INTRODUCTION
The capability of the human race to reproduce is a fundamental aspect of life. Our bodies evolved to be 'in tune' with their environment. This connection is vital for reproduction, as birth of young must coincide with plentiful food and suitable environmental conditions and thus a high chance of survival. Our fertility is also influenced profoundly by the environment including season and lifestyle. Evidence indicative of detrimental effects of environmental and occupational exposure on the reproductive system and related outcomes has steadily accumulated in recent decades, which is further compounded by persistent environmental endocrine disruptive chemicals. There has been growing concern that synthetic chemicals released into the environment have affected the development and/or function of the reproductive, endocrine, immune and nervous system of various animal species, including wildlife. Increasing reports on reproductive abnormalities such as decrease in sperm counts, increased incidence of hypospadias, cryptorchidism, testicular cancers, etc. in male and menstrual disorders and endometriosis in female from different parts of the world are indicative of the fact that environmental chemicals might have some role in these disorders.

The rate of infertility has gone up from 8-15% in industrialized countries (Dondero et al. 1991, Runnebaum et al. 1997). More than a quarter of infertility cases may be attributed to male factors (Templeton, 1995) and at least one half of the cases of human male infertility of unknown aetiology may be attributable to various environmental and occupational exposures (Steeno and Pangkahila 1984a,b, Gagnon, 1988, Irvine, 1998). Reproductive organ malformations, defects in the progeny have enormous emotional and practical implications for not only to the affected person but
also to their family as well as to the society. Therefore, we must ensure that genetic material should be passed unaffected to our descendants.

Demographers have been studying fertility in populations for many years, but it was not until the last 3-4 decades of the 20th century that epidemiologists and toxicologists took interest on this aspect (Bonde, 1999). There are reports regarding apparent drop in semen quality from different parts of the world particularly from western countries. A systematic meta-analysis of 61 studies, including 14947 normal men was undertaken by Carlsen et al. (1992). It showed a significant decrease in sperm concentration from 113 to 66 million /ml, and semen volume decline from 3.40 to 2.75 ml, over the period 1938-1990. This report generated a worldwide debate among researchers about declining trend in semen quality. Following years saw many research papers, with some supporting the theory (Bromwich et al. 1994; Suominen and Vierula, 1993) whereas some investigators disagreeing with Carlsen's theory (Fisch et al. 1996, Paulsen et al. 1996). Gopalkrishnan (1997) from Bombay, India mentioned a definitive trend of decline in semen quality. Still an intense debate is going on among the scientific community about the real picture regarding the decline of semen quality. We speculate that this decline in semen quality might be due to higher level of toxicants in the environment to which humans are exposed during critical period of development as well as during early childhood and adulthood. Earlier, Aitken (1997) also suggested that the widely publicized decline in human sperm counts reported in several European countries is happening at too fast a rate to be genetic and probably involves environmental factors.

Sharpe and Skakkeback (1993) postulated that apparent drop in sperm count may be due to the developmental exposure to estrogogenic xenobiotics. They may mimic, block, or both mimic and block a hormone response or bind to the receptors and create a novel reaction. Xenoestrogens may disrupt hormone-mediated events and inhibit normal signal transduction in the testis and epididymis by either binding to sex hormone binding globulins or blocking the cell surface receptor for these
proteins. The testis and accessory sex glands may be at particular risk for the estrogenic effects due to the presence of receptors for male gonadal hormones. The most commonly reported EDCs (Endocrine disruptive chemicals) that affect reproduction are the pesticides that mimic the effects of estrogens (Guillette et al. 2002). Endocrine disruptors, such as persistent organic pollutants may have a negative impact on sperm quality (Rignell-Hydbröm et al. 2005). Lead, cadmium, arsenic and mercury have been implicated as potential endocrine disruptors (Keith, 1998).

The male reproductive system is vulnerable to the effects of the chemicals and physical factors. This might be due to the fact that sensitive events take place during spermatogenesis and the persistent environmental pollutants and/or physical factors may affect some of these events. Several studies have attempted to determine possible associations between abnormal semen parameters and occupational exposure to organic solvents, metals and pesticides. Associations between exposure to certain pesticides, solvent and metals especially lead and reproductive abnormalities have been reported (Whorton et al. 1979, Telisman et al. 2000).

Human exposure to pesticides may occur by virtue of their occupation or environment. A classical example of reproductive toxicant is 1, 2 dibromo-3-chloropropane (DBCP). In addition to this, there is evidence of reproductive toxicity of a few other pesticides such as carbaryl and 2,4-dichloro phenoxy acetic acid, DDT (dichloro diphenyl trichloroethane) etc. A few studies are also available on the effects of multiple pesticide exposure on male mediated adverse reproductive outcome. In addition, physical factors such as high temperature also affect spermatogenesis in humans. Therefore, nature has also kept the scrotum outside the body cavity so that the temperature of the testis may be lower than that of the body temperature. Lahdetie (1995) reported that active sperm production is dependent on an environment that is 4 °C lower than the normal body temperature. Figa-Talmanca et al. (1992) reported adverse effects on sperm production due to chronic occupational exposure to high temperature in ceramic industry. With the rise in industrialization, the problem of air pollution has also increased.
Selevan et al. (2000), reported that young men may experience alterations in sperm quality after exposure to periods of elevated pollution. Mehta and Anand Kumar (1997) also reported a decline in semen quality and correlated these changes with air pollution indices like suspended particulate matter, sulphur dioxide and lead.

Metals are not biodegradable, have long biological half-lives and have the potential to accumulate in different body organs leading to unwanted side effects. Lead and cadmium are highly toxic metals. Both are pervasive in the environment and accumulate in the human body over a lifetime, including prenatal life (Telisman, 2000). The toxic effects of certain metals in different animal systems are well documented. Of all metals studied, probably the toxicity of lead has been most extensively reported. All the living beings including humans are exposed to lead to some extent due to contaminated air, water and food. A large number of workers are exposed to high doses of lead in various occupations such as lead based paints, construction, battery manufacturing or recycling, automobile repair, electronics, printing, welding and soldering, jewellery making and repair, stained glass window making, etc. The general population may also be exposed to lead through leaded pipes that supply drinking water, lead based paints, lead glazed ceramics, plants grown in lead contaminated soil, ayurvedic medicines, toys, pencils, etc. There is evidence that exposure to lead is associated with a variety of adverse reproductive outcomes such as spontaneous abortion, impaired fertility, decline in sperm counts and serum testosterone levels, etc among occupationally exposed workers. It has been accepted since long that lead exposure causes toxic effects on the human sperm, however, the level at which toxicity occurs is still debated among the scientific community.

Cadmium (Cd) is a ubiquitous element and a significant inorganic pollutant. Cadmium exposure can occur through contaminated air, water and food. Occupational exposure to cadmium occurs in industries such as metal plating, semiconductor manufacture, wire, plastic, or battery manufacture, welding, soldering, and ceramics, etc. Another major source of cadmium
exposure in the environment is cigarette smoke. Inverse correlation has
been reported between Cd and sperm density, sperm number per ejaculum
in a study carried out in China among non-smokers (Xu et al. 2003)
However, this was contradicted in a study among 12 men with proven fertility
(group I) and 44 normozoospermic patients (group II) as well as 118
unselected patients of an infertility clinic (group III) and two industrial workers
with occupational exposure to cadmium where no significant correlation
between seminal cadmium concentrations and conventional semen
parameters or between cadmium concentration and the fertility status of the
patients was observed (Keck et al., 1995) Cadmium is also associated with
deleterious effects on the gonadal function and with changes in the secretory
pattern of pituitary hormones like prolactin, ACTH, GH or TSH. Recent
reports have classified cadmium as an endocrine disruptor (Henson and
Cheredese, 2004) Other metals, which might also have adverse effect on
human male reproductive system, are mercury and chromium with a limited
degree of evidence (Kumar, 2004; Kumar et al. 2005).

Trace elements are required in small concentrations as essential
components of various enzyme systems. These trace elements, though they
constitute a very small portion of the total body composition, play an
important role in physiological functions of the body including reproduction.
They include Fe, Zn, Cu, Ca, Co, Mn, Mo, Se, Ni, Si, etc. Whereas some
trace elements such as zinc and selenium have been reported to benefit
reproductive function (Xu et al. 2003), high levels of some elements have
been shown to be detrimental to sperm function (Battersby et al. 1982). In
addition to the above, exposure to radiation (Cheburakov and Cheburakova
1993), increased stress (Sheiner, 2002), lifestyle factors such as smoking
(Wong et al. 2000), chewing tobacco (Said et al. 2003) and consumption of
alcohol (Muthusami and Chinnaswamy, 2005) have been reported to affect
semen parameters. However, few studies have found no association
between smoking and sperm quality (Vogt et al. 1986; Dikshit et al. 1987).

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travel through the blood to distant places in the body and bind to specific cell sites called hormonal receptors, where they exert their effects on growth, development, reproduction and behaviour. The successful and complete male germ cell development is dependent on the balanced endocrine interplay of the hypothalamus, pituitary and the testis. GnRH released by the hypothalamus elicits the release of follicle stimulating hormone (FSH) and luteinizing hormone (LH) from the pituitary gland (Babu et al. 2004). The balance of these hormones is essential for spermatogenesis. Very little information is available on the association between toxicants and with reproductive hormones and accessory gland markers. Keeping in view the above, the present study has been carried out with the following objectives:

1. To study the association of environmental/occupational exposure to toxicants and semen characteristics.
2. To determine the level of metals (Pb, Cd, Cu) in human serum/semen and their association if any with semen quality.
3. To find out the relationship between metal levels and accessory gland markers.
4. To determine the levels of reproductive hormones and their association with semen quality and metal level.

Ahmedabad is one of the highly industrialized cities of India. The industrial hubs in Ahmedabad are Narol, Vatva, Naroda, Odhav and other scattered locations, which were initially beyond the periphery of the city but now are very much a part of the city. There is predominance of small scale units engaged in manufacturing of textile processing chemicals, foundries, dyes and dye intermediates, engineering, steel rolling mills, etc. Moreover, the number of vehicles is increasing at a rapid pace leading to air pollution. Hence this study was conducted to evaluate the present scenario regarding the various environmental factors that affect the male reproductive system. Scientists are still debating on the exact role of environmental toxicants and semen quality and also the level at which the quality is deteriorated. There is scanty or sometimes inconsistent data pertaining to the role of environmental toxicants on deterioration in human semen quality.

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There are very few reports on the interrelationships between different metals in biological media. The results of this study will be of immense value in identifying the present pattern of residues of metals in the community as well as their relationship to semen quality and reproductive hormones and will open new horizons in the field of environmental reproductive toxicology.