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Lead Contamination in Metal Cookware Used in Educational Institutions

An exploratory pilot study in selected districts of Tamil Nadu for lead Contamination in metallic cookware

April - June 2024

Table of Contents

Acknowledgements

First and foremost, we extend our deepest gratitude to the Founder's Pledge for their generous funding support, which made this study possible. We are also immensely grateful to the institution heads who granted permission to conduct our research within their premises.

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PE Team

Tamil Nadu

About Pure Earth

Since its establishment in 1999, Pure Earth has completed 110+ environmental projects across 27 countries, shielding millions from toxic pollution. Collaborating with governments, NGOs, and academia, the organization designs innovative interventions to address environmental challenges. Specializing in reducing lead exposure in Low- and Middle-Income Countries (LMICs), Pure Earth contributes significantly to scientific research and advocacy in this field. Supported by entities like USAID and the World Bank, it has assessed 5,000+ contaminated sites, including 1,500+ with lead contamination. Through exposure-reduction efforts in over 50 communities, Pure Earth's work has yielded ground breaking research and reports, playing a crucial role in addressing global lead exposure issues.

List of Abbreviations

FSSAI	*Food Safety and Standards Authority of India*
IEC	*The International Electrotechnical Commission*
ICPMS	*Inductively Coupled Plasma Mass Spectrometry*
ISO	*The International Organization for Standardization*
IQ	*Intelligent Quotient*
LMIC	*Low- and Middle-Income Countries*
LOD	*Limit of Detection*
NABL	*National Accreditation Board for Testing and Calibration Laboratories*
NGO	*Non-Governmental Organization*
ODK	*Open Data Kit*
PE	*Pure Earth*
PPE	*Personal Protective Equipment*
PPB	*Parts Per Billion*
PPM	*Parts Per Million*
QC	*Quality Control*
RMS	*Rapid Market Survey*
USAID	*United States Agency for International Development*
XRF	*X - Ray Fluorescence*

Study Background

Lead-contaminated consumer goods pose a significant yet poorly understood health risk. Pure Earth conducted a "Rapid Market Screening" across 25 low- and middle-income countries to assess the lead concentration in consumer products which reported that in India, 51% of the metal food ware that were tested using XRF had lead above the threshold. Across all different types of metal food ware, 57% of the items that were found to be above the reference level were made of or labelled as aluminum or aluminum alloys[1]. Tamil Nadu was one of the study sites in Rapid Market Survey and the data reported that 70% of the metal food ware samples had lead more than the threshold level[2]. A reference level of 100 ppm was applied for ceramic and metal cookware based on 176 on-going leachability research, performed by Pure Earth[3].

However, there are several caveats:

- The absence of standardized safe lead levels in aluminum cookware complicates government regulation, hindering policies to prevent lead pollution.
- Limited understanding exists regarding lead bioavailability and leaching rates from aluminum cookware, impeding accurate assessment of its contribution to individuals' blood-lead levels.
- Furthermore, many homes with lead-poisoned children possessing leaded cookware also had other products exceeding lead thresholds, challenging the identification of the primary lead source.

Aluminum Cookware study in educational institution

Pic 1: High School, Tenkasi district, Tamil Nadu

Lead cookware in educational institutions, particularly in LMICs, poses a significant educational concern as it may be a primary source of lead exposure for children, impacting learning outcomes and health. Lead exposure can harm brain development, growth, and behavior, leading to lower IQ, attention issues, and underperformance in school, with potential long-term effects. Ensuring that schools use safe cookware is vital, as it

[1] https://www.nature.com/articles/s41598-024-59519-0
[2] https://www.pureearth.org/rapid-market-screening-program/
[3] https://www.pureearth.org/wp-content/uploads/2024/06/ssrn-4836675.pdf

could significantly mitigate the risk of lead poisoning and help contribute to narrowing the educational achievement gap.

Thus, an exploratory pilot study on the use of metallic cookware in educational institutions was planned and conducted in selected locations within Tamil Nadu to evaluate the potential lead contamination and its leachability into the food. The results of the pilot study are intended to inform the current situation, possible intervention strategies for cookware and identify the supply chain for this product.

Objectives of the study

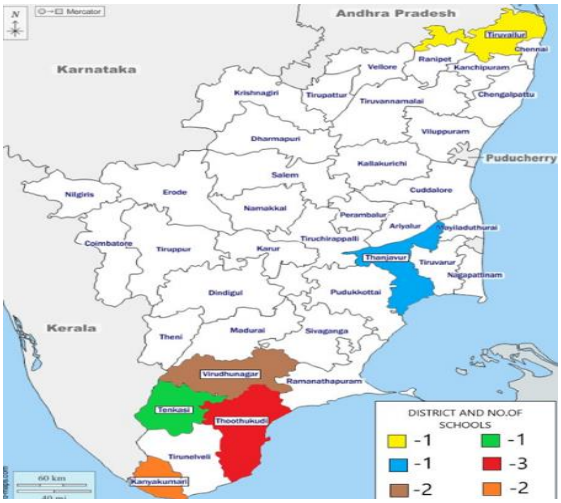
1. To determine the lead concentrations in metal cookware in educational institutions.
2. To describe the food program in the educational intuitions selected
3. To identify additional potential source of lead as a raw food and spices in educational institutions
4. To evaluate the potential affectation of lead into cooked food
5. To sensitize educational institutions on lead exposures
6. To address lead exposures and provide general recommendations.

Materials Used

Thermo Scientific Portable X -Ray Fluorescence (Model no XL3t700S), mobile with ODK tool, Tablet, Ziplock bags, sample collection containers from the lab, Permanent marker, Metal Spatula, PPE kit are few of the essential items used for this study.

Study locations

The pilot study was done in randomly chosen districts across Tamil Nadu, ensuring willingness and geographic representation across the state. Educational Institutions included both government-aided and private institutions. In total, 10 schools across 6 districts (Thiruvallur, Thoothukudi, Tenkasi,Virudhunagar,Thanjavur & Kanyakumari) of Tamil Nadu were selected for the study.



Map 1: Study Districts and educational institutions of Tamil Nadu

S.No	Districts	No of educational institutions
1	Thiruvallur	1
2	Thoothukudi	2
3	Tenkasi	1
4	Virudhunagar	2
5	Thanjavur	1
6	Kanyakumari	2
Total no schools		**10**

Table 1: List of study districts and number of educational institutions selected for the study

Study Team

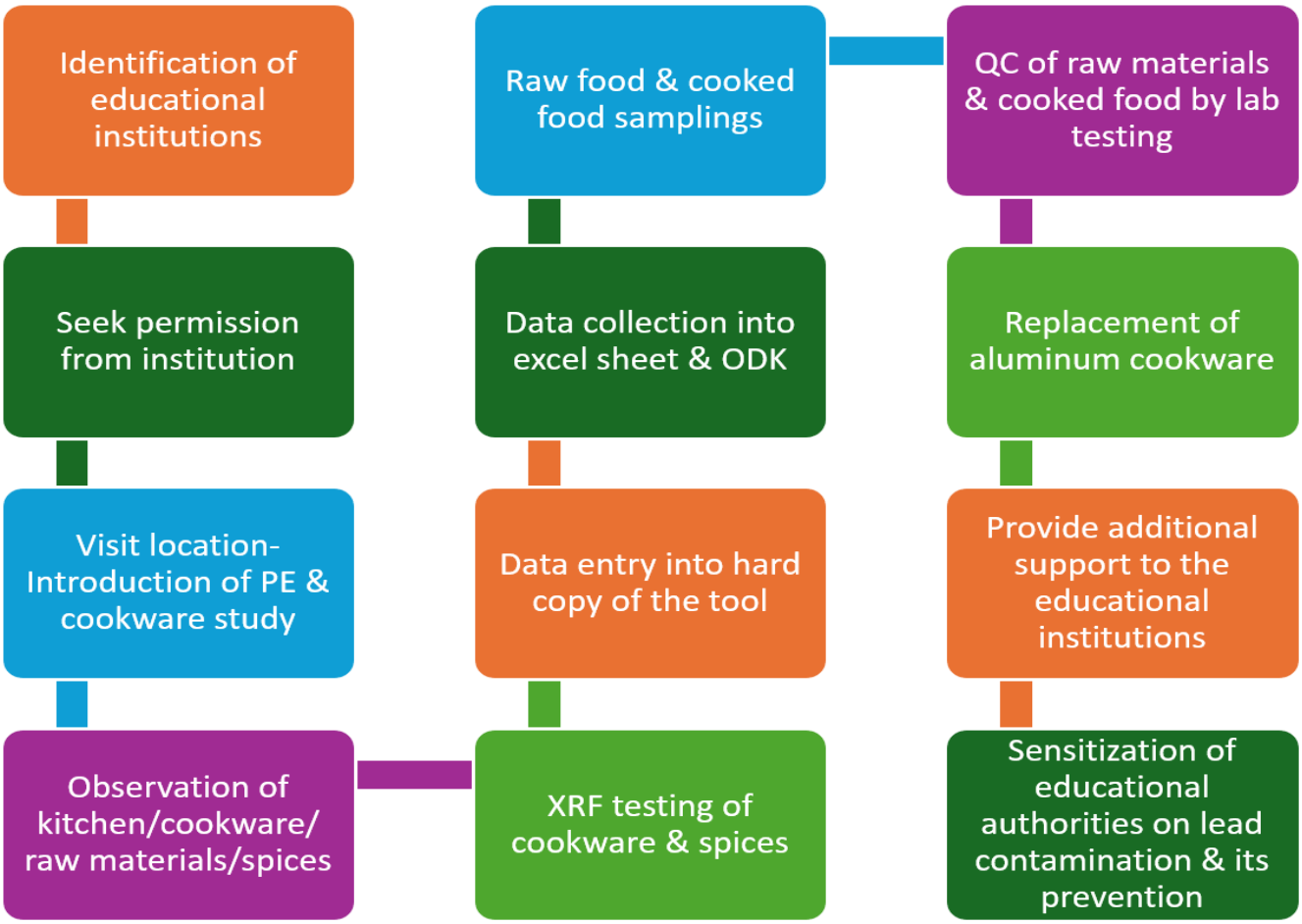
i. Ms.Emershia Sharmine – Program Manager, Tamil Nadu
ii. Mr.Bhaskar Raj – Program Associate, Tamil Nadu
iii. Mr. Gordon Binkhorst – Senior Technical Advisor, HQ
iv. Mr. Alfonso Rodriguez – Technical Director, HQ
v. Ms. Lavanya Nambiyar – Program Manager, Asia
vi. Mr.Gabriel Sanchez Ibarra – Vice President, Programs
vii. Ms.Debanjana Choudhury – Country Director, PE India
viii. Mr.Sandeep Dahiya - Communications & Advocacy Director, PE India

Timeline

Fieldwork for each institution typically spanned 2-3 days on average. The fieldwork commenced on April 1, 2024, and concluded on June 7, 2024.

Pic 2:
PE Team discussing about the study with the educational institution head & the team at Mangudi High School

Activities undertaken



Quality Check

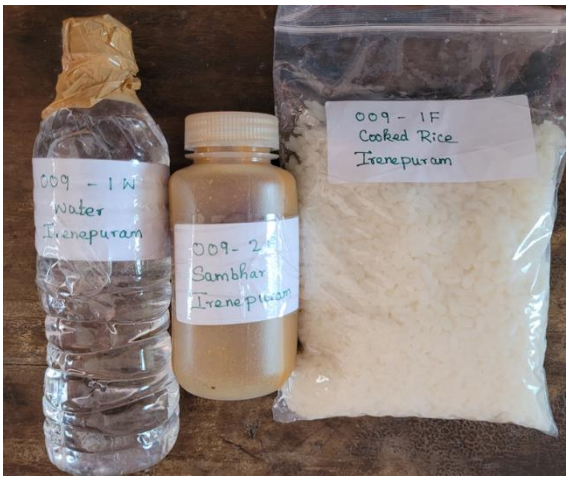
Lab testing was conducted as part of quality control on various samples such as spices, raw materials, cooked food and water. It also helps in identifying the level of lead in cooked food and also in the raw materials before cooking. For this purpose, the National Food Laboratory in Chennai was identified for the lab testing of the samples collected from the educational institutions. It complies with the ISO/IEC 17025:2017 requirements and is accredited by NABL and recognized as a referral laboratory by Food Safety Standards Authority of India (FSSAI) which is a statutory body under the administration of the Ministry of Health and Family Welfare, Government of India. FSSAI regulates the manufacture, storage, distribution, sale, and import of food articles, while also establishing standards to ensure food safety[4].

The lab used NFL – CPT/L3-RES-STP-002 method and the ICP-MS instrument which is an analytical instrument used for elemental determination in the cooked food and raw materials with a detection limit of 0.05 mg/Kg for food.

S.No	Type of Samples	No of samples
1	Raw materials	29
2	Spices	32
3	Water	4
4	Cooked food	15
	Total samples	**80**

Table 2: Type of samples and the number of samples collected

Pic 3: Raw material



Pic 4: Water and Cooked Food

[4] https://fssai.gov.in/cms/food-authority.php#

Reference Value

Food Safety and Standards (Contaminants, Toxins & Residues) Regulation, 2011 has specified maximum limits of metal contaminants in different food categories. The below standards are the permissible level of lead in different food products by FSSAI.

Items	Commodity	Legal Reference Value (mg/kg)
Raw materials	Raw Rice	2.5
	Dhal (lentil)	2.5
	Green Gram (lentil)	2.5
	Channa (lentil)	2.5
	Urad Dhal (lentil)	2.5
Cooked Food	Rice	2.5
	Sambhar	10
Spices	Turmeric powder	10
	Chilly powder	10
	Garam Masala	10
Water	Water	0.01[is: 3025 Part] (47)

Table 3: Reference value of lead in different food products by FSSAI

Study Findings

1. Type of educational institutions & location

Of the 10 study sites chosen, 9 are educational institutions and 1 is a privately-operated shelter home. Amongst the 9 educational institutions, 7 were government aided wherein they get government support in terms of cookware and dry rations like rice, dhal, oil, etc to prepare hot cooked meals for children. Geographically, 9 of these sites are in rural areas, while 1 is located in an urban area.

Chart 1: Type of institution

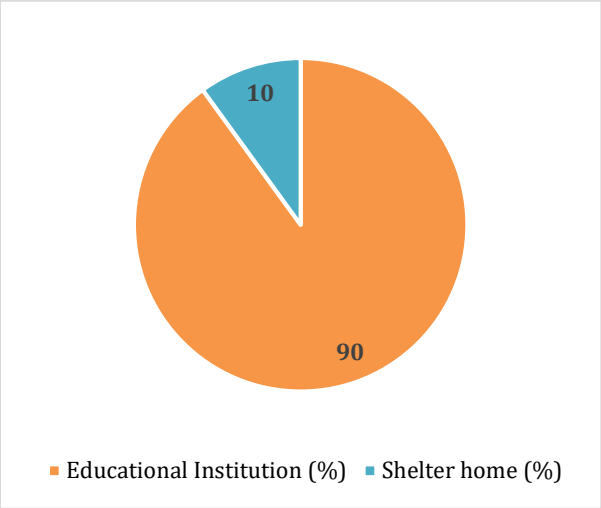
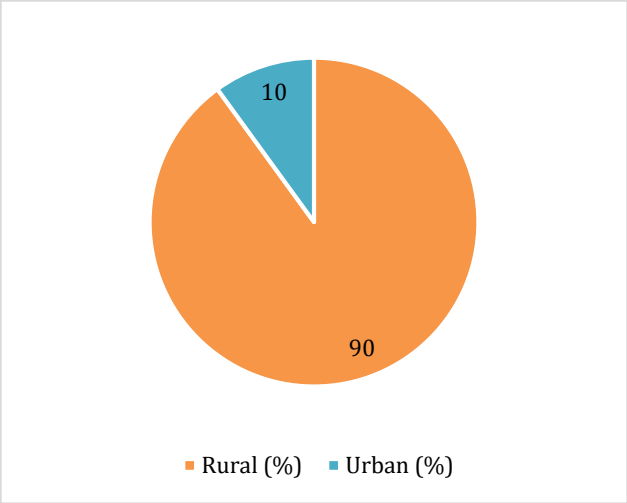


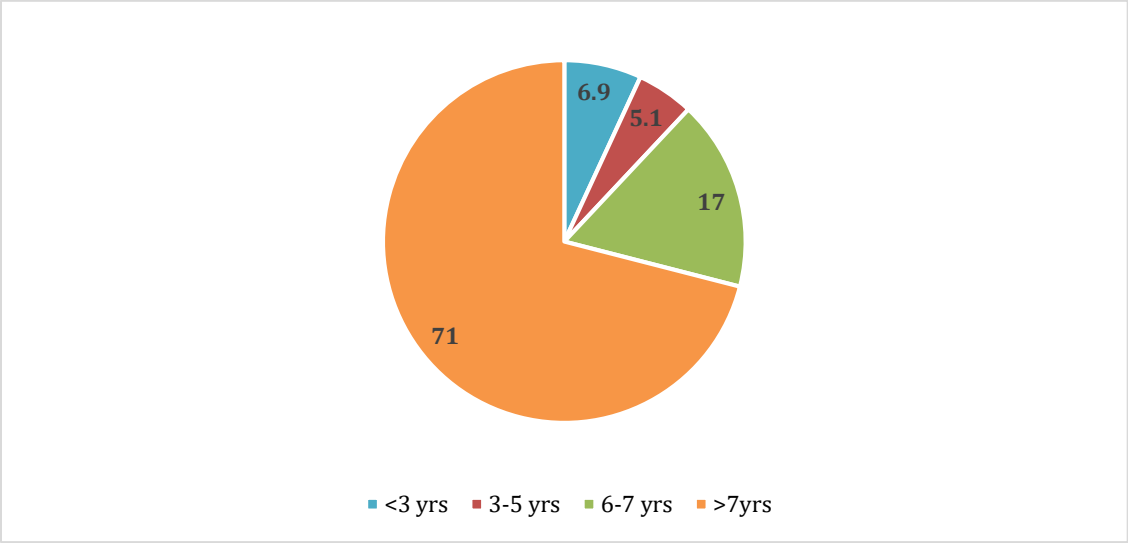
Chart 2: Type of location



2. *Age Distribution of Children in the educational institution*

The educational institutions included in this study had children ranging from 1 to 17 years old, with a total of 928 children across the 10 institutions. It was noted that 29% of the children were between the ages of 1 and 7, while the majority were over 7 years old.

Chart 3: Age Distribution of Children in the selected educational institution (%)

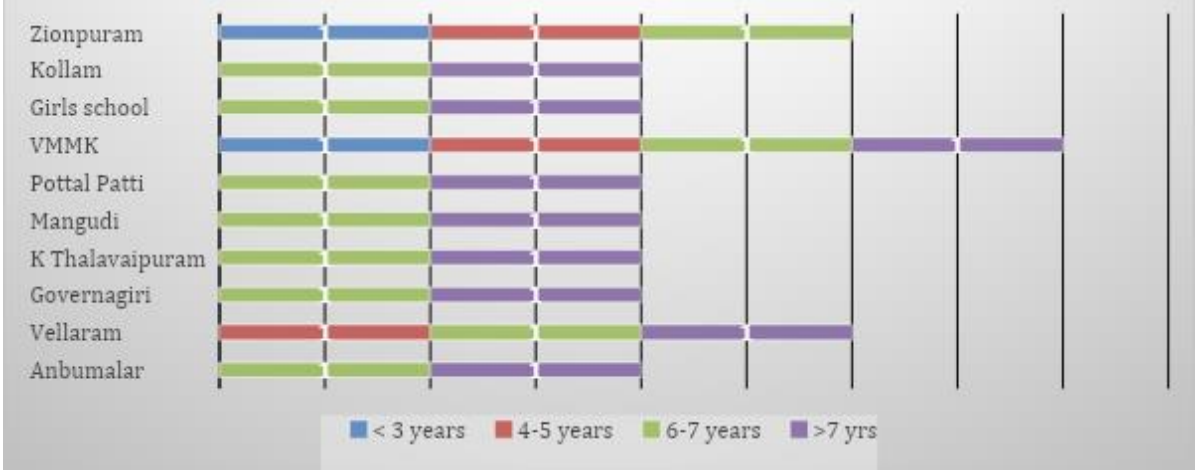


3. *Educational Institution Feeding Program*

Tamil Nadu is a pioneering State in India which introduced the Nutritious Meal program during the year 1982. Under the Ministry of Social Welfare and Women Empowerment, Primary School children in the age group of 5-9 years and Upper Primary School children in the age group of 10-15 years are provided with hot cooked nutritious variety meals inside the school campus itself, for five days a week for a total of 220 days in a year. Food grains (rice) at 100 gm per child per school day for primary children (1st to 5th grade) and at 150 gm for upper primary (6th to 10th grade) is provided. Eggs are served to all children from 1st to 10th grade on all 5 working days. Banana weighing 100 gms is provided for non-egg eating children[5]. Similarly, for children aged 2 to 5+ years, hot cooked meals under the Integrated Child Development Services is been provided[6].

All the study sites had feeding program for children within the premises. It was reported that only 2 educational institutions had feeding program for children less than 3 years, 3 institutions had feeding program for children between 4 and 5 years. All the 10 institutions had feeding program for children 6 -7 years and 9 institutions for children more than 7 years.

Chart 4: Feeding Program implemented by educational institutions according to age



4. Meals Provided at Schools

It was observed that 7 government aided schools provided only one meal, i.e., lunch, whereas the other 3 institutions provided all 3 meals ie Breakfast, Lunch and Dinner including snacks.

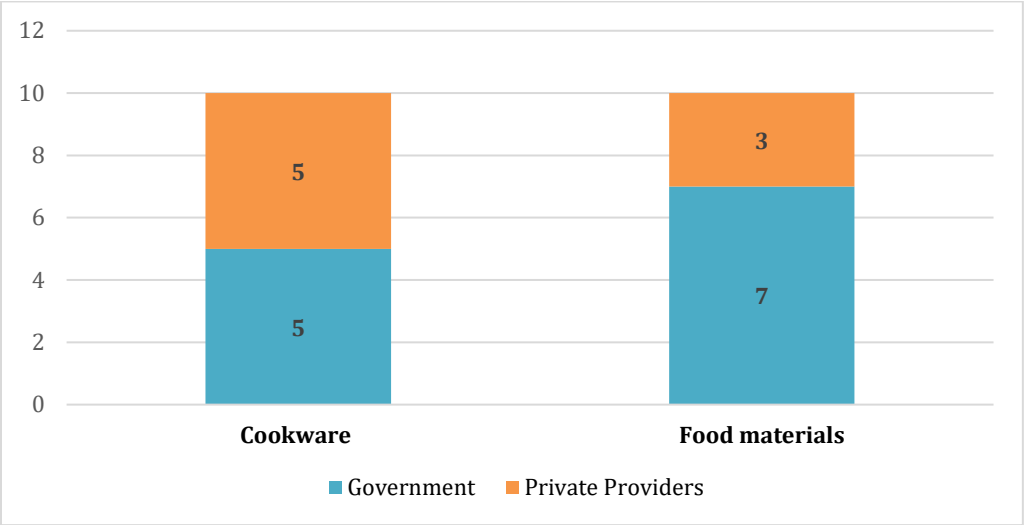
[5] https://www.tnsocialwelfare.tn.gov.in/website-345/en/specilisationsnutritious-meal-programme/puratchi-thalaivar-mgr-nutritious-meal-programme

[6] https://www.icds.tn.gov.in/icdstn/noon_meal.html

5. Cookware & Food Procurement

With regard to the procurement of cookware, it was reported that 5 schools received them from the government and the remaining 5 schools received them from private providers. In terms of food materials, 7 schools received them from the government and 4 schools received them from private providers.

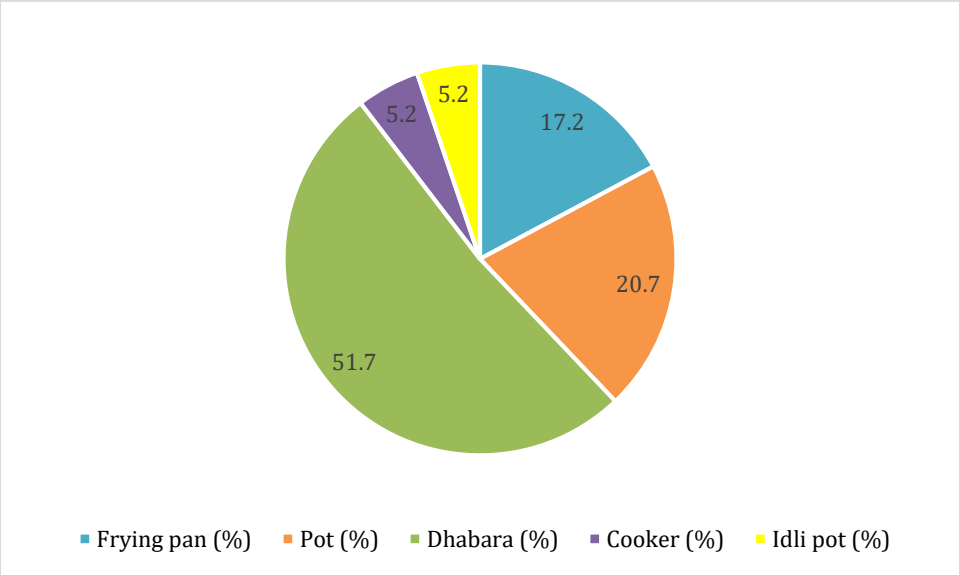
Chart 5: Provider of cookware and food Materials



6. Type of cookware tested for lead

Among the 58 cookware items tested for lead, 51.7% (30) were of the dhabara type, a wide-open vessel commonly used in educational institutions for cooking large quantities of rice and curry. This was followed by pots, which made up 20% (12) of the tested cookware.

Chart 6: Type of cookware tested for lead



7. Raw Materials & Spices Used in Feeding Program

On average, 98 grams of rice, 50 grams of millets, 25 grams of dhal, 50 grams of meat and 1 egg is provided to a child per day. Commonly used spices are chili powder, turmeric powder, curry powder, sambhar powder, and coriander powder. Some schools procure whole raw materials and grind them locally, while others procure from the market.

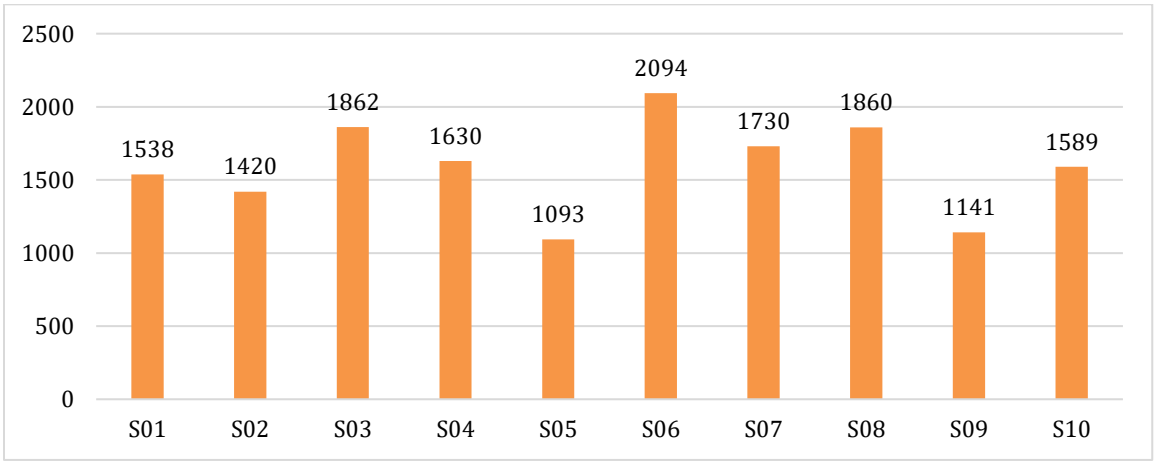
Test Results and Discussion

Pic 5: XRF testing of cookware from the study site

1) Lead detection of cookware

At least six cookware items were evaluated by educational institutions. Each cookware item was tested three times with a portable XRF to determine the average lead concentration. In total, 58 cookware items from all 10 locations were tested using XRF, with an average lead concentration of 1,604 ppm found across the cookware

Chart 7: Average lead concentration (ppm) in cookware by educational institutions



2) Lab testing of raw materials

29 raw food samples and water were tested in the lab for lead contamination. According to FSSAI standards, all the samples were within the permissible limits. However, three raw materials were found to exceed the 0.05 mg/kg detection limit.

3)Lab testing of spices

Approximately 32 spice samples were tested in the lab for lead contamination. Of these, two spice samples were found to exceed the detection limit ie 0.05 mg/kg but remained within the permissible limit set by FSSAI.

4) Lab testing of cooked food

In total, 15 cooked food samples were given to the lab for testing of lead. According to FSSAI standards, no lead was detected in the cooked food. The detection limit is set at 0.05 ppm, and all samples, except for the three highlighted in the table below, were above this detection limit ie 0.05 mg/kg.

Table 4: Lab results of cooked food for lead concentration

Food Sample code	Type of cooked food	Lead concentration reported (mg/kg)
001 - 1F	Boiled Rice	0.07
001 - 2F	Sambhar	< 0.05
002-1F	Tamarind rice	< 0.05
003-1F	Tamarind rice	< 0.05
004-1F	Tamarind rice	< 0.05
005-1F	Sambhar rice	< 0.05
006-1F	Tamarind rice	0.9
007 - 1F	Cooked Rice	< 0.05
007- 2F	Puli Kulambu	<0.1
008 - 1F	Cooked Rice	< 0.05
008 - 2F	Sambhar	0.07
009- 1F	Cooked Rice	< 0.05
009 - 2F	Sambar	< 0.05
010- 1F	Lemon Rice	< 0.05
010 - 2F	Egg	<0.1

Challenges Faced & Solutions Adopted

Before the start of the project and during the course of the study, several challenges were faced but were tackled and proceeded with the study:

- Due to elections and other state level meetings within the ministries, the Department of Social Welfare and Women Empowerment was unable to give permission to the study in the Anganwadi Centre, but the study team pursued the study among the private and government aided educational institutions by getting permission from the local authorities.
- There were codes of conduct across Tamil Nadu due to elections, which made carrying the XRF to various locations a challenge. In many places, security checks happened during the visit. Due to the availability of relevant documents on XRF, the situation was handled smoothly.
- The study was conducted in peak summer when the temperature went up to 45 degrees Celsius, but the willingness among the institutions was encouraging.
- Due to summer vacations in the month of April and May, few of the educational institutions were closed for a period of time. However, due to the rapport created by the PE team, the institution authorities gave space to conduct the study within the premises and were available with their team during the study.
- Lack of laboratory capacity assessment available in Tamil Nadu for the analysis of samples under the required level of detection

Limitations

- Since many of these institutions cook food on a large scale, replacing that aluminum cookware with alternative stainless steel of big size was a challenge as most of the retailers/whole sale dealers do not have big size stainless steel vessels.
- The widespread use of aluminum cookware in the studied institutions was largely due to its lightweight, low cost, and excellent heat conductivity. This preference for aluminum cookware posed a challenge, as it was ingrained in the institutions' practices. Although the PE team made efforts to sensitize the institutions on the potential affectation associated with aluminum cookware and suggested safer alternatives, the entrenched preference for aluminum may have limited the effectiveness of these interventions.

Risk Mitigation Actions Taken

- The lead-contaminated aluminum cookware were replaced with SS304 grade stainless steel. Type 304 is the most versatile and widely used stainless steel.

- Awareness materials and IECs, such as brochures on Pure Earth and its programs for mitigating the risks of lead poisoning and preventive measures at the household level, were distributed to the institution authorities and the team.
- Other than cookware, additional support like furniture and wall painting were also provided to some of the institutions.

Conclusion

The study reported that 98% of the cookware tested contained lead levels exceeding the reference value of 100 ppm, which is a significant concern. According to FSSAI standards, none of the raw materials, spices, or cooked food were expected to contain lead. The international reference value recommends a lower detection limit (0.01 ppm) to determine the potential ingestion of lead by the IRL whereas the lab that tested the food sample in Tamil Nadu had a higher value more than the global reference value as a detection limit. The Pilot Study is inconclusive, as NO correlation of lead in cookware and prepared foods was found. However, the sample size for the study is still small. Hence further research is needed to analyze the supply chain to identify how lead contamination occurs in cookware. Although the lead levels in the cooked food were within permissible limits and did not show detectable lead, the presence of lead in the cookware still warrants attention. Steps must be taken to completely eliminate lead contamination from food.

……End of Report……