Original Article

EFFECT OF HYPERLIPIDEMIA ON FERTILITY PARAMETERS IN MALE ALBINO RATS

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ABSTRACT

Background: Both industrialized and developing nations are experiencing an increase in lipid metabolic problems brought on by poor eating practices, which have an adverse effect on sperm quality and quantity. The oxidative stress, one of the most significant factors affecting the male gametes and linked to infertility, is a general characteristic of hyperlipidemia. This study aimed to determine the effects of a high fat diet on serum testosterone levels, sperm count and sperm motility in male albino rats.

Material and Methods: In this randomized control trial, 60 male albino rats were classified into two groups (groups A and B). Group A was a control group, and hyperlipidemia was induced in group B rats by adding 1% cholesterol and 15% palm oil to standard chow for four weeks. After four weeks, blood was taken through cardiac puncture for lipid profile and serum testosterone levels measurement. Semen was collected from cauda epididymis for sperm count and sperm motility. Data were analyzed by using SPSS version 20.

Results: In hyperlipidemic rats, serum testosterone, sperm count and sperm motility were significantly decreased with p-value= 0.03, 0.001, 0.028 respectively, compared to group A rats.

Conclusion: Decrease in testosterone, sperm count and motility after hyperlipidemia indicates its negative effects on male fertility

Key Words: Hyperlipidemia, High fat diet, Sperm count, Sperm motility

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INTRODUCTION

Infertility is one of the major health issues impacting 10-15% of couples of reproductive age.[1] Where a powerful characteristic is the reduction in semen quality. The "enemy of male fertility" has been described as obesity.[2] Nutrition can affect the sperm quality, positively or negatively, and this effect is influenced by dietary factors that are both qualitative and quantitative, such as the number of calories in each macronutrient and the specific carbohydrate, fatty acid and protein profiles.[3]

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Saturated fatty acid intake in excess and unhealthy high calorie diets hurt sperm quality, adversely influencing fertilisation. However , a balanced diet is linked to greater sperm quality, indicating that nutritional treatments may be crucial for maintaining male fertility.[4] Concentration, morphology, and motility are the three criteria used in a semen analysis, which is specifically used to evaluate and classify male infertility. These three characteristics have limits as indicators of sperm fertility.[5] Additionally, mounting evidence shows that changes in spermatogenesis, sperm function and endocrine profiles caused by lifestyle variables can impair male fertility.[6] Fast food deleteriously affects blood cholesterol, testosterone, sperm count, and quality. Lipid metabolic problems caused by unhealthy

eating habits are seen to be increased in both industrialised and developing countries. The quality of sperm and consequently, the fertilization process are negatively impacted by hypercaloric unhealthy diets and excessive consumption of trans and saturated fatty acids.[7] Dyslipidemia, or an imbalance in dietary lipids, has significantly increased the prevalence of obesity and overweight worldwide. The emergence of systemic oxidative stress, which is a known detrimental factor for the viability of male gametes and is related to infertility, is the main characteristic of dyslipidemia.[8] Male obesity causes the reproductive hormonal profile and semen production to diminish. Males who consume the HFD have more gonadal fat, which is thought to raise epididymal and testicular temperature and influence sperm count, maturation and storage. The enzyme aromatase, which transforms testosterone into oestrogen, is activated more frequently in excess fatty tissue. Oestrogen, through negative feedback, inhibits the release of GnRH, eventually decreasing FSH and LH levels. LH is required by Leydig cells for testosterone synthesis, while FSH has a crucial role in spermatogenesis. Also testosterone is the main androgen involved in the process of spermatogenesis in the testis , the resulting drop in testosterone levels leads to decreased sperm production. Low testosterone levels also appear to be associated with mitochondrial malfunction in Leydig cells and oxidative stress.[9,10] (Figure 1).

By disrupting gamete energy metabolism in animal models, high-fat diet intervention reduces the quality of sperm. Because HFD results in the production of high levels of reactive oxygen species which can destroy nearly all macromolecules, including DNA, protein, lipid, and carbohydrates, ROS have been linked to reduced testosterone levels, sperm motility and sperm count.[11]

Because of the high surge of dyslipidemia in young people in developing and underdeveloped nations, the harmful consequences of fat on reproductive processes should be considered.[12]

To determine the effect of high fat diet on serum testosterone levels, sperm count and sperm motility in male albino rats. Early start of metabolic disease is encouraged by adopting unhealthful eating habits, which may have unknown effects on reproductive function in later life.[13]

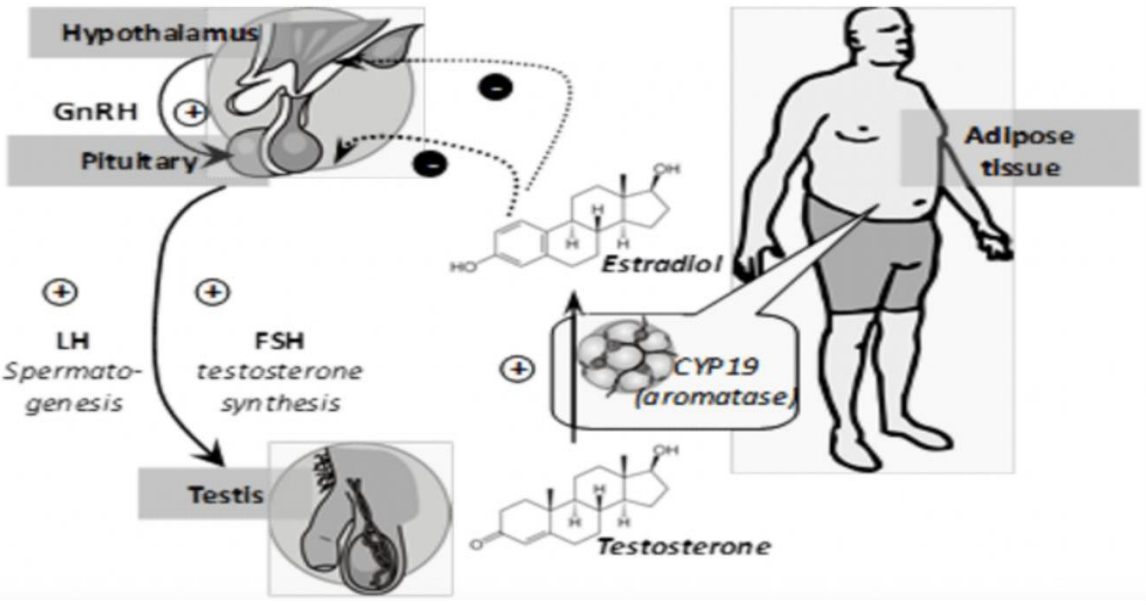

Figure-1: Increased adipose tissue is linked with decrease in testosterone levels and sperm count[9]

MATERIAL AND METHODS

The study was a randomised control trial. 60 male albino rats were divided into two groups, group A, control group (n=30) and group B, experimental group (n=30)

Animals were kept in the animal house of Akhtar Saeed Medical and Dental College Lahore. Animals were placed in cages, 10 rats per cage, for a minimum of one week for acclimatisation before the start of experiment. Animal house temperature was thermostatically maintained at 26±2˚C and a light/dark cycle.

Hyperlipidemia was induced in group B by addition of high cholesterol diet for four weeks[14]

Table-1: Composition of diet per 100g diet[14]

Composition	Normal diet	HFD
Yellow corn	60%	50.5%
Soybean	21%	17.3%
Fibres	11%	9.4%
Corn gluten	2%	1.4%
Nacl	0.5%	0.5%
Cholesterol	0%	1%
Palm oil	0%	15%

Blood samples were taken after four weeks from both groups through cardiac puncture to estimate lipid profile through calorimetric method and serum testosterone through ELISA. Semen was collected from cauda epididymis for sperm count and sperm motility.[15]

Data was analysed by using SPSS version 20. The mean and standard deviation of the variables were calculated. Significance of difference was determined by applying students t-test

RESULTS

The present study was performed to determine the effect of a high fat diet on serum testosterone, sperm count and motility.

Effect of high fat diet on lipid profile:

The difference of serum lipid profile parameters between group A (control) and group B (hyperlipidemic) was highly significant (p = 0.01) Table 2.

Table-2: Comparison of lipid profile

Parameters	Group A	Group B	p-value
Serum cholesterol mg/dl	210±8.48	293±21.9	0.001
Serum LDL mg/dl	125±3.86	169±6.95	0.001
Serum triglycerides mg/dl	195±7.73	216±16.9	0.001

Values are presented as mean ±SD

*p≤0.001, highly significant

Effect of high fat diet on serum testosterone, sperm count and sperm motility. After high fat diet supplementation, serum testosterone levels, sperm count and motility decreased significantly with p-value= 0.03, 0.001, 0.028 respectively, in group B compared to group A. Table 3.

There was a significant (p = 0.030) decrease in serum testosterone levels (3.22 ± 0.802) in group B as compared to group A (3.91±1.03).

Sperm count (79.24 ± 2.16) had highly significant (p=0.001) decrease in experimental group B in comparison to control group A (83.80±2.83)

Sperm motility (71 ± 4.31)showed significant decline (p=0.028) in group B as compared to group A (74±4.28)

Table-3: Comparison of serum testosterone, sperm count and sperm motility in Group A and Group B (mean ±SD)

Parameters	Group A	Group B	p- value
Serum testosterone (ng/ml)	3.91±1.03	3.22 ± 0.802	0.030**
Sperm count (Total No.X 10^6/ml)	83.80±2.83	79.24 ± 2.16	0.001*
Sperm motility (٪)	74±4.28	71 ± 4.31	0.028**

DISCUSSION

In the current study, we looked into how a high fat diet affected male rats' reproductive indices. Rats on the hyperlipidemic diet exhibited significantly higher levels of triglycerides, LDL, and cholesterol. Our key findings are that testosterone levels, sperm motility and sperm count significantly decreased in high fat diet fed rats.[16] According to one cross-sectional study conducted on 209 healthy males, eating more omega-6 and trans fatty acids, but less omega-3, is linked to worsening testicular functions, including lower levels of total and free testosterone and smaller testicles.[17] In 2019, You C et al, conducted a study in which there were two groups with 30 rats in each group, and 1% cholesterol diet was given to one of the group as exactly we did but in that study serum as well as intratesticular testosterone levels were measured at 4th, 8th and 12th weeks, the serum testosterone levels and intratesticular levels showed a decreasing pattern in rats who were treated with high cholesterol diet. So, their findings are consistent with those in our study.[18] One factor that may impact the outcomes is the composition and features of the high fat diet used in each trial. Males who consume the high fat diet have more gonadal fat, which is thought to impact sperm generation, maturation, and storage by raising testicular and epididymal temperature.[19]

An acknowledged risk factor for male infertility or subfertility is obesity. Male obesity affects endocrine hormone levels, including serum LH, testosterone, leptin, estradiol and FSH levels, as sperm function, specifically sperm motility, count, and morphology, according to several studies in humans and rats.[20] At the same time, testicular Leydig cells may begin to accumulate cholesterol due to dietary cholesterol. Although cholesterol is the main building block for testosterone production, having too much of it can be harmful because it triggers the endoplasmic reticulum stress response, downregulating the steroidogenic enzymes and reducing the in the amount of testosterone produced.[18] Ding N et al. had. Conducted a study to establish how a high fat diet could affect spermatogenesis, they found that one of the main reasons for the reduced sperm motility and production due to high fat diet is the development of abnormal gut microbiome. Epididymal inflammation, raised blood endotoxin and dysregulated testicular gene expression are likely the mediators of this phenotype.[21] Male reproductive potential may be significantly modified by diet. Therefore, it is important to emphasise daily nutritional exposure's function in maintaining or preventing male infertility. A strong positive correlation exists between sperm quality markers and a diet primarily plant-based and high in fish.[22] There are some limitations of this study. Serum FSH and LH levels and Malondialdehyde (MDA) levels should be measured. The effect of a hyperlipidemic diet on sperm morphology should also be analyzed.

CONCLUSION

High fat diet causes decline in serum testosterone, sperm count and motility.

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Conflict of interest: None

AUTHOR'S CONTRIBUTION

MT: Conception of idea, data collection and literature review
CN: Data analysis and critical review
MM: Proof reading and critical review
BY: Proof reading and critical review
SZ: Manuscript writing
FS: Critical review

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