Current Trends of Male Reproductive Health Disorders and the Changing Semen Quality

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Reproductive health is the basic human right which refers a state of complete physical, social and mental well-being and not merely the absence of disease and infirmity in all matters relating to the reproductive system and to its functions and processes.[1] However during the past few decades, a number of reports have appeared, which have raised serious concerns about the development of reproductive problems in animals and man.[2] Simultaneously, there have been controversial reports of alterations in human semen quality along with reports of an emerging incidence of congenital malformations of the male reproductive tract, such as cryptorchidism and hypospadias[3] and of an increasing trend of testicular cancer.[4]

Even though a lot of the changes observed in male reproductive health are controversial, there seems little discrepancy that testicular cancer is increasing in the rate of recurrence, with an unexplained increase in the age-standardized incidence observed in Europe[5] and the USA.[6] In the west of Scotland, the number of testicular germ cell tumors registered has more than doubled over 1990 than it was in 1960,[7] whereas a study from Norway reported that the age-related frequency of testicular cancer increased from 2.7/1 lakh individuals in 1955 to 8.5/1 lakh individuals in 1992.[4] In the USA, the overall age-related incidence of testicular and germ cell cancer has increased 3.5-fold during the past 60 years.[6] There is considerable geographical variation in both the occurrence of testicular cancer and in the observed rate of its growth.[8] The study by Bergström *et al.*[5] evaluated data from Denmark, Norway, Sweden, the former German Democratic Republic, Finland and Poland, including data on over 30,000 cases of testicular cancer from 1945 to 1989 in men aged 20-84. They reported considerable regional variation in both the incidence of testicular cancer and in the observed rate of increase, ranging from a 2.3% increase per annum in Sweden to 5.2% per annum in the former East Germany. However, from some other studies it is now clear that men with a history of cryptorchidism, inguinal hernia, hypospadias and hydrocele have a significantly increased risk of testicular cancer.[9] It has been suggested that paternal occupation before conception may alter the testicular cancer risk of offspring,[10] as may the parental use of pesticides or fertilizers[11] or childhood residence in areas with a high nitrate concentration in ground water.[12] In a case control study in the UK, Davies *et al.*[13] found that, while cryptorchidism was a major risk factor for testicular cancer, each extra quarter pint of milk consumed amplified the risk by 1.39-fold.

The incidence of congenital malformation of the male genital tract is also changing its pattern, with an increase in the prevalence of cryptorchidism and hypospadias.[14] Cryptorchidism has increased by as much as 65-77% over recent decades in the UK,[3] whereas USA data have shown that rates of cryptorchidism have not changed,[15] although a large study from the USA reported that rates of hypospadias have doubled between the 1970s and 1980s.[16] Källén *et al.*[17] who conducted a multicentre study of 8122 boys from seven malformation surveillance systems around the world, resolved that a true geographical variation exists in the prevalence of hypospadias at birth. Berkowitz *et al.*[18] who were considering at the risk factors for cryptorchidism, suggested that maternal obesity, low birth weight, the presence of other congenital malformations, ethnic group and a family history may be relevant. Others have suggested strong associations between cryptorchidism and low social class.[19]

The proposition that semen quality is changing is not new. In an article in 1974, Nelson and Bunge[20] reported data on 386 men presenting for vasectomy

Table 1: Some recent references showing current trends in semen quality worldwide (1982-2013)

	Year	Country	Sample size	Age	Semen volume	Sperm concentration	Sperm morphology	Sperm motility
Nieschlag *et al.*[33]	1982	Germany	43	A. 29 (3.2); B. 67 (7.8)	↓ (NS)	↑ (P<0.05)	↔	↓ (*P*<0.0005)
Homonnai *et al.*[34]	1982	Israel	555	A. 31 (0.2); B. 54 (4.2)	30% ↓	↔	↔	↓
Dondero *et al.*[35]	1985	Italy	445	A. <40; B. 40-60; C. >60	↓ after age 40 (NS)	↓ after age 40 (NS)	↓ (NS)	↓ after age 40 (NS)
Haidl *et al.*[36]	1996	Germany	64	A. 32.2; B. 50.3	↔ (NS)	↓ (P=0.01)	↓ (NS)	↓ (P=0.04)
Spandorfer *et al.*[37]	1998	U.S.A.	821	A. ≤39; B. 40-49; C. ≥50	↓ (P<0.05)	↔	↔	↓
Andolz *et al.*[38]	1999	Spain	20,411	31.9 (5.4); 15-74	0.5% ↓ per year of age	0.7% ↓ per year of age	0.2% ↓ per year of age	0.3% ↓ per year of age
Rolf *et al.*[39]	1999	Germany	3,437	19-63	↓ (P<0.0001)	↔	ND	↔
Eskenazi *et al.*[40]	2003	U.S.A.	97	22-80	0.03 mL decrease per year of age	r=−2.5% per year	ND	0.7% ↓ per year of age
Ng *et al.*[41]	2004	Australia	567	52-79	Age-dependent ↓ (*P*<0.001)	ND	25% ↓ per year (P<0.001)	ND
Meeker *et al.*[42]	2007	U.S.A.	388	>45	Age-dependent ↓	Age-dependent ↓	Age-dependent ↓	Age-dependent ↓
Stewart *et al.*[43]	2009	Australia	225	>30	↓ with low sperm count	Age-dependent ↓	Age-dependent ↓	↓
Tang *et al.*[44]	2012	China	104	A. <35; B. 35-39; C. ≥40	↔ (NS)	↔ (NS)	ND	↓
Jajoo and Kalyani[45]	2013	India	100	A. <30; B. ≥30	↓	↓	↓	↓

Data are represented as mean (SD). ↓=Decrease, ↑=Increase, ↔=No change, SD=Standard deviation, NS=Not significant at *P*<0.05, no *P* value indicates that no statistical testing was done in the USA. The mean sperm concentration of this group was 48 × 10^6/ml, only 7% of them were reported to have sperm concentrations above 100 × 10^6/ml which is far below than the concentrations reported in the earlier studies of 120 × 10^6/ml[21] and 145 × 10^6/ml[22] respectively. In 1951, MacLeod and Gold[23] had published their landmark study of semen quality in 1,000 male partners in infertile relationships, together with a similar number of men of proven fertility and reported an average sperm concentration of 107 × 10^6/ml, with 5% of them having sperm concentrations under 20 × 10^6/ml and 44% having above 100 × 10^6/ml. In 1980, James[24] reported the first review of published data on semen quality in men of proven fertility and in unselected normal men. Jensen *et al.*[25] in 1992 reawakened concern over the possibility of secular trends in semen quality, publishing a meta-analysis of data on semen quality of 14,947 men published since 1930 in normal men. Analysis for sperm concentration suggested an apparent decline from 113 × 10^6/ml in 1940 to 66 × 10^6/ml in 1990. Bromwich *et al.*[26] later speculated that much of the apparent change in semen quality could be accounted for by a change in the "accepted" definition of the lower limits of "normal" semen from around 60 × 10^6/ml in the 1920s[27] to 20 × 10^6/ml, which is the figure commonly accepted today.[28]

Most of the reports that appeared closely after the meta-analysis of Jensen *et al.*[25] provided alternative interpretations of the data. Auger *et al.*[29] published data on semen quality in fertile Parisian men by examining 1750 fertile men with consistent methods of subject recruitment and laboratory technique, during a 20 year period. They observed a fall in all of the classical measures of semen quality over time. Irvine[30] later observed that the median sperm concentration fell from 98 × 10^6/ml among donors born before 1959 in Scotland to 78 × 10^6/ml amongst donors born after 1970. In a similar study, Van Waeleghem *et al.*[31] observed declines in sperm concentration from a mean of 71 × 10^6/ml to 58.6 × 10^6/ml in sperm donors of Belgium.

Most lately, a very careful reanalysis of the historical data[25] on semen quality in normal men has been published.[32,46-52] Using a linear model, they found that sperm concentrations and the rate of decline in sperm concentration differed significantly across regions. This along with some other reports suggest that the reported world-wide decline in semen quality is also real [Table 1].

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