Blood lead levels in a remote, unpolluted rural area in South Africa

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Summary

The whole-blood lead levels of 14–16-year-olds in a remote, unpolluted rural area (Wupperthal, northwestern Cape Province) were determined. Graphite-furnace atomic absorption spectrometry was used to analyse lead levels. The mean whole-blood lead level was found to be 3.4 µg/dl. This value should also be considered to be representative of the natural 'background' whole-blood lead level of South Africans.

Methods

Unless otherwise stated, the specifications for the reagents, water, glassware, apparatus and procedure used were as reported previously by Subramanian and Meranger.14 Blood samples were obtained from children of 14–16 years of age by the finger-prick technique.11 Before sampling the skin was cleaned twice with cotton wool wetted in isopropyl alcohol (both lead-free).

Exactly 100 µl of blood was transferred (using a 100 µl Eppendorf pipette) to a heparinized tube and vigorously agitated. The heparinized blood samples were stored at 4°C until analysed. The ammonium phosphate-triton-X-100 matrix modifier was added to the heparinized blood and the lead analysis was carried out using a graphite-furnace atomic absorption spectrophotometer.14

We used a Pye-Unicam Model SP 9 atomic absorption spectrophotometer equipped with a strip-chart recorder, a Model SP 9 video graphite furnace, an autosampler, a Model SP 9 computer and a deuterium-arc background corrector. The apparatus settings were as reported previously14 except that the integration time was 2.5 seconds and the atomization time 3 seconds. After each analysis the graphite tube was cleaned by heating at 2800°C for 5 seconds. Since the element cadmium was not determined in this study, it was also omitted during the preparation stage of the lead standards, as described by Subramanian and Meranger.14 The lead concentrations are expressed as µg/l whole blood.

Results

Table I gives the mean, median, standard deviation and range for the whole-blood lead levels in 30 children.

| TABLE I. WHOLE-BLOOD LEAD LEVELS (µg/dl) IN 30 CHILDREN FROM AN UNPOLLUTED RURAL AREA |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| Median                         | 3.3             | Mean            | 3.4             | Standard deviation |
|                                |                  |                 | 1.5             | Maximum          |
|                                |                  |                 |                 | 7.5             |
|                                |                  |                 |                 | Minimum          |
|                                |                  |                 |                 | 0.5             |

Discussion

Various techniques for the determination of lead in blood have been reported previously. With almost all these methods it is
difficult to ascertain the precise charring temperature and to minimize the disturbance of the atomic sign. However, the electrothermal atomic absorption spectrophotometrical method of Subramanian and Meranger\textsuperscript{14} makes it possible to carry out accurate blood lead determinations. Furthermore, the exact procedure is fully described by them and can be followed without difficulty.

The remote area chosen for this study is far removed from traffic and any industry. Furthermore, this area is situated in a valley in the north-western Cape, between high mountains. Atmospheric lead pollution from the cities is not likely to reach the area. Lead pollution from vehicle exhaust gases is absolutely minimal because the use of vehicles in this area is a rarity. The people in this region are farmers who rely on their farming produce for their daily needs. The soil of their plots is cultivated manually. After extensive investigation of their possible use of lead pottery, plumbing and paint, we were completely satisfied that these sources of lead pollution were not relevant. Thus, the only possible lead source to which they are exposed is that which occurs in soil and water. It should be noted that the lead in the soil, if present, is firmly bound and therefore only a minimal amount can be incorporated by plants.\textsuperscript{2} The blood lead level determined compares very favourably with levels in remote rural societies elsewhere.\textsuperscript{15,16}

An average blood lead level of 3.4 µg/dl was reported in 103 Nepalese children and adults from the foothills of the Himalayas,\textsuperscript{11} and one of 5 µg/dl in 100 children from an unpolluted area in Papua New Guinea.\textsuperscript{12} According to Grandjean,\textsuperscript{12} the above investigations were performed carefully in order to avoid lead contamination that had marred many lead analyses in the past. Our results are also supported by findings in Venezuelan Indians (1 µg/dl).\textsuperscript{15}

The range of blood lead levels in the remote rural group was small, viz. from 0.5 to 7.5 µg/dl (Table I). This is to be expected because the subjects are exposed to a very similar lead intake. The mean blood lead level of 3.4 µg/dl should be considered to be the baseline lead level in South Africans, since this value varies with the degree of industrialization.

Since inhaled lead is easily absorbed into the bloodstream\textsuperscript{2} whence it is continuously laid down in the different zones of the teeth, a correlation between tooth lead and blood lead levels can be expected. The lead values in the different tooth zones of a sample from a rural area in South Africa were also determined.\textsuperscript{13} The ratios between the lead concentrations in enamel, dentine and whole tooth in a rural area to that in the whole blood in this remote rural area are 1.09, 1.51 and 1.44 respectively. Whether this ratio between tooth and blood lead levels will be a fixed one is a question still to be answered. However, if such a direct relationship does exist, it will be detected more easily in remote areas, because lead pollution is minimal in these regions. Unfortunately this statement could not be tested because of the absence of published data.

Since there is no definite blood lead threshold value at which toxic effects can occur, each country should be aware of its own natural baseline mean blood level. Today it is believed that lead pollution is associated with industrialization.\textsuperscript{3} Thus, any attempt to control lead pollution should aim to minimize the differences between the blood lead levels found in remote rural and urban populations in the country concerned.

**Conclusion**

It is clear that the mean whole-blood lead level of people in a remote rural area in South Africa is low and that it is comparable to those found in similar populations elsewhere.\textsuperscript{11,12} Measures against lead pollution should aim to restore the mean blood lead levels of the urbanized population to that found in their rural counterparts.

**REFERENCES**