Blood Lead Level among Children Aged 06-36 Month in Kathmandu Valley, Nepal 2015

- 150 — Death
- 100 — Encephalopathy
- Nephropathy
- Frank anemia
- Colic
- 50 —
- 40 — Decreased hemoglobin synthesis
- 30 — Increased vitamin D metabolism
  Increased risk of hypertenson in adulthood
- 20 — Increased nerve conduction velocity
- Increased level of erythrocyte protoporphyrin
- Decreased vitamin D metabolism
- Decreased calcium homeostasis
- 10 µg/dl — Developmental toxicity
  - Decreased IQ Level
  - Decreased hearing
  - Decreased growth
  - Impaired peripheral nerve function
  - Tansplacental transfer

World Health Organization
Country Office for Nepal

NEPAL HEALTH RESEARCH COUNCIL
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Blood Lead Level among Children Aged 06-36 Month in Kathmandu Valley, Nepal 2015

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Dr. Khem Bahadur Karki

Member Secretary (Executive Chief), NHRC

LIST OF ABBREVIATION

AAS	Atomic Absorption Spectrophotometer
ALA	AminuLevulinic Acid
ASV	Anodic Stripping Voltammetry
ATSDR	Agency for Toxic Substances and Disease Registry
BLLs	Blood Lead Levels
CDC	Centers for Disease Control and Prevention
EBR	Ethical Review Board
EPA	Environment Protection Agency
GAELP	Global Alliance to Eliminate Lead in Paint
IARC	International Agency for Research on Cancer
µg/dl	Microgram per Deciliters
NGO	Non- Governmental Organization
NHRC	Nepal Health Research Council (NHRC)
ppm	Parts per Million
WHO	World Health Organization
USFDA	United States Food and Drug Administration
SPSS	Statistical Package for Social Sciences

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EXECUTIVE SUMMARY

Introduction: Lead is a highly toxic metal which has contaminated our environment and creates health problems. Even a very small intake of lead is a serious and sometimes creates a fatal condition. Young children are at the greatest risk of health problems related to lead exposure. This study aims to assess blood lead levels (BLLs) among the children 06-36 months residing in Kathmandu Valley, Nepal.

Materials and methods: This was a hospital based cross -sectional study. A total of 312 children of 06-36 months old visiting paediatric unit of the TUTH, Patan Hospital and Siddhi Memorial Hospital of Kathmandu valley were enrolled in the study. Anodic Stripping Voltammetry (ASV) portable instrument was used to determine the blood lead level in children.Written informed consent were taken from parents and required data were collected using the structured questionnaire from the parents. Data were analyzed using the SPSS version 16.

Results: Out of the total 312 children enrolled in the study, 64.4% had the BLL exceeding the cut off points of centers for diseases control and prevention (CDC), (≥5µg/dl), while 35.6% had less than 5µg/dl of BLLs. A significant association was found between BLLs and the enamel paints painted in different parts of the house like walls, windows and doors (p=0.001). Further, multivariate analysis showed that BLLs was 4.5 times higher in children playing with dirt and dust (p=0.006) and children belonging to the ethnic group such as *Dalits,* disadvantaged *Janajatis* and *Non-Dalits Terai* caste groups, religious minorities and relatively advantaged *janajatis* had found significantly higher BLL compared to upper caste group(p=0.02).

Conclusion: This study demonstrates that children living in homes with the enamel paints on walls, windows and doors, belonging to the lower ethnic group and playing with dirt and dust had found significantly higher BLL. The evidence indicates that lead exposure must be addressed appropriately by health policy makers and argues for an improvement of natural home environment i.e. to reduce the burden of lead in paints. Society and parents need to be aware of the problem on lead poisoning during their childhood.

Keywords: Lead exposure, poisoning, blood lead level, Nepal

CHAPTER 1

INTRODUCTION

1.1 Background

Exposure to lead mainly occurs through inhalation of air and ingestion of lead in food, paint, water, soil, or dust. Lead accumulates in the body, in blood, bone, and soft tissue. Lead is a non-ferrous metal, and it is widely used in varieties of industries and consumer products. However, it is a non-essential element for human body, thus, long-term exposure and subsequent poisoning can affect every organ and systems. For example, lead is harmful to developing brain and nervous system of young children [1]. Its exposure and poisoning in adults can cause Parkinson's disease [2] and anaemia; affect kidneys, cardiovascular system, gastrointestinal tract and reproductive system in both men and women[3]. It is a cumulative toxicant that affects multiple body systems and is particularly harmful to young children. Childhood lead exposure is estimated to contribute to about 600,000 new cases of children developing intellectual disabilities every year. Lead exposure is estimated to account for 143,000 deaths each year with the highest burden in developing regions. The International Agency for Research on Cancer (IARC) has classified lead and inorganic lead compounds in group 2A : probable carcinogen [4]. In the past, lead was commonly used in gasoline as an anti-knocking agent. Now only a few countries use leaded gasoline[5].Besides gasoline, lead is also widely used in electronics, ceramics, crystal glass, lead-acid batteries, cables and paint. Increasing demand and continued use of lead in a wide variety of industrial and consumer products have increased its circulation in air, water and soil and consequential exposure to a large number of people worldwide.

At present there are no publicly available data on import, export and use of lead in Nepalese industries and consumer products being sold in the Nepali market. However, we believe that lead is widely used in following consumer products or industries in Nepal: lead-based paint; lead-acid batteries; lead plates, sheets, strip, foil, lead tubes, pipes and fittings; cable sheathing and alloys (lead alloys, unwrought). Among others, in household settings, potential lead exposure from lead acid battery and lead-based paint are major concerns. For example, a study conducted by Nepalese NGO, LEADERS Nepal has found the concentration of the tested paints up to 200,000 ppm (20%) lead by weight indicating serious exposure to people in Nepal [6]. Thus, there is a potential of lead exposure associated with dust created as painted surfaces deteriorate thorough use and weathering, when these surfaces are

prepared for repainting in homes. Most of these dusts are likely to fall onto surfaces in and around home resulting in their becoming contaminated with lead. Soils in areas where lead paint is present often become contaminated and are important exposure pathways for many children. Unfortunately, there is no information available on the association between the use of lead acid batteries at home and BLLs among children in Nepal, although this is one of the important indoor sources of lead exposure.

No safe blood lead level in children has been identified. Even low levels of lead in blood have been shown to affect intelligence quotient (IQ), ability to pay attention, and academic achievement. However, since 2012 CDC has recommended 5 micrograms per deciliter to identify children with detected blood lead level[7].

1.2 Statement of the problem and rationale for study

Lead is a non-essential element/metal for human body. Thus, long-term exposure and subsequent poisoning can affect all the organs and systems. For example, lead is harmful to developing brain and nervous system of young children[1]. Its exposure and poisoning in adults can cause anemia and Parkinson's disease, and can affect kidneys, cardiovascular system, gastrointestinal tract and reproductive system in both men and women[2, 3]. The IARC has classified lead and inorganic lead compounds in group 2A: probable carcinogen[4].

Over the last six years, an increase in income, availability of easy bank finance, and political stability in Nepal have led to a large expansion of the housing market. The constructions of a large number of houses, multi-story buildings and schools have also led to the consumption of large quantities of paints. In addition, there is a growing tendency among schools to put bright colors to attract students.

Despite the fact that decorative paints contain very high levels of lead, there is no standard for lead in paints in Nepal. Thus, paints containing very high levels of lead are easily and widely available in the market. Likewise, most of the paint containers do not contain labels showing lead concentrations. Therefore, consumers do not have an informed choice. Similarly, painters are also unaware of this problem and often apply or remove paints without any protections (e.g. respirators and gloves). As a result, they are exposed to very high levels of lead aerosols. In addition, there was a potential of lead exposure associated with dust created as painted surfaces deteriorate through use and weathering and when these surfaces are prepared for repainting in homes or schools.

1.3 Research objectives

General

- To assess BLLs among children (06-36 months) living in Kathmandu Valley.

Specific

- To assess BLLs in children residing in Kathmandu valley
- To explore the association between BLLs and socio-demographic variables
- To explore the association between BLLs and environmental variables
- To explore the association between BLLs and paint use in houses
- To explore the association between BLLs and lead acid battery use in houses
- To explore the association between BLLs and playing behaviour of children.

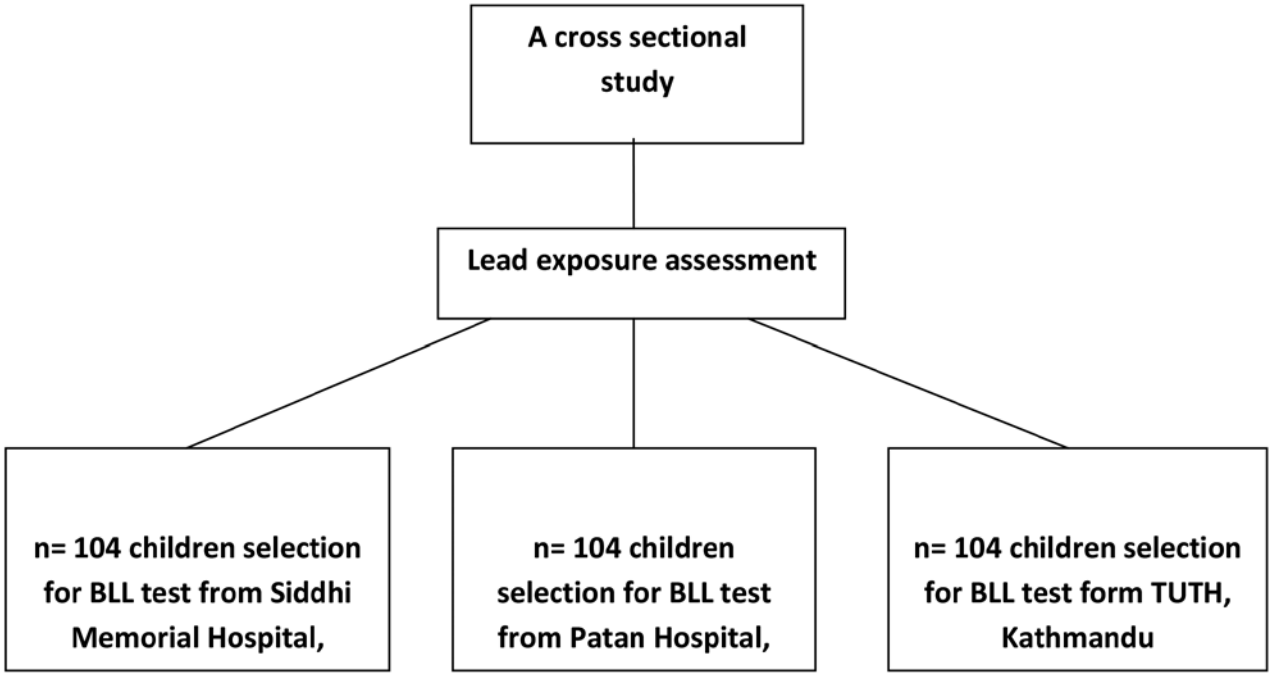
CHAPTER 2

METHODOLOGY

2.1 Study site and its justification

This study was conducted in urban centers of Kathmandu valley. Compared to rural areas, lead-based paints are widely used in urban areas of Nepal. Therefore, the study was mainly focused in the children's visiting the three major hospitals of Kathmandu valley (Patan Hospital, TUTH, and Siddi Memorial Hospitals).

2.2 Sample selection



2.3 Study Population and unit

The study population includes the Children of age group (06-36 months) visiting in three different hospitals (Siddhi Memorial, Patan Hospital, and TUTH). Children among 06-36 months visiting pediatric ward were taken as a study unit.

2.4 Criteria for sample selection

2.4.1 Inclusion criteria

- Children whose parents provided written informed consent
- Children attending for health check-up, immunization, and growth monitoring in pediatric department of three specialized hospitals (TUTH, Patan Hospital and Siddhi Memorial Hospital Bhaktapur) of Kathmandu valley.

2.4.2 Exclusion criteria

- Hospitalized children
- Children who were taking Ayurveda medicine
- Children with known occupational/accidental exposure to lead sources

2.5 Sample size calculation and its justification

The required sample size to compare population means, μo and μ1, with common variance, σ2, is based on the algorithm suggested by van Belle G (2008) equation:[8]

$$n = \frac{2(Z(1-\frac{\alpha}{2})+Z(1-\beta)\text{^}2}{(\frac{\mu o-\mu 1}{\sigma})\text{^}2}$$

For α =0.05 and β =0.20 the values of (Type I error of 0.05) and (Type II error, 0.20, 80% power) are 1.96 and 0.84, respectively. Since it is the one-sample situation, we have divided the numerator by 2. Hence calculated sample size was 312 using σ = 6. Where, non-response rate was assumed 15% for two groups.

The required sample size to compare population means, μo and μ1, with common variance, σ2, is based on the algorithm suggested by van Belle G (2008)[8]—Equation 1—as discussed above.

2.6 Sampling methods / techniques

Purposive sampling method was used for enrolment of children for this study. All participants under this study was recruited from the Department of Paediatrics of TUTH (n=104), Patan Hospital (n=104) and Siddhi Memorial Hospital Bhaktapur (n=104).All the children visiting Out Patient Department (OPD) of these three hospitals were checked up by doctors. After the check-up, counselling was provided to parents of eligible children about BLL study and interested parents were referred to study team for further information. The study team explained the objectives of study, potential risks and benefits of the study. Children whose parents provided written informed consent were enrolled in the study. Posters were also displayed in hospital about sources and adverse effects of lead on human

health. Interestingly, the response rate was 100% in the study.

2.7 Study design

A cross sectional study using quantitative methods.

2.9 Study variables

The dependent variable for this study was BLLs, children's prior-development status (to be reported by patents), and independent variables include environmental lead sources, proximity of home to highway/traffic density, time spent by children in schools and various rooms in the house, children's mouthing activity, home environment, parents' education and occupation, the main source of drinking water, and household socio-economic characteristics.

2.10 Data collection techniques / methods

Data were collected using following data collection techniques: (i) Structured interview questionnaires and (ii) Lead concentration measurement in capillary blood.

2.10.1 Exposure assessment

Structured interview questionnaires was administered by a trained interviewer to predict lead exposure in children. The questionnaire collected the information relating to: environmental lead sources, proximity of home to highway/traffic density, time spent by children in schools and various rooms in the house, children's mouthing activity, home environment, parent's education and occupation, the main source of drinking water and household socio-economic characteristics.

2.10.2 Measurements of Blood Lead Levels (BLLs) in children

Lead testing detects the level of lead in the blood, i.e. BLL. The BLL of children was measured using the Lead Care II Blood Analyzer, which is based on the Anodic Stripping Voltammetry (ASV) method and uses an electrochemical process that detects and measures the level of lead in a blood sample. This test requires about 2 drops of blood (50 µl of capillary blood) and BLL concentration was determined within 3 minutes. The reportable range of BLL from this test instrument was 3.3-65 µg/dL. During the test process, blood was mixed with a reagent, and a portion was dispensed onto single use disposable electrodes (sensors) where plating and subsequent stripping of lead will take place. This is far simpler to administer than traditional blood-lead tests, and the device can be used with capillary or venous sample. As a quality control measure, blood collection was conducted after thoroughly cleansing the fingertip with wet tissue paper.

2.11 Pre-testing the data collection tools

The study questionnaire was translated into Nepali and back-translated to ensure consistency with the English original. Before using the tools in actual study, the reconstituted questionnaires were pilot-

tested in the Siddhi Memorial Hospital and necessary adjustments were made. The data from the pilot testing were not used for the main study data analysis.

2.12 Validity and reliability of the study tools

The study questionnaire was based on the successfully used questionnaire in previously conducted study [9] and its modification was made as per our objectives. The study team extended these questionnaires and modify according to the need. BLLs in children were measured by an ASV based portable instrument, 'Lead Care' [10]. In general BLLs are accepted as the most valid method and reliable indicator of recent excessive lead absorption. ASV device was approved by the WHO and United States Food and Drug Administration (USFDA). This instrument was commonly used in mobile health units and in environmental and occupational health studies. Studies have demonstrated the suitability of 'Lead Care' for testing both occupationally exposed adults and children. Stanton and Fritsch (2007) have shown a good agreement of BLL test results between 'Lead Care' and AAS method [11].

2.13 Potential biases

There was a chance of selection bias in this study. Since the study participants were recruited from the hospital and not from the community or using any form of population sampling frame, which do not represent BLLs of children in the communities.

2.14 Data Management and analysis

The information generated was coded and decoded before the data entry. The data were entered in epi-data and were transferred into SPSS version 16 for data analysis.

2.15 Ethical consideration

The ethical clearance of this study was taken from Ethical Review Board (ERB) of the NHRC. An informed written consent was obtained from the parents of children before conducting the study.

CHAPTER 3

RESULTS

3.1. Socio-demographic characteristics of study population

Table 1 shows the distribution of children by age and sex groups. Of the total 312 children enrolled in the study, about (56.7%) of the children were male and (43.3 %) of the children were female.

Table 1: Age, sex distribution of children

The age group of children was not found significantly different by sex of children.

Age group (months)	Sex of children						p-value
	Male (n=177)		Female (n=135)		Both sexes (n=312)		
	n	%	n	%	n	%	
06-12	54	30.5	45	33.3	99	31.7	0.5
13-24	88	49.7	62	45.9	150	48.1	
25-36	35	19.8	28	20.7	63	20.2	
Total	177	56.7	135	43.3	312	100	

3.2 Stratification of blood lead level

The table 2 shows the stratification of blood lead level of the study population. It was found that 35.6% of the children had 0-5µg/dl of blood lead level and 64.4% have BLL above 5µg/dl which is elevated blood level as per the CDC new guidelines.

Table 2: Stratification of blood lead level of study population

Level	BLL interval (µg/dl)	Frequency	Percent
1	0-5	111	35.6
2	5-10	124	39.7
3	10-15	37	11.9
4	15-20	15	4.8
5	20-25	12	3.8

6	25-30	6	1.9
7	30-35	2	0.6
8	35-40	3	1.0
9	40-45	2	0.6
Total	0-45	312	100

3.3 Relationship of blood lead level with sex

Of the total 312 children enrolled in this study, 64.4% of the children had blood lead level i.e. (≥ 5µg/dl).There was not sufficient evidence to accept that BLLs differ by sex of children.

Table 3: Association between sex and blood lead level in children

Sex of children	Blood lead level						p-value
	0-5µg/dl		≥ 5µg/dl		Total		
	n	%	n	%	n	%	
Male	58	32.8	119	67.2	177	56.7	0.2
Female	53	39.2	82	60.7	135	43.3	
Both sexes	111	35.6	201	64.4	312	100	

3.4 Relationship of blood lead level with age group

The table 4 shows the distribution of age group of children with the BLL, the BLL (≥5µg/dl) in children was 64.4%. Whereas looking at age group, the prevalence of BLL, (≥5µg/dl)in children was highest among the age group of 13-24 months, i.e. 51.7%, followed by 6-12 months olds (27.9%) and 25-36 months olds (20.4%). Compared to all the age group of children blood lead level (≥5µg/dl) was higher in male children (67.2%) than female children (60.7%). Age group of children was not found significantly associated with the BLLs (P = 0.1).

Table 4: Association between the age group and blood lead level in children

Variables	Sex of children					
	Male		Female		Both sexes	
	0- 5 µg/dl	≥5 µg/dl	0- 5 µg/dl	≥5 µg/dl	0- 5 µg/dl	≥5 µg/dl
	n (%)	n (%)	n(%)	n (%)	n (%)	n (%)
06-12 months	24 (41.4)	30 (25.2)	19 (35.8)	26 (31.7)	43 (38.7)	56 (27.9)
13-24 months	25 (43.1)	63 (52.9)	21 (39.6)	41 (50)	46 (41.4)	104 (51.7)
25-36 months	9 (15.5)	26 (21.8)	13 (24.6)	15 (18.3)	22 (19.8)	41 (20.4)
Total	58 (32.8)	119 (67.2)	53 (39.3)	82 (60.7)	111 (35.6)	201 (64.4)
p-value	0.08		0.4		0.1	

3.5 Relationship of blood lead level with ethnicity

The majority (53.8%) of children with the blood lead level (≥5µg/dl) were from the relatively advantaged *janajatis* group, followed by upper caste (31.2%). About 5% of children were from religious minorities, 3.5% were from disadvantaged *Janajatis* and disadvantaged *Non-Dalit Terai* caste groups and 3% were from *Dalits.*

Table 5: Association between ethnic group and blood lead level in children

Variables	Sex of children					
	Male		Female		Both sexes	
	0- 5µg/dl	≥5µg/dl	0-5µg/dl	≥5µg/dl	0- 5µg/dl	≥5µg/dl
	n (%)	n (%)	n(%)	n (%)	n (%)	n (%)
Dalits	1 (1.7)	2 (1.7)	-	4 (4.9)	1 (0.9)	6 (3.0)
Disadvantaged Janajatis	1 (1.7)	4 (3.4)	2 (4)	3 (3.7)	3 (2.8)	7 (3.5)
Disadvantaged non-dalits Terai caste groups	-	5 (4.3)	2 (4)	2 (2.4)	2 (1.8)	7 (3.5)
Religious minorities	6 (10.3)	5 (4.3)	3 (6)	5 (6.1)	9 (8.3)	10 (5.0)
Relatively advantaged Janajatis	17 (29.3)	63 (53.8)	17 (34)	44 (53.6)	34 (31.5)	107 (53.8)
upper caste	33 (56.9)	38 (32.5)	26 (52)	24 (29.3)	59 (54.6)	62 (31.2)
Total	58 (24.7)	117 (75.3)	50 (37.9)	82 (62.1)	108 (35.2)	199 (64.8)
p-value	0.007		0.9		0.001	

Ethnicity was significantly associated with BLLs of the children (p = 0.001). In addition, when compared to sex separately, blood lead level in male, only was found significantly associated with ethnicity (p = 0.007).

3.6 Relationship of blood lead level in children and Parents education status

Table 6 shows that father of majority (29.6%) of children had completed bachelor level, followed by 28.6% completing intermediate level, 21.6% had secondary level, 11.3% had primary level and 9.3% had completed postgraduate.

Table 6: Association of education status of father and mother with blood lead level in children

Variables	Blood lead level of children					
	Father education status			Mother education status		
	0- 5µg/dl	>5µg/dl	Total	0- 5µg/dl	>5µg/dl	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	
Primary level	13 (11.8)	22 (11.3)	35 (11.5)	14 (14.1)	30 (16.9)	44 (15.9)

Secondary level	20 (18.2)	42 (21.6)	62 (20.4)	28 (28.3)	38 (21.3)	66 (23.8)
Intermediate level	33 (30)	54 (27.8)	87 (28.6)	29 (29.3)	64 (36.0)	93 (33.6)
Bachelor	32 (29.1)	58 (29.9)	90 (29.6)	22 (22.2)	41 (23.0)	63 (22.7)
Postgraduate	12 (10.9)	18 (9.3)	30 (9.9)	6 (6.1)	5 (2.8)	11 (4.0)
Total	110 (36.2)	194 (63.8)	304 (100)	99 (35.7)	178 (64.3)	277 (100)
p-value	0.9			0.3		

Of the total population, only 277 mothers were literate among them 33.6% of the mother's had completed intermediated level, 23.8% had secondary level, 22.7% had bachelor, 15.9% had primary level and 4.0% had complete postgraduate studies. It was found that about 63.8% of educated fathers and 64.3% of educated mothers, children's had a blood lead level greater than 5mg/dl. Parent's education status was not found significantly associated with the blood lead level in children.

3.7 Relationship of blood lead level in children and parents occupation status

About 29.5% of the fathers were service holder followed by own business (15.6%) and students (14%). Only 9.1% of fathers were engaged in agriculture. Just about one-third (31.8%) of the fathers were involved in other type of occupation, such as tailors, teacher, painters, foreign workers, drivers, architect, factory workers, etc. Whereas majority (75.2%) of mothers were housewives, followed by service holders 8.7%, own business 4.8%, agriculture 4.2%, and 8.7% were involved in other type of occupations such as teachers, tailors, beautician etc. Parent's occupation status was not significantly associated with the blood lead level in children.

Table 7: Association of father and mother occupation status with blood lead level in children

Variables	**Blood lead level of children**		
	0- 5µg/dl	**≥5**µg/dl	**Total**
	n (%)	**n (%)**	**n (%)**
Father's occupation			
Agriculture	10 (9.2)	18 (9.0)	28 (9.1)
Own business	22 (20.2)	26 (13.1)	48 (15.6)
Service	30 (27.5)	61 (30.7)	91 (29.5)
Students	10 (9.2)	33 (16.6)	43 (14.0)
Others	37 (33.9)	61 (30.7)	98 (31.8)
Total	109 (35.4)	199 (64.6)	308 (100)
p-value	0.2		

Mother's occupation			
Housewife	85 (76.6)	148 (74.4)	233 (75.2)
Agriculture	3 (2.7)	10 (5.0)	13 (4.2)
Own business	4 (3.6)	11 (5.5)	15 (4.8)
Services	8 (7.2)	19 (9.5)	27 (8.7)
Others	11 (9.9)	11 (5.5)	22 (8.7)
Total	111 (35.8)	199 (64.2)	310 (100)
p-value	0.4		

3.8 Relationship of blood lead levels in children and Presence of an inverter (with a lead-acid battery attached) and solar battery in the house

Regarding the presence of an inverter in the house, of the total 64.4% of children with the blood lead level (≥5µg/dl), nearly one-half (49.8%) had inverter in their house. Whereas 50.2% with (≥5µg/dl) of BLLs does not have an inverter in their house. The 35.6% of children who had BLLs less than 5mg/dl, among them 44.1% of have inverter in their house while 55.9% doesn't have an inverter in their house.

Table 8: Association between presence of inverter and solar battery in house with blood lead level in children

Variables	Sex of children					
	Male		Female		Both sexes	
	0- 5µg/dl	≥5µg/dl	0- 5µg/dl	≥5µg/dl	0- 5µg/dl	≥5µg/dl
	n (%)	n (%)	n(%)	n (%)	n (%)	n (%)
Presence of inverter in house (with a lead-acid battery attached)						
Yes	25 (43.1)	62 (52.1)	24 (45.3)	38 (46.3)	49 (44.1)	100 (49.8)
No	33 (56.9)	57 (47.9)	29 (54.7	44 (53.7)	62 (55.9)	101 (50.2)
Total	58 (32.8)	119 (67.2)	53 (39.3)	82 (60.7)	111 (35.6)	201 (64.4)
p-value	0.2		0.9		0.3	
Presence of solar battery in house						
Yes	9 (15.5)	13 (11.1)	6 (11.3)	10 (12.2)	15 (13.5)	23 (11.6)
No	49 (84.5	104 (88.9)	47 (88.7)	72 (87.8)	96 (86.5)	176 (88.4)
Total	58 (52.3)	117 (58.8)	53 (47.7)	82 (41.2)	111 (35.8)	199 (64.2)
p-value	0.4		0.8		0.6	

Among the children who had an inverter in the house, about 27% (male 27.2%, female, 26.7%) of children sleep in the room where the lead acid battery is kept, similarly 35.6% of the children played in the room where lead acid battery was kept (Annex Table A-1). Presence of inverter in the house was not found significantly associated with the blood lead level in children (p = 0.3). Of the total 64.2% of the children with BLLs (≥5µg/dl), only 11.6% of the children with the blood lead level(≥5µg/dl) had the solar battery in the house, while 88.4% doesn't have solar battery. In addition presence of solar battery was also not found significant related with the BLLs in children.

3.9 Relationship of BLLs in children with rooms and parts of the house containing enamel paints

Almost 99.4% (male 100%, female, 98.9%) of the children with (≥5µg/dl) of blood lead level sleeps and plays in the room containing enamel paint. As almost 80.4% of the house and rooms were painted with enamel paints, whereas only 19.6% of the houses or rooms were not painted (Annex table A-2).

Table 9: Association between the rooms and parts of the house containing enamel paints with blood lead level in children

Variables	Sex of children					
	Male		Female		Both sexes	
	0- 5µg/dl	≥5µg/dl	0- 5µg/dl	≥5µg/dl	0- 5µg/dl	≥5µg/dl
	n (%)	n (%)	n(%)	n (%)	n (%)	n (%)
Does the room where the child sleeps and plays contain enamel paint						
Yes	43 (100)	97 (100)	43 (97.7)	64 (98.5)	86 (98.9)	161 (99.4)
No	-	-	1 (2.3)	1 (1.5)	1 (1.1)	1 (0.6)
Total	44 (31.0)	98 (69.0)	44 (40.4)	65 (59.6)	87 (34.9)	162 (64.1)
p-value	-		0.7		0.8	
Parts of the house containing enamel paint						
Wall	-	8 (8.2)	1 (2.3)	10 (15.4)	1(1.1)	18 (11.0)
Window and door	34 (75.6)	40 (40.8)	21 (47.7)	24 (36.9)	55 (61.8)	64 (39.3)
Window, door & wall	11 (24.4)	50 (51.0)	22 (50)	31 (47.7)	33 (37.1)	81 (49.7)
Total	45 (31.5)	98 (68.5)	44 (40.4)	65 (59.6)	89 (35.3)	163 (64.7)
p-value	0.002		0.2		0.003	

Children sleeping and playing in the room that contains enamel paints was not found significantly associated with the blood lead level in children (p = 0.8). In addition, 64.7% (male 68.5%, female, 59.6%) of the children with BLLs (≥5µg/dl) lived in the house painted with enamel paints in different parts, such as wall, window and doors. Enamel painted on wall, window and doors were found

significantly associated with the blood lead level in children (p = 0.003). In addition, it was strongly associated with the blood lead level in male children (p = 0.002). Regarding the brand of paints used in the house, majority (63.4%) don't know which brand they had used to paints their house or rooms. Whereas, 11.5% of the houses were painted with *Pashupati* paints, followed by 10.7% *Asian* paints , 4.7% used *Berger* paints, 3.5% used *Mahalaxmi* paints, 2.7% *Reliance* paints, 1.9% use *Yeti* paints and 1.2% used other type of paints i.e. *Shalimar* paints (Annex table A-3).

3.10 Relationship of blood lead levels and children playing outside with dirt and dust

The table 10 shows that 64.3% of the children had BLLs (≥5µg/dl). About one-quarter (25.5%) of the children goes outside to play. In addition, 74.5% of the children with BLLs (≥5µg/dl) don't go outside to play. Children playing outside were found significantly associated with the BLLs (p = 0.003). Compared to sex individually male children playing outside were significantly associated with the blood lead level (p=0.002). Regarding the children playing with dirt and dust; about 42.9% (male 41.5% and female, 45%) of children with BLLs (≥5µg/dl) play with the dirt and dust. Children playing with dirt and dust were found significantly associated with the blood lead level (p = 0.0001). Of the total children who play with dirt and dust, 39.2% (male 36.8%, female, 42.5%) of the children with BLLs (≥5µg/dl) were found eating dirt and dust while playing. Children's eating dirt and dust was not significantly associated with the blood lead level in children (p = 0.06).

Table 10: Association between children playing outside with dirt and dust with blood lead level in children

Variables	Sex of children					
	Male		Female		Both sexes	
	0- 5µg/dl	≥5µg/dl	0- 5µg/dl	≥5µg/dl	0- 5µg/dl	≥5µg/dl
	n (%)	n (%)	n(%)	n (%)	n (%)	n (%)
Children playing outside						
Yes	3 (5.2)	29 (24.6)	9 (17)	22 (26.8)	12 (10.8)	51 (25.5)
No	55 (94.8)	89 (74.4)	44 (83)	60 (73.2)	99 (89.2)	149 (74.5)
Total	58 (33.0)	118 (67.0)	53 (39.3)	82 (60.7)	111 (35.7)	200 (64.3)
p-value	0.002		0.1		0.003	
Children playing with dirt or dust						
Yes	13 (22.4)	49 (41.5)	11 (21.2)	36 (45)	24 (21.8)	85 (42.9)
No	45 (77.6)	69 (58.5)	41 (78.8)	44 (55)	86 (78.2)	113 (57.1)
Total	58 (32.8)	118 (67.2)	52 (39.4)	80 (60.6)	110 (35.6)	198 (64.4)
p-value	0.01		0.005		0.0001	

Children eating dirt or dust						
Yes	3 (16.7)	21 (36.8)	6 (27.3)	17 (42.5)	9 (22.5)	38 (39.2)
No	15 (83.3)	36 (63.2)	16 (72.7)	23 (57.5)	31 (77.5)	59 (60.8)
Total	18 (22.9)	57 (77.1)	22 (33.3)	40 (66.7)	40 (27.5)	97 (72.5)
p-value	0.1		0.2		0.06	

3.11 Relationship of blood lead levels and Children playing with painted toys, batteries and peeling off paints from wall

Almost 76.9% (male 79.3, female 73.4) of children with the blood lead level (≥5µg/dl) play with the painted toys. Of the total children , nearly one-quarter (23.1%) with blood lead level (≥5µg/dl) play with batteries of which 23.9% were male and 21.9% were female. The children playing with the painted toys and batteries were not found significantly associated with the detected level of lead in blood.

Table 11: Association between children playing with painted toys, batteries and peeling off paints from wall with blood lead level in children

Variables	Sex of children					
	Male		Female		Both sexes	
	0- 5µg/dl	≥5µg/dl	0- 5µg/dl	≥5µg/dl	0- 5µg/dl	≥5µg/dl
	n (%)	n (%)	n(%)	n (%)	n (%)	n (%)
Children playing with painted toys						
Yes	45 (77.6)	92 (79.3)	39 (76.5)	58 (73.4)	84 (77.1)	150 (76.9)
No	13 (22.4)	24 (20.7)	12 (23.5)	21 (26.6)	25 (22.9)	45 (23.1)
Total	58 (32.8)	116 (67.2)	51 (39.3)	79 (60.7)	109 (35.6)	195 (64.4)
p-value	0.9		0.8		0.9	
Children playing with batteries						
Yes	9 (15.5)	28 (23.9)	12 (23.1)	18 (21.9)	21 (19.1)	46 (23.1)
No	49 (84.5)	89 (76.1)	40 (76.9)	64 (78.1)	89 (80.9)	153 (76.9)
Total	58 (32.8)	117 (67.2)	52 (38.8)	82 (61.2)	110 (35.4)	199 (64.6)
p-value	0.2		1.0		0.4	
Children peeling off paint from wall						
Yes	-	7 (6.0)	2 (3.8)	4 (4.9)	2 (1.8)	11 (5.6)
No	57 (100)	109 (94.0)	50 (96.2)	78 (95.1)	107 (98.2)	187 (94.4)
Total	57(32.8)	116 (67.2)	52 (39.3)	82 (60.7)	109 (35.6)	198 (64.4)
p-value	0.09		1.00		0.1	

Regarding children peeling off the paints from the wall, only 5.6% with BLLs (≥5µg/dl) peel off the paints from the wall. Children's peeling of the paints from the wall was not significantly associated with the blood lead level (P=0.1).

3.12 Relationship of blood lead level with Schooling of children

Of the total children only 16.4% (male 16.8%, female, 15.9%) with the blood lead level (≥5µg/dl) and 9% (male 3.4%, female, 15.1%) with the low detected (≤5µg/dl) blood lead level went to school.

Table 12: Association between schooling of children and blood lead level in children

Variables	Sex of children					
	Male		Female		Both sexes	
	0- 5µg/dl	≥5µg/dl	0- 5µg/dl	≥5µg/dl	0- 5µg/dl	≥5µg/dl
	n (%)	n (%)	n(%)	n (%)	n (%)	n (%)
Schooling of children						
Yes	2 (3.4)	20 (16.8)	8 (15.1)	13 (15.9)	10 (9.00)	33 (16.4)
No	56 (96.6)	99 (83.2)	45 (84.9)	69 (84.1)	101 (91.0)	168 (83.6)
Total	58 (32.8)	119 (67.2)	53 (39.3)	82 (60.7)	111 (35.6)	201 (64.4)
p-value	0.01		0.9		0.07	
Enamel paint on walls/windows of school/nursery						
Yes	1 (100)	19 (95)	7 (87.5)	12 (100)	8 (88.9)	31 (96.9)
No	-	-	1 (12.5)	-	1 (11.1)	-
Total	1 (9.1)	19 (90.9)	8 (40)	12 (60)	9 (23.8)	32 (76.2)
p-value	NA		0.4		0.2	

Almost 96.9% of the parents mentioned walls/windows of their school/ nursery were painted with enamel paints.

3.13 Relationship of blood lead level with Schooling of children

The blood lead level of children was significantly associated with area of residence of children (Table 13). Children living in Bhaktapur area had higher lead level in blood.

Table 13: Association between area of residence and blood lead level in children

Area of residence	Blood lead level						P-value
	0-5µg/dl		≥ 5µg/dl		Total		
	n	%	n	%	n	%	
Bhaktapur	23	20.7	84	41.8	107	34.3	0.003
Kathmandu	55	49.5	75	37.3	130	41.7	
Lalitpur	31	27.9	40	20.0	71	22.7	
Others	2	1.8	2	1.0	4	1.3	
Total	111	35.6	201	64.4	312	100	

3.14 Relationship of blood lead levels and motor and mental development delay in children

Of the total children surveyed, only 11.4% (10.9% male, 12.3% female) of the children with the blood lead level (≥5µg/dl) had a motor developmental delay. The developmental delay mentions by the parents were late walking 46.9%, late speaking 28.1% and late standing 12.5% (Annex Table A-4).

Table 14: Association between motor and mental development delay in children with blood lead level

Variables	Sex of children					
	Male		Female		Both sexes	
	0- 5µg/dl	≥5µg/dl	0- 5µg/dl	≥5µg/dl	0- 5mg	≥5µg/dl
	n (%)	n (%)	n(%)	n (%)	n (%)	n (%)
Motor developmental delay						
Yes	2 (3.4)	13 (10.9)	7 (13.2)	10 (12.3)	9 (8.1)	23 (11.4)
No	56 (96.6)	106 (89.1)	46 (86.8)	72 (87.8)	102 (91.9)	178 (88.6)
Total	58 (32.8)	119 (67.2)	53 (39.3)	82 (60.7)	111 (35.6)	201 (64.4)
p-value	0.09		0.8		0.3	
Mental developmental delay						
Yes	-	3 (2.5)	2 (3.8)	-	2 (1.8)	3 (1.5)
No	58 (100)	116 (97.5)	51 (96.2)	82 (100)	109 (98.2)	198 (98.5)
Total	58 (32.8)	119 (67.2)	53 (39.3)	82 (60.7)	111 (35.6)	201 (64.4)
p-value	0.5		0.1		1.0	

Of the total children enrolled in the study, only 1.5% of the children with the blood lead level (≥5µg/dl) had mental developmental delay. The symptoms of mental development delay mention by the parents were late understandings 20% and learning problems 80%. Almost 99.4% of the parents perceived their children to be physically active, whereas only 0.6% indicates their children were not physically active (Annex table A-4).

3.15 Relationship of blood lead levels and construction work near the house

Of the total children enrolled in the study only, 4.5% of the house with the children having BLLs (≥5µg/dl) and 3.6% with BLLs less than 5mg/dl were under- construction in the past six months.

Table 15: Association between construction work near the house and blood lead level in children

Variables	Sex of children					
	Male		Female		Both sexes	
	0- 5µg/dl	≥5µg/dl	0- 5µg/dl	≥5µg/dl	0- 5µg/dl	≥5µg/dl
	n (%)	n (%)	n(%)	n (%)	n (%)	n (%)
Construction work done on children house						
Yes	1 (1.7)	7 (6.0)	3 (5.8)	2 (2.4)	4 (3.6)	9 (4.5)

No	57 (98.3)	110 (94.0)	49 (94.2)	80 (97.6)	106 (96.4)	190 (95.5)
Total	58 (33.1)	117 (66.8)	52 (39.3)	82 (60.7)	110 (35.8)	199 (64.2)
p-value	0.2		0.3		1.0	
Construction work done near children house						
Yes	7 (12.3)	23 (19.8)	9 (17.0)	17 (21.0)	16 (14.5)	40 (20.3)
No	50 (87.7)	93 (80.2)	44 (83.0)	64 (79.0)	94 (85.5)	157 (79.7)
Total	57 (33.1)	116 (66.8)	53 (39.3)	81 (60.7)	110 (35.8)	197 (64.2)
p-value	0.3		0.6		0.3	

While regarding the construction near the house about 20.3% of the houses with the children having BLLs (≥5µg/dl) and 14.5% with the BLLs less then 5µg/dl were taking place near the surveyed children house.

3.16 Relationship of Blood lead level in bivariate (crude odds ratio) and multivariable model (adjusted odds ratio)

The table 15 shows the blood lead level under ethnicity category where children playing outside in dirt and dust, children eating dirt and dust, schooling of children, parts of house with enamel paints, and peeling off the paints from the wall in bivariate and multivariate analysis.

In bivariate analysis ethnicity, children playing outside with dirt and dust and parts of the house with enamel paints were found significantly associated with the blood lead level. Further multivariate analysis showed that BLLs was 4.5 times higher in children playing with dirt and dust (p=0.006) than their counterparts and children belonging to the ethnic group such as *Dalits*, disadvantaged *Janajatis* and *Non-Dalits Terai* caste groups, religious minorities and relatively advantaged *Janajatis* had found significantly higher blood lead level compared to upper caste group (p=0.02).

Table 16: Association between blood lead level and variables in bivariate (crude odds ratio) and multivariate model (adjusted odds ratio)

Variable	Crude odds ratio (95% CI)	p- value	Adjusted odds ratio (95% CI)	p- value
Ethnicity				
Dalits, disadvantaged janajatis and non-dalits Terai caste groups, religious minorities and relatively advantaged janajatis	2.661 (1.641- 4.314)	0.0001	3.432 (1.164- 10.120)	0.02

Upper caste	Reference		Reference	
Children playing outside				
Yes	2.824 (1.433- 5.564)	0.003	2.667 (0.742- 9.585)	0.1
No	Reference		Reference	
Children playing in dirt and dust				
Yes	2.695 (1.582- 4.592)	0.0001	4.526 (1.550-13.217)	0.006
No	Reference		Reference	
Children eating dirt and dust				
Yes	2.218 (0.951- 5.176)	0.06	1.413 (0.442- 4.520)	0.5
No	Reference		Reference	
Schooling of children				
Yes	1.984 (0.938- 4.197)	0.07	3.455 (0.887-13.453)	0.07
No	Reference		Reference	
Parts of house with enamel paints				
Window door & wall	2.502 (1.472- 4.254)	0.001	1.398 (0.496-3.937)	0.5
Door & window	Reference		Reference	
Peeling off paints from the wall				
Yes	3.147 (0.685- 14.465)	0.1	1.289 (0.101-16.425)	0.8
No	Reference		Reference	

CHAPTER 4

DISCUSSION

We analyzed blood lead level data for 312 children who presented to the clinic for the regular checkups in TUTH, Patan hospital and Siddhi Hospital of Kathmandu valley. 'No safe' blood lead level (BLL) in children has been identified [12-14]. Our study findings show that 64.4% of the children had blood lead level exceeding the CDC cutoff points (≥ 5µg/dl). Whereas 35.6% of the children had BLL below the CDC cutoff points (less than 5mg/dl). This study is comparable to the study conducted in the Primary School Children of Kathmandu Municipality, Nepal[15].

From the analysis, we found that (67.2%) of male children had higher BLLs and higher prevalence of lead poisoning than Female children i.e. (60.7%). The finding of our study is comparable to the observations conducted in US and Canada [16, 17]. This may be due to several possible explanations. First, boys may participate in extra outdoor activities than girls, which results in a higher lead exposure. Second, boys are prone to have behavioral patterns, such as being naughty, active; and have worse health habits compared to girls, which may lead to more lead exposure. A recent study conducted in Baltimore, Maryland showed that the association of gender and BLL was modified by physical activity and race/ethnicity [18].

We also found blood lead level in children was significantly associated with a lower ethnic group of children, such as *Dalits*, disadvantaged *Janajatis* and *Non-Dalits Terai* caste groups, religious minorities and relatively advantaged *Janajatis* ($p=0.001$ in bivariate and $p=0.02$ in multivariate). This might be explained by the fact that the lower ethnic groups of children belong to families with lower socio-economic status. Socio-economic conditions of the parents can adversely affect the lives of children in many ways; low economy people usually work in the hazard control areas where the potential sources of lead may be present and the children often accompany the parents to the hazardous area and play and spent the whole day in such environment without any protection. Most of the children might even carry food preserved in the newspapers and eat it without washing their hands. It was reported in the study conducted in the past, that wrapping sandwiches in newspapers and the behavior of putting their hand in the mouth was a significant predictor of lead exposure in children [19]. Besides, deficient of clean drinking water, nutritious and healthy food lead to the cause of undernourishment in children. In addition, ethnic group of children's may also be exposed to

different sources of lead at home such as dirt and dust. Some of the studies have also found that dust lead levels in homes were more closely correlated than any other sources [20, 21].

Our findings show almost 80.4% of the rooms and houses were painted with the enamel paints. Our study also revealed significant association of enamel paints painted in different parts of the house (wall, windows & doors) with the blood lead level in bivariate analysis (p=0.001). It may explain by the fact enamel paints on the walls, windows and doors might be contaminated with the dust coming from the outdoors. In addition, every house painted with the lead based paint on the interior or exterior are more likely to have contaminated with lead dust above U.S. Environmental Protection Agency (EPA) clearance levels[22] as well as the paints used in Nepal have confirmed high lead contents [23] beyond the limit set by Global Alliance to Eliminate Lead in Paint (GAELP). Although GAELP set a limit of 90 ppm [0.009%] in paint and many countries have already established paint regulation to meet the standard of GAELP. However, Nepal has also already recommended 90 ppm for lead in paints and is in the process to come in legislation and actions for eliminating lead from paints.

The finding shows that children's who go outside to play was significant with the blood lead level (p=0.003). This may be explained by the facts that the children might have regular playing habit with the cheap toys, dust, painting materials, duration of time spent to play and hand-to-mouth activities may led the younger children to inhale or ingest lead from dirt or dust while playing outdoors. The finding also showed that children playing with dirt and dust were significantly associated with the BLLs (p<0.001). Ingestion of dirt and dust during playtime activity appears to be a more significant pathway than inhalation for young children [24]. Among the children who play dirt and dust about 39.2% with the BLLs (≥5µg/dl) were found to be eating dirt and dust. Though no significant association was found in our study still different investigators have found extensively varying associations between levels of lead in dust and children's blood lead levels. Blood lead levels usually rise to about 3-7 µg/dL for every 1,000-ppm increase in dust lead concentrations [24-26]. The study was hospital-based and limited within the Kathmandu valley. Thus, the study does not intend to represent the national level. However, this provide for the first time, important baseline about BLL among children in Nepal. Further studies are needed to determine attributing factors of high BLL in children in Nepal.

CHAPTER 5

CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

Lead can be toxic to the people of any age group, but young children are at higher risk because their bodies absorb more of it, and they are more vulnerable than adults to the effects of lead exposure. This is the first study conducted to characterize the lead exposure and lead poisoning from lead-based paint and lead acid battery among children 06-36 months in Kathmandu Valley, Nepal. Blood lead level in children is a matter of health concern as lead exposure can affect nearly every system in the body, thus, the study team investigate about 312 children from three different hospitals of Kathmandu valley. The findings showed that about 64.4% of the children exceeds the CDC standard of blood lead level (≥5µg/dl) whereas 35.6% had a blood lead level less than 5µg/dl.

Based on this study finding, it can be concluded that blood lead level was significantly associated with the enamel paints in different parts of the house (p=0.001). As our finding also shows that almost 80.4% of the houses contain enamel paints and usually painted on the windows, doors and walls. By simply opening and closing a window and doors containing lead-based paint, lead dust can be released and that can cause irreparable damage to the children.

Apart from the children belonging to ethnic group such as *Dalits*, disadvantaged *Janajatis* and *Non-Dalits Terai* caste groups, religious minorities and relatively advantaged *Janajatis* (p=0.02) and children playing outside with dirt and dust (p=0.006) were strongly associated with the BLLs. Lead poisoning in children is often caused by lead dust, and even very small amounts can be very harmful in children. Lead dust travel through the air and dust coated in the child's hands while playing are inhaled by the children through the hand to mouth behavior.

Lead in the blood during childhood can have adverse health effects on a child’s cognitive function, academic performance, and endocrine systems. Too much of lead in a child’s blood may lead to anemia, decreased muscle and bone growth, hearing damage, learning disabilities, nervous system and kidney damage, speech, language, and behavior problems, and brain damage.

5.2 Recommendations

The findings of the study provide enough evidence to draw following recommendations for the parents and for the Government Agencies.

Recommendations for the parents

1. Provide preventive guidance to parents of all young children regarding sources of lead and help them to identify sources of lead in their child's environment.
2. Encourage parents to identify lead hazards and sources in their homes and to protect their child's form exposure to lead, including the safe implementation of control measures before BLLs increase.
3. Encourage the parents to perform a diagnostic BLLs test for all children suspected of having lead exposure.
4. Warn the parents about the dangers posed by unsafe environment while playing outside and urge them to be aware of the possible re-emerging sources of lead in children's while playing with dirt and dust.

Recommendations for Government Agencies

1. Develop and implement strategies to encourage the safe elimination of lead hazards from the lead based-paints from the Nepalese markets.
2. Increase efforts should be done to resolve the lead-based paint hazards safely before children are exposed.
3. Government should expand the services that promote primary lead poisoning prevention and extend the systems that facilities clinicians and parents to learn about such services.
4. It should endorse the use of early improvement programs for all the children of families with low levels of economic and social resources who are living in the areas where exposure to lead is expected.
5. Establish jurisdictional policies that mandate ensuring lead safety in housing and enforce these mandates.
6. Effective implementation of lead in paints standard in Nepal

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Annex I: Questionnaire

Participant number:

Consent Form

Parental Permission/ Informed Consent to Participate in Research

Characterization of lead exposure and lead poisoning from lead-based paint & lead acid battery among children 06-36 months in Kathmandu Valley, Nepal

You and your child are being asked to participate in a research study. Before you give your permission to participate, it is important that you read the following information. Ask as many questions as necessary to be sure you understand what you will be asked to do.

Investigators:

The Principal Investigator of this study is Dr. Megnath Dhimal. He is the chief Research officer of the Nepal Health Research Council.

Purpose of Study:

Lead is a chemical found in many products. However, it can harm children's learning, growth and hearing. We want to find out how many children in Kathmandu Valley have high levels of lead in their blood. This will help us learn how bad the problems are and what needs to be done to protect children from lead poisoning. We also want to test the children's hemoglobin level in their blood to better understand its associations with their blood lead level.

Description of Study:

We will be selecting 312 children from the Kathmandu, Lalitpur and Bhaktapur District. We would like your child to participate in this study. First the study worker will describe the purpose of the study to you and ask you few questions to determine if your child is eligible to participate in the research. If your child is eligible, we will ask you for your permission to allow your child to be a part of this study. If you agree, the study worker will ask you some questions about the health and developmental history of your child, his/her behavior and activities, the house and its residents, and the factors that could cause lead exposure.

After the study worker has asked you the questions, we will offer you a free blood lead test and hemoglobin level test for your eligible children who are participating in this study. A medical assistant who is certified to draw blood will prick the child's finger and take about 2 drops of blood. He/she will use new instruments that are clean and completely safe. The blood test will take less than 5 minutes.

Risks or Discomforts:

The study includes a blood sample. Your child will feel a slight prick to the finger. Before the finger stick, the area of the finger prick will be cleaned with an alcohol swab. After taking the blood, the area will be covered with a small bandage to prevent infection. You will be instructed to maintain slight pressure on the area to minimize additional bleeding. Your child may have a slight bruise, soreness or swelling after the test is over. It is possible that your child may feel restless or uncomfortable and may resist the finger prick. If this is the case, you may ask the nurse to try again at a later time. Or you

may decide that it is not possible to participate.

Benefits of the Study:

We cannot guarantee that you or your child will receive any benefits from this study. As part of your evaluation, you may obtain updated information on lead poisoning. However, you will not receive any medical benefits from this pre-study screening. If you agree to take part in the study and if your child was found to have blood lead level above a threshold value or a hemoglobin level not within the acceptable range, he/she will be referred to the pediatrician immediately, rather than waiting for days or weeks for lab results to come back.

Confidentiality:

All names used on the questionnaires or observation forms will be kept confidential. We will not link your name with your responses to these questions or with the observations we will make here today. When we report the results of this study, no information on your name or your child‘s name will appear.

Costs and/or Compensation for Participation:

There are no costs to you associated with your participation in this study.

Voluntary Nature of Participation:

Participation in this study is voluntary. Your decision of whether or not to participate will not affect your future relations with the hospital or with Nepal Health Research Council. If you decide to participate, you are free to withdraw your consent and to discontinue participation at any time. You will not suffer any penalty or loss of benefits to which you are otherwise entitled.

Questions about the Study:

If you have any questions about the research now, please ask now. If you have questions later about the research, you may call Dr. Meghnath Dhimal (01-4254220), Principal Investigator of this project.

Agreement:

Your signature below indicates that you have read the information in this document and have had a chance to ask any questions you have about the study. Your signature also indicates that you agree to participate in the study and have been told that you can change your mind and withdraw your consent to participate at any time. You have been given a copy of this agreement. You have been told that by signing this consent document you are not giving up any of your legal rights.

_____	_____
Signature of Parent or Guardian	Date
_____	_____
Signature of Researcher	Date

PART A – Basic Information

1. Hospital Code…….....……

2. Introduction of interviewer …….

3. Date of Interview: ☐☐ ☐☐ ☐☐☐☐

DAY MONTH YEAR

4. Have participant provide consent after read this form in detail.

Yes ……..…1

No……..2

5. Language of interview

English ……1

Nepali……...2

6. Time of interview ☐☐ ☐☐

Hours Minute

7. Phone number (if possible)

8. Child diagnostic Research Code Child OPD number ☐☐☐☐☐☐☐

9. Name of the child:

10. Caste of child:

11. Gender of child Male ……1

Female…….……2

12. Date of Birth of the child: English

☐☐ ☐☐ ☐☐☐☐

DAY MONTH YEAR

Nepali ☐☐ ☐☐ ☐☐☐☐

13. Age (in months): ☐☐

14. Mothers name of child: _____

15. Fathers name of child: _____

16. Home address: _____

17. Nearest landmark: _____

PART B – Family Specific

18	Do you (child mother) read and write?	yes……1 no……..2 (if illiterate go to question number 21)
19	How many years of schooling have the MOTHER completed?	Informal education……..……....……...1 less than primary…..…….……....…….2 Primary.....…….....……....……..3 Secondary...…….....….....….4 higher secondary ….....…….5 graduated education completed …….…….....……6 Post graduated education completed …….....…….7 No response to this question …….…….....88
20	What is your cast	Dalit……....……..1 Disadvantaged Janajati…….....2 Disadvantaged non dalit Terai caste group…….....3 Religious minority …….....…..4 Relatively advantage Janajati……..….....….5 Upper caste…….....….....6 No response to this question.....…… … .....…88
21	Current Marital status (Child mother)	Unmarried……...……..1 Married…….....….2 Separate…….…....……3 Divorce……..…...….4 Widow……..….5 Unmarried but stay together……..…….....…6 No response to this question.....…….….....…88
22	What is the mother's occupation since from last 6 month?	No work (Housewife)……..……....……1 Agriculture……..……..…2 Carpet worker…….....…3 Daily wage earner…….....….4 Self-employed…….....…5 Services……....….6 Student……...…….....…..7 unemployed (can do work)……....…..….8 Unemployed (cannot do work)…….....…9 Others……..…..10 Not response……..……....88
23	Does your (child) father read and write	yes ……...……..……1 No…….…...……..2

24	How many years of schooling have the father completed?	Informal education……..…….....……...1 less than primary..…….…….…….....……2 Primary.....……..…….....……3 Secondary…….…….....….4 higher secondary …….....…..5 graduated education completed …….....……6 Post graduated education completed …….7 No response to this question ……..……...88
26	What is the father's occupation?	Agriculture…….……1 Carpet worker……...…….……...…2 Daily wage earner……...…….3 Self-employed…….……4 Services……5 Student…….……6 unemployed (can do work)…….....……..7 Unemployed (cannot do work)……..……...……8 Others…….…..…..9 Not response……..……....….88

PART C – Household-Specific

27	What is the ownership type of your home?	Owner occupied…….....……1 Rental……...…….…2 Others (Specify:)…..…….....…..3
28	how rooms in your household	…….....……
29	how many number stay in this home	…….....……
30	Which types of kitchen rooms does your family use?	living and kitchen room is single……..…….....…1 kitchen and bedroom is separate…….....…..…2 livingroom,kitchenandbedroomisseparate…….3
31	Describe the road traffic (Light= some cars, motorcycles; Heavy = highway) outside your house?	None……...…….……...…1 Light…….……...…….…….....….2 Heavy……..……..……...…...3
32	Has any work been done on your house in the past 6 months? (Any activity that has been disturbed the house environment, such as painting, sanding, window replacement, etc.)	Yes…….....1 No….……..…….……...…...2 Doesn't know…….....99
33	If yes, specify type of work done on house.	

34	Has any work been done near to your house in the past 6 months? (Any activity that has been disturbed the house environment, such as painting, sanding, window replacement, etc.)	Yes……..……..1 No…..……..……..……..……..2 Doesn't know…….....99
35	If yes, specify type of work done on house.	……
36	Does any family member do following work or hobbies that could involve exposure to lead? (*Circle all that apply)*	In construction or renovation of buildings…....…...1 In metal foundries (metals processing)…….....2 As an automobile mechanic……...…..….....….3 As a welder……..……...……...……...…...4 In fishing……...……...…...5 Working with stained glass or jewelry…….....6 occupations involves painting.....7 Battery recycling/manufacturing.....8 No……..……..9 Doesn't know……..…….....….99
37	Does pregnant mother do following work that could involve exposure to lead? (*Circle all that apply)*	In construction or renovation of buildings….....1 In metal foundries (metals processing)….....2 As an automobile mechanic……..…….....….3 As a welder……...……..……...……...4 In fishing…….....……...5 Working with stained glass or jewelry…….....6 Occupations involves painting.....7 Battery recycling/manufacturing.....8 No……..……..9 Doesn't know……...…..….....99

38	Where does the water you use for cooking/drinking come from?	Brought by truck ……...…...…1 Piped water into the house.....…….....…2 River/pond/surface water.....….....….3 Stone spout.....4 Water well.....5 Others (Specify:)…….....6 Doesn't know……...…..…99

39	What do you do to make water safer to drink?	Nothing…….....1 Boil.....2 Use water filter.....3 Strain through cloth.....4 Add chlorine/bleach.....5 Solar disinfection …….....6 Others (Specify:)…..…....7 Do not use other method ……....……..…8 Doesn't know……..……....……..99
40	Do you have an inverter in your house (with a lead-acid battery attached)?	Yes .....1 No.....2 Doesn't know……..……....……..99
41	Have solar battery in your home	Yes .....1 No.....2 Doesn't know……..……....…..99
42	Does the child sleep in the room where a lead acid battery is kept?	Yes.....1 No.....2 Not applicable…..……..…….....99
43	Does the child play in the room where a lead acid battery is kept?	Yes.....1 No.....2 Not applicable…….....99

Continuation of Household specific questions- on enamel painting

Enamel paint refers to an oil-based paint that gives covered surfaces a shiny and glossy appearance.

44.1	What type of house does the child live in?	Traditional (mud)…… .....……1 Modern (cement)…….…….....…...2 Mix…….....……3
44.2	Are any of the rooms inside your house painted with paint?	Yes .....1 No.....2
45	If yes which brand's paints you have used?	Pasupati ….....…1 Asian…….....2 Berger…….....3 Yeti…….....….4 Nepal…….....…5 Mahalaxmi….....6 Rilayansi….....…7 Jasmin…….....8 Baba…….....9 Others explore the name….....10 Do not know…….....99
46	Does the room where the child sleeps and plays contain enamel paint?	Yes .....1 No.....2 Not applicable.....99
47	Which parts of the house contain enamel paint?	Walls….....1 Windows.....2 Door .....3 Windows + Door…….....….4 Door + Walls…….....…...5 Windows + Walls…….....…...6 Windows + Door + Walls…….....….....7 Other, specify.....8 Not applicable.....99
48	How long has the child been living in this current house?	_____months

49	Has the child previously lived in another house containing enamel paint?	Yes .....1 No.....2 Doesn't know……..……..…….....…….99
50	If yes, from what age to what age did your child live in this other house?	_____months to _____months

PART D – Child Specific

51	Where was your child born?	Home…….…….....…….1 Health center….. ……..…….....……2 Hospital…….……..…….....…..…..3 Doesn't know…….....….....…….99
52	Was your child born on time?	Yes……..…….....……1 No…….....……..2 Doesn't know…….....……..99
53	If no, how many weeks prematurely?	_____Weeks
54	Are you aware of any MOTOR developmental delay in your child in comparison to other children? (Ex: age of walking, standing, speaking)	Yes…….....…….....……1 No……..…….....……..2 Doesn't know……..…….....…99
55	If yes, please specify.	
56	Are you aware of any MENTAL developmental delay in your child in comparison to other children? (Ex: school performance, reading, writing)	Yes…….…….....……1 No……..…….....…..2 Doesn't know…….....…..99
57	If yes, please specify.	
58	Would you describe your child to be physically active?	Yes……..…….....……1 No……..……..…….....…..2 Doesn't know…….…….....….99
59	Does the child play with other children?	Yes……..…….....……1 No……..……..…….....…..2 Doesn't know…….....….99

60	Does your child have any of the following issues in the last 6 months: fainting, jerky movement, convulsion, irritability?	Yes……1 No……2 Doesn't know……99
61	If yes, please specify	
62	Has your child taken any Ayurvedic medicine in the last 6 months?	Yes……1 No……2 Doesn't know……99
63	If yes, please mention name of drug, its purposes and duration.	
64	In the last 6 months, have you seen your child suck on thumb?	Yes……1 No……2 Doesn't know……99
65	In the last 6 months, have you seen your child playing in dirt or dust?	Yes……1 No……2 Doesn't know……99
66	In the last 6 months, have you seen your child eat dirt or dust?	Yes……1 No……2 Doesn't know……99
67	In the last 6 months, have you seen your child play with painted toys in mouth?	Yes……1 No……2 Doesn't know……99
68	In the last 6 months, have you seen your child play with batteries (AA, AAA….)?	Yes……1 No……2 Doesn't know……99
69	In the last 6 months, have you seen your child peel off paint from wall/ eat paint chips?	Yes……1 No……2 Doesn't know……99
70	Do you consider your child's sleep a problem?	Yes……1 No……2 Doesn't know……99
71	If yes, specify.	
72	Does your child go to school or daycare?	Yes……1 No……2 Doesn't know……99
73	If yes, how many hours a week?	_____ hours a week

74	If yes, does the school/nursery contain enamel paint on walls/ windows?	Yes……..…….....……1 No……..…….....……2 Doesn't know…….....…..99
75	Does your child play outside?	Yes……..…….....……1 No……..…….....…..2 Doesn't know…….....…99
76	If yes, how many hours a week?	_____ hours a week

PART E – Blood Lead Level (BLL) Measurement and Hemoglobin Level Measurement

77. Blood collection time: ☐☐ ☐☐

78. Blood collection vial ID:.....

79. BLL: ☐☐ ☐ µg/dL

80. Circle: Capillary / Venous ☐☐☐

81. Weight: ☐☐ ☐☐ kg

82. Height: ☐☐ ☐☐ cm

83. Preliminary major complain and diagnosis……

Annex II: Data Table

Table A-1: Children sleeping and playing in a room where a lead acid battery is kept

Variable	Sex of children		
	Male	Female	Both sexes
	n (%)	n (%)	n (%)
Does the child sleep in the room where a lead acid battery is kept			
Yes	28 (27.2)	23 (26.7)	51 (27.0)
No	75 (72.8)	63 (73.2)	138 (73.0)
Total	103 (54.5)	86 (45.5)	189 (100)
Does the child play in the room where a lead acid battery is kept			
Yes	32 (31.1)	35 (41.2)	67 (35.6)
No	71 (68.9)	50 (58.8)	121 (64.4)
Total	103 (54.8)	85 (45.2)	188 (100)

Table A2 : House painted with enamel paints

Variables	Blood lead level		
	0-5µg/dl	≥5µg/dl	Total
	n (%)	n(%)	n (%)
Yes	86 (80.4)	156 (80.4)	242 (80.4)
No	21 (19.6)	38 (19.6)	59 (19.6)
Total	107 (35.5)	194 (64.6)	301 (100)

Table A3 : Type of paint brand used

Characteristics	Frequency (n)	Percent (%)
Pashupati	29	11.5
Asain	27	10.7
Berger	12	4.8
Yeti	5	2.0
Mahalaxmi	9	3.6
Reliance	7	2.8
Others (Shalimar)	3	1.2

Don't know	160	63.5
Total	252	100

Table A4 : Symptoms of motor and mental development delay in children

Characteristics	Frequency (n)	Percent (%)
Motor development delay		
Can't speak or don’t speak	1	3.1
late speaking	9	28.1
Late walking	15	46.9
Walk slowly	1	3.1
Late standing	4	12.5
Walking & speaking	2	6.3
Total	32	100
Mental development delay		
Late understanding	1	20
Learning problems	4	80
Total	5	100

Nepal Health Research Council
Ramshah Path, Kathmandu

Annex II: List of participants in dissemination workshop

Title: *Dissemination workshop of findings of assessment of Blood Lead Level (BLL) of children living in Kathmandu Valley*

Venue: Meeting Hall, *Ministry of Health and Population, Ramshah Path, Kathmandu*

Date: July 30, 2015

Name list of Participants

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