

Reproductive Epidemiology of Aluminium Foundry Workers

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ABSTRACT 160 non-smoking male workers engaged in the production of aluminium alloys were studied for their reproductive performance. The reproductive parameters studied included number of pregnancies, stillbirths, abortions in their wives and number of neonatal deaths, premature births, congenital abnormalities in their offspring. For comparison, 150 controls belonging to the same age group and socio-economic status and with no occupational exposure to any known physical or chemical agent were also studied. A significant increase in the percentage of abortions, congenital defects and a significant decrease in the percentage of livebirths were observed in the exposed group when compared with the control group. This could be due to occupational exposure to fumes of aluminium at the workplace.

INTRODUCTION

Chronic exposure to chemicals at workplace might result in the induction of mutations in the somatic cells and germ cells as well. Paternal occupational exposure can be used to evaluate possible heritable mutations. Epidemiological studies attempt to discover associations between specific exposure and biological outcomes (Narod et al. 1988). Several studies have evaluated the reproductive outcome of paternal exposure to different chemicals in a wide range of occupational setups. Dimich-Ward et al. (1996) studied the effects of paternal exposure to wood preservatives in a sawmill and reported an increased risk for anencephaly, spinabifida and congenital anomalies of genital organs. A study on lead workers and professional bus drivers reported decreased number of births indicating reduced fertility in the exposed compared with the controls (Lin et al. 1996). Hema Prasad et al. (1995) reported a significant increase in abortions in the wives of pharmaceutical industry workers exposed to sulfonamide drugs.

Aluminium finds its wide application in electrical industry, motor vehicle engineering, air-

craft and building construction, household appliances etc. Aluminium alloyed with other metals is mainly used in construction, machinery and electric conductors etc. Extensive studies were carried out on health (Radon et al. 1995; San et al. 1998), biochemical effects (Selden et al. 1999), cytogenetic effects (Sorsa et al. 1982; Haugen et al. 1983) and cancer morbidity (Romundstad et al. 2000; Tremblay et al. 1995) in workers employed in aluminium industries. However, studies on the reproductive performance of aluminium workers are scarce. Hence an attempt was made to study the reproductive epidemiology of workers engaged in the production of aluminium alloys.

MATERIALS AND METHODS

160 non-smoking male employees engaged in the production of aluminium alloys formed the subjects of the present study. They were involved in melting aluminium ingots and alloying with magnesium and silicon followed by casting, rolling and coiling of aluminium wire, rods and conductors used for power transmissions. During the process the workers were exposed to high temperatures, fumes of aluminium, other metals, burnt gases etc. The age range of the workers was 20-50 years and duration of their employment in the factory ranged from 1 to 14 years. For comparison, a control group of 150 non-smoking male workers belonging to the same age group and socio-economic status with no occupational exposure to any known physical or chemical agent were also studied. All the men in the exposed and control groups were non-alcoholics.

A standard questionnaire was used to record information on age, sex, duration of employment, health, medication, type of marriage (whether affinal or consanguineous), reproductive history

etc. The reproductive parameters included number of pregnancies, livebirths, stillbirths, abortions in their wives and number of congenital defects, premature births, neonatal deaths in their offspring. The data obtained was analysed statistically using chi square test.

RESULTS

The details on the incidence of livebirths, abortions, stillbirths among the wives and the frequency of premature births, neonatal deaths and congenital defects in the offspring of both exposed and control groups are presented in the table 1. The percentage of fertile males decreased from 99.33 in the control group to 99.13 in the exposed group. This decrease in fertility was statistically insignificant ($P > 0.05$). There was a significant increase in the percentage of abortions and decrease in the percentage of livebirths in the wives and congenital defects in the offspring of the exposed as compared to the controls ($P < 0.05$). Although there was an increase in the percentage of stillbirths and neonatal deaths in the offspring of the exposed, this increase was not statistically significant when compared with controls. There were no premature births in both exposed and control groups.

DISCUSSION

The present study showed decrease in the percentage of livebirths, increase in percentage of abortions in the wives of workers indicating impaired reproductive performance of the workers occupationally exposed to aluminium fumes, high temperatures and burnt gases like SO_2 , CO_2

and CO at workplace. Although our study indicated reduction in the fertility of the workers. Mur et al. (1998) indicated no reduction in the fertility of aluminium industry workers.

Several studies on aluminium industries presented evidence for exposure to polycyclic aromatic hydrocarbons, fluoride etc., at the workplace. High exposure levels of polycyclic aromatic hydrocarbons (PAH) was reported in the potroom aluminium reduction plants (Romundstad et al. 2000). Airborne exposure to fluorides (Seixas et al. 2000) and aluminium (Rollin et al. 1996) were reported in aluminium smelters. While Tremblay et al. (1995) indicted exposure to coaltar pitch volatiles like BSM (Benzene - soluble matter) and BaP (benzo (a) pyrene), Sorsa et al. (1982) indicated exposure to SO_2 in aluminium industry. So, it is evident from the above studies that the workers in aluminium industries have chronic exposure to aluminium. PAHs, fluorides, coaltar pitch volatiles, SO_2 etc. In support of these findings some studies have reported concentrations of aluminium, PAHs, fluorides in urine and serum of aluminium workers (Valkonen et al. 1997; San et al. 1998; Selden et al. 1999; Radon et al. 1999; Seixas et al. 2000). Earlier studies have also presented evidence on the mutagenicity of aluminium air particulates sampled from aluminium plants in Salmonella TA100 and TA98 strains (Meilzynska et al. 1995).

The health hazards like impairment of pulmonary function, bronchitis, bronchial asthma etc., reported in aluminium workers reflect the toxic effects of occupational exposure to aluminium and other chemicals at the workplace (Radon et al. 1999; San et al. 1998; Lund et al. 2000). The increased risk for bladder and pancreatic cancers was also reported in aluminium plant workers (Carter et al. 1992; Romundstad et al. 2000).

Any time inside the industry of the present study the temperature would not be less than 50°C - 60°C . Studies on male individuals with occupational exposure to extreme low and high temperatures revealed an increased risk for testicular cancer (Zhang et al. 1995). Smuelvich et al. (1990) reported elevated incidence of different cancers in children of parents with exposure to high temperature and other occupational factors

Table 1: Reproductive histories of aluminium foundry workers

Particulars	Control group	Exposed group (1-14 years)
Number of Males	150 160	
Numbrr of Fertile males	149 (99.33)	157 (98.13)
Number of Pregnancies	660 485	
Number of Livebirths	620 (93.94)	433 (89.28)*
Number of Abortions	25 (3.79)	32 (6.60)*
Number of Stillbirths	5 (0.76)	6 (1.24)
Number of Neonatal deaths	8 (1.21)	9 (1.86)
Number of Congenital defects	2 (0.03)	5 (1.03)*

Values given in the parentheses are percentages

* $P < 0.05$

prior to conception. Besides high temperatures, the workers of the present study are also exposed to burnt gases like carbon monoxide. A study on workers exposed to high temperature and carbon monoxide revealed high incidence of antibodies to Hsp 27, Hsp 60, Hsp 71, abnormal ECG B echogram changes, significant increase in the activity of alanine transferase and higher extent of DNA damage in the lymphocytes of the workers compared to the controls (Wu et al. 1996). Earlier, the mutagenicity of aluminium was reported in *in vitro* and *in vivo* system in animal models (Roy et al. 1990; Roy et al. 1991; Oitive et al. 1991; Parada and Jaszczak, 1993) So chronic exposure to aluminium fume, high temperature and burnt gases at workplace may prove hazardous in the long term.

The present study revealed impaired reproductive performance in workers employed in aluminium alloy production. This might have resulted due to exposure to aluminium fumes in the industry. Thus it is obligatory on the part of the management to take appropriate steps to minimise exposure to aluminium and burnt gases at the workplace. Otherwise undue exposure might result in health and genetic effects in the workers.

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