Environmental lead and children's intelligence

Obvious hypothesis is ignored

EDITOR,—Stuart J Pocock has always been profoundly sceptical of a causal relation between lead and IQ.[1] Accordingly, the recent paper by him and colleagues deserves a cautious welcome, if only because the data show conclusively that a doubling of body lead from 10 to 20 μg/dl of blood (0·48 to 0·97 μmol/l) or 5 to 10 μg/g of tooth is associated with an IQ deficit of 1-2 points after allowance for confounding variables.[2] Unfortunately, the "standards of objectivity and critical appraisal" that the authors find so lacking in others are crucially absent from the discussion of their paper, in which, seemingly, any hypothesis is entertained other than the obvious—namely, that lead reduces IQ.

Although the authors concede that this is plausible, they dismiss neuropsychological studies in animals as providing "only indirect support" but fail to mention the reproducibility of such data.[3] Nor do they consider studies in humans that have shown biochemical effects at blood lead concentrations well within the range studied epidemiologically—studies that include the effects of lead on enzyme systems central to neurological function.[4]

It needs to be remembered that the natural (that is, pre-technological) blood lead concentration in children has been calculated at 0·016 μg/dl (0·0008 μmol/l)[5] and that the concentrations typically found in modern children are greater by three orders of magnitude. Furthermore, it requires only a quadrupling of the concentration to bring children into the range associated with neuropathy, coma, and ultimately death. For no other neurotoxin is there such a narrow gap between what is typical and what is toxic, so no one should be surprised when small deficits in IQ are shown by epidemiological studies.

It is unfortunate that these studies have to rely on tooth lead content or blood lead concentration as an indirect measure of exposure to lead on the far side of the blood-brain barrier. Perhaps Pocock and colleagues should turn their attention to the extent to which epidemiological studies underestimate the true impact of lead on children's intelligence.

ROBIN RUSSELL JONES
Former chairman, Campaign for Lead Free Air

St Thomas's Hospital,
London SE1 7EH

1 Pocock J, Ashby D, Smith M. Lead exposure and children's intellectual performance. *Int J Epidemiol* 1987;16:57-67.
2 Pocock J, Smith M, Baghurst P. Environmental lead and children's intelligence: a systematic review of the epidemiological evidence. *BMJ* 1994;309:1189-97. (5 November.)
3 Silbergeld E. Experimental studies of lead neurotoxicity: implications of mechanisms, dose response and reversibility. In: Rutter M, Russell Jones R, eds. *Lead versus health. Sources and effects of low level lead exposure.* Chichester: John Wiley, 1983: 191-216.
4 Blair J, Hilburn M, Leeming R, McIntosh M, Moore M. Lead and tetrahydrobiopterin metabolism: possible effects on IQ. *Lancet* 1982;i:464.
5 Flegal A, Smith D. Lead levels in preindustrial humans. *N Engl J Med* 1992;326:1293-4.

Cleveland study hypothesis was not confirmed

EDITOR,—Stuart J Pocock and colleagues' objective review of the epidemiological evidence with regard to environmental lead and children's intelligence provides a carefully conducted set of analyses of a complex and confusing set of studies.[1] It contrasts sharply with reviews recently published in the United States.

The authors suggest that maternal alcohol dependence contributed to the effectiveness of adjustment for covariates in the prediction of IQ in the Cleveland study, of which I was principal investigator.[2] I wish that it was so. Our hypothesis that fetal exposure to alcohol has a direct effect on IQ and an effect interacting with that of lead was not confirmed. Our otherwise powerful covariate set controlled for childhood illness, including otitis media, and race, which had little or no variance in other studies.

CLAIRE B ERNHART
Professor

Case Western Reserve University,
Cleveland, Ohio, USA

1 Pocock SJ, Smith M, Baghurst P. Environmental lead and children's intelligence: a systematic review of the epidemiological evidence. *BMJ* 1994;309:1189-97. (5 November.)
2 Ernhart CB, Morrow-Tlucak M, Worf AW, Super D, Drotar D. Low level lead exposure in the prenatal and early preschool periods: intelligence prior to school entry. *Neurotoxicol Teratol* 1989;11:161-70.

Taiwan results are not included

EDITOR,—Stuart J Pocock and colleagues' systematic review of recent studies of environmental lead and children's intelligence[1] does not include a cross sectional study from Taiwan.[2] This may be because the study's outcome measure was the score in Raven's coloured progressive matrices test rather than the score on the more commonly used Wechsler intelligence scale for children. As an author of the study in Taiwan I have reanalysed our data, using an appropriate IQ score for each value in the coloured progressive matrices test.

The coloured progressive matrices test is scored from 0 to 36, is free of obvious cultural content, has no time limit, involves visual-spatial reasoning, and correlates strongly with the score on the Wechsler intelligence scale for children and other measurements of IQ. I translated each child's score in the coloured progressive matrices test to the equivalent IQ score to obtain figures directly comparable with those of Pocock and colleagues. I used the Standford-Binet distribution of IQ for schoolchildren in Taipei City to assign each score an IQ score.

The data from the Taiwanese study can be presented in the form used in Pocock and colleagues' table III. The study drew children from urban primary schools and two schools near lead smelters. The group with complete data comprised 458 children aged 6-8 with a mean IQ score of 106. The blood lead concentration of 60 children from the schools near the smelters averaged 13·0 μg/dl (0·63 μmol/l), and their tooth lead content averaged 6·2 μg/g. From this we estimated a mean blood lead concentration of 9·0 μg/dl (0·43 μmol/l) for the entire cohort, whose tooth lead averaged 4·3 μg/g. The significant covariates were parents' education, sex, and grade at school. Forty potential covariates were considered. Adding additional variables did not decrease the lead coefficient. The data were not log transformed.

When the data were analysed as in Pocock and colleagues' table IV, an increase in tooth lead from 5 to 10 μg/g was associated with a change in IQ of −3·6 (SE 1·0) (unadjusted) and −2·2 (0·9) (adjusted) (P=0·02). The population in Taiwan is generally well nourished, and use of alcohol, tobacco, or illicit drugs while pregnant is virtually zero.

These Taiwanese data are consistent with the overall pattern described by Pocock and colleagues. Adding them to the review increases the total number of children included, improving the statistical resolution slightly. More importantly, however, these data extend downward the range of lead concentrations for which an effect is seen. If a threshold for lead's effects on intelligence is to be found it is at yet lower concentrations.

MICHAEL B RABINOWITZ
Associate scientist

Marine Biological Laboratory,
Woods Hole, MA 02543, USA

1 Pocock SJ, Smith M, Baghurst P. Environmental lead and children's intelligence: a systematic review of the epidemiological evidence. *BMJ* 1994;309:1189-97. (5 November.)
2 Rabinowitz M, Wang JD, Soong WT. Dentine lead and child intelligence in Taiwan. *Arch Environ Health* 1991;46:351-60.

Hair lead studies were excluded

EDITOR,—In their meta-analysis to measure the magnitude of the relation between IQ in children aged ⩾5 and the body burden of lead Stuart J Pocock and colleagues excluded studies that used hair lead because "it is recognised as an unreliable measure of body burden."[1] The idea that hair is not a reliable indicator comes mainly from the possibility of exogenous contamination of hair and the fact that most studies have shown no or weak links between blood lead concentration and hair lead content. We showed that exogenous contamination of hair was not as high as expected when meticulous and thorough washing procedures were used.[2]

Hair and blood provide complementary but not exclusive information about body lead content. With regard to exposure during pregnancy, blood lead concentrations provide information on the degree of exposure currently and recently but not during earlier, possibly more vulnerable, periods of development. Analysis of hair is a potentially more attractive means of assessing long term exposure and seems useful in estimations of exposure in utero, when central nervous system cells are highly vulnerable. Lead is concentrated in head hair, which can be collected without injury and easily preserved and analysed. For measurement of past or current exposure, hair seems better than blood. Our estimation of intrauterine exposure to lead by analysis at birth of neonates' hair and their mothers' hair in a six year prospective study showed that such exposure had a significant negative correlation with the main scores of the McCarthy scales of children's abilities. This study was performed on 81 children, which is a smaller sample than that required in studies of blood.[3] The fact that a relation was found proves that a powerful and useful tool—hair—was used.

Another physiological argument supports the use of hair lead content. A study by our group assessing the influence of environmental lead on membrane ion transport in a French urban male population showed that blood lead concentration was related to cotransport of sodium and potassium ions and was not related to Na^+, K^+ ATPase activity while hair lead was related to Na^+, K^+ ATPase activity.[4] Because Na^+, K^+ ATPase is the main mechanism of the action potential in nervous system cells, we undertook a prospective study. The aim of this study was to evaluate whether the relation between exposure to lead in utero (as estimated from the blood concentration and hair lead content) and subsequent neuropsychological development (at 9 months and (measured with the McCarthy scales) 3 years) could be partly mediated by Na^+, K^+ ATPase activity. The preliminary results (unpublished data) of this study seem to agree with this hypothesis.

GUY HUEL
Director of research
DAVE CAMPAGNA
Research fellow
THIERRY MOREAU
Director of research
PASCALE TUBERT-BITTER
Researcher

Epidemiological Research Unit,
National Institute for Health and Medical Research,
94807 Villejuif,
France

1 Pocock SJ, Smith M, Baghurst P. Environmental lead and children's intelligence: a systematic review of the epidemiological evidence. *BMJ* 1994;309:1189-97. (5 November.)
2 Huel G, Everson RB, Menger I. Increased hair cadmium in newborns of women occupationally exposed to heavy metals. *Environ Res* 1984;35:115-21.