Bull. Environ. Contam. Toxicol. (1994) 53:325–331

Environmental Contamination and Toxicology

Comparison of Lead and Zinc Levels in the Hair of Pupils from Four Towns in the Kumasi Municipal Area of Ghana

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Received: 9 July 1993/Accepted: 25 January 1994

When metals enter the body of living organisms, even in trace amounts, they may not be metabolized and may accumulate if not excreted. During the process of accumulation they may attain levels which may be toxic to the organism (Klein et al 1970, Somers 1971). In the body some of the metals may accumulate in special organs or tissues where they may effect changes. Others may remain in the general body fluid and influence all enzyme systems. Some of these influences may be beneficial and others detrimental. Hence it is important to learn of metals which enter the body so that any undue increases in their amounts may be avoided.

The bone is usually the site for the accumulation of metals and may serve as a store house and contain a library of the record of what have entered the body of the organism. However human bone is not easy to sample. The hair, though lesser known as site for accumulation of metals, it accumulates more lead per unit weight than any tissue in the body including even body fluids such as blood and urine, Kopito et al (1967). The human hair, depending upon the belief, culture and scientific awareness of the people may be easy or difficult to sample. In many instances the hair of humans especially that of males is cut and disposed off as waste materials. Apparently such unwanted hair could be analysed and studied to learn of both external and internal exposure of the population to contamination and pollution. A knowledge of levels of metals in non-occupationally exposed citizens as compared with those in occupationally exposed people may serve as a guide in protecting the whole population against industrial pollution and its associated diseases.

The report presented here is part of a project designed to find the levels of metals in the hair of the population in general before looking at the levels which may be obtained in some mine workers or occupationally exposed, in the country. Such levels may serve as natural background levels for future reference.

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MATERIALS AND METHODS

As earlier stated by Golow et al (1992), numerous difficulties were encountered in collecting hair samples. Similar problems were met with in the present investigation. This was due to superstitious beliefs. It was more difficult to collect samples from schools in which the head teachers were females. However, some measure of success was accomplished in schools headed by males.

At various schools fifty of each sex who volunteered had their hair cut in such a way that the style of hair-do was not altered. The hair samples were put into separate envelopes. The ages and sexes of the pupils were recorded on each envelope containing hair samples. The heights and weights were not taken.

In the laboratory the hair samples were washed with double distilled water and dried in the oven at 100-105°C to constant weight. Weighed quantities of each sample were put into separate boiling tubes in triplicates. To each tube with weighed hair sample were added 15 - 25mL concentrated AnalaR HNO_3 and stirred with glass rods until the evolution of brown fumes ceased. The tubes were stoppered with glass stoppers and stored in a locker for 48 hrs. The contents of the boiling tubes were digested in sand bath for about 1 hr. The solutions in the tubes were cooled, filtered through Whatman No. 41 filter paper and made up to 50mL mark in a graduated flask with double distilled water. The treated samples were put in separate plastic bottles and analysed in an Atomic Absorption Spectrophotometer, Varian 1275, Australian make for the metals, lead and zinc.

A solution of 25mL concentrated AnalaR HNO_3 made up to 50mL with double distilled water was used as blank for background levels of the metals in the acid and the distilled water. Standard solutions in the range of the levels measured were filtered through Whatman NO. 41 filter paper and measured in the AAS. There was no loss in the levels of the metals in the standard solutions.

To 60 boiling tubes were added known amounts of the metals and digestion and filtration procedures carried out a number of times to determine the recoveries. An average of 98 - 101% recoveries was obtained for the two metals. To known weights of hair samples which had been previously analysed were added known amounts of the metals. These were also analysed as above. These spiked samples also gave results similar to the recoveries stated above.

The means of each metal in the pupils hair were calculated for the sexes. The standard deviations and coefficients of variation were calculated. The correlation coefficients, r, and the regression coefficients, b, were also calculated. With the help of the regression coefficients estimates for the dependent variables were found and used in plotting against the ages. The

mean levels of the metals in the towns were also plotted against number of houses.

RESULTS AND DISCUSSION

From the mean levels of the metals measured in the hair samples of the pupils there was no distinct indication of the variation with sex, Tables 1 and 2. However boys in Ayeduase and Kwadaso had higher levels of lead in the hair than the girls from the same towns. On the average the levels of lead in the hair of pupils in Ayeduase School were the highest. The next highest was Atonsu - Agogo. Ayigya and Kwadaso School children had the lowest levels of lead in their hair. The lead levels in the hair was much lower than those for children who had chronic exposure to the metal, [Patterson 1965].

Zinc was higher in the hair of boys than that of girls at Ayeduase and Ayigya but at Atonsu-Agogo and Kwadaso the girls had more zinc

Table 1. Mean levels of lead and zinc in micrograms per gram of hair in female pupils from four Schools in Kumasi City. The coefficient of variation percent is represented by cv. Number of houses is from 1984 population census of Ghana.

Town and School	Pb		Zn		No. of Houses
	Mean	Cv	Mean	Cv	
Ayeduase School	28.27	71.72	274.08	32.28	64
Ayigya School	6.28	46.27	188.33	26.01	151
Atonsu-Agogo	13.22	40.03	176.78	45.55	139
Kwadaso School	5.16	32.56	184.65	55.18	187

Table 2. Mean levels of lead and zinc in micrograms per gram of hair in male pupils from four Schools in Kumasi City. The coefficient of variation percent is represented by cv. Number of houses is obtained from 1984 population census of Ghana.

Town and School	Pb		Zn		No. of Houses
	Mean	Cv	Mean	Cv	
Ayeduase School	32.88	73.98	291.00	32.99	64
Ayigya School	6.17	47.81	193.33	16.56	151
Atonsu-Agogo	13.11	64.21	166.78	40.78	139
Kwadaso School	7.50	55.78	164.23	46.19	187

in their hair than the boys. The zinc levels were lower than 5ppm the amounts which may be toxic to the body [Patterson 1965].

The variations observed may be due to the amounts consumed in food and water and inhaled in air in the particular neighbourhood. These may be dependent on the Chemistry of the surrounding environment.

Another factor which may account for the variations may be the proximity to roads. This may be similar to the findings by Daines et al [1970] in the air. But this point need not be overstressed because the distances of the Schools from main roads were not measured. Even this may not provide the answer because the pupils

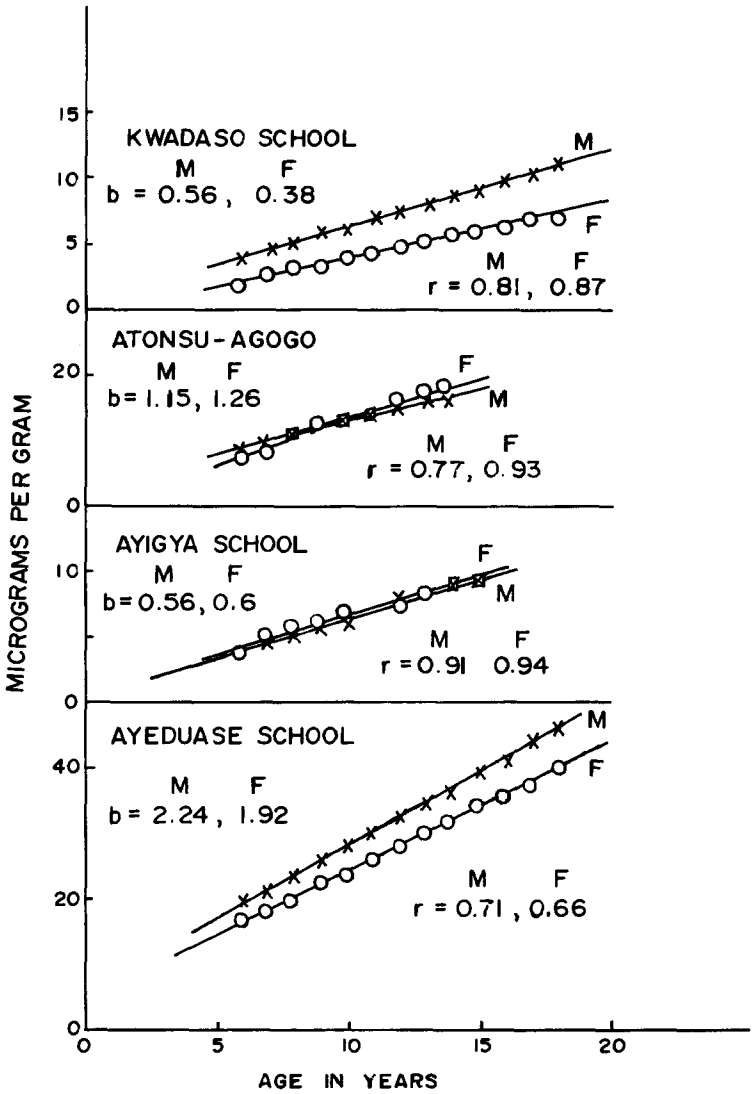

FIGURE I Regression of Pb in hair of pupils on age at Ayeduase, Ayigya, Atonsu - Agogo and Kwadaso Schools in Kumasi.

spent only a small fraction of their time on the school compounds and did not eat nor drink much in the schools. They spent greater portion of their time in the houses and ate and drank more in their homes. Thus the answer for the variations observed might be found in their places of abode.

Ayeduase is a small suburb with one major road running through it. Most of the buildings are built along the length of this road. Majority of the pupils therefore live near this road and hence might have vehicular lead and zinc in their hair similar to what was found in San Diego by Chow et al [1970]. Ayigya, Atonsu-Agogo and Kwadaso are larger and do not have only one major road

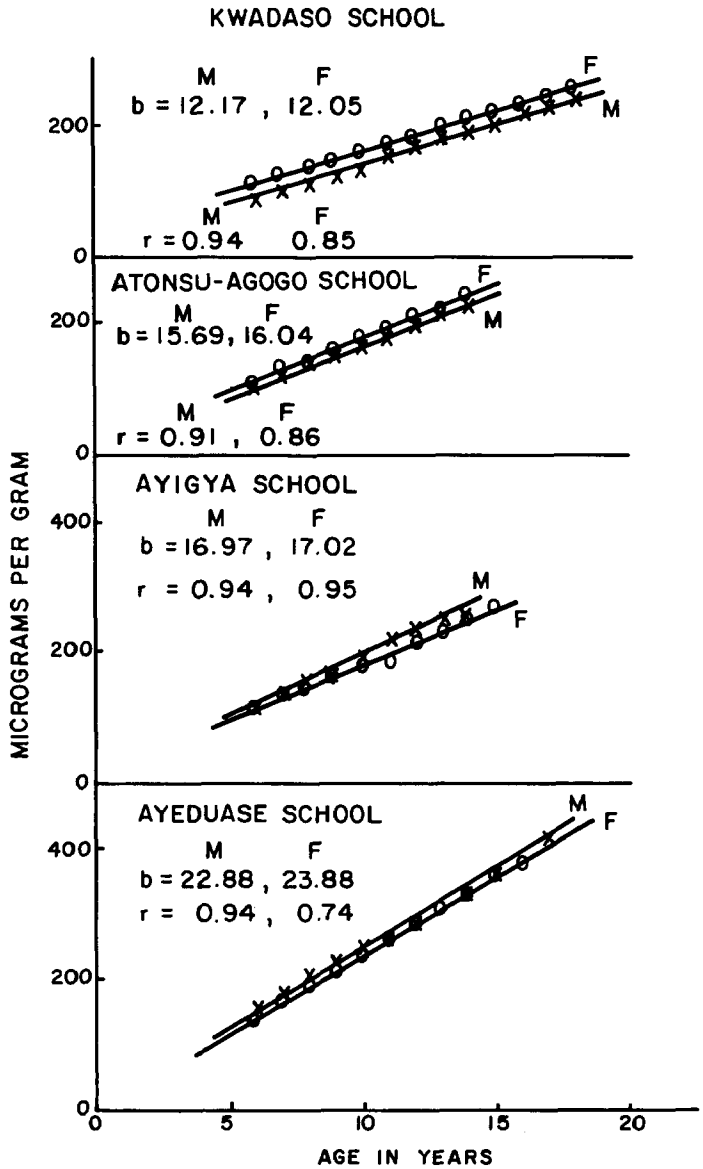

FIGURE 2 Regression of Zn in hair of pupils on age at Ayeduase, Ayigya, Atonsu-Agogo and Kwadaso Schools in Kumasi City.

about which the houses are crowded. Hence the majority of the children did not live near main roads and thus lower vehicular lead and zinc in their hair, Tables 1 and 2.

From Figs 1 and 2 the correlation coefficients, r, were close to unity and hence a linear relationship existed between levels of metals in the hair of the pupils and age. Both sexes displayed similar patterns. This relation was confirmed by the regression

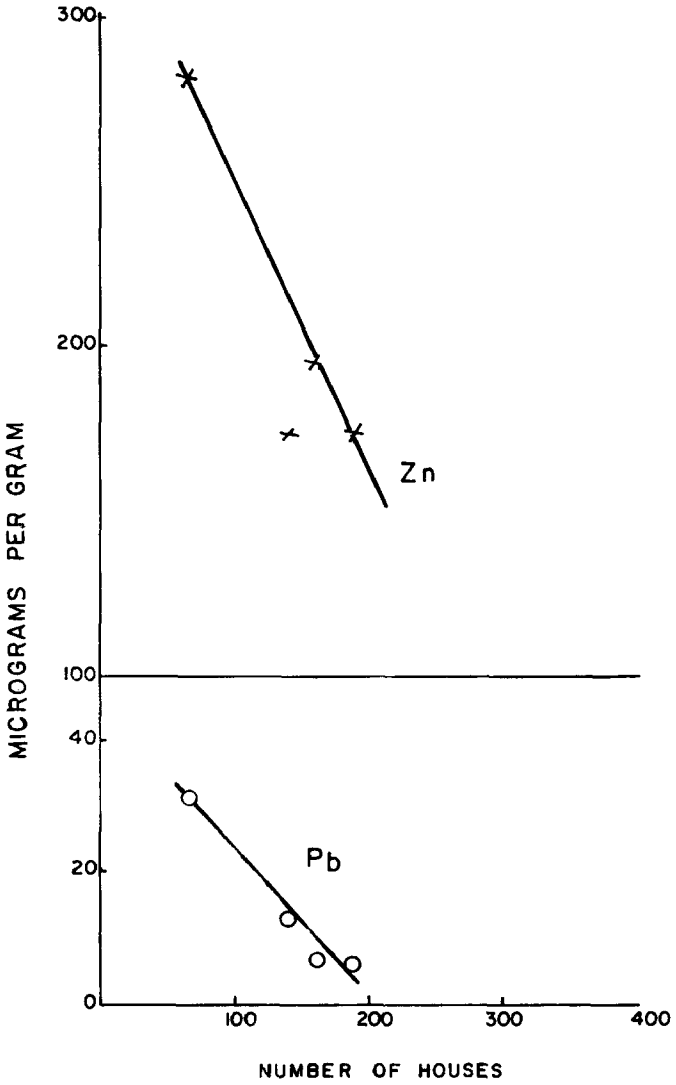

FIGURE 3 Lead and zinc in hair of pupils versus number of houses in Ayeduase, Ayigya, Atonsu-Agogo and Kwadaso

of micrograms of the metals per gram of hair on age, Figs 1 and 2. Both sexes showed linear regression lines. Depending on the regression coefficients, b, the slope were variable. The essential metal zinc had the largest regression coefficients and the most toxic of the two, lead, had the smallest regression coefficients. This is similar to what was observed by Golow et al (1992). Thus a relationship might exist between toxicity or essentiality and regression coefficients of the metals in hair on age. Ayeduase pupils had the largest regression coefficients for both metals because they had the highest levels of the metals in

their hair. They certainly were more exposed to contamination than pupils from the other towns. The explanation for this is that majority lived in houses very close to the main road.

The graph of mean levels of the metals in the hair of pupils versus number of houses, Fig 3, produced straight lines which decreased linearly with the number of houses. Hence in a town with larger number of houses not crowded about main roads the inhabitants may have lower levels of vehicular metals in their hair. Thus the way a town is planned will have a direct effect on vehicular metals in human hair.

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