Introduction

Approximately 37% of men of reproductive age smoke cigarettes, with Europe having the highest tobacco use among all the WHO regions. Smoking cigarettes has been associated with a deterioration of sperm quality, including motility, concentration and morphology, which are the parameters most frequently used in clinical settings to assess fertility. However, the evidence is not unequivocal, and some studies have found no effect on semen.

In 2010, the WHO established new criteria for laboratory examination of human semen. Additionally, new reference values for semen characteristics were proposed, which were markedly lower than those reported in previous manuals. Given the high prevalence of smoking and the new WHO laboratory criteria for the examination of human semen, the role of cigarette exposure on semen parameters needs a new look.

Study question

To assess the impact of smoking on semen parameters according to the updated World Health Organization (WHO) methods for laboratory evaluation of human semen.

Study design

We conducted a systematic search using MEDLINE/Pubmed, SJU discover and Google Scholar to identify all relevant studies published after release of the latest (2010) WHO methods for laboratory evaluation of human semen. The titles and abstracts retrieved were initially screened. Full texts of selected abstracts matching inclusion criteria were obtained. Review articles and reference lists were hand searched. Studies were analyzed for inclusion independently by two of the authors, and any discrepancies were resolved by discussion.

Participants and settings

Participants were males aged 13 years and older from fertility/urological clinics and andrology laboratories. The outcome measures were semen volume, sperm concentration, motility and morphology which are the parameters commonly used in clinical settings to assess fertility.

One exposure (smoking) was compared at once (no multivariate analysis). The following characteristics were assessed for each study: (a) Study population (infertile versus general population), and Data collection methods (e.g. semen analysis according to the edition of WHO manual). To determine validity, each included study was assessed according to the criteria for nonrandomized studies to assess the risk of bias.

Statistical analysis was done using RevMan 5.0 software and Metafor package for R. Pooled mean differences (MD) between comparison groups were calculated to determine the effect size. Both fixed effects models (FEM) and random effects models (REM) were fitted to assess the model-types that were most suited to the data. Heterogeneity was evaluated using the Q test and the I-squared statistic.

Main results and the role of chance

Overall, 20 studies were identified and these included data on 5865 subjects. Exposure to cigarette smoking was associated with reduced sperm count (Figure 1), motility (Figure 2) and morphology (Figure 3), but results suggest that the method for morphology analysis affected the magnitude of effect size (Figure 3).

Subgroup analyses indicated that effect size of smoking and deterioration of sperm count (Figure 4) was higher in infertile men than the general population. These differences were not observed regarding motility and morphology according to the population type.

Limitations, reasons for caution

Despite including only studies published after the release of the 2010 WHO manual, only seven studies specifically utilized this edition for semen analyses. The remaining studies utilized previous versions, namely the 1999 (4th) and 1992 (3rd) editions.

Studies included in our meta-analysis were mostly observational in nature, which prevented us from making inferences on cause-effect mechanisms. Pregnancy as an outcome measure was not assessed in any of the studies included in our review.

The number of studies included in each meta-analysis varied according to the sperm parameters reported: 13 provided data on semen volume, 20 provided data on sperm count, 15 provided data on motility and ten provided data on morphology.

Wider implications of the findings

The results of this study have implications for men at reproductive age, health care providers and decision makers alike. Since smoking is a modifiable lifestyle factor that is particularly prevalent among such men, health programs focusing on smoking cessation are expected to have a positive impact on semen quality and consequently male fertility.

Study funding: Institutional | Competing interest: None