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SYSTEMATIC REVIEW: THE RELATIONSHIP BETWEEN LEAD EXPOSURE IN CHILDREN AND PARENTAL OCCUPATION

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ABSTRACT

Lead is a toxic heavy metal and a common occupational and environmental toxin. Lead is used in more than 900 occupations. Lead exposure may produce serious consequences for the health of children. We do meta-analysis articles from PubMed, Google Scholar and Science Direct. We found 24 studies from 14 countries after selected from 1703 countries. Results showed that parental occupations that can increase lead levels include are e-waste worker, fishing net production, lead industry worker, construction, household bullet production, vehicle employee, mining worker, farmer, technician, repair work at home, smelting worker, metal seeker, plumber, battery/lead recycler, laundry-person, artisanal worker, scrap metal cookware production, and jewelry production.

Keywords: *blood lead level, children, parental occupation.*

1. Introduction

For over two millennia, there has been documented evidence of lead poisoning. Despite this long history, lead is still the most commonly used non-iron-based metal in our economic system because it possesses exceptional qualities, such as being durable, easily shaped, resistant to decay, a good conductor of electricity, having a low melting point, and being completely recyclable (1). Lead (Pb), a harmful substance, exists in the environment within the air, soil, and bodies of water.

Expectantmothers and young chil dren are the demographic most susc eptible to the harmful effects of lead (2). The prevalence of lead exposure had a considerable negative impact on both international public health and economic stability in 2019, with estimates indicating that lead exposure resulted in 765 million IQ points lost in children and 5.5 million deaths related to cardiovascular issues.

A research paper from 2021 emphasized that 632 million children, primarily located in countries with low to moderate incomes, have blood lead concentrations beyond 5 µg/dL, which was formerly the standard blood lead level for children in the United States. Additionally, a report issued by the United Nations Children's Fund (UNICEF) in 2020 proposed that potentially 800 million children could demonstrate blood lead levels higher than this designated limit (3).

Lead represents a hazardous heavy metal that frequently acts as a toxin in both work-related and environmental contexts. Children's health may suffer significantly as a result of contact with lead. The asymptomatic presence of lead poisoning has become increasingly prevalent among young people as a result of the element's widespread existence in the environment and its ongoing application across various sectors (4). The potential for lead poisoning arises in children because of their tendency to consume inedible objects (pica), their oral-centric exploratory behaviors, their heightened absorption of ingested lead relative to adults, and their greater susceptibility to lead poisoning owing to their still-developing central nervous systems (5).

Children face a greater risk of lead toxicity due to the distinctive characteristics of their growth and developmental phase, wherein their absorption rate of lead is approximately four to five times greater than that of adults, whereas their lead excretion rate is only around two-thirds of that observed in adults (6). Lead has the capacity to permeate the body through the respiratory system, the digestive system, and the skin, and subsequently spread via the systemic circulation (7), inducing toxicity in diverse tissues and organs, including the liver, kidneys, blood system, central nervous system (CNS), bones, and teeth (8). Lead is used in more than 900 occupations (9). Kids whose

parents have jobs where they might come into contact with lead are at risk of indirect exposure. Lead can be unintentionally transported from the workplace by a parent and end up on their skin, clothing, or footwear, later being deposited in their residences or cars. Earlier studies have indicated significant lead contamination in the dust found within the residences or vehicles of individuals employed in construction or lead-based paint removal. Additional research has revealed increased lead levels in the bloodstream of offspring whose parents worked in areas such as construction, radiator and battery maintenance, metal recycling, paint-related tasks, furniture restoration, and lead oxide creation (10). Lead is also found in industrial products and household items, including gasoline, paint, ceramics, ceramic glazes, canned food, candy, cosmetics, jewelry, toys (7), stained glass, and crystal containers (11). Although leaded gasoline, paints, toys, drinking water, and other major sources are being faded out, there still exist pockets of lead exposure which need deliberation and study (12). In Indonesia, lead exposure has been attributed to the haphazard collection and recycling of Used Lead-Acid Batteries (ULABs), Pb in paint, artisanal and small-scale gold mining, industrial activities, cigarettes, and few other Pb related activities (2).

This systematic review aims to know relationship lead exposure children and parental occupation.

2. Materials and Methods

We review the literature on the relationship lead exposure between children and parental occupation. For this systematic review, the PRISMA guidelines were followed.

a. Search strategies

A comprehensive search of databases was undertaken using PubMed, Science Direct, and Google Scholar which were searched up from January 1, 2015 to July 01, 2025. For the PubMed, Science Direct and Google Scholar, the keywords were "Blood Lead Level", "Children", "Parental Occupation".

b. Eligibility criteria

Inclusion Criteria: In this review, studies that fulfilled the following criteria were considered for inclusion.

- Population: Children.
- Exposure: Lead from parental occupation
- Comparator: The reported reference group (non-exposed group) for each study.
- Outcomes: Articles reported the health effects of lead exposure of children from parental occupation.
- Study Design: A cross-sectional study, cohort, meta-analysis, case control, case study.
- Time frame: All studies reported up from January 1, 2015 to July 1, 2025, were considered.
- Language of published articles: Only full-text articles written in English were considered.
- Publication issue: Peer-reviewed journal articles published from January 1, 2015 to July 1, 2025.

Exclusion criteria: No registration (DOI/ISSN), only abstract, no lead/plumbum, no children, no parental occupation were excluded.

c. Data abstraction/extraction

The data extraction format was included (name of the author and publication year, study country, study design, participant, research instrument and research result. Zotero reference manager software was used to collect and organize studies and for the removal of duplicate studies. The PRISMA flow diagram was used to summarize the selection process.

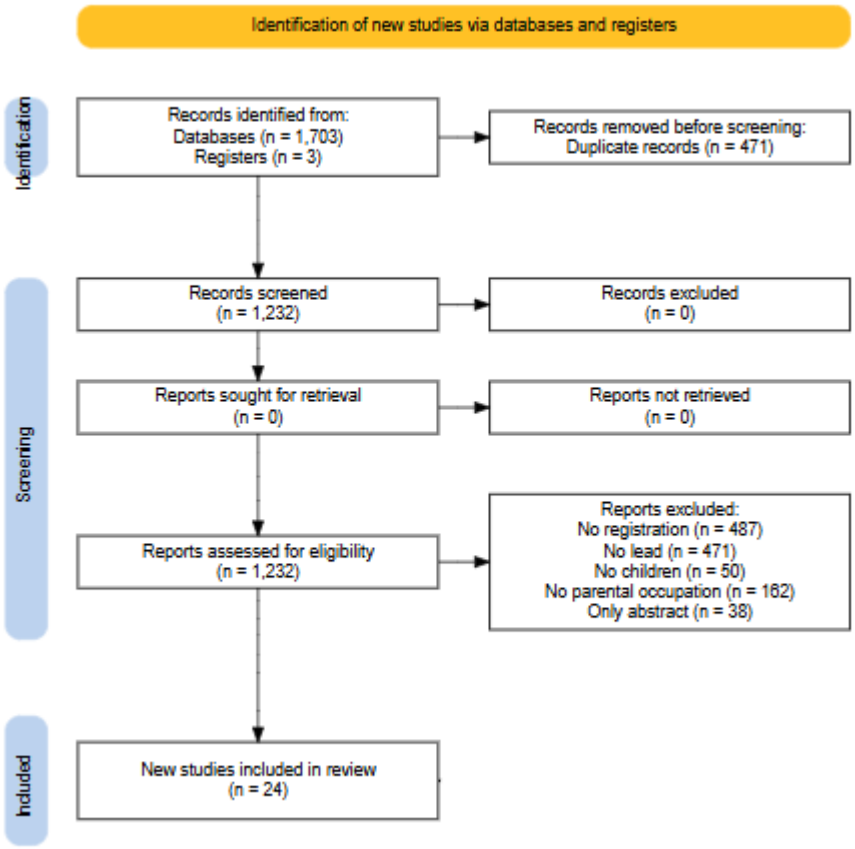
3. Result

During the searching process, a total of 1.703 studies were identified. They were identified from PubMed, Science direct, AJOL, and Google Scholar. From a total of 1.703 articles, 471 articles were removed because duplication, 487 were removed after no registration (DOI/ISSN), 471 articles were removed because no lead/plumbum, 50 articles were removed because no children, 162 articles were removed because no parental occupation. Moreover, 38 articles were excluded for abstract only. Lastly, 24 articles were included in this systematic review.

Articles from country China (6), Iran (1), Thailand (1), USA (3), Georgia (1), Sweden (1), Tanzania (1), Indonesia (2), Uruguay (1), India (2), Bangladesh (1), Madagascar (1), Zimbabwe (1), and Congo (1).

From 24 studies, 13 studies had correlation between paternal occupation and elevated high blood lead level (BLL >3,5µg/dL), 11 studies didn't have correlation between paternal occupation and elevated high blood lead level. Parental occupations that can increase lead levels include are e-waste worker, fishing net production, lead industry worker, construction, household bullet production, vehicle employee, mining worker, farmer, technician, repair work at home, smelting worker, metal seeker, plumber, battery/lead recycler, laundry-person, artisanal worker, scrap metal cookware production, jewelry production.

From 24 studies, 13 studies told about the effect of lead exposure. Elevated blood lead level can induce immune cell (impact neutrophil, lymphocyte, monocyte, interleukin counts). Clinical signs of blood lead include anorexia, abdominal pain, vomiting, constipation, tiredness, headache, lethargy, drowsiness, irritability, hyperactivity. Blood lead level make low vitamin D, iron, zinc calcium, TSH (thyroid stimulating hormone) and high GABA. Blood lead level impair mental intellectual development, cognitive, motor and behavioral, academic performance, neurodevelopment (fine motor, gross motor, language, social). Blood lead level can increase cancer disease, atopic dermatitis, allergic rhinitis, anemia. Lead toxic make low birth weight, premature birth, lower height, weight body (stunting, wasting, underweight). Even high blood lead level can seizure, delirium.



No	Author	Year	Country	Study design	Participants	Instrument	Major Findings
1	Zhang et al. (13)	2020	China	Cross sectional	147 children (3-7 years old)	BLL, Questionnaire	Maternal occupation with e-waste (33.3% / p <0.001)
2	Zhang et al. (14)	2017	China	Cross sectional	151 children (3-7 years old)	BLL, Questionnaire	BLL=8.22 µg/dl, Fathers occupation are farmer (20%).
3	Zhang et al. (15)	2025	China	Cross sectional	604 children (3-6 years old)	BLL, Questionnaire	Mother's occupation: company employee (53,7%) Father's occupation: company

							employee (53%)
4	Zardast et al. (5)	2020	Iran	Cross sectional	400 children (1-7 years old)	BLL, Questionnaire	Children whose fathers were laborers had higher BLC (p =0.01)
5	Yimthiang, et al. (8)	2019	Thailand	Cross sectional	311 children (3-7 years old)	BLL, Questionnaire	Parental occupation in producing fishing nets with lead weights (POR 17.54, 95%; CI: 7.093, 43.390; $p <$ 0.001)
6	Wei, et al. (7)	2024	China	Cohort	32 chilren (0-6 years old)	BLL Clinical data	Family members engaged in lead exposure related industries (9,4%)
7	Senanayake, et al. (4)	2023	USA	Case study	1 child (4 years old)	BLL Clinical data	BLL=74,7 µg/dL Father worked in construction
8	Rylander, et al. (3)	2025	Georgia	Cross sectional	1635 children (5-7 years old)	BLL Questionnaire	Household lead bullet production (OR = 6.66; 95% CI: 1.41, 31.6)
9	Rossides, et al. (16)	2023	Sweden	Case control	9653 (maternal) 12521 (paternal)	Clinical data	OR maternal (1.00 (0.88, 1.13)) OR paternal (1.01 (0.96, 1.06))
10	Oliveri, et al. (10)	2022	USA	Cross sectional	320 establihsments	Questionnaire	Lead was found everywhere in the dust taken from the cars of workers (n = 60), showing

							that it was easily carried from the job site; levels varied from 5.7 to 84,000 µg/ft2, with an average level of 234 µg/ft2 when looking at the data geometrically.
11	Nyanza, et al. (17)	2021	Tanzania	Cross Sectional	883 pregnant woman	BLL Questionnaire	The type of work a mother does ($\chi 2$ = 3.36, p = 0.186) and the type of work a father does ($\chi 2$ = 1.38, p = 0.501) were also examined.
12	Mansyur, et al. (2)	2024	Indonesia	Cross sectional	564 children (1-4 years old)	BLL Questionnaire	The type of work a mother does ($\chi 2$ = 3.36, p = 0.186) and the type of work a father does ($\chi 2$ = 1.38, p = 0.501) were also examined.
13	Li, et al. (18)	2025	China	Cross sectional	32543children (1 month – 7 years old)	BLL Questionnaire	Father/mother occupation are as worker, peasantry.
14	Kordas, et al. (19)	2018	Uruguay	Cross sectional	673 children	Pb-blood Pb-urine Questionnaire	Parents have potential occupation exposure to metals (26,9%)

15	Kinally, et al. (1)	2025	World	Meta-analysis	39 studies		BLL impacts was 31.4 µg/L from occupational and take-home exposure
16	Hore et al. (20)	2017	USA	Cross sectional	230 adults and children	BLL, Questionnaire	Repair work at home (CI=4.40(1.80;10.75) Occupational risks (CI=1.74(0.66;4.61))
17	Goel and Chowgule (12)	2019	India	Cross sectional	15 children	BLL, Questionnaire	Jewelry lead smelting undertaken within their houses had a significantly higher BLL (p = 0.004)
18	Chowdhury, et al. (21)	2021	Bangladesh	Cross sectional	69 children	BLL, Soil lead level Interview	Parental occupation didn't have significance to elevated blood lead level
19	Champion, et al. (22)	2022	Madagascar	Cross sectional	362 children (6months-6 years old)	National statistic, Environmental scan survey	Metal worker (p=0.00) Plumber (p=0.03) Battery/lead recycling (p=0.03) Pipeline (p=0.03) Laundry-person (p=0.01)
20	Chagonda, et al. (23)	2023	Zimbabwe	Cross sectional	86 children	BLL, Water lead level Questionnaire	Parental occupational exposure (p=0.550)

21	Carsi, et al. (24)	2024	Congo	Cross sectional	28 workshops	Pb-dust Pb-blood Pb-urine	Resident children from the cookware foundries, had higher urinary Pb [6.2 µg/g creatinine (2.3–19.3), n = 6]
22	Cai et al. (6)	2021	China	Cross sectional	255 children (7-12 years old)	BLL, TSH, FT3, FT4, GABA Questionnaire	80% of their parents work as miners or farmers
23	Ansari, et al. (25)	2020	India	Cross sectional	41 children	BLL, Questionnaire	Paternal occupation farmer (100%)
24	Afandi, et al. (26)	2025	Indonesia	Cross sectional	35 cases dan 40 control	BLL, Questionnaire	Parental occupation (p=0.50)

Summary Finding

No	Author	Year	Country	Occupation	Health effect
1	Zhang et al.	2020	China	Maternal occupation with e-waste (33.3% / p <0.001)	In Guiyu, young individuals exhibited elevated concentrations of Pb, IL-1β, and IL-6, alongside reduced levels of lymphocytes, IL-1RA, and IL-13. A positive relationship was found between the number of neutrophils and Pb exposure.
2	Zhang et al.	2025	China	Mother's occupation: company employee (53,7%) Father's occupation: company employee (53%)	The participants had an average age of 5.4 ± 0.8 years, and their blood lead levels (BLLs) measured 19.7 ± 12.1 µg/L. For every 1 ng/mL rise in Vitamin D levels,

					there was a corresponding 0.29 µg/L drop in BLLs (95% confidence interval: -0.43 to -0.16, p < 0.001). A point of change was observed at a Vitamin D level of 38.679 ng/mL; past this point, further reductions in BLLs were not seen (β = -0.506, 95% confidence interval: -0.777 to -0.235, p <0.001).
3	Zardast et al.	2020	Iran	fathers were laborers had higher BLC (OR=5.56 (1.44-21.40), p=0.01)	Children could had anorexia, weight loss, paleness, constipation, abdominal pain, and vomiting.
4	Yimthiang, et al.	2019	Thailand	Parental occupation in producing fishing nets with lead weights (POR 17.54, 95%; CI: 7.093, 43.390; *p* < 0.001)	Children had low birth weight and and abnormal growth.
5	Senanayake, et al.	2023	USA	Father worked in construction	The patient has a history significant for atopic disease,
6	Rylander, et al.	2025	Georgia	The likelihood of manufacturing lead bullets at home was significantly higher (odds ratio = 6.66, 95% confidence interval: 1.41 to 31.6) when comparing households that did so against those that did not.	Height [cm (mean ± SD)] 116:1±13.0 (p<0.001) Weight [kg (mean ± SD)] 23:8±5.7 (p<0.001)
7	Rosside s, et al.	2023	Sweden	OR maternal (1.00 (0.88, 1.13))	Cancer

				OR paternal (1.01 (0.96, 1.06))	
8	Mansyur, et al.	2024	Indonesia	Children whose fathers exhibited blood lead levels at or above 20 µg/dL alsopresented with comparably heightened blood lead levels (p<0.01CS). The predominant employment category for the parents of the individuals surveyed was that of temporary laborers (30.5%).	
9	Li, et al.	2025	China	Mother's occupation worker (OR worker = 1.53; OR peasantry= 1.31) Father's occupation (OR worker =1.24, OR peasantry =1.25	
10	Hore et al.	2017	USA	Home maintenance and improvements (CI=4.40(1.80;10.75) Job-related hazards (such as jobs in building, bridge or steel construction, marksmanship, or the reuse of metals or batteries) (CI=1.74(0.66;4.61))	
11	Goel and Chowgule	2019	India	Jewelry house lead smelting activity [OR 7.2 (95% CI 1.4–38.3)]	BLL 37.0 ± 29.3 Hb 8.5 ± 2.1 Neurological symptoms included seizures and drowsiness.
12	Champion, et al.	2022	Madagascar	Metal worker (p=0.00) Plumber (p=0.03) Battery/lead recycling (p=0.03) Pipeline (p=0.03) Laundry-person (p=0.01)	The geometric mean BLL (geo-SD) in our study was 6.9 (2.0) µg/dL

13	Carsi, et al.	2024	Congo	Children residing in proximity to establishments manufacturing cookware exhibited elevated lead levels in their urine [6.2 µg/g creatinine (2.3–19.3).	

4. Discussion

In present meta-analysis, parental occupations that can increase lead levels include farmer, metal prospectors, metal seeker, scrap metal cookware maker, battery worker, repair worker, electronics waste worker, ammunition maker, mining worker, jewelry worker, cable solderer, plumber, construction worker, automotive worker, fishing tackle maker, and laundry-person.

Children whose mothers worked in e-waste recycling ($p<0.001$) had the highest lead concentrations. The data indicated that children in Guiyu had higher levels of Pb, Cd, Hg, As, IL-1β, and IL-6, but lower levels of lymphocyte, IL-1RA, and IL-13 (13). A study on Iranian preschool children revealed elevated blood lead levels linked to fathers working as laborers (OR 5.56 (1.44-21.40), p 0.01). The children, who had BLL≥µg/dL, experienced anorexia, weight loss, paleness, constipation, stomachaches, and vomiting (5). A study conducted in Ningbo kindergartens discovered that the average blood lead level among the 604 child participants was 19.7 ± 12.1 µg/L. The results were associated with the mother's occupation ($p<0.001$) and the father's occupation ($p<0.001$). In Vitamin D quintile analysis, compared to the lowest level (Quintile Q1: <24.8 ng/mL), higher quintiles demonstrated notably reduced BLLs. In particular, Quintiles Q2 and Q3 exhibited BLL reductions of −4.08 (95 % CI: −6.77 to −1.4, $p = 0.003$) and −5.98 (95 % CI: −8.65 to −3.31, $p < 0.001$), respectively. Quintile Q4 showed the most significant reductions, with a decrease of −5.82 (95 % CI: −8.5 to −3.14, $p < 0.001$) (15). The investigation into elevated blood lead (Pb) levels in 311 children residing in a coastal fishing community in Pakpoon Municipality, Nakhon Si Thammarat, Thailand, showed a geometric mean BLL of 2.81 µg/dL, ranging from 0.03 to 26.40 µg/dL. Parental work related to producing fishing nets using lead weights was markedly associated with an increase in the prevalence odds ratio (POR) for elevated blood Pb (POR 17.54, 95%; CI: 7.093, 43.390; $p < 0.001$). Elevated blood Pb was linked to a 2.042 (95%; CI: 0.999, 4.174) fold rise in the POR for abnormal growth ($p = 0.050$) (8).

In a clinical case study conducted in Nanning, China, involving 32 children, it was observed that 3 cases (representing 9.4%) involved children whose parents had jobs where they were exposed to lead. The findings revealed that the majority of the 32 children exhibited symptoms such as

excessive activity, being easily annoyed, reduced desire to eat, discomfort in the stomach area, loose stool or difficulty passing stool. The amount of hemoglobin (HGB), the average size of red blood cells (MCV), the average amount of hemoglobin in each red blood cell (MCH), and the percentage of red blood cells in the blood (HCT) in the children with lead poisoning were all lowered to varying extents and were less than what is considered normal. The level of β2-microglobulin in the urine was elevated (7).

In research on the blood lead levels of children in Georgia, it was discovered that manufacturing lead bullets at home (indicated as yes or no: OR = 6.66; 95% CI: 1.41, 31.6) was a predictor of BLLs ≥3.5 μg/dL, but it was not a predictor of BLLs ≥10.0 μg/dL. The average height [cm (mean ± SD)] was 116.1±13.0 ($p<0.001$), and the average weight [kg (mean ± SD)] was 23.8±5.7 ($p<0.001$) (3). In a Swedish study examining the link between parents' work exposure to metals and the chance of their children developing cancer, it was found that 38.5% of mothers and 53.8% of fathers were manual laborers. The cancers that affected the children included leukemia, lymphoma, tumors of the central nervous system, and other types of cancer (16).

In Michigan, a research project assessing possible lead exposure risks for children in their homes pinpointed 320 facilities where lead might be utilized or present. The survey answers indicated that a large number of employees were exposed to lead, and there was insufficient training and application of optimal strategies to stop lead from being transported from the job site. Examination of dust particles (n = 60) taken from employee vehicles revealed lead was routinely carried away from the workplace, with levels spanning from 5.7 to 84,000 μg/ft2 and averaging at 234 μg/ft2 geometrically (10).

According to a study of metalloid effects on young babies in Tanzania, maternal employment ($\chi2 = 3.36$, $p = 0.186$) with 6.2% of mothers working in mining, and paternal employment ($\chi2 = 1.38$, $p = 0.501$) with 29.6% of fathers working in mining (17).

Regarding the research on high blood lead levels in 32,543 children (aged 0-6 years) in China, the findings indicated that if the mother was a worker (OR = 1.53) or a peasant (OR= 1.31) or the father was a worker (OR worker = 1.24, OR peasantry = 1.25), there was a correlation. The total weighted occurrence of Elevated Blood Lead Level, described in this study as BLL ≥ 50 μg/L, was 4.1%, varying across different geographical areas, with the western part of China having the lowest occurrence, Shaanxi province reporting the least, and Hebei province showing the most. Poor hygiene practices, certain traditions, usage of traditional medicines, living on the first floor, substandard drinking water, indoor air contamination, and second-hand smoke exposure are still risk factors for EBLL (BLL ≥ 50 μg/L) among Chinese children aged 0–6 years (from 1 month to under 7 years), even after considering factors like gender, age, region, yearly family

income, education level, and the jobs of parents and guardians (18).

The systematic review of lead exposure found 39 studies were from 26 countries; 22 were from low- and middle-income countries, with an average sample size of 1003 participants. BLL impacts were 31.4 µg/L from occupational and take-home exposure (1). In study of lead exposure among South Asian people in New York City, factor recent repair work at home significantly increased the odds of having elevated blood lead levels (adjusted OR 3.22; 95 % CI 1.49–6.97), having had occupational risks (adjusted OR 2.69; 95 % CI 1.15–6.30) (20).

An investigation into the nerve-related harm caused by lead in children working in India's handmade jewelry sector. Outcomes showed that individuals displaying nerve-related symptoms were more likely to be involved in smelting lead at home [OR 7.2 (95% CI 1.4–38.3)]. Nerve-related symptoms seen in children included fits (n = 12) and sleepiness (n = 3) (12). A blood lead level survey conducted in Madagascar determined that factors statistically related ($p<0.05$, assessed via single-variable logistic regression) to raised BLL (at ≥5 µg/dL) were the father's employment (metal mining/processing (OR: 8.42 and plumbing/pump maintenance) and the mother's employment (laundering clothes (OR: 3.16)) (22). Research on children's blood lead levels in Zimbabwe showed that kids were exposed to lead via their parents' jobs ($p=0.550$) (23).

A biological monitoring investigation of individuals working in cookware production using recycled metal. Surface dust samples were taken from the work areas, and blood and urine samples were obtained from both employees and residents living near the cookware workshops. The average amount of Pb in surface dust was greater in cookware production sites (347 mg/kg). The typical blood Pb amount in cookware workers (n = 24) was 118 µg/L (IQR 78.4–204); children living nearby cookware production sites had higher levels of Pb in their urine [6.2 µg/g creatinine (2.3–19.3), n = 6] compared to adults [2.3 (2.2–2.5), n = 3] (24).

In a study of BLL in children in Patna, 100% of children with BLL exceeding 20µg/dL had fathers employed as farmers. This indicates that all children whose fathers were farmers had high BLL. Children having BLL above 5 µg/dl experienced problems like anemia, excessive activity, decline in school performance, fatigue, headaches, lack of energy, stomach discomfort, and confusion (25).

5. Conclusion

Accumulating evidence suggests that children have high blood lead levels due to their parents' occupations. A meta-analysis found that parental occupations that can increase lead levels include are e-waste worker, fishing net production, lead industry worker, construction, household bullet production, vehicle employee, mining worker, farmer, technician, repair work at home, smelting worker, metal seeker, plumber, battery/lead recycler, laundy-person, artisanal worker,

scrap metal cookware production, and jewelry production.

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