Childhood Lead Poisoning in Brussels
Prevalence Study and Etiological Factors

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Abstract

The objectives of this study were twofold: firstly, to assess the frequency (prevalence) of childhood lead poisoning in some districts of Brussels and secondly, to identify within the dwellings the major source of lead as well as the risk factors connected with this intoxication.

The study population (533 participants) was selected among children who visited childhood health centres in downtown Brussels. The reference group was chosen among children living outside Brussels city center. A case-control study was undertaken to meet the second objective of the investigation.

The average blood lead level (PbB) was 104 µg/l in the study population compared with 36 µg/l in the reference group.

The 100 µg/l “non effect level” put forward by the Centres for Disease Control (CDC) and by the French legislation, is exceeded by 50% of the children living in this rundown environment. The major cause of intoxication is the presence of old lead-based paints in dwellings (Odd Ratio (OR): 4.4) constructed before 1940. Hand-to-mouth activity, pica activity (OR: 17.1) and a lack of hygiene are factors, which combined, promote intoxication. When the dwellings are undergoing renovation, this risk increases (OR: 7.2).

1. INTRODUCTION

Today, lead is still responsible for a great number of intoxications of the general population, most of these are predominantly observed in children (childhood lead intoxication) [1] and this is the subject of this study.

1.1 Risks of intoxication for children [2]

Children are more at risk from intoxication than adults for three reasons:

Their nervous system is still developing (lead has severe effects on this system), their intestinal absorption is stronger (they absorb 50% of ingested lead compared to 10-20% in adults) and the risk of ingesting leaded particles is much greater in children due to their hand-to-mouth and pica activities (the repeated ingestion of non-nutrient and non-medicinal substances). Iron or calcium deficiencies can also increase this absorption rate [3].

1.2 Digestive and pulmonary route of lead absorption [1]

Lead penetrates the organism essentially through the digestive and pulmonary systems. Lead penetrates mostly through the digestive tract by the ingestion of contaminated food, such as water having run through lead pipes, acidic drinks (fruit juices, tea, etc…) that have been kept in leaded containers (locally-made metal teapot [4] and ceramics [5], crystal decanter etc…), dust and paint chips in old, run down houses or in houses undergoing renovation work.

In some very specific circumstances (i.e. thermal paint stripping), lead fumes can be inhaled (there is 50% absorption, whatever the age). Lead can also penetrate through the skin, the conjunctiva and the placenta barrier (particular care must be given to pregnant women).
1.3 Symptoms

Acute encephalopathy is generally observed in case of very severe intoxication. However, there is no evidence available documenting an association between the degree of the intoxication and the clinical manifestations. For chronic intoxications, clinical signs are inconsistent and non-specific. The neurological symptomatology is characterised by sleeplessness, lack of concentration or lapses of memory, behavioral problems such as aggressiveness, irritability, nervousness or apathy. The major digestive manifestations are abdominal pains, vomiting, persistent constipation. The stagnation or regression of the weight/height curve, a delay in mental development (with a reduction of the IQ scores), abnormal paleness and/or biological analytical results, which indicate anaemia, must point to lead intoxication.

2. METHODOLOGY

The objectives of this study were twofold: firstly, to assess the frequency (prevalence) of childhood lead poisoning in some districts of Brussels and secondly, to identify within the dwellings the major source of lead as well as the risk factors connected with this intoxication.

2.1 Prevalence study (frequency of lead poisoning) [6]

The selected participants of the study (n=533) were aged from six months to six years and were patients of ONE Centers (Office de la Naissance et de l’Enfance – childhood health centers) in the six randomly chosen districts. The random selection of the districts was based on the criteria of a high proportion and high density of old dwellings. A blood sample was taken from each child and the blood lead (PbB) level was used as the classification parameter for placing each child in a risk category. This category indicates either the seriousness of the exposure or the seriousness of the poisoning as well as the degree of urgency for medical and environmental actions [7]. A reference group (n=111) was made up of children of the same age, living in Brussels but not downtown and whose blood test was required for other medical reasons.

2.2 Case-control study

Each detected case of intoxication with a PbB higher than 250 µg/l (n=29) was matched with two control children of the same age and gender having a PbB below 150 µg/l and residing in the same district (n=60). All these children were part of the prevalence study. Quantitative analysis of lead present in paint, dust and water was carried out on samples taken from the dwelling of each case and control child. Other factors associated with the intoxication risk were evaluated using a questionnaire on the age and condition of the dwelling, as well as the nationality, age and behaviour of the child and other possible sources of risk such as jewellery, painted toys, khol/surma [8], ceramics etc.

3. RESULTS AND DISCUSSION

3.1 Prevalence study

Referring to the risk categories established by the Centers for Disease Control (1991), 6% of the 533 participants had blood lead levels (PbB) higher than the medical intervention threshold (250 µg/l). Fifteen children out of the 29 intoxicated children had to be hospitalised and treated with chelator agent. More than half of the study population (51.2%) had a PbB higher than the “non effect level” of 100 µg/l (Fig. 1 and Fig. 2). The average PbB was 104 µg/l in the study population compared with 36 µg/l found in the reference group. Lead toxicity is potentiated by anemia caused by iron deficiency. These parameters for anemia were defined, in the present study, as a blood ZPP level above 350 µg/l or a ferritine level below 10 µg/l. This
point must be emphasized as this type of anemia was also observed in the not severely intoxicated group of children, i.e. with PbB under 250 µg/l (19.5 or 34% according to ZincProtoPorphyrin (ZPP) or ferritine biological parameter). In the intoxicated population of children (those with a PbB over 250 µg/l), 70% of the ZPP and 77% of the ferritine exceeded the anemia parameter threshold. Twenty one intoxicated children with a PbB higher than 250 µg/l, had a ZPP above 350µg/l and 77 % of the ferritine were under 10µg/l.

3.2 Case-Control study

The case-control study demonstrated that:

a. The major cause of intoxication is the presence of dust or chips of old lead-based paints in dwellings constructed before 1940, associated to hand-to-mouth activity, pica behaviour and a lack of hygiene. The hand-to-mouth activity is the factor the most important as validated by the statistical tests of sensitivity, specificity and the Odd Ratio (table 1);

b. The risk significantly increases, whilst the dwelling is being renovated;

c. A reduction of the system’s iron reserves raises the risk of intoxication;

d. Drinking water was not significant in this particular study, most probably because of the very high pH of the distribution water;

f. Gender is not a risk factor;

g. Risk is not age dependent (between 6 months and 6 years).

Table 1 Risk factors tests

<table>
<thead>
<tr>
<th></th>
<th>Sensibility</th>
<th>Specificity</th>
<th>Odd Ratio (CI 95%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>House Rehabilitation</td>
<td>0.28</td>
<td>0.95</td>
<td>7.2 (1.5-38.6)</td>
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<td></td>
<td></td>
<td></td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>Pica Hand-Mouth</td>
<td>0.72</td>
<td>0.87</td>
<td>17.1 (5-61.2)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>Paint chips 1.5-4.9 g/kg</td>
<td>0.72</td>
<td>0.55</td>
<td>3.2 (1.0-10.6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>Paint chips &gt;5 g/kg</td>
<td>0.62</td>
<td>0.73</td>
<td>4.4 (1.3-14.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>p&lt;0.05</td>
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</tbody>
</table>
The daily tolerable doses recommended by the Joint FAO/WHO Expert Committee on Food Additives is 3.5 µg/kg of corporal weight [9]. If a child, weighing 12 kg, eats just 1 g of paint chips (contaminated with a 5 g/kg Pb) in one day, his daily lead intake will amounts to 5000 µg, which is approximately 120 times the daily-tolerable dose!

CONCLUSION

Lead poisoning of young children residing in old and poorly maintained dwellings is a very real public-health problem, the extent of which is not negligible. The systematic detection of this intoxication has become an urgent necessity for infants and young children within the framework of a prevention and medical policy.

References