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Chronic Thumb-Sucking as a Pathway for Childhood Lead Exposure in Libya: A Case Report

Rehab M. H. El Fagie *
Forensic and Toxicology Department, Faculty of Medicine, Alasmarya Islamic University, Zliten, Libya

مص الإبهام المزمن كمسار للتعرض للرصاص في مرحلة الطفولة في ليبيا: دراسة حالة

رحاب مفتاح حسين الفقي*
قسم الطب الشرعي والسموم، كلية الطب، الجامعة الأسمرية الإسلامية، زليتن، ليبيا

Corresponding author: r.elfagie@asmarya.edu.ly

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Abstract:
Background: Lead poisoning is a major global health issue, particularly among children. The Centers for Disease Control and Prevention (CDC) states that there is no safe blood lead level for children. Libya currently lacks a lead screening program. Young children are more exposed due to behaviors such as thumb sucking, especially when they come into contact with lead-contaminated soil. High blood lead levels in early childhood are linked to speech delays, even at levels that were once thought to be low risk.
Case Presentation: Herein, we report a lead poisoning case involving a 4 years' boy and his younger sister who were exposed to the same environment simultaneously, sharing the same type of food, but the boy had a habit of chronic thumb sucking. However, the boy presented with delayed expressive language, whereas his sister showed no significant symptoms. Upon investigation, the boy exhibited an elevated plasma lead level of 19 µg/dL, whereas his sister had a plasma lead level of 10 µg/dL. The boy received calcium and iron supplementation for three months, and a bitter-tasting deterrent was applied to the thumb to stop the sucking habit. The habit was resolved, and the follow-up blood lead level decreased to 9 µg/dL. Expressive speech became fluent with a decline in the blood lead level.
Conclusion: Thumb sucking is important pathway of lead exposure in children and behavioral intervention combined with environmental counseling can evidently lowering blood lead levels.

Keywords: thumb-sucking; lead toxicity; blood lead level; pediatric; speech delay; hand-to-mouth behavior.

الملخص
الخلفية : يُعتبر التسمم بالرصاص مشكلة صحية عالمية كبرى، لا سيما بين الأطفال. تؤكد مراكز الوقاية والسيطرة على الأمراض منها أنه لا يوجد مستوى آمن للرصاص في دم الأطفال. تفتقر ليبيا حالياً إلى برنامج فحص للرصاص. يتعرض الأطفال الصغار للتلوث بشكل أكبر بسبب سلوكيات مثل مص الإبهام، خاصة عندما يتلامسون مع تربة ملوثة بالرصاص. ترتبط المستويات المرتفعة من الرصاص في الدم في مرحلة الطفولة المبكرة بتأخر النطق، حتى عند المستويات التي كانت تعتبر سابقاً منخفضة الخطورة.
عرض الحالة : نعرض هنا حالة تسمم بالرصاص لطفل يبلغ من العمر 4 سنوات وشقيقته الصغرى، حيث تعرّضا لنفس البيئة في وقت واحد، وتناولا نفس النوع من الطعام، ولكن كان لدى الطفل عادة مزمنة في مص الإبهام. بينما ظهر على الطفل تأخر في اللغة التعبيرية، لم تظهر على شقيقته أي أعراض ملحوظة. عند الفحص، أظهر الطفل مستوى مرتفعاً من الرصاص في البلازما بلغ 19 ميكروغرام/ديسيلتر، بينما كانت نسبة الرصاص في بلازما شقيقته 10 ميكروغرام/ديسيلتر. تلقى الطفل مكملات الكالسيوم والحديد لمدة ثلاثة أشهر، وتم وضع مادة مرة الطعم على الإبهام لوقف عادة المص. تم التغلب على هذه العادة، وانخفض مستوى الرصاص في المتابعة إلى 9 ميكروغرام/ديسيلتر. أصبح الكلام التعبيري طليقاً مع انخفاض مستوى الرصاص في الدم..

الاستنتاج: يُعد مص الإبهام مساراً مهماً للتعرض للرصاص لدى الأطفال، ويمكن للتدخل السلوكي المقترن بالتوجيه البيئي أن يخفض مستويات الرصاص في الدم بشكل ملحوظ.

الكلمات المفتاحية: مص الإبهام؛ سمية الرصاص؛ مستوى الرصاص في الدم؛ طب الأطفال؛ تأخر النطق؛ سلوك وضع اليد في الفم.

Introduction

Childhood lead poisoning is a significant public health issue. Lead is a neurotoxin, and its ideal blood concentration is zero. Children are highly sensitive to lead poisoning because of their metabolic and growth characteristics. Lead can easily penetrate the brains of children because their blood–brain barrier is not fully developed. Children with slightly to moderately increased blood lead levels (BLLs) often experience reduced IQ scores and behavioral disorders, especially social withdrawal, depression, atypical body actions, aggression, and destruction. (1,2)

The estimated prevalence of finger sucking in Libyan children aged 3 to 6 years within the population ranged from 9.5% to 13.4%. (3) Understanding the routes of lead exposure in very young infants is an essential precursor to identifying effective strategies for minimizing blood lead (PbB) levels throughout infancy, Kranz et al. Al suggested that a 4-month-old infant could absorb up to 4 μg of lead a day (equivalent to a PbB level of up to approximately 2.4 μg/dl) by mouthing their fingers. (4)

Lead contamination in Libya arises from the complex interactions of anthropogenic activities and industrial and agricultural practices, with different risk levels across regions. According to Aishah et al, Soils in urban areas are excessively affected by intense industrial, commercial, and agricultural activities. Cities such as Tripoli, Benghazi, Al-Marj, Misurata, Sirt, and Zwara exhibited very high contamination degrees (CD > 24), poor quality control, and aging Libyan industrial infrastructure, which could be the primary predisposing factors rather than natural environmental factors. The food chain is another significant exposure route. *M. A. Elbagermi* et al. evaluated fruits and vegetables in the Misurata area and detected Pb in various produce, with the highest concentrations found in mangoes (1.5 mg/kg), followed by strawberries, watermelons, grapes, and tomatoes. These elevated levels in certain crops are closely linked to pollutants in irrigation water, farm soil, pesticides, and traffic emissions from nearby highways. Together, these findings confirm that Libya's lead problem is not uniform. (5)

The majority of existing literature on lead exposure in Libya has focused on contaminated soil, groundwater, and drinking water as the primary mediators of exposure risk. Evidence from these research highlighted that drinking water represents a critical and often overlooked pathway. Water as a source of lead contamination were occurred after water leaves the treatment plant, making monitoring difficult. This problem has been overlooked in Libya to date. Galal M. Elmanfea et al. evaluated groundwater wells in El-Beida City and found that lead concentrations ranged from 0.33 to 0.50 mg/L, which exceeded both the WHO permissible limit of 0.01 mg/L and Libyan national standards. This contamination could be attributed to the corrosion of household plumbing systems and PVC pipes, which are manufactured with lead and added nitrate and can increase the risk of lead leaching into drinking water. Furthermore, Buzgeia et al. found that both local and imported bottled water brands fulfilled Libyan specifications for metal content. To control lead contamination risk in Libya, they need to give greater attention must be paid to water quality. This is particularly true in regions with deteriorating industrial infrastructure and poor quality control of plumbing materials. In European nations, drinking water has received great attention, and public prevention programs have focused on lead exposure, especially through drinking water. In Germany, a free testing service was provided to private households in cooperation with local public health authorities to evaluate the current level of lead contamination in drinking-water supplies. (6,7,8)

More over in the United States, the approach to preventing childhood lead poisoning has evolved through three major phases over the past 50 years. Initially, from 1971 to 1991, the focus was on medical intervention. This shifted between 1992 and 2015, when strategies began to incorporate housing and health measures for primary prevention. Since 2015, efforts have been concentrated on broadening successful interventions and addressing other health issues related to housing. (8)

Due to the absence of a lead control program in Libya and the multifactorial nature of lead intoxication, many Libyan children can be affected by lead toxicity without seeking medical advice, and the situation can worsen if accompanied by chronic thumb sucking. We describe a child with a long-standing thumb-sucking habit, combined with daily outdoor soil play, who was diagnosed with a blood lead level of 19 µg/dL, associated with expressive speech delay, and in whom behavioral cessation of the habit paralleled a fall in blood lead level and resolution of the speech difficulty.

Case Presentation

A 4-year-old boy presented with delayed expressive speech. Gross and fine motor development was age-appropriate, and all primary teeth had erupted, with dental caries on the labial surface of the upper incisors. The parents reported that he had difficulty speaking in full sentences and communicating verbally with others, prompting further work-up.

His developmental and behavioral history was notable for a thumb-sucking habit that began at 4 months of age and persisted thereafter. The habit occurred specifically during quiet periods before sleep, when the child was hungry, frightened, or watching television; he was not reported to suck on any other object, toy, or surface other than his fingers. The family noted that the child played in soil daily, sucking unwashed fingers after playing on contaminated ground or floors, with no peeling paint or traditional remedies. They lived in a new house, away from the highway, with no fuel station nearby, and in a good socioeconomic class. His mother and father were lecturers at the university.

He has one sister below 5 years (3years) who had age-appropriate language, gross, and fine motor development. She did not have a thumb-sucking habit, and they lived in the same house. sharing the same food and water sources. Her plasma lead level was 10 µg/dl.

General physical examination revealed normal growth with no pallor, hepatosplenomegaly, or focal neurological findings. His Developmental Quotient (DQ) was 77.

Diagnostic assessment

The laboratory evaluation results are presented in Table 1. The child's blood lead level was 19 µg/dL, which is above the CDC blood lead reference value of 3.5 µg/dL (10). Hemoglobin was mildly reduced at 10.7 g/dL with a normal white cell count, and iron indices (iron 36 µg/dL, TIBC 286 µg/dL, UIBC 250 µg/dL) suggested early iron insufficiency, with a low calculated transferrin saturation. This is clinically relevant because iron deficiency increases gastrointestinal lead absorption and commonly coexists with pediatric lead poisoning. Serum calcium, thyroid-stimulating hormone, and free T4 levels were within normal limits, making primary thyroid dysfunction or hypocalcemia unlikely contributors to the child's speech delay.

Table 1. *Laboratory findings at the presentation.*

Parameter	Result	Reference range
Blood lead level	19 µg/dL	< 3.5 µg/dL (CDC reference value)
Hemoglobin	10.7 g/dL	11.0–14.0 g/dL (age-appropriate)
WBC count	6.9 × 10^3/µL	5.0–15.5 × 10^3/µL
Serum iron	36 µg/dL	50–120 µg/dL
TIBC	286 µg/dL	250–425 µg/dL
UIBC	250 µg/dL	150–375 µg/dL
Serum calcium	9.7 mg/dL	8.8–10.8 mg/dL
Free T4	88.6 (assay units as reported)	Within reported reference interval
TSH	3.2 µIU/mL	0.7–5.9 µIU/mL

Therapeutic intervention

Management focused on eliminating the exposure pathway and supporting lead clearance rather than chelation therapy, consistent with an asymptomatic child whose blood lead level did not reach the threshold at which chelating agents are typically indicated. The child received oral calcium supplementation for three months because calcium competes with lead for intestinal absorption. A bitter-tasting deterrent (Ecrinal, a bitter nail polish formulation) was applied to the thumb to discourage the habit of sucking. The family was also advised to reduce direct soil contact and reinforce hand hygiene after outdoor play.

Outcome and Follow-up

With the consistent use of the bitter deterrent, the child’s thumb-sucking habit stopped. Over the follow-up period, his expressive speech became fluent, and he was able to speak in full sentences, and his speech became clear to foreign listeners. His Developmental Quotient (DQ) was 93. Repeated blood lead testing showed a decline from 19 µg/dL to 9 µg/dL, which temporally corresponded with the cessation of the habit and the calcium supplementation course.

Discussion

This case presents a 4-year-old Libyan boy with a blood lead level of 19 µg/dL, which is more than five times the CDC reference value of 3.5 µg/dL, manifesting as delayed expressive language and a Developmental Quotient of 77. The clinical presentation aligns with the established neurodevelopmental consequences of lead exposure, where even low-level elevations correlate with cognitive deficits, behavioral disorders, and language delays. The subsequent improvement in speech fluency and DQ (rising to 93) following the intervention,

alongside the decline in blood lead from 19 µg/dL to 9 µg/dL, provides compelling evidence that lead toxicity was the primary driver of this child's developmental delay.

In the Libyan setting, chronic thumb sucking emerged as the probable risk factor of elevated lead levels in children. This conclusion was supported by multiple clinical studies. First, the parents reported that the child played in the soil daily and sucked unwashed fingers after playing on a contaminated ground or floor. As documented in Libyan studies, soil contamination with lead is widespread, particularly in urban and industrial areas, with cities such as Tripoli, Benghazi, and Misurata exhibiting very high degrees of contamination (CD > 24). Second, thumb sucking occurred frequently during multiple daily activities, raising the risk of ingesting lead-laden soil particles adherent to the fingers of the children. Third, the child's early iron insufficiency (serum iron 36 µg/dL, low transferrin saturation) is clinically significant, as iron deficiency is known to increase gastrointestinal lead absorption, compounding the exposure risk. Finally, the time-based correlation between habit cessation and the decline in blood lead level from 19 µg/dL to 9 µg/dL strongly supports thumb sucking as the primary exposure route for lead.

Several alternative sources of lead exposure were carefully considered but were deemed less likely to be the cause in this case. House dust and paint were excluded, as the family resided in a new house with no peeling paint, eliminating the classic source of childhood lead poisoning from deteriorated lead-based paint. Drinking water contamination was also considered, as the boy shares the same water source with his sister, whose blood lead level was only 10 µg/dL—elevated but obviously less than her brother's level. This indicate the water is not the only source. Finger sucking was considered the main pathway be existent in this case, accounting for a proximal of 50% of lead exposure. Traditional remedies and cosmetics were excluded by family report. Traffic emissions and proximity to fuel stations were ruled out because the family lived away from highways and had no nearby fuel stations. Food contamination, a recognized source of lead exposure in Libya through fruits and vegetables irrigated with contaminated water, is unlikely to explain the marked difference between siblings who share the same diet and lifestyle.

The management approach—focusing on exposure elimination through bitter deterrent application, calcium supplementation to compete with lead for intestinal absorption, and parental counseling on hand hygiene and soil contact reduction—was appropriate for a mildly symptomatic child with a blood lead level below the threshold for chelation therapy. The intervention over six-month period produced remarkable improve after cessation of thumb-sucking, the blood lead was declined to 9 µg/dL, associated with significant improvement in speech fluency and DQ (from 77 to 93). This favorable outcome supports the importance of early detection through the establishment of a lead screening program and the introduction of preventive measures. Furthermore, Libyan studies have documented widespread soil contamination, elevated lead levels in agricultural products, groundwater pollution, and breast milk contamination, indicate healthcare providers must maintain a high index of suspicion for lead exposure in children with neurodevelopmental concerns.

Aiman M. Bobaker et al. revealed that fingernail samples from Libyan farmers had elevated levels of lead (Pb). This agricultural pathway is particularly concerning because it suggests that lead contamination enters the food chain not only through contaminated irrigation water and soil. Serrar et al. evaluated breast milk from lactating women in Misrata and found that 98.5% of samples exceeded the WHO acceptable lead limits, with estimated weekly intakes of lead and Cd exceeding the provisional tolerable weekly intake in multiple samples. These findings highlight the need for urgent interventions to protect infant health, as breastfeeding poses a significant risk of environmental lead contamination from mother to child. (9, 10) Together, these studies reveal that lead exposure in Libya is widely spread, also it extends deeply into agricultural communities through pesticide and fertilizer use and breast milk contamination. This complex exposure supports urgent need to comprehensive screening, occupational protection, and interventions to break the cycle of contamination.

Limitations

This case is alarming, as it suggests an increased risk of lead poisoning among Libyan children, further population-based studies is required to get more generalized data.

Conclusion

This case demonstrates significant role of chronic thumb sucking in exposing child to lead contamination specially in the Libyan setting, where environmental lead contamination is persistent. In absence of lead control program in Libya such case emphasizes urgent need for establishing lead screening program in Libyan children, and introduce public health interventions to reduce environmental lead contamination in Libya.

Implications and public health recommendations

1. Public health authorities in Libya should establish and implement a BLL screening program for the population.
2. known or suspected to be at risk of lead exposure. It must be referred for the measurement of lead levels in biological and environmental samples. provide effective and rapid diagnosis, treatment, and increased awareness of lead poisoning and other environmental threats.
3. Establish and implement housing intervention and health measures for primary prevention of lead poisoning.
4.

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Ethical Statement: This case study was conducted in compliance with the Declaration of Helsinki. All investigation performed were part of routine clinical care, and no experimental interventions were undertaken. Written informed consent was obtained from the child's parents for the publication of this case report, the patient's identity has been fully anonymized to protect confidentiality.

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Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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