

REVIEW ARTICLE

Fertility and Occupational hazards: Review of the Literature

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ABSTRACT

Workplace exposures and hazards have detrimental effects on many organ systems in the body including the reproductive system. The evidence of the reproductive effects of occupational hazards is obtained through a synthesis of the available literature. These effects vary and overlap due to the multiple nature of exposures in the workplace. Hazardous agents include pesticides, solvents and heavy metals. The reproductive effects include reduced fecundity, abnormal sperm quality, increased risk of low birth weight, miscarriages and permanent sterility. These problems are not readily identified as having occupational causes in developing countries such as Nigeria where infertility has a high family and social consequence. Epidemiological studies in Nigeria are needed to evaluate the reproductive effects of workplace exposures. Protective measures such as proper house keeping, education and the use of personal protectives at the workplace are advocated (*Afr J Reprod Health 2009; 13[1]:159-165*).

RÉSUMÉ

La fécondité et les risques du métier. Les expositions dans les lieux de travail et les risques ont des effets nuisibles sur plusieurs systèmes d'organe dans le corps y compris le système de reproduction. L'évidence des effets des risques du métier sur la reproduction est disponible à travers une synthèse de la littérature dont on dispose. Ces effets varient et se chevauchent à cause de la nature multiple des expositions des lieux de travail. Les agents de risque comprennent les pesticides, des solvants et des métaux lourds. Les effets sur la reproduction comprennent la fécondité réduite, une qualité anormal du sperme, l'augmentation du risque d'un poids de naissance bas, de fausses couches et la stérilité permanente. Ces problèmes ne sont pas facilement identifiés comme ayant des causes relevant des risques du métier dans les pays en développement tel que le Nigéria où la stérilité a une haute conséquence familiale et sociale. Il faut des études épidémiologiques au Nigéria pour évaluer les effets des expositions aux lieux de travail sur la reproduction. Des mesures protectrices telle une bonne économie domestique, l'éducation et l'utilisation des protections personnelles dans les lieux de travail sont préconisées (*Afr J Reprod Health 2009; 13[1]:159-165*).

KEYWORDS: Fertility, Fecundity, Occupational hazards, Sperm quality, Reproductive problems

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Introduction

The reproductive system is sensitive to and can be adversely affected by hazards in the work place. Occupational exposures to various risk factors are generally higher than environmental exposure.¹ Occupational hazards include biological, physical, chemical, mechanical and psychosocial causes. Biological hazards include viruses and bacteria, for example tuberculosis, which can cause orchitis and epididymitis.^{2,3} Coal miners and workers in dust-prone occupations such as asbestos and silica industries are at an increased risk of contracting tuberculosis. Physical hazards include heat, injuries, radiation and pressure. The testes due to its location outside the body can easily be injured and its function affected by extreme temperatures. Chemical hazards constitute the greatest risk. This is in part because most workers do not know the effects on fertility and are not adequately protected. The chemicals interfere with the normal function of the endocrine system, which is responsible for growth, sexual development and many other essential physiological functions. The routes of exposure to occupational hazards are ingestion, inhalation and contact. The reproductive effects of work-place hazards include abnormal sperm morphology, reduced sperm count, delay in getting pregnant, abortions, and congenital malformations.⁴⁻⁶

Infertility is of public health importance in Nigeria. The incidence of infertility has been reported to be 15%.⁷ Another study from eastern Nigeria

reported that 65% of infertility was primary in nature with a median duration of five years.⁸ The male factor was found to be responsible for the infertility in 42% of the subjects. Oligozoospermia and asthenozoospermia were the most common aetiological factors responsible for male infertility.⁸ These multiple abnormalities of semen have been observed to be significant contributors to infertility in Nigeria.⁹ The commonly reported causes of infertility in Nigeria are mainly infectious,¹⁰ although occupational causes have not been investigated. Infertility causes marital disharmony, which often leads to divorce. Women are often blamed for the infertility and men engage in polygny in an attempt to have children.¹¹ Reproductive impairments place a burden on the family, on the society and affected individuals could easily be stigmatized. It is not uncommon for families to break up on account of inability to have children. Both the male and female reproductive systems are affected by workplace hazards although the male system has been more extensively studied. In this review, the effects of some workplace exposures on the reproductive system will be discussed. These include pesticides, solvents, radiation and heavy metals.

Occupations involving Pesticide Exposure

Workers in pesticide manufacturing or formulating industries are exposed to chemicals during handling or spraying. The chemical groups include

organophosphorus and organochlorine compounds. Such chemicals include 1, 2-dibromo-3-chloropropane (DBCP), cabaryl, carbamate, dichlorodiphenyl-trichloroethane (DDT) and 2, 4-dichloro phenoxy acetic acid. In Israel¹², and the United States of America (USA),¹³ dibromochloropropane has been shown to cause severe damage to spermatogenesis and complete atrophy of the seminiferous epithelium in exposed workers.

In India, two studies amongst cotton field workers exposed to pesticides reported an increased risk for all reproductive health indices, including male infertility and negative pregnancy outcome of their wives¹⁴ and higher rates of abortions.¹⁵ In the Netherlands, exposure to pesticides has been associated with reduced fecundity and longer time to get pregnant.¹⁶ A recent report from China showed that DDT exposure was associated with earlier age at menarche and increased risk of experiencing a shortened menstrual cycle.¹⁷

Occupations involving exposure to toxic solvents

Exposure to solvents occurs in manufacturing processes, dry-cleaning, degreasing, printing, panting and paint removal industries. Some of the chemicals include 2-bromopropane, ethylene glycol, carbon disulphide and trinitrotoluene (TNT). A study from Finland showed that parental exposure to organic solvents is associated with decreased fertility.¹⁸

Amongst Korean workers, 2-bromopropane was found to cause amenorrhoea, high gonadotrophin levels in females, spermatogenic alterations including azoospermia, oligospermia and reduced sperm motility in males.¹⁹ Glycol ethers in particular, 2-ethoxyethanol (2-EE) and 2-methoxyethanol (2-ME) are widely used in different industrial and domestic products and were generally considered safe because of their low volatility. However, a study from the USA shows that they are associated with the risk of spontaneous abortion and sub-fertility, amongst female workers but not amongst spouses of male workers with potential exposure to the agent.²⁰ Glycol ethers are now classified by the European Union Criteria as toxic to reproduction and workers are invited to avoid dermal contact through the use of adequate protective equipment.⁶ In China, exposure to TNT was found to increase the liquefying time of semen, decreased the concentrations of some elements in semen (such as copper, zinc, sodium, magnesium and selenium) and altered the motility and morphology of spermatozoa.²¹

Occupations involving high temperature

Some work processes such as baking, the ceramic industry and welding generate very high temperatures, which are inimical to the proper functioning of the reproductive system. A group of researchers from Germany reported that oligoastheno-teratozoospermic patients

had a significantly higher ($p < 0.01$) scrotal heat stress and temperature compared with normozoospermic men. The same group found an improvement of semen quality by nocturnal semen cooling.²² Amongst welders in the United Kingdom, the proportion of sperm with normal shape declined significantly after six weeks of exposure to heat and increased after a break in exposure.²³ In Italy, a higher prevalence of pathologic sperm profile has been found in exposed subjects in the ceramic industry compared with controls.²⁴

Occupations associated with radiation

Radiation is known to be toxic to the reproductive system and especially the foetus. These changes occur because radiation induces chromosomal changes, which lead to congenital abnormalities. Radiation exposure of pregnant mothers and the developing foetus can cause adverse reproductive effects.

A study in the United States of America among more than 100 prisoners, who volunteered themselves for testicle X-irradiation, showed that a dose of 0.11 Gy could cause substantial suppression of sperm counts and a dose of 3-5 Gy could lead to permanent sterility.²⁵ A study of semen quality of cleaners at the Chernobyl sites in Ukraine showed that the men had asthenooligospermia and were observed in men exposed to a dose higher than 100mSV.²⁶ However, a second study from the same area showed that exposure to relatively short-term radiation did not cause long-lasting disruption of endocrine status and

spermatogenesis.²⁷ In addition, some other researchers from Denmark report that exposure to low frequency magnetic fields is not deleterious to fertility.²⁸

Occupations involving toxic metal exposure

Workers who are exposed to heavy metals (such as lead, chromium and cadmium) are at an increased risk of reproductive dysfunction. These metals are used in the printing and battery making industry. Raised blood lead levels have been shown to decrease fecundity among male workers and levels below 40mg/dl may significantly prolong time to pregnancy in Taiwan²⁹ and found to be inversely related to semen quality in South Africa.³⁰ Recently a group of researchers from the USA reported that increased seminal plasma lead levels had adverse effects on in-vitro fertilization success rates.³¹

In Italy, among workers engaged in production of coins, whose exposure was mainly to metal fumes (cadmium, lead, nickel, chromium and manganese) and solvents, a reduction of fecundability was observed.³²

Preventive measures

Although detailed epidemiological evidence on the reproductive effects of workplace hazards in Nigeria is lacking, the effects may be underestimated and the burden of disease attributable to these factors high. The magnitude of the effects may be greater in developing countries such as Nigeria where there are very few

standards of safety and the welfare of the worker is often not of primary interest to the management of industries. It should be noted that with the largely informal nature of the Nigerian economy, many people work in cottage and small-scale industries such as dyeing and pesticide making. In these industries, workers are exposed to hazards for long hours and the exposure dose is largely unregulated as the primary gain is financial gain. Besides, dwelling quarters are often used as work places further exposing the worker's family and neighbours.

The rationale behind this review in Nigeria in particular is to sensitize many occupational health practitioners and the human resource managers of relevant industries to some of these hazards and the preventive measures. Occupational hazards involving pesticides can be prevented by wearing face masks and protective hand gloves. The same applies to exposure to solvents. Adequate ventilation of the environment is another useful step. The effects due to high temperatures can be mitigated by reduced exposure and limiting the time on the machine. For hazards due to radiation exposure, the hazards must be recognized, exposure limited and protection made available in wearing of lead aprons and lead lining the work place.

Conclusion

Occupational exposures are not easy to prove as many of the chemicals and hazards also occur in the environment. However, the reduced fecundity found in

certain occupations is much higher than what is found amongst the general population. In addition, the effects tend to be multi-dimensional and it is not easy to attribute any abnormality to be solely due to one chemical. Above all, prevention of exposure through education, information, better work pace practices such, as house cleaning are important. Protection of the worker through the provision of personal protectives will also go a long way in reducing the exposure of the workers and preserve their reproductive ability. Studies have shown that workers who are well protected do not suffer adverse reproductive effects and when exposure is low, there is no prolongation in the time to pregnancy.^{33,34}

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