Reproductive BioMedicine Online (2011) 23, 717–723

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ARTICLE

An exploration of the association between male body mass index and semen quality

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Abstract Obesity is becoming a serious problem, especially in industrialized societies. This study was designed to explore the association between body mass index (BMI) and semen quality. Semen analysis and demographic data were collected from male partners of couples undergoing fertility investigations in a referral fertility centre. Men were classified into groups according to their BMI (A, <18.5; B, 18.5–24.99; C, 25–29.99; D, ≥30 kg/m^2). Data from 2035 men were analysed using logistic regression. There were 18, 839, 909 and 269 men in groups A, B, C and D, respectively. Taking group B as the reference, adjusted odds ratios (95% CI) for groups A, C and D for semen volume <2 ml were 1.57 (0.49–5.01), 1.06 (0.82–1.38) and 1.69 (1.20–2.38), respectively; for sperm morphology <15%, 1.44 (0.45–4.61), 1.07 (0.86–1.33) and 1.50 (1.06–2.09); for sperm concentration <20 million/ml, 0.46 (0.10–2.07), 1.03 (0.82–1.31) and 1.00 (0.72–1.41); and for motility <50%, 2.62 (0.73–9.45), 0.96 (0.78–1.18) and 0.75 (0.56–1.01). In conclusion, obese men are more likely to have lower semen volume and fewer morphologically normal spermatozoa than men with normal BMI.

KEYWORDS: body mass index, male fertility, male obesity, semen quality

Introduction

Obesity is recognized as a serious problem in the developed world and is conventionally categorized on the basis of body mass index (BMI). Values between 18.5 and 24.99 kg/m^2 are considered to be normal; individuals with BMI ≥25 kg/m^2 are considered to be overweight, while those with BMI ≥30 kg/m^2 are considered to be obese. Those with a BMI <18.5 kg/m^2 are considered to be underweight (World Health Organization). There has been a marked increase in the proportion of men who are obese in England from 13% in 1993 to 24% in 2008 (NHS Information Centre, Lifestyles Statistics, 2010). In Scotland, the Scottish Health Survey in 2003 indicated that two-thirds of men (65%) were either

1472-6483/$ - see front matter
doi:10.1016/j.rbmo.2011.07.018

overweight or obese (The Scottish Executive, 2005). Obesity is known to be a risk factor for reproductive problems in women, including ovulatory dysfunction (Balen et al., 2007). Relatively few studies have explored the association between obesity and male fertility.

In a cross-sectional study on Danish young men, Jensen et al. (2004) reported reduced semen quality to be associated with high or low BMI. Since this study, a few studies, the majority of them with small sample sizes, have examined this topic and came up with varying and occasionally conflicting results. While some of these studies reported a negative impact of raised BMI on semen quality (Chavarro et al., 2010; Hammoud et al., 2008; Hofny et al., 2010; Koloszar et al., 2005; Kort et al., 2006; Magnusdottir et al., 2005; Martini et al., 2010; Robeva et al., 2008; Sekhavat and Reza, 2010; Stewart et al., 2009), others showed no significant association (Duits et al., 2010; Fejes et al., 2005; Li et al., 2009; Nicopoulou et al., 2009; Paasch et al., 2010; Pauli et al., 2008; Ramalu-Hansen et al., 2010). Qin even reported that being overweight may improve semen quality (Qin et al., 2007). A recent systematic review reported no evidence of an association between increased BMI and semen parameters. Due to significant clinical heterogeneity in the sample populations and different outcome measures, this review was unable to aggregate data from many of the identified studies in terms of a meta-analysis (Macdonald et al., 2010) and highlighted the need for more population based studies 'with large sample sizes'.

The aim of this study was to examine the effect of BMI on semen parameters (which is the main tool used to assess the male partner in couples presenting with subfertility), with appropriate adjustments for possible confounders. The Aberdeen Fertility Clinic receives about 500 new infertility referrals per year and clinical details of both partners are entered prospectively into the Fertility Clinic database. Semen analysis is performed routinely for all male partners and data on over 20,000 samples are entered concurrently on the Aberdeen Andrology Laboratory database. This provides an opportunity to link the body mass index of men to their semen analysis parameters.

Materials and methods

Ethical approval for this study was obtained from the North of Scotland Research Ethics Service. Data were extracted on all male partners of couples attending for infertility investigations at the Aberdeen Fertility Clinic from 1990 to 2007. Variables extracted included age, height and weight, social deprivation (Scottish Index of Multiple Deprivation (SIMD) http://www.scotland.gov.uk/Topics/Statistics/SIMD), smoking status, alcohol intake, type of infertility (primary or secondary), coital frequency, and having a history of drug abuse, erectile dysfunction or ejaculatory failure.

Electronic results of semen analyses were linked to the demographic and clinical data on all men (including date of sample, period of abstinence prior to producing the sample, semen volume, sperm concentration, percentage progressive motility and percentage normal morphology). The study excluded men with previous surgery for vasectomy or vasectomy reversal and men with azoospermia.

Semen analysis

Each man provided a semen sample by masturbation into a sterile plastic container. Analysis of the semen samples was carried out using both computer-assisted semen analysis (CASA) and manual methods appropriate to each sample. In samples where the sperm concentration was less than 2 million/ml, morphology was not assessed.

A total of five biomedical scientists carried out all the analyses over the 18-year period of data collection. Quality control comprised of weekly assessment of inter-operator variability for concentration and motility measurements. Variations between operators and between manual and CASA measurements were audited regularly. Quarterly participation in the UK National External Quality Assessment Service (NEQAS) was also used for concentration and morphology (anonymous).

Statistical analysis

The 1998 Scottish Health Survey found that 4.5% of adult Scottish males were underweight, 33.3% had a normal weight, 42.6% were overweight and 19.6% were obese (Shaw et al., 2000). For a study of 2000 men with BMI distributed in this fashion, and assuming 22% of the men with a normal weight had low sperm concentration (Jensen et al. 2004), separate chi-squared tests would have over 80% power to detect an odds ratio of 2.25 compared with the underweight men, an odds ratio of 1.45 compared with the overweight men and an odds ratio of 1.55 compared with the obese men, with a two-sided 5% level of significance.

Demographic characteristics were compared between men whose BMI data were available and men without this information. Independent *t*-tests and Mann–Whitney *U*-tests were used to compare normally and non-normally distributed data, respectively. Chi-squared tests were used for comparisons of categorical data. Men whose BMI data were not available were excluded from the study.

The study population was divided into four groups depending on their BMI, underweight ($<18.5\ kg/m^2$), normal weight ($18.5–24.99\ kg/m^2$), overweight ($25–29.99\ kg/m^2$) and obese ($\geq 30\ kg/m^2$). Demographic characteristics and semen parameters were compared across the four BMI groups using chi-squared tests for categorical data, ANOVA tests for normally distributed data and Kruskal–Wallis tests for non-normally distributed data.

Semen parameters were then classified as abnormal using the 1999 World Health Organization (WHO) criteria as follows: volume <2 ml, concentration <20 million spermatozoa/ml, progressive motility <50% and normal morphology <15% (World Health Organization, 1999). The association between BMI and having abnormal semen parameters was examined using chi-squared tests and logistic regression to adjust for possible confounding factors.

Missing values of demographic characteristics and semen parameters were excluded from all analyses. The Statistical Package for Social Sciences version 16.0.2 was used for analysis (SPSS, USA).