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Blood lead levels in Pregnant women and the neonate

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ABSTRACT: Population studies carried out during the 1980s had shown that the Maltese population was characterized by high blood lead (PbB) levels. These high levels appeared to be a feature at all age groups including neonates. A number of environmental control measures had been initiated to attempt to decrease these PbB levels. The present study reviews PbB levels in pregnant women and newborns. It is shown that mean cord PbB levels decreased significantly in the last decade from a mean of 165.1 + 87.9 ug/l in 1985 to 89.79 + 31.23 ug/l in 1996. This decrease did not correlate with the increasing use of multimineral supplements which include the zinc cation said to be useful to counter the effects of chronic lead intoxication. Placental transfer of lead is also shown to follow closely maternal levels with a correlation coefficient of 0.81. In spite of the apparent decrease in PbB levels, about half of newborns still have levels which require preventive community measures.

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Introduction

A number of studies carried out throughout the 1980s have shown that the Maltese population, including newborns, are chronically exposed to lead in their environment and have been reported to have significantly higher blood lead (PbB) levels than those proposed by the European Community. In a population study carried out in 1981, the Maltese population sample (n = 538) appeared to have higher PbB levels than the reference values proposed by a directive of the European Community with a reported mean value of 307 ug/l (EEC: 200 ug/l) and a 98th percentile of 863 ug/l (EEC: 350 ug/l). Under a rigid quality control programme (WHO-UNEP), these elevated levels were a feature of both the male and female population, with overall lower values for females[1]. The PbB levels in Malta were similar in both men and women suggesting that this was not an occupational hazard but a continuous environmental one. A follow-up study two years later reported a slight drop in the mean PbB levels, but still elevated at 243 ug Pb/l[2]. Subsequent studies have persistently confirmed the high PbB levels in the various sections of the Maltese population including neonates[3]. Other studies have shown that PbB levels are elevated in Maltese children aged 7-9 years with a mean of 241.5 ug Pb/l in Malta and 194.4 ug Pb/l in Gozo[4]. The causes for this high PbB level in the Maltese population have still not been fully elucidated, but are partly related to the high traffic density of the Islands[4]. The objectives of the present study were to determine whether these high levels have been maintained in the pregnant and neonatal population after the introduction of community preventive measures, and to assess the placental transfer kinetics of the lead cation.

Materials and methods

Paired blood samples were collected during labour from the mother and from the maternal side of the umbilical cord. The specimens were collected at random from all deliveries occuring in one specific month at Karin Grech Hospital, excluding only cases of multiple births or bad perinatal outcome pregnancies. Thirty-eight samples of paired blood samples were considered suitable for assessent. PbB levels were assayed by atomic absorption spectrophotometry, electrothermal atomization (AAS-ETA) using a modified Fernandez method[5]. The mother was interviewed regarding the mineral supplements she had been prescribed during her pregnancy. The cord blood [CB] assays were then compared to 76 similar criteria samples analysed in 1985[3]. Statistical analysis was performed using a software package which included the Student's t-test and single linear regression.

Results

The 1985 group was assessed to have a bimodal distribution of CB PbB levels with a "breaking" point around 200 ug/l3. The mean and s.d. CB PbB levels of the 1985 population were estimated as 165.1 ± 87.9 ug/l

(Table 1). About two-thirds of these neonates had PbB levels greater than the Centres for Disease Control (CDC) recommendations of 100 ug/l[6]. Of these 31.6% of neonates had PbB values greater than 200 ug/l. In contrast, the 1996 CB PbB levels were significantly ($p<<0.001$) lower at 89.79 ± 31.23 ug/l. No neonates in this group had PbB values greater than 200 ug/l (Table 1). Despite the 45.6% PbB level decrease noted in the last decade (Figure 1), a large proportion of neonates in 1996 (47.4%) still have values for which the CDC recommends community prevention activities (>100 ug/l).

Table 1: Cord-blood PbB values - 1985 and 1996

PbB level ug/l	1985 n = 76 no.	%	1996 n = 38 no.	%
< 49	4	5.3	5	13.2
50 - 99	15	19.7	15	39.5
100 -149	17	22.4	18	47.4
150- 199	16	21.2	0	-
200 - 249	13	17.1	0	-
> 250	11	14.5	0	-
mean + s.d.	165.1 ± 87.9 ug/l		89.8 ± 31.2 ug/l	

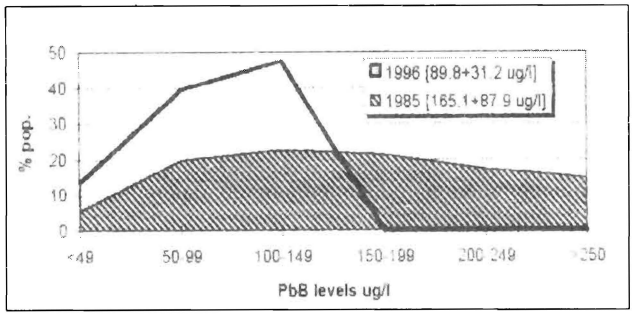

Figure 1 - Blood lead levels distribution: 1985 and 1996

The reasons for this shift over the last decade have not been identified. It has been proposed that zinc administration can alleviate the toxic effects of lead in human subjects[7]. The proportion of zinc-containing prescriptions during pregnancy has definitely increased in the last decade from about 1% in 1987[8] to the present rate of about 44.7%. However the mean maternal PbB levels in women receiving zinc supplementation was not statistically different to the levels obtained from women who did not receive zinc supplements (114.9 ± 43.4 vs 102.4 ± 37.5 ug/l p>0.1). Similar results were obtained in the cord-blood PbB levels (92.2 ± 30.7 vs 87.8 ± 32.3 ug/l p>0.5). It thus appears that the increasing use of zinc supplementation in multimineral preparations has not contributed towards the decrease in blood lead levels during the last decade (Table 2).

The mean and s.d. CB PbB levels in the 1996 population was estimated as 89.8 ± 31.2 ug/l. These levels were similar to, but slightly lower than, the maternal PbB levels reported at 108.0 ± 40.2 ug/l. The differences between the maternal and cord blood levels were statistically significant ($p<0.05$). None of the women had levels greater than 200 ug/l, but 47.4% had PbB values in the 100-149 ug/l range, while a further 10.0% had values in the 150-199 ug/l range.

The mean CB:maternal ratio was estimated as 0.87 ± 0.22. There appeared to be a close linear correlation between maternal and CB PbB levels with a correlation coefficient of 0.81 (Figure 2). The correlation coefficient for paired samples (n = 40) assayed in 1985 was estimated as 0.79. This high linear correlation suggests that the transfer of the lead cation through the

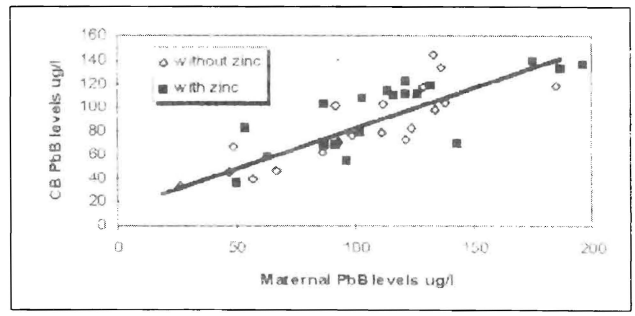

Figure 2: Lead cation Placental transfer

placenta is by simple passive diffusion, while the high CB:maternal ratio confirms that the lead cations cross the placenta rapidly and follow very closely the maternal PbB levels. The placental transfer of the lead cation did not, in any way, appear to be influenced by zinc supplementation since the cord-blood:maternal ratio was similar in women receiving iron with/out zinc (Table 2).

Discussion

Trace elements are having an increasing impact on clinical and community medicine. Much remains to be discovered about their roles, metabolism, and how they

Table 2: Blood lead levels by mineral supplementation (1996 sample)

Mineral supplementation	no.	%	CB PbB levels ug/l mean ± s.d.	mat. PbB levels ug/l mean ± s.d.	maternal:fetal ratio mean ± s.d.
TOTAL POPULATION	38	100.0	89.8 ± 31.2	108.0 ± 40.2	0.87 ± 0.22
without zinc	21	55.3	87.8 ± 32.3	102.4 ± 37.5	0.89 ± 0.22
with zinc	17	44.7	92.2 ± 30.7	114.9 ± 43.4	0.84 ± 0.23
Statistical Significance			t test = 0.429 p > 0.5 n.s.	t test = 0.938 p > 0.1 n.s.	t test = 0.679 p > 0.1 n.s.

interact with other major and minor nutrients. Several studies have shown that lead passes freely through the placenta so that a significant correlation (r = 0.63 - 0.8) between maternal and umbilical CB PbB levels has been observed[9,10,11]. The present study confirms that lead passes freely across the placenta with a correlation coefficient of 0.79 - 0.81, similar to that previously reported in the literature. Lead competes for similar binding sites with zinc, a trace element which has been suggested to be essential for normal growth. Because of this competition, it has been proposed that zinc administration can alleviate the toxic effects of lead in human subjects[7]. There has been a significant increase of multimineral (including zinc) prescriptions during pregnancy over the last decade. In 1987, 90.6% of Maltese pregnant women were reported to have received haematological supplementation during their pregnancy. However only 1% received supplementation which included the zinc cation[8]. In 1996, an overall 92.1% of the women received haematological supplementation during their pregnancy, including 44.7% who received also zinc supplements. The present study has failed to confirm any therapeutic benefits towards decreasing PbB levels by the use of zinc supplements during pregnancy either in the mother or fetus. Furthermore zinc administration did not appear to affect placental transfer of the lead cation. Zinc levels in the form of zinc protoporphyrin (ZPP) have been shown to be higher in the Maltese population than in the Belgian studied population, statistically ($p<0.007$) correlating to PbB levels with a correlation coefficient of 0.48 [1].

The establishment in the 1980s that the Maltese population had very high PbB levels resulted in a community drive to decrease the introduction of lead in the environment. This educational and legislative drive was primarily aimed at controlling the importation of red lead paint, and diminishing the use of lead-treated wood as firewood in bakeries. Further efforts were made to promote the use of unleaded petrol and controlling the disposal of used engine oil as fuel in bakeries. It now appears that these preventive measures have had a satisfactory effect on the Maltese environment. This study confirms that there has been a definite lowering in PbB levels in women and newborns. This decrease in PbB levels does not appear to be related to changing prescription habits, and thus is more likely to be due to community preventive activities. In spite of the reported decrease, newborn PbB levels remain sufficiently elevated by CDC criteria[6] to require continuing preventive measures. The availiable data show that females and children are more sensitive than males to the toxic effects of lead, and it has been suggested that for full protection, females require a lower health-based occupational exposure limit for PbB than males. It is thus suggested that females with blood lead level values over 100 ug/l should have careful follow-up. More than half the Maltese pregnant women assessed in 1996 fell within this range. The exact effects of chronic subtoxic lead exposure on the fetus has yet to be fully determined, but protection of the developing embryo from injury due to lead exposure is an important point to be considered.

A recent study has shown that infants exposed in utero to lead levels greater than 100 ug/l lost 4 to 6 points on development tests[6]. A further possible health risk could arise from mothers with high blood lead concentrations transferring lead to the suckling infants through breast milk, in addition to that already transported through the placenta. Maternal blood lead concentrations have been shown to increase during lactation possibly because the mineral is released from the skeleton during times of increased demand for calcium[12]. A significant correlation between maternal blood and breast milk lead levels ($r = 0.29$, $p < 0.01$) has been demonstrated[11], while the 6-month PbB levels of breast-fed infants correlated very well ($r = 0.42$, $p = 0.0003$) with the lead content of breast milk[13].

Conclusion

Mothers with PbB levels greater than 100 ug/l should be given educational and nutritional counselling and a detailed environmental history should be taken to identify any obvious sources or pathways of lead exposure. Newborns with blood lead levels greater than 100 ug/l should be regularly screened every 3 to 4 months with repeated blood lead tests, and later screened for possible medical and neural complications. Infants with confirmed PbB levels greater than 200 ug/l must receive medical and environmental follow-up [6].

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