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Impact of Environment on Reproductive Health

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Abstract

Health problems due to adverse environmental factors are likely to dominate in this century. We are exposed to a deluge of toxic substances in our daily life and they have deleterious effect on our health in general but more so on reproductive health.

Environmental factors can influence reproductive health. Disinfectants, pesticides, heavy metals, smoke of automobiles, nuclear dust, organic solvents released in the environment have adverse effect on reproductive process. Increased emissions of greenhouse gases, exposure to narcotic drugs, tobacco and alcohol also can disrupt the reproductive process. Environmental changes can cause chromosomal damage, structural and functional fetal birth defects, endocrine disruption, infertility, spontaneous abortion, stillbirth and cancer. There is an increase in the number of women working in high-risk industries. Use of some drugs during early pregnancy may be responsible for fetal malformation. Team approach is essential to reduce these adverse effects. Government, industries, local bodies and the community must work in harmony to save humanity from the catastrophe.

Key words: Environment, Chemicals, Reproduction, Infertility, Gynecological cancers, Fetal malformation, Occupational hazards.

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Impact of Environment on Reproductive Health

Clean air, clean water and good soil are essential for maintaining good health in animal and vegetable kingdom. Detereoration in any of these can have adverse effect on health. It is unfortunate but true that the environment in which we live is getting polluted and is responsible for many health problems we are facing today. Scientists have warned us that many of these adverse environmental changes are man made and it is imperative that we reverse these processes before it is too late. Two agencies have tried to focus our attention to this problem. First is World Health Organization (WHO). It gives a 'slogan' every year on the world health day. In 2008, WHO gave a slogan **'Protect health from climate change'**. The second one is the Nobel prize for peace given to Mr.Al Gore, former vice-president of United States of America and Shri Rajendra Pachauri, chairman of intergovernmental panel on climate change for their efforts for effectively addressing climate changes. The prize is given in recognition of the efforts of these two men for reducing the ill effects of the adverse climate change. We are proud that Shri Pachauri hails from India. We feel that WHO efforts and Nobel prize committee's award this year for Climate change will help in reducing health problems due to environmental pollution. Al Gore while receiving the prize, said, "We are confronting a planetary emergency, a threat for survival of our civilization. The earth has fever and the fever is rising. Without realizing, we have begun to wage war on earth itself. Now, we and earth's climate are locked in a relationship familiar to war planners - **'Mutually assured destruction.'** But I hope, we have the ability to solve this crisis and avoid the worst of its consequences, if we act boldly, decisively and quickly" (1).

Clinicians must be grateful to scientists of two disciplines for focusing our attention to environmental pollution – Zoologists and Community Medicine scientists. Zoologists were the first to give documented evidence of the ill effects of environmental contaminants to wild life. Theodora Colborn of the world wild life fund and her colleagues have listed 45 chemicals that can disrupt the reproductive system or hormone system. Exposure to these chemicals may be responsible for following effects in animals (2):

- Thyroid dysfunction in birds and fish,
- Decreased fertility in birds, fish, shellfish and mammals,

- Decreased hatching success in birds, turtles and fish,
- Gross birth deformities in birds, fish and turtles,
- Male fish, birds and mammals that are feminized,
- Female fish, birds and mammals that are masculanized, and
- Compromised immune system in birds and mammals.

In a hurry to globalize, developing countries are industrializing very rapidly at the cost to the environment. The increase in technology for industrialization demands its pound of flesh in terms of deteriorating environment. Though many countries have formulated laws to prevent industrial pollution, the laws are violated by industries with impunity as they continue to dump industrial waste. The developed countries are more conscious about environmental pollution and have made strict laws to prevent pollution. Therefore, many of these hazardous industries are being shifted to developing countries and the hazardous waste is being dumped in developing countries. David Nelson, an expert in US environmental protection agency calls it **'Industrial neo-colonialism'** (3) Polluted environment is a great health risk. It is necessary to strike a balance between the need for industrialization and the need to protect the environment. It can cause several health problems. However, we shall restrict our discussion to the impact of environmental changes on reproductive function.

Endocrine Disruptors

It has been shown that several chemicals including dioxin, PCB, dicofol, insecticides and fungicides have the capacity to act as estrogen like hormones. Theodora Colborn, a zoologist from USA, suggested the term **'endocrine disruptors'** for such substances that interfere with or mimic the action of hormones and then upset the normal growth, behavior and reproduction. Endocrine disruptors may have a transient effect on adults but these effects can be permanent in fetus causing malformations (Table 1). They can throw off the system by sending wrong signals or blocking the right signals. In animals, single dose of dioxin administered during a critical 'window of vulnerability' in pregnancy can lead to life long health effects in the offspring. Men exposed to Agent Orange, a herbicide containing dioxin, are more likely to father children with birth defects. Maternal exposure to PCB seems to result in developmental delays

Table 1: Etiology of human congenital malformations observed in the first year of life

Congenital malformation	Incidence
Unknown	65-75%
Genetic	15-25%
Environment related Nutrition related 4% Infectious agents 3% Mechanical problems 1-2% Chemicals & prescription drugs <1%	10%

Source: Brent et al. (1992)

in children (4). In Lake Ontario, the water contains many synthetic chemicals including PCB, pesticides, DDT, etc.The newly hatched chicks from these lakes, some males have oviducts and gonads resembling ovaries and oviduct system in female birds are developing abnormally. Bird species that fed on great Lakes fish show behavior changes, failed reproduction and early mortality in the offspring. Similar studies from Alligators from Lake Apopka in Florida, shows that Alligator eggs from these lakes, 80-95% failed to hatch compared to 20-30% from other lakes (2).

The evidence that environmental estrogens affect wild life is strong. Evidence for similar risks to human beings is fragmentary, but also diqueting. Estrogen mimics are extremely potent in parts because unlike most estrogens, they cross the placental barrier exposing the fetus to greater than normal levels of hormone (2).

In men, some studies indicate that estrogenic compounds affect the development of sertoli cells in the testicles. Sertoli cells secrete male hormone that regulate sperm production, the descent of testicles and the development of urethra. Researchers in North America and Europe are studying if these estrogen disruptors could cause prostate and testicular cancer and lower sperm counts (5). That exposure to environmental chemicals can impair semen quality is clearly plausible and, in some heavily polluted environments

of Europe, such effects are clearly evident. However, it should be emphasized that most of the human data are correlative and involve mechanisms that await resolution.

Clinicians must also be grateful to scientists from Community Medicine who were the first to draw attention to diseases caused by contamination of air, water and soil. Clinicians generally are more focused on the diagnosis and treatment of diseases. They are less focused to study the impact of environmental factors. Obstetricians till recently were too engrossed in managing problems of infertility, abortions, obstetric haemorrhage, low birth weight babies and fetal malformation on individual basis. They did not realize that some of the obstetrical and gynaecological problems they were dealing with were the result of environmental influences. It is encouraging to note that the modern obstetrician is getting aware of the impact of environmental factors in his clinical practice.

Environment may be affected by air pollution, water pollution and soil pollution. The environment whether it is air, water or soil, can be contaminated by following physical factors, chemical factors, ionizing radiation and infections.

Air pollution is mainly caused by smoke resulting from automobiles, industrial gases, smoke from domestic cooking using cow-dung cake, wood, etc. All these increase the levels of lead, carbon monoxide, fluorides, etc. WHO report says, "625 million people live in urban areas whose average levels of sulphur dioxide are unacceptably high. Sulphur dioxide emissions are notching up at 4% per year" (6). Burning of oil wells in Kuwait in February 1991 is the worst manmade pollution in history. The smoke from these oil wells caused global warming and ozone depletion. The air pollution due to nuclear dust after atomic bomb explosion in Hiroshima and Nagasaki in 1945 and Chernobyl is now a matter of history. The most recent gas tragedy is leak of Methyl isocynate (MIC) gas from pesticides plant in Bhopal in 1984. It caused increased incidence of abortion, IUGR, stillbirth and increase in perinatal mortality (7).

Water pollution is mainly caused by industrial waste dumped in river or lake. Urban sewage contaminates water supply that may cause typhoid, cholera, amoebiasis, and infective hepatitis, etc. Infective hepatitis in a pregnant woman may cause severe morbidity due to liver failure, postpartum hemorrhage, preterm birth and fetal loss. G.I. tract infections

may result in abortion, preterm birth or fetal loss. Environment may affect reproductive performance in the following ways:

- Infertility/sub fertility,
- Spontaneous abortion,
- Intra-uterine growth retardation (IUGR),
- Low birth weight babies,
- Stillbirth,
- Structural and functional birth defects,
- Chromosomal damage,
- Hormonal disruption,
- Menstrual problems, and
- Breast & Genital malignancy

Physical factors and reproductive health

The physical factors that can affect maternal and perinatal health are local uterine defects, altitude, temperature, hypoxia, noise, ultra-sound, etc. Air gets rarified at high altitudes and results in low oxygen saturation in blood. This may cause low birth weight, IUGR, preterm birth. Increased temperature is known to cause malformations in animals. It is difficult to know the effect of temperature in humans because drugs are usually given to lower the body temperature. High temperature does cause preterm birth that may increase perinatal mortality. The sperm count is reduced when exposed to high temperatures. Ultrasound does not have any embryotoxic or teratogenic effect in humans but fetal malformations have been reported in mice after exposure to ultrasound. Malformations have also been reported with radio stimuli in mice but not in human beings. Microprocessors have brought video-display terminals into offices and homes. The ionizing Radiation generated by video-display consists of rays, which have adverse effect on reproduction. It is good to note that x-rays emitted by cathode ray tube in video-display terminal are entirely absorbed by the green glass screen (8). The scan of recent literature suggests that women working with video-display terminals are not at excess risk (9).

Chemicals and drugs

Environmental pollution by chemicals could result from the following:

- Industrial chemicals,
- Occupational chemicals,
- Domestic chemical products,
- Pharmaceutical products-drugs.

Pollution due to chemicals is on the increase all over the world. The number of women employed in chemical factories is increasing. Improper disposal

of industrial waste is adding to the pollution. Increasing use of automobiles, which emit poisonous gases, adds to the environmental pollution. Exposure in the body to smoking (active or passive), alcohol and substance abuse is on the increase, which affects reproductive health. Chemicals including carbon dioxide, sulphur, carbon monoxide, lead, mercury, arsenic, and organic chemicals have adverse effect on reproduction.

Lead

Lead is mainly used in painting, printing, battery and smeltering industries and is an occupational hazard to the women. Lead can also enter the body from contaminated soil and drinking water. Lead crosses the placenta both by passive diffusion and active transport. Lead crosses the human placenta as early as 12-14 weeks gestation. Fetal bone and liver may have higher lead concentration than maternal tissues. In the past lead was used as an abortifacient. Lead is known to produce infertility, abortion, stillbirth and microcephaly. Even paternal exposure to lead affects the fetus. Wives of men working in lead based industry are at a higher risk of abortion, stillbirth and preterm birth. Hamilton (10) and Nogaki (11) reported higher incidence of abortion among female lead workers. Lead also affects male gonads causing chromosomal alterations, and abnormalities in sperm count. Prematurity and stillbirth in workers in lead industries was 8.2 percent as against 0.2% in controls (12). Lead is also associated with pregnancy induced hypertension (13).

Mercury

Mercury salts are used in fungicides, in laboratories and in industries. Experimentally it has been shown that dose of 2.5-7.5 mg/Kg of methyl mercury chloride have an embryo lethal and teratogenic effect on mice and rats (14). Mercury can produce anomalies in central nervous system and skeletal system. In Mina-mata tragedy in Japan, fish used to consume water contaminated by industrial waste, which contain mercury salts. People consumed these contaminated fish. It resulted in 134 deaths out of which 25 were fetuses. Very high mercury levels were found in pregnant women and also in female children up to the age of five years (16)

Pesticides, Fungicides and Organic Solvents

Organic solvents are diverse group of low molecular weight chemicals that are liquids and are able to dissolve other organic substances. These organic solvents are found in industries and also in domestic use. The organic solvents

mainly are varnish, kerosene, toluene, carbon tetrachloride, acetone, etc. Long term exposure to organic solvents resulted in reduced fetal weight and impairment in skeletal growth in rats (15). Any of these organic solvents are teratogenic and embryo toxic. These may produce hydrocephalus, cardio-vscular anomalies and skeletal defects (15).

Most of the pesticides and fungicides contain DDT, Paratheon, Demeton, and Penthion, etc. Pantheon acts on the genital tract. Germ cells are severely degraded. Ovogenesis is inhibited. Demeton and Pantheon cause abortions and small number of malformations in mice. Some of these chemicals are used as preservatives for cereals and other food grains. In 1958 in Kerala, 100 persons died after consuming imported food grains, which accidentally got mixed up with ethyl perathcon. In Karnataka, consumption of crabs and fish from fields sprayed with maletheon and endrine resulted in congenital dwarfism in 1975 (16). The most recent and tragic event is the Bhopal gas tragedy in 1984. In Bhopal, one pesticide plant with methyl isocynate (MIC) was leaking and this gas spread in the entire town of Bhopal. It resulted in loss of 3800 lives and markedly increased incidence of abortion, IUGR, stillbirth and increase in perinatal

Table 2: Recent Accidents due to exposure to chemicals

Episode	Event	Result
Mina-Mata bay Tragedy in Japan. (1956-72)	Methyl mercury waste dumped in Sea. Fish affected	Large scale mercury poisoning. Increase in fetal malformation & Still birth rate
Bhopal Gas Tragedy. (1984)	Leak of methyl-isocynate gas in Union carbide plant	↑ fetal malformation, Stillbirth, IUGR, spont.abortion 3800 deaths
Kerala State Tragedy. (1958)	Imported food grains accidentally mixed with ethyl parathion	100 deaths. ↑ abortion and still birth
Karnataka State Tragedy. (1975)	Consumption of crabs and fish sprayed with maletheon & endrine	↑ Dwarfism

mortality (7, 20, 21) (Table 2). However, WHO report states that "Pesticides do not seem to be dangerous to the human embryo when used in accordance with regulation guide lines. But excessive or accidental use may have dangerous effect on the offspring."

Research studies show that a 400% increase in ectopic pregnancies and increase in breast cancer in USA, since 1970 may be the result of exposure to pesticides and other endocrine disrupting chemicals. If the connection between environmental estrogens and breast cancer is proved, it may be possible to lessen the risk for this disease by reducing exposure to these chemicals (17, 18).

Some governments have defined safety levels of chemicals for industrial workers. This is aimed at protecting the workers. When safety limits are exceeded, the worker is taken off from the exposure area. These legislations are not always followed especially in developing countries. Moreover, one is not sure if safe levels of chemicals in the mother are also safe for the unborn child. Lead is an example for such discrepancy.

Life style of people can cause environmental pollution

In India and other developing countries, the life style of the population can adversely alter the environment. Cow-dung cake and wood are used as domestic fuel in closed ill ventilated huts and households (see photos). Many men smoke Bidi in the close rooms causing further pollution. This passive smoking affects the health of people in the house especially pregnant women and children. The smoke generated in close surrounding, increases the levels of carbon monoxide causing hypoxia, fatigue and respiratory diseases. This may also result in preterm labor and low birth weight babies. The fumes caused by trucks, buses, cars and auto-rickshaws also pollute the environment [Table 3] The use of kerosene in place of petrol in many auto-rickshaws, adds further to the

Table 3: Carbon dioxide Release per capita

(Per metric ton)

USA	19.7
UK	9.9
Canada	17.3
Australia	15.5
Japan	8.5
Thailand	1.4
India	0.8
Haiti	0.1

Source: Population reports

pollution. The ban on use of kerosene exists only on paper. The fumes consist of lead, carbon monoxide, nitrogen oxide, etc. The effect of burning 1000 liters of petrol is shown in Table 4.

Table 4: Generation of matters after combustion of 1000 liters of petrol

Matter	Amount
Carbon monoxide	360 Kg
Hydrocarbon	24-48 Kg
Nitrogen	6-18 Kg
Sulphur	60-100 G
Organic acids	250 G
Ammonia	250 G

Source: Ramchandran, Health Action (1991)

Dumping half burnt dead bodies, sewage refuse, and toxic industrial waste further pollutes the rivers and lakes. Most of the rivers in India are thus polluted because of lack of civic sense in the population and failure of the government to punish the culprits.

Constant exposure to video terminals and cell phones are also known to affect reproductive behavior. Use of cellular mobile phones is reported to cause reduced sperm count and may cause behavioral changes in children. Increasing intake of alcohol and narcotic drugs has adverse effect on maternal and fetal health.

Corbett *et al.* (19) have shown that birth defects occurred nearly three times more often in 621 Michigan nurse anesthetics. A total of 16.4 % of nurses practicing anesthesia during pregnancy had children with birth defects compared to only 5.7 % of nurses not practicing anesthesia. Wyatt (22) reports an increased risk of abortion, stillbirths and fetal malformation among women anesthetics. It may be due to prolonged inhalation of anesthetic agents.

Tobacco, alcohol and narcotic drugs

While smoking is gradually on the decline in the developed world, it is on the increase in developing world. Smoking is wrongly symbolized as a sign of social status or modernism. Tobacco is not only inhaled as in smoking, but is chewed as well as used as nasal snuff. In India small pouches of tobacco sold under the name 'Gutka' finds its place in the pockets of many students and even elderly men and women. Men who smoke heavily generate spermatozoa that suffer from high levels of DNA damage, largely as a result of oxidative stress. One of the consequences of this DNA damage is that the children of such men exhibit an increased incidence of childhood

cancer (23). Far more sinister effect of smoking is its ability to induce DNA damage in the germ line and thereby influence the health and well being of future generations (24, 26). We are probably all carrying around in our genes the genetic legacy of our great-grandfather's pipe-smoking habit. The risk of tobacco includes low birth weight babies, preterm births, and increased chance of spontaneous abortion. The British perinatal mortality survey has shown that smoking in later months of pregnancy is definitely prejudicial to the normal growth and survival of the fetus. The survey showed that perinatal mortality was 41.1/1000 births among smokers as compared to 32/1000 births in non-smokers (25). Tobacco – active or passive smoking –has similar effect on pregnancy outcome. There is some correlation between maternal smoking and child development. At the age of 10 years, there is four months delay for reading and five months delay for mathematics.

Moderate consumption of alcohol has no significant effect on pregnancy and the fetus. Excessive use of alcohol (more than 30 ml per day) affects fetal growth and may result in Fetal Alcohol Syndrome (FAS) in the newborn.

The use of narcotic drugs by modern youth is on the increase all over the world. It has caused socio-economic problems, increased crime rate and adverse reproductive outcome. There is also increased risk of AIDS because of sharing the common needle. Pregnant women are at increased risk of abortion, stillbirth and perinatal death. There is increased infant mortality due to lack of infant care by the drug addicts. The narcotic drugs usually consumed are hashish, marijuana, cannabis and opium. Little and Snell (27) have shown that there is 20 % risk of preterm birth, 30% risk of delivering small for date babies and four times high perinatal mortality among users of narcotic drugs. Our study results are shown in Table 5 (Unpublished data). The adverse reproductive impact of alcohol and narcotic drugs is not only because of the alcohol consumption or narcotic drugs, but such people are usually careless about their diet. They are also at risk of other medical diseases. They do not attend antenatal care clinics regularly and do not follow medical advice.

Impact of Drugs used in clinical practice

Unfortunately, drugs are often prescribed to women without knowing pregnancy status. The first trimester of pregnancy is the period of organogenesis and some drugs may cause fetal

Table 5: Drug Abuse and Obstetric Performance

Complication	Drug Addict=45	Controls N=60
Spontaneous abortion	10.2%	5.8%
Still births	1.7%	1.1%
Neonatal death	2.8%	0.6%
Perinatal mortality	4.2%	1.8%
Infant mortality	1.9%	Nil

Bhatt RV. (Unpublished data)

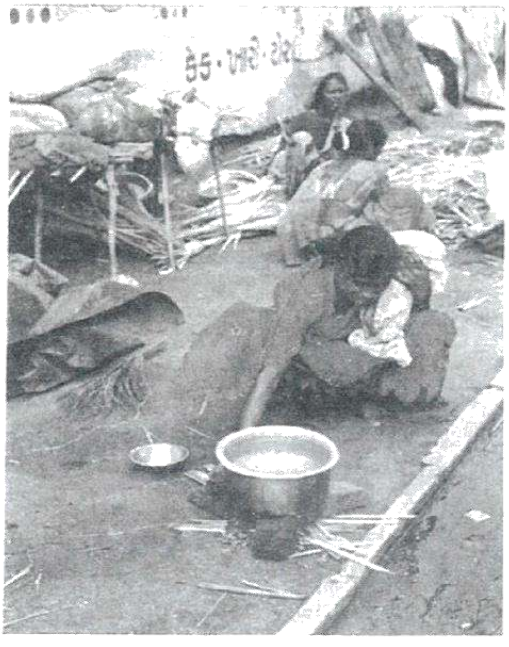
malformations. Drugs and environmental chemicals induce only 2-3 percent of total malformations. Thalidomide tragedy is fresh in the minds of clinicians. Thalidomide was administered to pregnant women for vomiting. It resulted in limb defects-phocomelia. Use of estrogen in pregnant women has resulted in vaginal adenosis in the offspring in later life. It is suggested that placental barrier is protective and many harmful substances cannot reach the embryo. However, recent studies have shown that there is no 'placental barrier' per se. Most drugs and chemicals cross the placenta (28). The teratogenic potential of a drug can be evaluated only if one considers the agent, the dose in which it is administered, the species being studied and the stage of gestation at the time of exposure. Vitamin A and aspirin are not teratogenic during the sensitive orgenogenetic period if used in appropriate dose, but they are teratogenic at higher doses. The list of drugs that can cause harm to the fetus is long and more and more drugs are added periodically. Anticonvulsants, some hypoglycemic agents, antiemetics, corticosteroids, cytotoxic drugs and some hormones are believed to have adverse effect on fetus. It is unfortunate that 'drug audit' does not exist in India. Clinicians are rarely challenged about the drugs they prescribe. It is necessary that clinicians know the teratogenecity of commonly used drugs. The use of Internet by many educated patients makes them more aware (sometimes even more than the clinician) about the drugs prescribed to them. Clinicians must always rule out pregnancy before prescribing drugs to women in childbearing age. Reference

Common causes of Environmental Pollution

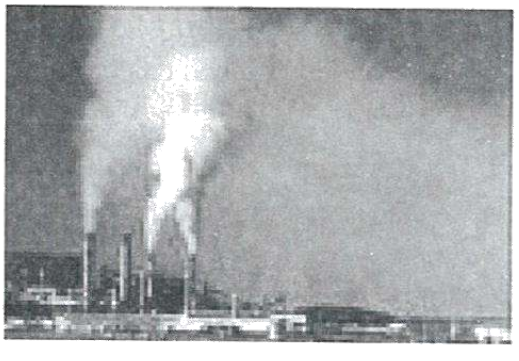
Pollution due to Automobile fumes

Pollution due to domestic fuel

Pollution due to pesticide & insecticide spray



Use of wood as domestic fuel



Air pollution by industries

manuals of "Use of Drugs in Pregnancy" are available in India. Clinicians must remember that **"There are no safe drugs; there are only safe physicians".**

Conclusion

Environmental factors pose a threat to reproductive health. The factors that cause environmental pollution are, largely man made. We may not be able correct all environmental factors but at least prevent some. The control of environment is teamwork. The government, industries, municipal corporations, community, non-governmental organizations (NGOs, print and visual media must work together to reduce the hazards of environmental pollution. The government must make legislation to define safety exposure limits for all industries. If the exposure limits are more than permissible, the industries must be penalized. The pregnant women working in 'high risk' industries must be isolated from ill effects of teratogens. Pregnant women (nurses and anesthetists) should not be allowed to work in operation theatres dealing with inhalation gases. The use of kerosene in auto-rickshaws, which causes severe pollution, must be prohibited. The rural people must be advised not to use cow-dung cake and wood in closed huts without safety measures. This needs education to the community because these agents are used as fuel for centuries. Use of tobacco, alcohol and narcotic drugs should be stopped or reduced. Passive smoking must be discouraged in presence of pregnant women and children. The clinicians must exercise more care while prescribing drugs to pregnant women. Teratogenic drugs must be avoided in pregnancy (at least in the first trimester). **Making legislation is not the end of the story. There must be suitable machinery to implement the laws of the land and deterrent punishment given to offenders.**

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