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Occupationally related lead exposure in the general population

A population study of 40-year-old men

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GRANDJEAN P, HOLLNAGEL H, OLSEN NB. Occupationally related lead exposure in the general population: A population study of 40-year-old men. *Scand j work environ health* 7 (1981) 298—301. Eighty-eight percent of all 40-year-old male residents of four suburban municipalities of Copenhagen County were examined for the lead concentration in their blood and interviewed regarding job category and place of work. Of the 504 men, 482 were currently employed, 18 were unemployed, and 4 were pensioners. The total median blood lead level was 13 μg/100 ml (0.6 μmol/l). Men employed in construction, industrial production, and transportation had the highest lead levels, while very low concentrations were found among pensioners and farmers. Blue-collar workers had higher blood lead results than white-collar workers. Very high levels were found in two men employed at a secondary lead smelter, but otherwise increases in lead concentrations were comparatively small. However, the occupationally related, increased blood lead levels identified in this population contributed significantly to normal "background" levels.

Key terms: blood lead concentration, occupational exposure, epidemiology.

Among the nonferrous metals, lead is probably the one with the widest range of applications (7). Thus lead and lead compounds are used in several branches of industry, and the US Public Health Service (4) has listed 113 occupations with potential lead exposure. Although lead poisoning usually occurs in few branches of industry, eg, secondary lead smelters, shipbreaking enterprises, and battery factories, occasional cases are reported from several other industries (5, 13). Screening studies have suggested that perhaps 1 % of the working population is exposed to significant amounts of lead (5, 13). In addition many workers may have indirect occupational exposure to lead. Thus, under certain conditions, "bystanders" are subject to increased lead exposure (3, 6). Occupationally related lead exposure may, therefore, be a relevant factor in the total lead load of the population.

In a cross-sectional study, we have examined a subsample of 40-year-old individuals residing in the western suburbs of Copenhagen. Median blood lead concentrations were found to be 13 μg/100 ml (0.6 μmol/l) for 504 men and 9 μg/100 ml (0.4 μmol/l) for 548 women, and part of this difference seemed to be related to the occupational exposures of the males (12).

Population

All male residents of the Glostrup, Herlev, Ledøje-Smørum and Brøndbyerne (except Brøndby Strand) municipalities born in 1936 were invited to a free health examination at the Copenhagen County Hospital in Glostrup. Eighty-eight percent of the men accepted the invitation, and a total of 504 individuals were examined during 1976—1977. Four hundred and eighty-two men were actively employed at the time of examination. With regard to demo-

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graphic characteristics, the group studied appears quite similar to Danes as a whole within a comparable age span, except that farming and fishing were poorly represented in the population studied.

Data collection

The methodology used in the present study has been described in detail by Hollnagel (9). Blood was collected by venipuncture in the morning after fasting and abstinence from smoking. The analytical technique and the quality control program has been described by Olsen et al (12). All results are averages of duplicate analyses on different days. (The average coefficient of variation was 8 %.) Blood lead concentrations are given in micrograms of lead per 100 ml of blood, and results in this unit may be converted to micromoles of lead per liter of blood by dividing by 20.7. Experienced interviewers classified both job and place of work according to the classifications used in the Danish Population Census, 1970 (2). Nonparametric statistical tests have been used. For multivariate analysis, however, we examined sufficient marginals of multiple contingency tables according to the log linear model (1). Two-tailed p-values were calculated.

Results

At the time of the examination, 18 men were unemployed, and 4 were on pension. Their median blood lead level [13 μg/100 ml (0.6 μmol/l)] was the same as the median for the 482 men currently employed, but the pensioners tended to have lower blood lead concentrations [median, 8 μg/100 ml (0.4 μmol/l)] than the other men examined. The employment of the 482 actively employed 40-year-old men was rather stable — 95 % had been in their present job for eight months or more, and only 1 % had been in their present job for two months or less.

Most blood lead levels were rather low. Only two men, both employed at a secondary lead smelter, showed results between 40 and 60 μg/100 ml (1.9 & 2.9 μmol/l, respectively). A comparison of major groups of places of work showed a significant tendency of higher blood lead levels in construction, industrial production, and transportation (table 1). A similar comparison for the 40-year-old women showed no significant tendencies. The classification used is rather crude and reveals little information on lead exposures. According to the results of a screening study of several thousand workers at more than 200 Danish facilities, the places of work were separated into two groups, with and without potential lead exposure, respectively. Major findings of the screening project have already been published (5). In table 2 the blood lead levels for these two groups are compared for both white- and blue-collar workers. In general the white-collar workers had relatively low lead levels. Thirty-five men (7 %), mostly blue-collar workers, were employed at facilities with potential lead exposure.

The relationship between job categories and blood lead levels is explored in table 3. Unskilled construction workers appear to have the highest exposures, while most

Table 1. Distribution of blood lead levels (μg/100ml) of 482 40-year-old men according to place of work.[a] (1 μg/100 ml = 0.05 μmol/l).

Place of work	Number of men	Median	10th—90th percentiles
Construction	53	14	9—21
Industrial production	143	13	9—20
Transportation	55	13	9—21
Service agencies, etc	133	12	8—19
Commerce	92	12	9—20
Farming	6	7	5—14

[a] Kruskal-Wallis test: $p < 0.001$.

other jobs seem to entail lead exposures at a lower level. From the experience of the screening study (5), the job classes were grouped according to expected risk of occupational lead exposure (table 4). Fifty-six male blue-collar workers (12 %) held jobs with potential lead exposure, while none of the 548 women examined held any of these jobs.

Within the branches of industry with possible lead exposure, an increase of blood lead levels was independent of job classification. At places of work without generalized lead exposure, however, jobs with possible risk of lead exposure were associated with increased blood levels when compared to other jobs. Thus both place of work and job category are important indicators of possible occupational lead exposure.

The blood lead levels in this population were significantly related to other parameters such as alcohol consumption, month of examination, and smoking habits (12). However, extensive multivariate analyses revealed that only alleged alcohol consumption was a potential confounding factor. Thus, in jobs with possible occu-

Table 2. Distribution of blood lead levels (μg/100ml) of 482 40-year-old men according to potential lead exposure at work.[a] (1 μg/100 ml = 0.05 μmol/l)

Exposure	Number of men	Median	10th—90th percentiles
Improbable: self-employed, managers, and professionals	287	12	8—20
Improbable: skilled and unskilled workers	160	13	8—20
Possible: self-employed, managers, and professionals	9	14	10—22
Possible: skilled and unskilled workers	26	15	9—36

[a] Kruskal-Wallis test: $p < 0.05$.

Table 3. Distribution of blood lead levels (μg/100 ml) of 482 40-year-old men according to job categories.[a] (1 μg/100 ml = 0.05 μmol/l)

Job category	Number of men	Median	10th—90th percentiles
Self-employed and managers	45	14	9—12
Technical professionals	83	13	8—21
Other professionals and service personnel	168	12	8—19
Skilled workers: glass, metals	49	13	9—20
Skilled workers: construction	25	14	10—24
Skilled workers: other trades	31	12	8—19
Unskilled workers: construction	6	16	7—20
Unskilled workers: transportation	32	13	9—20
Unskilled workers: other trades	43	13	8—19

[a] Kruskal-Wallis test: $p < 0.05$.

Table 4. Distribution of blood lead levels (μg/100 ml) of 482 40-year-old men according to potential job-related lead exposure.[a] (1μg/100 ml = 0.05 μmol/l)

Job category	Number of men	Median	10th—90th percentiles
Self-employed, professionals, and service personnel	296	12	8—20
Skilled and unskilled workers, improbable exposure	130	13	8—20
Skilled and unskilled workers, possible exposure	56	14	9—21

[a] Kruskal-Wallis test: $p = 0.08$.

pational lead exposure, increased blood lead levels were also related to slightly decreased intakes of alcoholic beverages. This reverse relationship was in contrast to the findings for the total population (12). However, the confounding was limited and did not significantly change the tendencies shown in tables 3 and 4.

Discussion

Occupationally related lead exposures have previously been identified in population studies. Thus increased blood lead levels in garage mechanics and policemen were recorded in the Three-City Study (14). Similar results were recorded by Hofreuter et al (8). In a remote area in Finland, Nordman (11) found lower blood lead levels in retirees and farmers than in other males. Although heavy lead exposure seems to occur in only a limited number of occupations, job-related exposures may add a small but significant part to the lead burden of a much larger part of the male population. Of particular interest is the finding of significantly lower median blood lead levels [7—8 μg/100 ml (0.3—0.4 μmol/l)] in the few farmers and pensioners examined than in other 40-year-old men [13 μg/100 ml (0.6 μmol/l)]. In epidemiologic studies of environmental lead exposure, occupational parameters may therefore be important. A recent publication from the US National Academy of Sciences (10) concludes that "a serious effort should be made to reduce the baseline level of exposure to lead for the general population of the United States." This recommendation, which may be applicable in many other countries, may include the occupationally related exposures as described in this paper. Such exposures constitute a preventable part of "baseline" exposures of a significant fraction of the male population.

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