Lead Absorption in Children Residing Near a New South Wales Lead Smelting Complex (Australia)

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Excessive lead absorption in children due to the ingestion of lead-containing materials, such as paint flakes, has been widely reported in the literature (Freeman, 1969). Excessive absorption due to lead in ambient air, and residence in areas close to emission sources of lead, is less well documented, and still a matter of contention.

This survey reports on the lead absorption of children residing close to a large lead-smelting complex, (Sulphide Corporation Pty. Ltd.,) known to be an emission source of airborne lead. It is located at Cockle Creek, near Newcastle, New South Wales (Australia) and the townships of Argenton and Boolaroo are within one mile of its radius.

The route of such absorption might be by inhalation of airborne lead, or by ingestion of contaminated food. Children and infants might be especially at risk, due to their predilection for absorbing environmental lead.

Method

Two hundred and four children and infants were included in the survey. They were drawn from both Argenton and Boolaroo, in response to an appeal to parents to submit their children for testing. The blood lead and haemoglobin levels for each child were estimated.

50 microlitre quantities of whole blood, standards and secondary controls were sampled by means of an Oxford Sampler, and placed in a Spinko micro-centrifuge tube. Red cells lysis and chelation was performed using Saponin-Ammonium Pyrrolidine Dithiocarbamate reagent.

After mixing on a vortex mixer the chelated lead was extracted into Methyl Isobutyl Ketone and the M.I.B.K. extract tested in a Varian Model 61 Carbon Rod Atomizer.

The unknowns were read against the standard calibration curve.

By questionnaire, information from parents was sought to determine whether the child indulged in "pica", or was the child of a lead-smelter worker, and the geographical location of each child's residence.

Levels of lead in ambient air of the residential areas were measured by the Air Pollution Control Branch of the Division of Occupational Health and Radiation Control.

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Results

Histogram 1

Shows the distribution of the blood lead levels in the 204 children. As can be seen from the histogram, the blood lead levels show a normal distribution curve, with a mean value of 15 microgrammes of lead per 100 ml. of blood, and a standard deviation of 5.9 /ug/100 ml.

The majority of school children were in the ages ranging from seven to twelve years old. Twenty-one were infants under three years old. The youngest was a baby aged ten months; the eldest child in the survey was fourteen years old. There was no significant correlation between blood lead levels and age (Correlation coefficient = 0.19).

Haemoglobin estimations on the children were also carried out. No child had a haemoglobin level below 10g. per 100 ml. and none of the children were considered to be anaemic.

Air Pollution Data

Measurement of ambient lead in air, in the vicinity of the Lead Smelting Complex at Cockle Creek commenced on the 27 June 1972. Initial measurements (up to 21 July 1972) from 30 sample sites ranging from 275 to 2,000 metres from the works gave an average value of 9.6 microgrammes of lead per cubic metre of air (/ug/M^3) with a range from 0.15 to 31.6 /ug/M^3 on 24 hour samples. Additional lead emission control was instituted at the works in 1972, and from the beginning of August 1972, four fixed monitoring stations were used, and sampling was carried out on a rotational basis in accordance with E.P.A. Standard procedure (E.P.A. Federal Register August 14 1971 Volume 36 No. 158, Part 11). For the period July 1972 to April 1973 the mean level of lead in air was 2.2 /ug/M^3.

From April 1973 two monitoring stations were used on a rotational basis. One was 275m. from the plant, and the second was 800m. which is the point of theoretical expected maximum ground level concentration. The mean level of lead in air from April 1973 to December 1973 was 2.78 /ug/M^3.

Discussion

The Air Pollution data from this area indicate that ambient lead in air levels were generally above 2 /ug/M^3, a level which has been suggested as a possible air quality standard in the U.S.A. However, this suggested standard has not been adopted and the methods by which it was arrived at have been the subject of much criticism. No evidence of any health hazard at this level has been produced, and it is pertinent to record that the current upper level of lead in air allowed in the industrial situation is 200 /ug/M^3.

Thus examination of population groups for the classical signs of lead intoxication will be unproductive, and the only practical method of assessing the effects of ambient lead in air on communities is the measurement of blood lead levels.

The internationally accepted limits for blood lead levels in biologically normal populations were set out by Zeilhuis in 1972 following the Amsterdam Conference on Environmental Lead. For children these criteria were that at least 50% of any group should have a blood lead of 20 ug/100ml. or less, no more than 2% should have a blood lead level over 35 ug/100ml. and no child should have a blood lead level over 40 ug/100ml.

Using this Amsterdam permissible percentile distribution, the group of children in this survey had normal blood lead levels. In percentage terms 83% had blood lead levels of 20 ug/100ml. or less, 2% had levels of 35 ug/100ml. and no child exceeded 40 ug/100ml.

The generally agreed definition in New South Wales of the lower limit of haemoglobin below which anaemia is considered to be present ranges from 10 gm/100ml. at birth rising to 11.0 gm/100ml. at the age of 14 years. None of the children in this survey were considered anaemic.

A lead survey in Bristol, U.K., showed that there was an increased risk of lead absorption among lead smelters children because of lead dust brought into the home by their fathers.

Seven children in our survey whose parents worked at the Sulphide Corporation Pty.Limited had a mean blood lead level of 13.0 ugm/100ml. (S.D.= 4.3). This group can be compared with 147 children whose parents did not work at the lead smelter and had a mean blood lead level of 14.9 ugm/100ml. (S.D. = 5.4) Student "t" test shows however that there is no significant difference in the mean blood lead levels between these two groups ($P > 0.05$). This finding is not surprising, as lead workers in the Sulphide Corporation don clean work clothes before they start their shift, and change back into street clothes at the end of their shift. There is thus no reason to suspect that these workers bring lead dust into their home environment.

Children exhibiting the pica habit are also more at risk from lead poisoning than children without this habit.

"Pica" is defined as eating unnatural foods, including dirt, plaster and paint flakes. In the first year of life, it takes the form of mouthing, but not ingestion, of any object the infant can grasp. Later on, the child begins to eat non-food substances, but the habit usually disappears when the child is between 3 and 5 years of age. Emotionally disturbed children tend to acquire this habit (Chisolm, 1970). In this survey, pica was considered present in children of any age when the answer to the following question on the questionnaire form was in the affirmative.

Has your child ever had the habit of chewing or eating any non-food items such as toys, old paint, soil etc".

Eighteen children with a history of "pica" had a mean blood level of 18.2 ugm/100ml. (S.D.= 5.8). This group can be compared with 125 children with no history of "pica" and had a mean blood lead level of 14.2 ugm/100ml. S.D. + 4.9). Student "t" test shows that there is no significant difference in the two groups ($P > 0.05$).

As far as this survey is concerned, children with a history of "pica" did not show an increase in lead absorption. Children, of course, often place non-food items in their mouths, and some mothers may have given negative answers to the "pica" question for fear of being told that they had not trained their children correctly.

Comparison of possible differences in lead absorption by children living in the townships of Argenton and Boolaroo was also carried out. Argenton is north of Sulphide Corporation and Boolaroo is southwest of the industry, and both areas are approximately the same distance from the Sulphide Corporation. The Standard Wind Analysis in the area (combined summary 0900 and 1500 hr. reading, 1967-1971), showed that the prevailing wind drift from the Sulphide works was towards Argenton. Figures available for 1972 and 1973 show the same trend. Assuming other factors remain equal, and that lead pollution from the Sulphide works is an important factor in lead absorption among children, then we would expect a greater degree of absorption in children living in Argenton than in Boolaroo.

Ninety three children living in Argenton who had a mean blood lead level of 15.5 ugm/100ml. (S.D. = 5.8) were compared with a group of 77 children living in Boolaroo who had a mean blood lead level of 14.9 ugm/100ml. (S.D. = 5.8). Student "t" test shows there is no significant difference in the two groups.

In summary, judged by the internationally accepted criteria (Zeilhuis, 1972) none of the children surveyed showed an abnormally high blood lead level, or low Hb. level, and none of the potentially high exposure groups had elevated blood lead levels.

The children surveyed were not a random sample, but they did comprise about 50% of all school-age children in the area, and we have no reason to think that they were unrepresentative of all children in the area.

Comparison with other studies of blood lead levels must be made with caution.

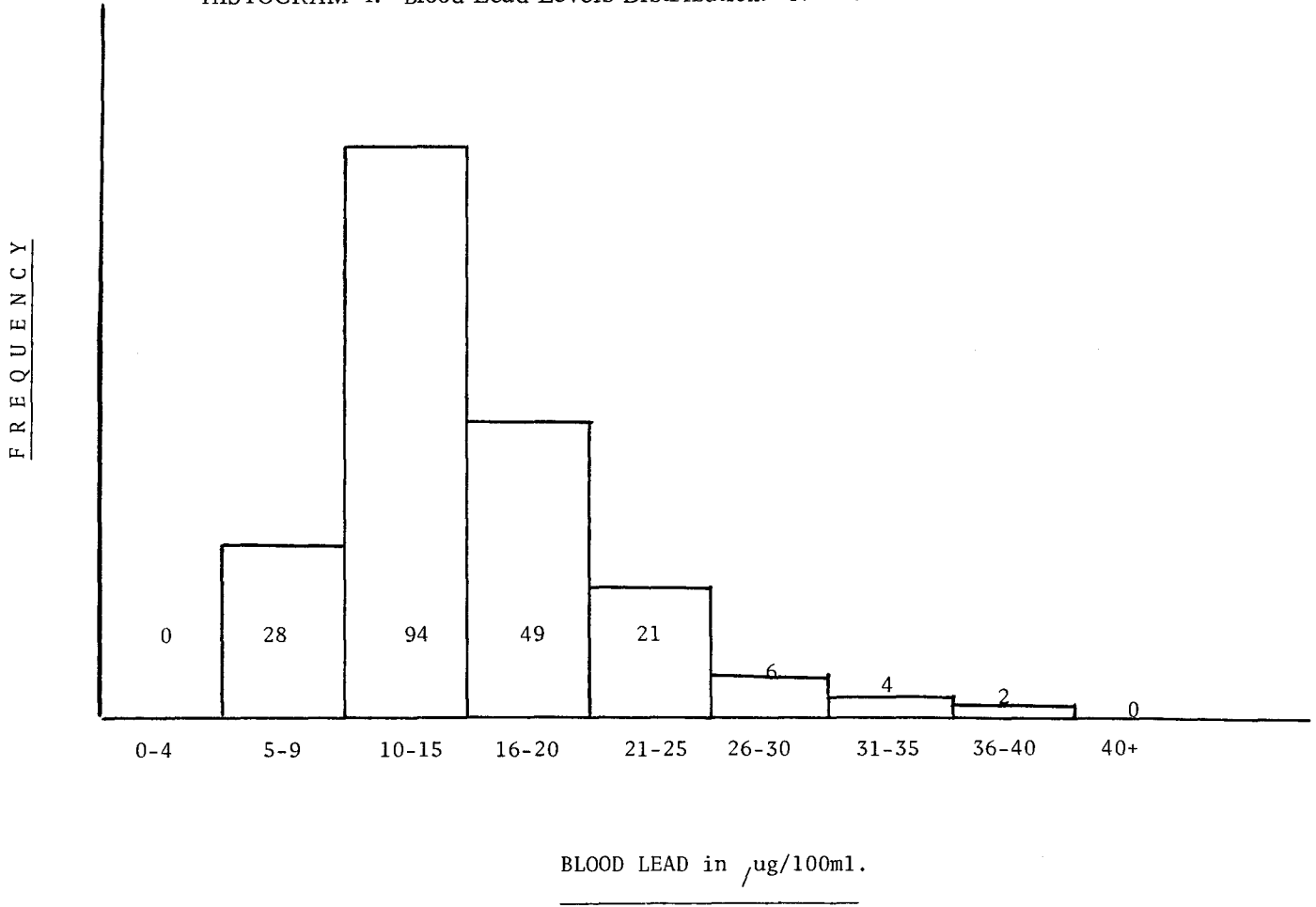
Differences in socio-economic status, age, and perhaps most importantly, in laboratory analysis can all hinder a true comparison between sample groups. However, similar blood lead levels have also been measured by one of us (J.A.B) in a group of 90 children selected at random from a school in Port Kembla, N.S.W. Thus, it would seem that the children from Cockle Creek represented a biologically normal Australian group, as far as blood lead levels are concerned.

Conclusions

This survey in Cockle Creek did not indicate any excessive absorption of lead among the children examined, despite their proximity to a lead smelting complex.

We wish to acknowledge the permission of the Commissioner for Environmental and Special Health Services of the Health Commission of New South Wales to publish this article.

HISTOGRAM 1. Blood Lead Levels Distribution. N = 204



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