Blood lead levels in motor mechanics

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Summary

The whole-blood lead levels of a group of motor mechanics in the Cape Peninsula were determined. Blood was analysed using a graphite furnace atomic absorption spectrometer. The mean whole-blood lead levels of the motor mechanics and of urban controls were 28,4 μg/dl and 9,7 μg/dl respectively, and comparison of these with that of a group from an unpolluted rural area (3,4 μg/dl) revealed highly significant differences.

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It is generally accepted that in most countries vehicles burning leaded petrol are the major contributors to environmental lead pollution.[1,2] Tetra-ethyl lead additives in petrol act as antiknock agents. The lead content of petrol varies — an upper limit of 0,15 gdm^{-3} has been set by West Germany, while in the UK a more lenient limit of 0,40 gdm^{-3} is applied.[2] Although no lead additives are included in diesel, paraffin or fuel oils, raised blood lead levels have been found to be maximal among diesel-engine workers because these mechanics are exposed to high-pressure-resistant lubricants containing lead naphthenate.[3] High lead concentrations were also found in gear oil (9 290 ppm) and used motor oils (1 500 - 3 500 ppm).[3]

Exhaust fumes consist of various lead-containing compounds,[4-6] inhalation of which results in elevated blood lead levels.[2] The rate of inhaled lead absorption into the blood stream is more rapid when the particle size of the lead compounds is small.[2] Chamberlain *et al.*[7] reported a very small diameter (~ 0,015 μm) for the primary exhaust lead particulates, which are then subject to growth in the ambient air.

Lead levels in vehicle exhaust fumes vary between 2 000 and 10 000 $\mu g/m^3$.[4] Hirschler *et al.*[4] demonstrated a strong correlation between the quantity of lead emitted in exhaust gases and the driving mode — higher concentrations can be reached during fast accelerations because of the resuspension of lead deposited in the vehicle exhaust system.

In an extensive study by Annest *et al.*[8] it was shown that the reduction in the lead content of petrol in the USA has resulted in a 37% decrease in blood lead levels to a mean value of 9,2 μg/dl. In a recent study of a sample from a population in an unpolluted rural area in the north-western Cape (Wupperthal)[9,10] an average blood lead concentration of 3,4 μg/dl was measured, while an urban control group had a mean level of 9,7 μg/dl.[11] The mean blood lead levels of different population groups generally range between 10 and 30 μg/dl in adults,[12] and are usually marginally higher in children.

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There is considerable debate regarding effects upon the health of children exposed to relatively low levels of environmental lead pollution. However, investigators believe that mental impairment and behavioural disorders are recognizable in children exposed to low levels of lead pollution.[13-16] Recognizable symptoms of lead poisoning have been reported at blood lead levels of 70-80 μg/dl.[4] It is generally accepted that lead pollution can produce a variety of effects on the human body[17-21] because of its widespread deposition in tissues such as the central nervous system, bones, teeth, skin and mucosa.[17] Among others, lead poisoning has been found responsible for mental retardation,[15] cerebral palsy,[20] recurrent seizures[20] and hyperactivity.[13,22] For these reasons, it was decided to determine the whole-blood lead levels of a group of motor mechanics in the Cape Peninsula.

Subjects and methods

Details of the experimental procedure are as for the accompanying article (p. 323).[9] Briefly they are as follows. Collected whole-blood samples were heparinized in test tubes and ammonium phosphate-triton-X-100 matrix modifier was added. The blood samples were analysed for lead content by means of a graphite-furnace atomic absorption spectrometer.

We determined the whole-blood lead levels of 31 mechanics from 10 randomly selected motor workshops in the Cape Peninsula. None of the mechanics had been on holiday within 4 months before blood collection. Their ages varied between 28 and 56 years and they had been employed as qualified motor mechanics for periods ranging from 4 to 28 years. They normally worked for 8 hours a day and their working environments varied from crude to modern workshops.

A control group was randomly selected and comprised 25 urban adults who in their daily routine were not exposed to atmospheric lead pollution. Neither their occupations nor their usual activities suggested that they were in contact with known sources of lead pollution.

Results

Table I gives the mean, median and standard deviation of whole-blood lead levels of motor mechanics and of urban controls. These results were compared statistically with those found in a population sample from a remote, unpolluted rural area[9,10] in South Africa (mean 3,4 μg/dl). The *t*-tests performed on the three data sets (motor mechanics, urban controls and remote rural sample) indicated highly significant differences ($P < 0,01$).

TABLE I. WHOLE-BLOOD LEAD LEVELS (μg/dl) OF MOTOR MECHANICS AND URBAN CONTROLS

	Motor mechanics ($N = 31$)	Controls ($N = 25$)
Mean	**28,4**	**9,7**
SD	**11,3**	**4,1**
Median	**26,0**	**10,0**

Discussion

As far as could be ascertained, this is the first controlled study of the whole-blood lead levels of a sample of South African motor mechanics. The subjects studied showed blood lead concentrations significantly higher than the mean values of both the urban controls (Table I) and the rural group.[9,10] The highest and lowest lead levels of the motor mechanics were 56,0 and 14,0 μg/dl respectively, while those of the urban controls were 16,0 and 3,0 μg/dl respectively. Thirty-two per cent of the motor mechanics were found to have blood lead levels above the upper limit of 30 μg/dl which has been reported for different population groups throughout the world.[12] On the other hand, none of the subjects tested revealed a blood lead level above 70 μg/dl, which is regarded as a level at which symptoms of lead poisoning would become apparent.[2]

The mean lead level found in this study (Table I) is lower than that reported elsewhere in the world. Clausen and Rastogi[3] in Denmark determined a mean lead value of 44,6 μg/dl, while Hammond[23] in the USA found a mean lead level of 38 μg/dl. The difference could possibly be accounted for by the fact that our sample did not include diesel mechanics. Clausen and Rastogi[3] found a high blood lead level of 57,4 μg/dl, such high levels being found especially among motor workers employed in workshops where diesel engines were repaired.

The statistically significantly raised blood lead levels of the motor mechanics could be the result of exposure to several sources of lead pollution. Absorption could occur largely by inhalation of vehicle exhaust gases. In addition, the lead found in lubricants[3] and petrol could penetrate the skin surface and enter the body, albeit in very small amounts. Small quantities might also be ingested.

Although the mean blood lead levels of the South African motor mechanics are lower than those of their counterparts elsewhere,[24,25] these workers are at risk of lead intoxication. This risk, however, is less than that of workers engaged in industries that utilize lead. On the other hand, the signs and symptoms of lead poisoning are generally manifested as a result of an incremental accumulation of the metal in the tissues. Since lead has no known metabolic role in man, it is important to achieve environmental conditions which will minimize lead exposure and ensure population blood lead levels which do not differ significantly from baseline levels — such as that determined in the remote rural population[9] — in South Africa.

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