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Association of Body Mass Index with Semen Quality and Sexual Hormone Levels among Men in Intrauterine Insemination

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Abstract

Background: The available evidence on the role of obesity and BMI on male infertility has been controversial or inconclusive to some extent. Objectives: To investigate the role of BMI on semen quality and hormone levels in men received intrauterine insemination. Material and Methods: A total of 390 males seeking artificial insemination in our department were recruited. BMI, blood pressure and semen parameters were assessed. Morning blood sample was taken for serum levels of testosterone (T), prolactin (PRL), luteinizing hormone (LH), follicle stimulating hormone (FSH), and estradiol (E_2). Results: Subjects were divided into four groups according to BMI. There was no significant difference among groups in any of semen parameters and serum levels of FSH, LH, PRL and E_2. Obese and overweight men were found having lower serum levels of T and higher levels of E_2/T ratio than those of normal and underweight men. BMI was not found to be associated with semen parameters. Conclusion: This study has not found evidence of an association between BMI and semen parameters, but obesity has a negative effect on serum testosterone levels.

Keywords

Body Mass Index, Obesity, Semen, Sexual Hormone

1. Introduction

Subfertility affects at least 10% of the population in the developed world [1]. Assisted reproductive technology,

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such as artificial insemination with husband sperm, is able to treat couples with fertility problems, especially for infertile men [2]. The interaction between obesity and fertility has received increased attention owing to the rapid increase in the prevalence of obesity in the developed world. Some studies reported that obesity not only related to health problems like diabetes, hypertension, and sexual hormonal status, but also related to reproductive problems [3]-[5]. Obese men exhibit poor sperm quality, reduced androgen levels, elevated estradiol levels and reduced inhibin B correlating with the degree of obesity [6] [7]. On the other hand, some studies reported that there was no significant correlation between body mass index (BMI) and semen or hormonal parameters [8] [9].

The available evidence on the role of obesity and BMI on male infertility has been controversial or inconclusive to some extent. We hypothesized that BMI was inversely correlated with fertility, manifested by reduced semen concentration and serum levels of testosterone. The aim of this study was to investigate the effect of BMI on semen quality and sexual hormone levels in infertile men.

2. Material and Methods

This is a retrospective study conducted at department of infertility and sexual medicine from February 2009 to February 2012. Infertility is defined by World Health Organization as the failure of a couple to conceive a pregnancy following 12 months of unprotected intercourse [10]. A total of 390 males seeking artificial insemination with husband sperm (AIH) in our department were recruited. The study was approved by the reproductive medicine ethics committee of our hospital. Written informed consent was obtained from participating patient.

Subjects were exposed to medical history evaluation as well as physical and systemic examination. Exclusion criteria included apparent genital infection, uncontrolled hypertension, and azoospermia. Because patients with total progressive sperm under 5 million were advised to accept intracytoplasmic sperm injection (ICSI) treatment, most of these patients accepted ICSI and not included in this study. Total progressive sperm count (10^6/ejaculate) = Total sperm count (10^6/ejaculate) ∗ sperm activity (%). BMI was calculated as the weight in kilograms divided by the square of height in meters. The participants were divided into four groups based on BMI (<20.0 kg/m^2 labeled as underweight, 20 < BMI ≤ 25 kg/m^2 labeled as normal weight, 25 < BMI ≤ 30 kg/m^2 labeled as overweight, and >30.0 kg/m^2 labeled as obese). This BMI classification has been suggested for reproductive endocrinology research [11].

According to WHO guideline, two semen samples about a week apart were taken from each participant by masturbation after 2 - 5 days of abstinence [12]. The samples were assessed by CASA system (sperm class analyzer, V4.0.0, Spain). The result of semen with higher total progressive sperm count was collected in this study. Venous blood samples were withdrawn from each subject for hormone levels analyze. Serum testosterone (T, nmol/L), prolactin (PRL uIU/mL), luteinizing hormone (LH, mIu/mL), follicle-stimulating hormone (FSH, mIu/mL), and estradiol (E_2, pmol/L) levels were estimated by the Chemiluminescence method (Siemens healthcare diagnostics Inc, USA).

3. Statistical Analysis

Data were analyzed using SPSS (version 13) statistical software. Mean serum sexual hormone levels and E_2/T ratios were compared among BMI groups using one-way analysis of variance. Semen parameters were also compared in the same way. To assess the correlation between BMI and other variables, the spearman correlation analysis was calculated. All the statistical tests were done on a two-tailed basis, and P-value <0.05 was considered a statistically significant result.

4. Results

Three hundred and ninety males participated in the study. After the subjects were classified into four groups based on BMI, we found that blood pressure increased accompanying with the increase of BMI. There was no significant difference among four groups in any of semen parameters and serum levels of FSH, LH, PRL and E_2. Obese and overweight men were found having lower serum T levels and higher E_2/T ratio levels than those of normal and underweight men. The clinical characteristics, serum sexual hormone levels and semen characteristics of subjects are shown in **Table 1**.

Using the spearman correlation analysis, there was no significant correlation between BMI and any of semen parameters, but a significant negative correlation between BMI and serum T levels was found (**Table 2**).

Table 1. Semen characteristics and sexual hormone levels compared for males among BMI groups.

	BMI groups							
	≤20		20 < BMI ≤ 25		25 < BMI ≤ 30		>30	
	n = 46		n = 231		n = 100		n = 13	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (Years)	31.43	3.47	33.08	4.92	33.56	5.78	34.62	6.47
SBP (mmHg)	120.64[d]	11.70	118.96[cd]	11.28	122.34[bd]	11.47	129.77[abc]	15.04
DBP (mmHg)	71.40[d]	8.73	71.45[cd]	9.43	74.15[bd]	9.56	81.31[abc]	12.53
Semen volume (mL)	3.45	1.49	3.09	1.31	3.53	1.49	2.72	1.32
Sperm concentration (10^6/mL)	59.75	42.94	65.79	43.87	63.42	43.73	69.29	48.68
Total sperm count (10^6/ejaculate)	206.45	191.06	203.43	158.44	222.06	186.32	179.21	164.28
Sperm motility (%)	52.53	19.59	50.08	22.63	50.78	20.95	59.12	21.24
Total progressive sperm count (10^6/ejaculate)	85.35	116.87	76.91	86.74	74.23	78.95	67.92	65.65
FSH (mIU/mL)	5.54	3.30	4.88	2.73	4.63	2.26	5.04	3.23
LH (mIU/mL)	4.91	3.32	4.14	2.27	3.84	1.67	4.11	1.68
PRL (ng/mL)	190.72	93.23	197.44	109.79	207.86	155.32	200.55	107.23
E_2 (pmmol/L)	172.13	87.15	151.43	70.54	150.27	70.36	197.24	78.67
T (mmol/L)	24.04[bcd]	10.73	19.22[ac]	8.12	16.36[ab]	6.07	16.64[ab]	11.50
E_2/T	7.29[cd]	2.85	8.53[cd]	4.52	10.31[abd]	5.47	17.24[abc]	11.56

[a]Significant difference between this group and underweight group; [b]Significant difference between this group and normal weigh group; [c]Significant difference between this group and overweight group; [d]Significant difference between this group and obese group.

Table 2. Correlation between BMI and different variables.

	SBP (mmHg)	DBP (mmHg)	T (mmol/L)	E_2/T
r	0.153	0.141	−0.285	0.289
p	0.003	0.007	0.000	0.000

Several clinical and hormonal variables were entered in multiple regression analysis to detect relation to sperm concentration and the total sperm count. Only the serum levels of FSH showed significant association with sperm concentration and the total sperm count. These data are shown in **Table 3** and **Table 4**.

5. Discussion

The aim of this study was to investigate the impact of BMI on semen parameters and reproductive hormones. When the mean semen parameter values of each BMI group were compared, we did not find significant changes among these groups. This study did not reveal any relationship between BMI and any of semen parameters of the studied population. The results of this study were generally in accordance with some previous studies [8] [9].

It is generally accepted that BMI have association with sexual hormones levels as well as semen quality [6] [7] [13]. Several studies showed a deleterious effect of obesity on semen quality both in normal fertile and subfertile males [14] [15]. However, there are several reports supporting our findings. In one meta-analysis, no relation between BMI and semen parameters was found [16]. It appears that the relationship between BMI and sperm quality has not been clarified. Further study with adequate sample is needed to reach a solid conclusion.

As for the relationship between BMI and sexual hormonal profile, it is already accepted that BMI is associated with alterations in the levels of testosterone and estrogens [17]. Researchers found significant relations between BMI and serum levels of progesterone and E_2, but BMI were not associated with PRL or LH serum concentrations in a Nigerian study on 120 men [18]. In this study, obese and overweight men were found having lower serum levels of T and higher levels of E_2/T ratio than those of normal and underweight men. It was found

Table 3. Multiple regression to predict sperm concentration.

Model	B	STD. Error	t	p
(Constant)	80.5	5.428	14.829	0
FSH	−2.56	0.95	−2.68	0.01

Serum FSH levels showed a negative association with sperm concentration (p = 0.01).

Table 4. Multiple regression to predict total sperm count.

Model	B	STD. Error	t	p
(Constant)	252.08	20.84	12.098	0
FSH	−7.94	3.66	−2.17	0.03

Serum FSH levels showed a negative association with total sperm count (p = 0.03).

that there is a significant negative correlation between BMI and serum T levels.

The levels of E_2/T ratio in men of obese and overweight group increased significantly compared with those of normal and underweight groups, but the serum E_2 levels were compared among groups. Obese man has more adipose tissues than non-obese man's, which containing aromatizing enzyme that covert androgen into estrogen [19]. In obese man, the serum testosterone levels were decreased and then the substrate for conversion might also decrease. That might explain why not the serum E_2 levels but the levels of E_2/T ratio increased along with BMI.

In this study, there was a significant negative correlation of serum FSH levels and sperm concentration. Moreover, serum FSH levels were significantly associated with total sperm count in the multiple regression model. Serum FSH levels of the patients can predict sperm concentration and total number of sperms. Normal function of the gondotrophic axis, especially normal FSH secretion, plays crucial roles in spermatogenesis [20] [21]. Several experimental and clinical studies have demonstrated the importance of FSH in regulating a normal quantitative spermatogenic process in animals and humans [22] [23]. It has also been suggested that high serum FSH levels is intimately related to a decrease of spermatogenesis function.

Because most of patients with total progressive sperm under 5 million were advised to accept ICSI treatment, azoospermia and severe oligozoospermis were not included in this study, therefore limiting the possible generalization of this study to all adult men. In MacDonald AA studies, among men with a normal BMI, oligozoospermia was found in 21.7% of men, whereas in men with a BMI > 25, the prevalence of oligozoospermia was 24.4%. BMI did not seem to significantly affect the prevalence of oligozoospermia [16]. Based on some articles, we think the findings of this study are reliable and valuable in this field. The lower proportion of obesity (3.33%) also was the limitation of this study. We will increase the sample size and improve the criteria next step.

6. Conclusion

In conclusion, this study has not found evidence of an association between increased BMI and semen parameters, but obesity has a negative effect on serum testosterone levels. Population-based studies with larger sample sizes and longitudinal studies are required.

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