High body mass index has a deleterious effect on semen parameters except morphology: results from a large cohort study

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Objective: To evaluate the influence of body mass index (BMI) on semen characteristics.
Design: Cohort study.
Setting: Single private andrology laboratory.
Patient(s): All patients (n = 10,665) consulting for a semen analysis from October 9, 2010, to October 8, 2011. When analyses were repeated on the same patient, only the first was included.
Intervention(s): Recording of self-reported weight and height and of semen analysis.
Main Outcome Measure(s): All parameters of standard semen analysis: pH, volume, sperm concentration per mL, total sperm count per ejaculate, motility (%) within 1 hour after ejaculation (overall and progressive), viability (%), and normal sperm morphology (%). Parametric and nonparametric statistical methods were applied, and results are given either with mean $\pm$ SD, or 10th, 50th, and 90th percentiles.
Result(s): Semen volume decreased from 3.3 $\pm$ 1.6 to 2.7 $\pm$ 1.6 mL when BMI increased from normal (20–25 kg/m^2) to extreme obesity (>40 kg/m^2). The same was true for semen concentration (56.4 $\pm$ 54.9 to 39.4 $\pm$ 51.0 million/mL), total sperm count (171 $\pm$ 170 to 92 $\pm$ 95 million), and progressive motility (36.9 $\pm$ 16.8% to 34.7 $\pm$ 17.1%). The percentage of cases with azoospermia and cryptozoospermia increased from 1.9% to 9.1% and from 4.7% to 15.2%, respectively. The other semen characteristics were not affected. Multivariate models including age and abstinence duration confirmed these results.
Conclusion(s): In this study, on a large patient sample size, increased BMI was associated with decreased semen quality, affecting volume, concentration, and motility. The percentage of normal forms was not decreased. (Fertil Steril® 2014;102:1268–73. ©2014 by American Society for Reproductive Medicine.)
Key Words: BMI, semen volume, concentration, motility, morphology, obesity

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The impact of weight abnormalities on female fertility has been analyzed at length. High (>25 kg/m^2) and low (<18 kg/m^2) body mass index (BMI) have been related to ovulation dysfunction, decreased fecundity, and lower pregnancy rates (1–3). In contrast, relatively few papers have addressed this question in men in the past, even if literature is now growing. Recently, Relwani et al. (4) concluded that semen parameters are unrelated to BMI but vary with selective serotonin reuptake inhibitor (SSRI) use and previous urologic surgery. However, that study was conducted on a relatively small sample (530 men), and the relationship with a prediction of clinical pregnancy failed to reach significance (P=.06). In a systematic review with meta-analysis, MacDonald et al. (5) found only five out of 31

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studies to be suitable for analysis. They concluded that there was no evidence for a relationship between BMI and sperm concentration or total sperm count, but noted a negative relationship between increased BMI and testosterone, SHBG, and free testosterone levels. The main limitation was that data from most studies could not be aggregated for meta-analysis, and population-based studies with larger sample sizes and longitudinal studies were required.

Recently, Shayeb et al. (6) published a study on 2,035 men, all partners of couples attending for infertility investigations in a single Fertility Clinic from 1990 to 2007. They found a statistically increased risk of low (<2 mL) semen volume (odds ratio [OR] 1.69, 95% confidence interval [CI] 1.20–2.38), and lower (<15%) normal sperm morphology (OR 1.50, 95% CI 1.06–2.09) in obese (BMI $\geq$30 kg/m^2) versus normal men, but no relationship with sperm concentration and motility. There was no significant relationship in men who were moderately overweight (BMI 25–30 kg/m^2) or with low weight (BMI <18.5 kg/m^2). Moreover, the large study duration (18 years) meant that only 38% of samples could be used owing to missing data on BMI. Finally, it was not mentioned if there were several sperm analyses performed for the same man during the study period and how they were handled. More recently, Colaci et al. (7) showed that fertilization rate was higher among obese men than among normal-weight men in conventional IVF cycles. No statistically significant associations were found between male BMI and the proportion of poor-quality embryos on day 3, slow embryo cleavage rate, or accelerated embryo cleavage rate. Male BMI was unrelated to positive β-hCG rate, clinical pregnancy rate, or live birth rate per embryo transfer. However, among couples undergoing intracytoplasmic sperm injection (ICSI), the ORs for live birth in couples with obese male partners was 84% lower than those where the men had normal BMI. The authors suggested a possible deleterious effect of male obesity on the chances of having a live birth among couples undergoing ICSI. Finally, MacDonald et al. (8), in 511 men, found a correlation only between BMI and normal sperm morphology. Barazani et al. (9) concluded from a literature review that sperm parameters would be adversely affected by diet intake, even if studies on the relationship between obesity and sperm quality was conflicting, and Palmer et al. (10) concluded from a literature review that results on this relationship were conflicting. Sermondade et al. (11), in a multinational meta-analysis on 13,077 men, concluded that overweight and obesity were associated with an increased prevalence of azoospermia or oligozoospermia, but with an important limitation due to the heterogeneity of the studied populations (both general population and infertile couples). They also emphasized that the possible impact of weight normalization on improvement of sperm parameters should be evaluated further.

The aim of the present study was to evaluate the influence of BMI on semen characteristics in a large cohort of semen analyses performed in a single andrology laboratory during 1 year.

MATERIAL AND METHODS

Patients and Variables

Self-reported weight and height were routinely recorded for each man performing a semen analysis in our laboratory since October 9, 2010. The present study investigated all analyses up to October 8, 2011. Men were referred to our laboratory in the course of a couple infertility evaluation of any origin. When more than one semen analysis had been performed for the same man, only the first one was selected for analysis, i.e., 10,665 out of 11,715. Age and abstinence period were also routinely recorded.

Semen Analysis

Semen samples were collected in the laboratory by masturbation into a sterile container and men were instructed to respect a period of 2–7 days of abstinence beforehand. After liquefaction, semen analysis was carried out according to the latest World Health Organization (WHO) laboratory manual for the examination and processing of human sperm (12), except for morphology. A routine analysis included assessment of pH, semen volume (mL), sperm concentration (million/mL), total sperm count (million), percentage motility (overall and progressive), and percentage normal forms. Sperm morphology was assessed according to a modified David classification (13, 14) after Harris-Schorr staining. Concentration and total sperm count were quoted as “0” in cases of azoospermia. Motility and morphology were measured on all cases without azoospermia or cryptozoospermia. Patients with abstinence duration <2 days (1.9%) or >7 days (2.7%) or where abstinence was not reported (n = 43) were excluded, leaving 10,197 patients for analysis.

Statistical Analysis

All quantitative variables were reported with mean and standard deviation or median and 10th and 90th percentiles as appropriate. The study population was divided into six groups according to WHO BMI classification (15): underweight (<18.50 kg/m^2), normal weight (18.50–24.99 kg/m^2), overweight (25.00–29.99 kg/m^2), moderate obesity (30.00–34.99 kg/m^2), severe obesity (35.00–39.99 kg/m^2), and morbid obesity ($\geq$40.00 kg/m^2).

The relationships between BMI and semen characteristics were analyzed with the use of correlation coefficients for natural BMI and analysis of variance (ANOVA) for groups of BMI. Then, multivariate variance-covariance analysis (general linear model) was used to take into account age and abstinence duration. Sperm concentration and total sperm count were analyzed both with natural values and with their log transformations, as often proposed (16), as well as with parametric ANOVA and ANOVA on ranks, and with Kruskal-Wallis test. Age was divided into two categories, <40 and $\geq$40 years. Finally, a multilogistical model was used to analyze the risk of having the following: low volume (<1.5 mL), low concentration (<15 million/mL), low sperm count (<39 million), low progressive motility (<32%), according to WHO reference lower limits (5th percentiles) for semen characteristics (17) according to increasing BMI, and controlling for age and abstinence duration. In this model, ORs are given with their 95% CIs.

Analysis was performed using SAS (Statistic Applied Software) 9.1.3 Service Pack 3, on the INSERM computer (Villejuif, France).