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The relationship between body mass index, semen and sex hormones in adult male

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Summary: This study was aimed at evaluating the relationship between body mass index, sex hormones and semen characteristics in male adults. 120 male adults aged 20 to 50 years who consented to participate in the study were used. Serum samples collected from each subject were analyzed for Luteinizing hormone (LH), Follicle stimulating hormone (FSH), Prolactin (PRL), Progesterone, Estradiol and testosterone by classical ELISA method. Semen samples obtained by masturbation after 72 hours of abstinence were analyzed for sperm count and motility. The results showed statistically significant correlations at 99% confidence level between body mass index and serum concentrations of progesterone and oestradiol and sperm count. No significant correlations were observed between body mass index and sperm motility, serum concentrations of prolactin, testosterone and luteinizing hormone. In conclusion, this study has shown that statistically significant correlations exist between body mass index, semen characteristics and male sex hormones and may broaden our understanding of the physiology of male fertility/infertility.

Keywords*:* Body mass index, Semen quality, Male sex hormones, Fertility/infertility.

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INTRODUCTION

Body mass index (BMI) defined as the weight in kilograms divided by the square of the height in meters (kg/m^2) and calculated from a person's weight and height (CDC, 2009). It is a simple index of weight-for- height, that is commonly used to classify people as underweight, normal weight, overweight and obese (WHO, 2006). It is a very good indicator used to categorize weight in terms of what is healthy and unhealthy. BMI does not measure body fat directly, but it has been shown that it correlates with direct measures of body fat, such as underwater weighing and dual energy x-ray absorptiometry (DXA) (Garrow and Webster, 1985; Meiz et al, 2002). BMI can thus be considered an alternative for direct measures of body fat. The concept of body mass index as a measure of health status is convenient to use, cheap, easy to understand and the values apply to both men and women. Its application and appreciation is simple and easy, irrespective of educational status, gender, age and culture (Egwurugwu, 2008).Infertility is becoming an increasingly Public health problem. It tends to breed distrust, fear, anxiety, depression and low self esteem. Obesity is a well recognized risk factor for female infertility (Pasquali et al, 2003).However, with the increasing prevalence of sedentary life styles and dietary changes, obesity is emerging as an important cause of adverse health outcomes, including male infertility (Hammoud et al, 2006). Male factors alone constitute about 25%-30% of all cases of infertility, and they contribute to another 30% in combination with female factors. Obesity has recently been proposed for addition to the list of known etiologies of male infertility (Jensen et al, 2004).Obese males usually express a characteristic hormonal profile described as "hyperestrogenic hypogonadotropic hypogonadism". Total body fat, intra-abdominal fat, and subcutaneous fat have all been associated with low levels of total and free testosterone (Strain et al, 1982; Haffner et al, 1993; Tsai et al, 2004).

The concept of BMI is now widely used in various health assessment, treatment, prevention, promotion

and monitoring programs such as: mortality and morbidity studies (Calle et al, 1999; Jee et al, 2006); blood pressure (Wang et al, 2002); perception of overweight, obesity and associated factors (Fonseca and Gasper de Mantos, 2005); cognitive studies (Cournot et al, 2006); measure of sexual attractiveness (Tovee et al, 1998); assessment and prediction of future health costs (Thompson et al, 2001); as a measure of health care (Nakanishii et al, 2000); monitoring of oral contraceptive drugs (Murayama et al, 2003) and wound healing (Platt et al, 2003). Body mass index has been associated with alterations in sperm parameters in several reports (Jensen et al, 2004; Kolszar et al, 2005; Kort et al, 2005; and Magnusdottir et al, 2005).This study was therefore aimed at unravelling the relationship between body mass index, semen quality and serum levels of male sex hormones in adult Nigerians from which our understanding of male fertility/infertility may be enhanced.

MATERIALS AND METHODS

One hundred and twenty adult male subjects who consented to in writing to participate in this study were all Ibos, resident in Orlu South Eastern Nigeria, seen at the Fertility Clinic of Feziechi Hospital Orlu from January 1 to December 31, 2009 irrespective of occupation, religion, education and socio-economic status. Exclusion criteria include: known cases of hypertension, diabetes mellitus, under and /over-aged persons, known endocrine disorder and height less than 1.5m.

The local ethics standard of the hospital for Biomedical Research was respected and approval obtained from the hospital ethics committee. The research also conforms to the Helsinki Declaration on Biomedical Research.

Venous blood samples were collected into plain universal containers, allowed to clot and retract properly, and then it was centrifuged at 5000 rpm for 5 minutes. The supernatant was then stored frozen at -20°C until analyzed.

Serum samples were analyzed for Luteinizing hormone (LH), Follicle stimulating hormone (FSH), Prolactin (PRL), Progesterone, Estradiol and testosterone by classical ELISA method, using Human Diagnostic kits (Human Diagnostic Company Germany).

The semen samples were obtained by masturbation and ejaculated into clean sterile wide-mouthed universal containers from men who abstained from ejaculation for 72 hours prior to collection. The samples were collected in privacy in the laboratory side- room to reduce the time of collection and arrival at the laboratory. The samples were kept warmth (20-40°C) to avoid reduction in sperm motility. The samples were allowed to stay on the bench for a period of 30 minutes for liquefaction to take place. The analysis of semen samples was performed according to WHO criteria (World Health Organization, 1999).

Statistical analysis

The results were expressed as Mean ± SEM. Tests of correlation were determined using the Pearson's correlation coefficient, at 99 per cent confidence level using SPSS version 15.0 (Alistair, et al, 2002).

RESULTS

One hundred and nine (91%) subjects submitted complete specimens i.e. blood and semen for analysis. Thus this study achieved 93% participation rate.

Table 1.
The mean values of the parameters studied

Parameters studied	Mean ± SEM
Body mass index (Kg/m^2)	25.53±0.29
Age(years)	28.30±0.76
Weight(Kg)	69.53±0.70
Height(M)	1.67±0.01
Luteinizing hormone (ng.ml)	8.12±0.34
Follicle stimulating hormone (ng/ml)	7.07±0.28
Prolactin (ng/ml)	16.89±0.79
Progesterone (ng/ml)	0.40±0.05
Oestradiol (ng/ml)	10.25±1.49
Testosterone (ng/ml)	6.00±0.24
Sperm count (millions/ml)	59.09±3.24
Sperm motility (%)	64.67±1.3

Table 2.
Pearson's correlation coefficient between body mass index, semen quality and male sex hormones.

Parameters studied	Body mass index
Body mass index	1
Luteinizing hormone (ng/ml)	-0.055
Follicle stimulating hormone(ng/ml)	-0.070
Prolactin (ng/ml)	-0.044
Progesterone (ng/ml)	0.403*
Oestradiol (ng/ml)	0.331**
Testosterone (ng/ml)	0.000
Sperm count (millions/ml)	-0.273**
Sperm motility (%)	0.165

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

The results indicate that significant positive correlations were found only for serum progesterone and serum oestradiol. Body mass index showed significant and positive correlations with serum progesterone ($r = 0.413$; $p<0.01$) and oestradiol ($r =0.331$; $p <0.01$) as shown in Figures 1 and 2.

Figure 3 shows a significant and negative correlations were observed between BMI and sperm count (r =0.273; p< 0.01).

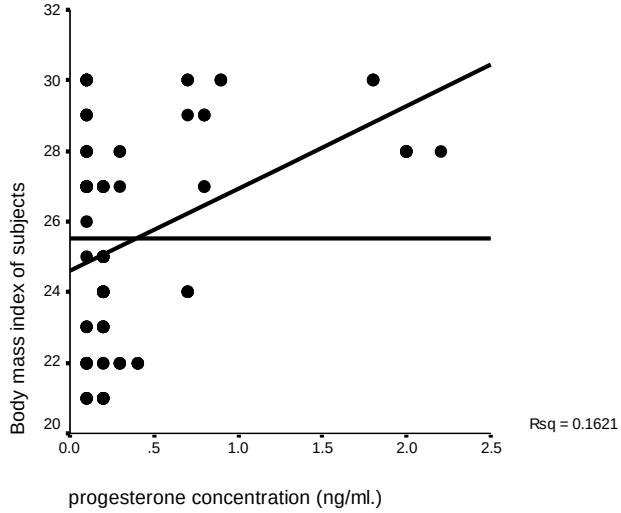

Figure 1: The relationship between Body mass index and serum progesterone concentration.

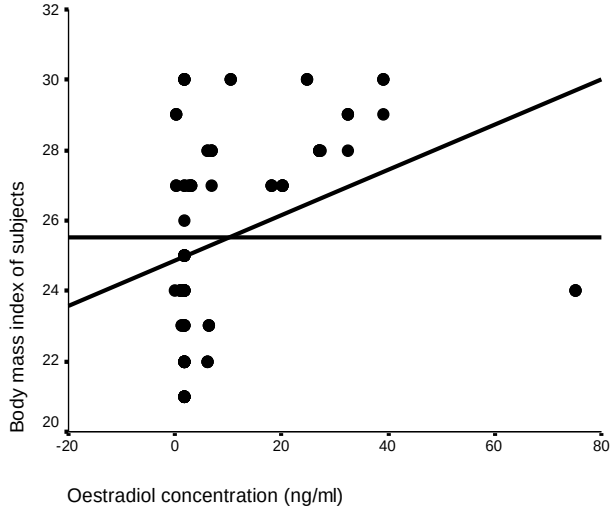

Figure 2: Relationship between body mass index and serum oestradiol concentration.

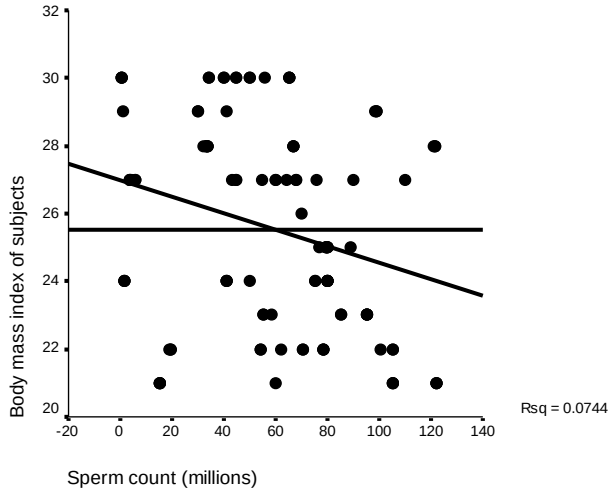

Figure 3: The relationship between body mass index and sperm count.

Non- significant and negative correlations were found between BMI and serum luteinizing hormone (r = -0.055; p>0.01); follicle stimulating hormone (r = -.0.070; p>0.01); prolactin (r = -0.044; p>0.01) and sperm motility (r = -0.165; p>0.01).

DISCUSSION

Body mass index, a measure of body weight and height has a lot of expository potentialities in the quest to know more about man, especially his health, well being, fears, socio-cultural problems and procreative abilities. Over weight and obesity is seen by many as evidence of "good living" in many developing countries like Nigeria. However, with increasing awareness, though still at rudimentary stages, the implications of overweight and obesity are beginning to dawn on the health practitioners, patients, relations and health promoters.

One hundred and twenty subjects participated in this study, however only one hundred and nine (91%) submitted complete specimens i.e. blood and semen for analysis. Thus the research achieved 91 per cent participation rate**.** It is likely that researches using body fluids in humans, especially semen are sometimes prone to low participation rates in man due to varied religious and socio-cultural belief systems. In Nigeria, issues of sexuality are usually not discussed in the open, talk less asking someone to produce his semen for scientific research purposes. Thus, this study also suffered a little low participation rate as only 9.2 per cent of the subjects could submit their semen for analysis. It has also been observed that epidemiological studies of semen quality are hampered by problems such as low participation rates

Table 3.
The International Classification of Body mass index

Classification	BMI(kg/m^2)	
	Principal cut-off points	Additional cut-off points
Underweight	<18.50	<18.50
Severe thinness	<16.00	<16.00
Moderate thinness	16.00 - 16.99	16.00 - 16.99
Mild thinness	17.00 - 18.49	17.00 - 18.49
Normal range	18.50 - 24.99	18.50 - 22.99
		23.00 - 24.99
Overweight	≥25.00	≥25.00
Pre-obese	25.00 - 29.99	25.00 - 27.49
		27.50 - 29.99
Obese	≥30.00	≥30.00
Obese class I	30.00 - 34-99	30.00 - 32.49
		32.50 - 34.99
Obese class II	35.00 - 39.99	35.00 - 37.49
		37.50 - 39.99
Obese class III	≥40.00	≥40.00

Source: Adapted from WHO, 1995, WHO, 2000 and WHO 2004.

and poor comparability of results due to methodological differences in semen analysis (Dhooge et al, 2007 and Meeker et al, 2007).

The present study showed a mean BMI of 25.53±0.299. The internationally accepted classification of body mass index is shown in Table 3. The overweight range of BMI category observed in this study may be attributable to the occupation and life style of the subjects who were mainly civil servants and medical students with little or no time for approved levels of physical activity. It is known that with the increasing prevalence of sedentary life styles and dietary changes, obesity and overweight are emerging as important causes of adverse health outcomes, including male infertility (Hammoud et al, 2006).

The present study clearly suggests that, there is a relationship between BMI, semen quality and serum concentration of some male sex hormones. There are significant and positive correlations between body mass index and serum concentrations of progesterone and oestradiol. Increase in BMI was associated with increase in serum levels of progesterone and oestradiol. However, there was significant and negative correlation between BMI and sperm count. Increase in BMI was associated with decrease in sperm count among the subjects studied. These findings are in agreement with previous works (Jensen et al, 2004; Koloszar et al, 2005; Kort et al, 2005; Magnusdottir et al, 2005; Hammoud et al, 2006; Ergun et al, 2007; Pasquali et al, 2007; Qin et al, 2007; and Chavarrow et al, 2009).

Many postulations have been advanced to explain the casual relationship between BMI and altered semen parameters. Firstly, endocrine abnormalities seen in obese males may explain these findings. Low levels of free and total testosterone have been found in obese males. This could be due to the decrease in the binding capacity of sex hormone- binding globulin (SHBG), the reduction of LH pulse amplitude and hyperestrogenemia (Vermeulen et al, 1993). Isidori and co-workers (1999) also observed that altered metabolism or an excess of fat-derived hormonal products may cause an impairment of testicular interstitial function. Intratesticular testosterone levels (normally 100-fold greater than circulating concentrations) are correlated with spermatogenesis (Coviello et al, 2004; Coviello et al, 2005; Jarow and Zirkin, 2005; Matthiesson et al, 2005).

Secondly, inappropriate suppression of the hypothalamic-pituitary-gonadal axis by elevated oestrogens derived from peripheral aromatization, and resulting decreased testosterone production reflected in low levels of circulating testosterone and intratesticular testosterone may explain some of the altered semen parameters seen in obese men. Olivia and co-workers (2001), observed that exposures to environmental chemicals with oestrogenic activity may impact human reproductive health. Again, obese men have been shown to exhibit higher levels of circulating oestradiol and /or elevated oestradiol/testosterone ratios in multiple studies (Schneider et al, 1979; Jensen, 2004; Fejes, 2006).

In conclusion, this study has shown the statistically significant correlations between body mass index, semen characteristics and male sex hormones. We therefore suggest that the possible dangers of overweight and obesity should be considered in the planning, implementation, monitoring and evaluation of intervention strategies in the management of fertility/infertility.

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