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INVITED RESEARCH HIGHLIGHT

Semen Analysis

Semen quality: variations among fathers and effects of moderate alcohol drinking

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Semen analysis results from over 750 fathers in the USA demonstrated marked differences in the quality of semen from men at different locations and of different ethnic groups. Another paper failed to demonstrate any effects of moderate alcohol consumption during the week before provision of an ejaculate on semen quality and few on serum hormones, of over 8300 men in Europe and the USA. While these observations are interesting, the reasons for regional and ethnic differences in semen quality of fathers are unclear. Although, there was no attempt to confirm the participant-provided level of alcohol consumption, an increase in serum testosterone in the men at the higher end of alcohol intake is compatible with an alcohol effect on liver metabolism, although whether alcohol intake was the cause of higher testosterone, or men with higher androgen levels consume more alcohol, is not known.

The quality of human semen and the lack of effect of imbibing alcohol on it has recently been presented in separate papers published in the USA¹ and Europe.²

SEMEN QUALITY IN FERTILE MEN

Redmon *et al.*¹ reported the semen characteristics of over 750 fertile men enrolled in the Study for Future Families (SFF) in five US cities. Overall results from the fertile men revealed values close to those compiled by Cooper *et al.*³ for the fifth edition of the WHO semen manual:⁴ median values were for semen volume 3.7 ml (WHO value 3.7 ml), sperm concentration $67 \times 10^6 \text{ ml}^{-1}$ ($73 \times 10^6 \text{ ml}^{-1}$), total sperm count 240×10^6 (255×10^6), sperm motility 52% (61%) and total motile sperm count 128×10^6 (145×10^6). Some preliminary values from the SFF study⁵ were incorporated

in the WHO data,³ but the more extensive data from the US here confirm that semen of this quality is compatible with male fertility. Of interest were marked regional and ethnic differences in semen quality.

The lower quality of semen from men in Missouri observed in preliminary data⁵ was confirmed here,¹ but is of little significance for paternity, as these men were fathers. The cause of the lower values though cannot be determined, since the duration of the men's residence in the state (whether they had the recently moved there or had grown up there) was not presented. Neither can it be known if the area's environment had affected semen quality of long-term residents or if men drawn to Missouri had low sperm counts before they moved there.

A technical problem that plagues all semen analysis studies is that only the donor knows how the sample was collected. As the first (epididymal) seminal fraction is sperm-rich, it is important that it is not lost during collection, but if it is, it should be reported at the time.⁴ Although not expressly given in the technical papers^{5,6} on semen analysis cited in the Redmon *et al.*¹ paper, instructions to report any seminal loss were part of the protocol for all SFF study centres (CK Brazil, personal communication); and if such loss were reported the semen was not analyzed and another appointment made for a further sample collection. Whether there was a greater unreported loss of semen by the men in Missouri than men in the other cities is unknown. A similar lack of reporting seminal loss could explain the lower sperm counts in Blacks, a phenomenon found in all the regional centers. As the proportion of Blacks was not the highest in Missouri, an ethnic difference in semen quality does not explain the low results there, so other explanations need investigation.

Ethnic differences in testicular structure and spermatogenic potential have been

demonstrated in a study of 12 Chinese men, 8 Hispanics and 12 Caucasians.⁷ The Chinese exhibited a lower testicular parenchymal weight, a smaller seminiferous tubular diameter, a lower daily pachytene spermatocyte production per gram parenchyma, a greater Sertoli cell number per gram parenchyma, a lower germ cell/Sertoli cell ratio and a lower number of primary spermatocytes, round spermatids and Sertoli cells per man than the other races. Such results could explain the greater sensitivity of Chinese than Caucasians to spermatogenic inhibition by contraceptive steroids. However, in preliminary studies of five African Americans, five Hispanics and five Caucasians (data from Johnson *et al.* 1984⁸ but only reported in Johnson *et al.* 1998⁷) no difference in parenchymal weight, daily sperm production (DSP) per gram or DSP per man were found among the races, so more detailed histological studies of the testes of Africans may be warranted to explain the lower semen quality of this ethnic group.

SEMEN QUALITY IN MODERATE ALCOHOL DRINKERS

The Jensen *et al.*² study, on effects of low-to-moderate alcohol drinking on semen quality of over 8000 men, both fathers and men of unknown fertility status, has a simple message, but one that is difficult to interpret. The authors took the volunteer's recall of alcohol intake (from adding beer, wine and liquor consumption) in the week preceding the provision of a semen and blood sample. Alcohol intake was calculated by assuming one unit of alcohol to contain 12 g of alcohol, donors were categorized as having taken 0 g, 12–120 g, 132–240 g or >240 g alcohol per week, and their seminal quality was assessed. The authors also made the assumption that the weekly intake before semen sample provision was indicative of weekly intake

over the last 3 months (i.e. the period covering a spermatogenic cycle), when the spermatozoa assessed here would have been formed. In this moderate range of alcohol consumption (median weekly intake 96 g alcohol) there were no differences between groups in semen quality or in serum inhibin, luteinizing hormone and follicle-stimulating hormone; however, with over 240 g week⁻¹ alcohol, serum total and free testosterone were raised. This rather comforting result of a lack of drinking alcohol on potential fertility, as reflected by the results of semen analysis, needs to be considered in more detail.

In studies of the effects of smoking and caffeine on semen quality, non-invasive measurements of analytes have been used to prove compliance. Nicotine and its metabolites transhydroxy-nicotine and cotinine can be found in semen of smokers. Whereas nicotine is found at a higher concentration in semen than serum, its metabolites are present at serum levels. Cotinine is also found in urine and saliva,⁹ and the measurement of salivary cotinine provides a non-invasive method for checking the extent of smoking of volunteers. Similarly, caffeine rapidly enters semen and equilibrates with blood levels after ingestion of instant coffee.¹⁰ Caffeine and its metabolites paraxanthine, theobromine and theophylline can be measured in saliva, and after caffeine ingestion both caffeine and paraxanthine levels in serum and saliva rise and fall in parallel.¹¹ Although after 24 h of caffeine abstinence neither caffeine nor paraxanthine can be detected in serum or saliva, they both can be measured after maintenance of routine caffeine ingestion during the 24 h before sampling,¹² so salivary measurements of its metabolites may be useful in monitoring compliance in studies on caffeine administration and semen quality.

Although blood and semen samples were taken in the Jensen *et al.*² study, no measurements of alcohol were made on them. The authors thus had to believe the participants' statements on the last week's alcohol intake. Is it possible to confirm a participants' claimed extent of alcohol ingestion by non-invasive means? It is known that alcohol rapidly enters the male tract: by 30 min after ingestion of brandy (30% alcohol by volume [ABV]) it is in prostatic fluid at the concentration found in blood, and by 1 h

is in both the first and second fractions of a split ejaculate; thereafter semen levels decline in parallel with those in serum.¹³ Ethanol is also measurable in saliva,¹⁴ but its rapid elimination post-ingestion may mean that no trace of yesterday's alcohol intake would be measurable the following day, so the sensitivity of the assay may have to be increased, or measurement of a surrogate of alcohol intake could be contemplated.

To put the published figures in perspective requires collating the data with other estimates of the alcohol content of drinks, their recommended intake and differences in terminology. One alcohol unit is defined as 10 ml or 8 g of pure alcohol (the amount that an average adult can process in 1 h), not the 12 g alcohol per unit assumed in the Jensen *et al.*² paper. Eight grams of alcohol equal a single measure (25 ml) of whisky (ABV 40%), a third of a pint of beer (ABV 5%–6%), or half a standard (175 ml) glass of wine (ABV 12%). By this measure, one glass of wine contains 2 U (16 g) alcohol and one pint of beer 3 U (24 g). This agrees with other estimates of two standard drinks' containing 30 g alcohol (15 g per glass). Wine bottle labels often state the number of alcohol units per bottle or per glass, and caution that excessive drinking (undefined) may affect the drinker's ability to drive or operate machinery, or to cause (unspecified) health problems. At or below the moderate drinking limits reported by Jensen *et al.*² which had no effect on semen quality, the labels could be amended to include unlikely effects on male fertility.

However, the recommended limits of alcohol consumption vary with country. In Hong Kong, the Department of Health and Social Security recommends men not to exceed consumption of 3–4 units per day or 21 units per week, where one unit is defined rather confusingly, not as one unit of alcohol, but as one glass of wine or as one pint of beer. Thus, the daily limit means either 3–4 glasses of wine per day (6–8 U or 48–56 g alcohol) or 3–4 pints of beer (9–12 U or 72–96 g) and a weekly limit is either 21 glasses of wine (42 U or 336 g alcohol) or 21 pints of beer (62 U or 496 g). These are 3–5 times higher than the median weekly intake reported by Jensen *et al.*² to have no effect on semen quality, and above the levels that raised serum free testosterone. Thus, the maximum alcohol ingestion limits suggested in Hong Kong are

associated with unknown effects on semen quality but with known increases in serum testosterone. The effects on semen quality of imbibing these larger, presumably more representative quantities of alcohol, should be investigated.

COMPETING INTERESTS

The author declares that he has no competing interests.

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