculated that should be ≥1.5 mL. Sperm concentration (commonly known as 'sperm count') is regarded as the total number of sperm in a measured volume of an ejaculation. The sperm concentration is reported as the number of sperm per mL of semen that should be ≥15 million per mL. Total sperm number (also known as 'total sperm count') is described as the total number of sperm in the ejaculate, calculated by multiplying the semen volume by the sperm that should be ≥ 39 million. Sperm motility (i.e. swimming

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Table 1. Semen parameters based on the body mass index before the 6-month exercise intervention.

BMI, kg/m^2	Volume, mL	Concentration (million/mL)	Motility, %	Morphology, %
Control	3.54 ± 3.45	63.2 ± 1.24	67	55
< 25	3.12 ± 2.21	62.5 ± 2.2	62.2	51.2
25-30	2.64 ± 3.15	48.5 ± 1.95	51	40.2
31-35	1.8 ± 2.95	35.3 ± 2.11	45	28.2

Abbreviation: BMI, Body Mass Index.

or movability of sperm) or the number of motile (moving) sperm is compared with the number of non-motile sperm and is expressed as the percentage of the total number of sperm that should be ≥ 40% motile within 60 minutes of ejaculation.

Sperm vitality ('live' sperm) that is the number of sperms in the sample which are 'alive' is a percentage of the total number of sperms that should be ≥ 58%. Sperm morphology (the shape of the sperm) that is defined as the number of ideally formed sperms (defined as 'normal') is compared to the number of incorrectly shaped sperms (normally defined as 'abnormal'). It is described as the percentage of the total number of sperms that should be ≥ 4%. White blood cell count routinely occurs in semen. Huge amounts of white blood cells in the ejaculate can be defined as an infection of the reproductive tract. However, in some men it happens for no known reason. This factor should be < 1 million per mL. Semen pH is measured to test if the ejaculate is alkaline or acidic. Semen should be slightly alkaline. More acidic semen, along with a low amount of semen, can be a sign of possible blockage in the flow of semen. Its pH should be ≥ 7.2.[2]

Male germ cells are prone to produce ROS (reactive oxygen species) in different levels of development such as the acrosomal reaction and fusion of sperm and oocyte. Reactive oxygen species will be deactivated by existing antioxidants (vitamins C and E) in semen.[9] Oxidative stress happens when either the level of reactive oxygen species is high or antioxidants defects occur.[10] Increased levels of ROS will reduce the sperm motility.[11,12] Nowadays different techniques are designed to determine the level of spermatozoal DNA destruction caused by oxidative stress. A reliable one is measuring of 8-hydroxy-dioxy guanosine biomarker.[13]

Obesity could intensify the risk of infertility in men. Elevated body mass index (BMI) reduces the total amount of sperm and increases the DNA damage in sperms.[14] Calorie limiting diet would improve testicular gene expression in immature rhesus.[15] The reduction of body fat mass causes hypothalamic-pituitary-testicular fitness and increases in the production of testosterone in infertile men.[16] In humans, reducing calorie intake improves gene expression in epididymis (post testicular) and sperm maturation instead.[17]

This study compared the effectiveness of exercise interventions for reducing BMI and vitamin C on male fertility parameters (semen volume, sperm concentration, motility and normal morphology).

MATERIALS AND METHODS

This interventional study was conducted on 200 men who were referred to private clinics. They were 20 to 60 years old, did not have varicocele and chronic diseases history and used certain medications prescribed by the private clinics. Their medical history including age, blood group, familial, medical, and sexual history, lifestyle, personal consent, intercourse frequency per month, drinking alcohol, using certain medications, smoking habits, chronic diseases and personal sexual satisfaction was documented. Men with diabetes, hypertension, mumps history, sexually transmitted diseases and varicoceles were excluded from the study. The participants were randomly allocated into two groups based on BMI and also, 50 men of both groups with normal spermogram were placed in the control group. In both groups, men with a BMI of 30 to 35 were placed in group 1st group, those with a BMI of 25 to 30 in the 2nd group and those with a BMI less than 25 in 3rd group. In the exercise group, a six-month daily intensive exercise program was designed under a couch's supervision to reduce weight. In the vitamin C group, 1,000 mg of vitamin C were given every other day as supplement.

Semen Sampling Method

Semen samples were collected once, at the beginning of study and at the end of the intervention. Sperm samples were taken by masturbation after 3-5 days of sexual abstinence and kept in a plastic container. Then it was incubated at 37°C for 30 minutes and was analyzed after one hour.

The sperms were counted by light microscope with a magnification of 400. Different characteristics of semen including the appearance, size; pH, color, viscosity, liquefaction time, concentration and sperm motility were

Table 2. Semen parameters in men according to body mass index after six months of exercise interventions.

BMI, kg/m^2	Volume	Concentration (million/mL)	Motility, %	Morphology, %	*P* Value[a]	*P* Value[b]	*P* Value[c]	*P* Value[d]
Control	3.6 ± 3.11	65.5 ± 2.21	65	65	.1	.2	NS	NS
< 25	3.10 ± 2.25	63.3 ± 3.11	63.1	61	.5	.3	NS	.02
25-30	3.52 ± 3.51	55.8 ± 2.13	55.8	58.1	.02	.01	NS	.001
31-35	2.85 ± 3.1	48.9 ± 3.11	54.1	35	.001	.003	.01	.01

Abbreviations: BMI, Body Mass Index; NS, not significant.
a *P* value for semen volume, b *P* value for sperm concentration, c *P* value for sperm motility, d *P* value for sperm morphology.

investigated. Statistical analysis was done by Statistical Package for the Social Science (SPSS Inc, Chicago, Illinois, USA) version 16.0. *P* value significance was less than .05 and confidence interval was at 95%. Paired *t*-test was used to compare the results before and after interventions.

RESULTS

The participants' mean age was 35.2 years old. In exercise intervention group, the average of weight loss was 3.2 kg in the control group, 4 kg in men with a BMI less than 25, 6.1 kg in people with a BMI of 25 to 30 and 8.5 kg in those with BMI more than 30. The increase in semen volume of those with 25-30 (P = .02) and more than 30 BMI (P = .001) was significant (**Table 1**). The increased concentration of sperm per mL of semen in those with 25-30 (P = .01) and more than 30 (P = .003) BMI was also significant. Improving sperm motility after two hours in men with more than 30 BMI (P = .01) was significant. The increase in normal sperm morphologies in men with less than 25 (P = .02), 25 to 30 (P = .001) and more than 30 (P = .01) BMI were significant (**Table 2**).

In vitamin C group, the average semen volume did not change significantly (**Table 3**). However, the improvement of sperm concentration in men less than 25 (P = .01), 25 to 30 (P = .01), more than 30 (P = .02) BMI was were significant. Sperm motility increased in all three groups (P = .001), (P = .02) and (P = .003). The percentage of sperm with normal morphology was not significant (**Table 4**).

DISCUSSION

According to the results of this study, decreasing the body mass index can improve volume, concentration, motility and normal morphology of the sperm. Consumption of vitamin C can also improve of sperm concentration and motility. These findings are similar to findings of Dawson and colleagues which was done on infertile smokers. Their patients were given 1 gram per day of vitamin C and a high dosage regimen. They showed that diet improves fertility parameters.[18]

In another study on 97 fertile men, Eskenazi and colleagues found out that consuming vitamin C can increase sperm concentration and motility.[19] However, a study that was done by Kessopoulou and colleagues showed that antioxidants, particularly vitamin E cannot affect sperm quality for eight weeks.[20] They stated that in this study the time for improvement of fertility parameters was too short in their study.

Regarding physiological aspect, antioxidants may protect germ cells from oxidative damage.[21] Oxidative damage is associated with reduction of sperm mobility and capacity of oocytes-sperms fusion.[22] After facing with reactive oxygen species, sperm membrane will be rigid and cause fracture and damage in cell membrane. Treatment with antioxidants can prevent the sperm membrane from lipoproxidation damages.[23] Treatment with antioxidants also prevents the sperm DNA damage and mutation.[24]

Obesity is a health problem that is related to male infertility and abnormal fertility parameters.[25] Jensen and colleagues reported the semen analysis is abnormal in obese men and, the prevalence of oligospermia

Table 3. Semen parameters in men according to body mass index before taking vitamin C.

BMI, kg/m^2	Volume	Concentration (million/mL)	Motility, %	Morphology, %
Control	3.82 ± 3.26	64.5 ± 1.75	61.1	58
< 25	3.51 ± 4.12	61 ± 2.32	65.12	52.8
25-30	2.15 ± 3.62	45.2 ± 1.3	48.32	40.5
31-35	2.5 ± 3.16	40.1 ± 2.12	38.3	35.1

Abbreviation: BMI, Body Mass Index.

Table 4. Semen parameters in men according to body mass index after taking vitamin C.

BMI, kg/m^2	Volume	Concentration (million/mL)	Motility, %	Morphology, %	*P* Value[a]	*P* Value[b]	*P* Value[c]	*P* Value[d]
Control	3.75 ± 4.11	65.2 ± 2.11	60.5	58.2	NS	.01	NS	NS.
< 25	3.42 ± 3.52	68 ± 2.14	68.7	55.8	NS	.01	.001	NS
25-30	2.11 ± 2.13	55.8 ± 3.4	58.4	41.1	NS	.02	.02	NS
31-35	2.10 ± 3.34	51.4 ± 2.11	45.5	39.2	NS	.01	.003	NS

Abbreviations: BMI, Body Mass Index; NS, not significant.
a *P* value for semen volume, b *P* value for sperm concentration, c *P* value for sperm motility, d *P* value for sperm morphology.

is more, compared to men with normal BMI.[16] Kort and colleagues noted that increase in BMI is negatively linked with number of normal sperm, sperm concentration, motility and serum testosterone levels. This is consistent with the results of our study.[14] Studies show that weight loss can improve the quality of semen parameters leading to more fertility.[26] Although obesity is associated with a reduced number of intercourse as well as erection dysfunction[27] it seems that a hormone deficiency is at the beginning of this vicious cycle that causes the disorder in semen parameters.[28] This would be interesting topic to evaluate the pathologic effects of obesity on sexual desire and erection dysfunction. Moreover, other food regimen or supplements as major nutritional factor, could be examined for enhancing the sperm motility.

CONCLUSIONS

The study was designed to assess of the relationship between weight loss interventions and semen parameters. It also investigated the influence of oral vitamin C, as an antioxidant on semen quality. Weight loss can cause a significant increase in semen volume, sperm concentration, mobility and percentage of normal morphology. Consumption of vitamin C can significantly improve sperm concentration and mobility. But the volume of semen and the percentage of normal morphology does not change significantly.

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CONFLICT OF INTEREST

None declared

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