SUMMARY AND CONCLUSION
The decreasing trend in fertility rates in many industrialized countries is now so dramatic that it deserves much more scientific attention. It is speculated that changing lifestyle and increasing environmental exposures, e.g., to endocrine disrupters and persistent chemicals, are behind the trends in occurrence of male reproductive health problems. The number and quality of sperm produced by the testis is determined to a great extent by the interaction of three factors: 1) the genetic make-up of the spermatogonia; 2) normal Sertoli and Leydig cell function, and 3) the interaction of Sertoli, Leydig, and germ cells with endogenous factors and the environment. Even if the genetic endowment of Sertoli and germ cells were to be optimal, sperm quality and number can be greatly compromised by environmental factors (Alvarez, 2003).

The present study was carried out in order to study the effect of toxic exposures—both self-reported occupational as well as environmental—on male reproduction. A total of 212 subjects were enrolled randomly from those who were attending OPD of Obstetrics and Gynecology Department Civil Hospital, Ahmedabad, India. A brief history was recorded on pre-tested proforma, such as smoking, tobacco chewing, and alcohol habits. Information regarding occupational exposure to agents that could possibly affect spermatogenesis such as exposure to metals, pesticides, heat, and solvents was also recorded. Reproductive history was noted for all the men and their partners, which included duration of active married life, abortions, neonatal deaths, etc.

Semen samples were obtained by masturbation in a sterile container and evaluated for physical parameters such as pH, liquefaction time,
viscosity and volume. Detailed microscopic examination of semen was carried out to note the total sperm count, motility, morphology, viability and number of pus cells, etc. The assessment of the sperm membrane was done using the hypoosmotic swelling test (HOS test). Biomarkers for the function of the accessory sex glands such as zinc for prostatic function, fructose for seminal vesicles, alpha - glucosidase for epididymal dysfunction were also measured. Analysis of reproductive hormone levels (LH, FSH and testosterone) was carried out in serum as well as seminal plasma. In addition, prolactin level was measured in seminal plasma. Seminal plasma samples were digested using microwave digestion and Pb, Cd and Cu were measured in serum and seminal plasma.

For analysis purpose, the study subjects were classified as “fertile” and “subfertile”. Fertile subjects included normospermic subjects whereas subfertile included azoospermic, oligozoospermic, asthenozoospermic as well as oligoasthenozoospermic subjects i.e. subjects either having sperm count below 20 million/mL and/or rapid progressive motility less than 25%. The influence of confounding factors such as age, body mass index and lifestyle factors-smoking, chewing tobacco and alcohol consumption was also assessed. Attempt was made to correlate exposure to toxic substances with semen quality and hormone levels. Levels of metals in blood/serum and seminal plasma were also correlated with semen quality parameters such as sperm count, fast progressive motility, sperm morphology and with biomarkers of accessory sex glands.

The results indicated that about 23.6% subjects were alcohol consumers, 53.3% of the subjects indulged in chewing tobacco and arecanut quid. The number of chewers was higher than the number of smokers. No statistically significant change was observed in semen parameters among subjects indulging in any of these habits. However, among oligozoospermic men, marginally lower sperm count was observed among smokers in comparison to non-smokers, chewers in comparison to non-chewers, and alcohol consumers compared to non alcohol consumers.
While categorizing the subjects into "Exposed to toxic substances" and "Unexposed" according to their status of exposure to toxic metals, pesticides, solvents, heat, etc. based on their occupational history, it was observed that 42% of the subjects had either present or previous exposures to harmful substances. There was a significant effect of exposure to toxic agents on sperm count as well as sperm morphology (p<0.05). This indicates that those persons working in occupations involving hazardous exposure are more at risk of having poor semen quality. When individual toxicants were analyzed, it was observed that subjects exposed to pesticides had an increased risk of developing subfertility suggesting the potential role of pesticide exposure in semen quality. In addition, exposure to toxic substances resulted in significant elevation in serum FSH levels which indicate a probable damage to Sertoli cell function.

Considerable levels of lead and cadmium were observed in seminal plasma indicating that these metals accumulate in the reproductive organs. Lower sperm counts were observed among subjects with higher seminal plasma lead levels. Similarly, lead was observed to have a significant negative effect on normal sperm morphology. Further, a significant negative correlation was also observed between seminal plasma lead and mean percentage of sperms having normal double-stranded DNA.

Mean zinc level in both serum and seminal plasma was lower among azoospermics compared to subjects with normal count. In addition, positive correlation was observed between zinc and all the sperm parameters, indicating a positive role of zinc in reproductive function. Higher percentage of immature spermatozoa with concomitant decrease in seminal plasma zinc among subjects having higher seminal plasma lead levels suggests that lead may exert its effect by lowering zinc levels and indirectly affecting the antioxidant defence mechanism leading to DNA damage.

Mean sperm count, fast progressive motility, and normal morphology values were lower among subjects whose seminal plasma cadmium levels
were above 10 μg/L. However, the difference between the subjects having Cd level < 10 μg/L and ≥ 10μg/L was statistically non significant. The present results indicated that lead in seminal plasma is a better indicator of lead toxicity to reproductive system as compared to blood lead. In case of copper, serum copper was found to be a good indicator of toxicity to reproductive system than seminal plasma copper. These indices can be used as markers of toxic exposure to these metals. Alteration in levels of reproductive hormones in serum among exposed persons as well as the relationship of hormone levels with semen parameters obtained in the present study indicates that if used in conjunction with toxicity parameters, measurement of hormone levels give useful information regarding the type of damage caused to the reproductive system.

The present study clearly suggests that exposure to toxicants through occupation and environment as well as lifestyle factors (tobacco smoking, chewing and alcohol consumption) might play an important role in deterioration of semen quality. Hence, action is needed to reduce the workplace exposure and eliminate unwanted toxicants in the environment. Further well planned animal and human studies are required to assess the toxic potential of various chemicals not yet properly tested on human reproductive function.