Original Research Article

A Survey-Based Analysis of the Usage Experience of Aluminium Metal Vessels in Our Lives for Risk Assessment Among Kadapa City, Andhra Pradesh, India

ABSTRACT

Objective: The aim of this study was to determine the purpose, usage, and side effects of the aluminium vessels used by participants.

Methods: It is a survey-based study designed to check the extent of aluminium involvement in their lives and perception of awareness. The 12-item questionnaire was administered to the participants who were English-literate and Telugu (local) language. In total, 500 participants indicated that they had used aluminium metal vessels. Section 1 with demographic information, and Section 2 with twelve questions with multiple correct answers.

Results: The findings of this study indicate that knowledge, purpose, usage, and side effects of aluminium metal vessels. However, the current consensus among the respondents is that current aluminium toxicity-focused knowledge is inadequate for such an application.

Conclusion: The current study was designed to explore the frequency of aluminium usage in various forms in the Indian population of Kadapa city of Andhra Pradesh and investigate any preferential difference in aluminium usage with education and occupation. The major findings are that the majority of respondents used aluminium vessels for different purposes, and fewer were aware of safety concerns. Using aluminium vessels causes different health problems. However, this study recommended alternatives to aluminium vessels, such as brass, stainless, and copper, etc.

Keywords: Aluminium metal utensils, safety concerns, renal failure, side effects

1. INTRODUCTION:

"Aluminium is a versatile metal with multiple properties, making it suitable for a wide range of applications. It is the third most common element used in different alloys with other metals such as copper, zinc, or magnesium" [1]. "Aluminium wrought utensils are commonly used in developing countries for the purpose of mass cooking in the hostel messes and armyand as aluminium foil in cooking and food packaging in both developing and developed countries. Its various forms are a part of most households in India" [2, 3].

"The aluminium industry is progressing, with the majority of current and projected growth coming from newly extracted aluminium metal, non-recycled aluminium, as might be commonly perceived, and has the potential to enter and accumulate within the biotic cycle. However, once aluminium has entered the biotic cycle, it has little prospect of a quick return to the lithospheric cycle, and biota is now subject to an ever-increasing burden of potentially biologically available aluminium. The consequences of a burgeoning burden of aluminium in the biotic cycle have already been manifested in the deaths of fish and trees in acidified surface waters and catchments respectively" [4].

"Generally, according to the World Health Organization (WHO), the established daily intakeof aluminium is 1 mg per kg of body weight. Now a days, human beings are overexposed to

aluminium because of several reasons" [5]. "According to the European Food Safety Authority(EFSA), the exposure of aluminium among the European population is 28.6-214 µg/kg bodyweight per day" [6].

"Besides, the geochemical cycle for aluminium has now turned into a biogeochemical cycle,primarily indirectly due to human activities, such as the acidification of catchments by aciddeposition of anthropogenic origin or directly by the extraction of aluminium from its inert boxite ores. It is approximately 125 years since the advent of 'The Aluminium Age'. The ability to separate aluminium metal from its ores on an industrial scale changed aluminium from being a largely decorative metal to the most widely used metal of the 21st century" [7].

"Aluminium when adequately alloyed and anodized, can resist corrosion by water, salt, andother environmental agents, and it also has a wide range of other chemical and physical agents" [8]. "It is highly soluble in an acidic environment; acid rain can cause the amount ofdissolved aluminium in the surrounding water to increase" [9, 10].

"Aluminium metal has physical and chemical properties that make it usable for making utensils because its density of 2.7 g/cm3 is nearly one-third of steel (7.83 g/cm3), making it lightweight. high-strength purpose mixed with alloys such as copper, manganese, and zinc. These alloys also resist progressive oxidization; aluminium, when exposed to air, combines with oxygen to form an inert and colourless aluminium oxide film on the exposed surface, which blocks further oxidation" [8].
"Aluminium's multiple properties, such as being good heat conductors, lightweight, inexpensive, and non-sticky nature, have made it a vessel of choice for cooking purposes. The extensive aluminium usage in cooking has made it a daily component of our diet due to its leaching into food" [11].

"Generally, aluminium cooking vessels and other sources augment the aluminium load in thehuman body, furthering this phenomenon. Drinking water is one such, where aluminium compounds are used as a coagulant in the water treatment process, which increases its aluminium content" [12]. "However, aluminium is primarily excreted by the kidney, and its accumulation is an important concern in patients with impaired renal functions. It can get

accumulated in other organs such as the brain, bones, liver, and other tissues and is associated with toxic sequelae" [13].

This study assesses the extent of aluminium exposure in daily life and identifies contributing factors through a survey-based analysis for a small population in Kadapa city, Andhra Pradesh. The survey form was designed to the explore the frequency of aluminium usage in various forms concerning the Indian population and investigate through different categories of gender, occupation, and education.

2. METHODS

2.1. Study design:

This study was a survey-based research design to check the extent of aluminium involvement in their lives from different sources and their perception of awareness. It is a descriptive form of research done by non-random sampling to have an unbiased representation of the total population. It is a questionnaire-based survey that acquired primary data from a mixed population of Kadapa City from different backgrounds. Social media (WhatsApp) was used for the data collection. An elaborate questionnaire was prepared on Google Form and the link was circulated.

2.2. Sample size:

A total of 500 responses were included in the study. The Internet was used as a source to collect secondary data because of its limitless networking of resources. Core questions focused specifically on aluminium metal issues, including purpose, uses, reasons, durability, and side effects as they relate to aluminium toxicity.

2.3. Questionnaire:

The 16-item questionnaire with 2-4 options included two sections: Section 1 with demographic details and Section 2 with twelve questions with multiple correct answers.

(Appendix-1). The completed questionnaires were collected and analyzed for the data. Data was expressed as counts and percentages.

3. RESULTS

3.1. Demographic profile

Demographic data of participants relating to age, gender, occupation, and education are shown in Table 1. In total, 500 questionnaires were distributed. Out of 500 participants, 37.2% were male and 62.8% were female. giving a 100% response rate in this questionnaire. Despite the proven toxicity of aluminium vessels, 78% of individuals utilize and store, and 22% do not utilize. (Fig 1).

Table. 1. Data showing the frequency analysis of the demographic details.

Demographic variable	No.	(%)
Sex		
Male	186	37.2%
Female	314	62.8%
Age		
18-30	82	16.4%
31-40	150	30%
41-50	220	44%
51-60	30	6%
61 and above	18	3.6%
Education		
SSC	125	25%
+2	45	9%
Graduation	160	32%
Post Graduation	75	15%
Other	95	19%
Occupation		
Working	210	42%
Not working	290	58%

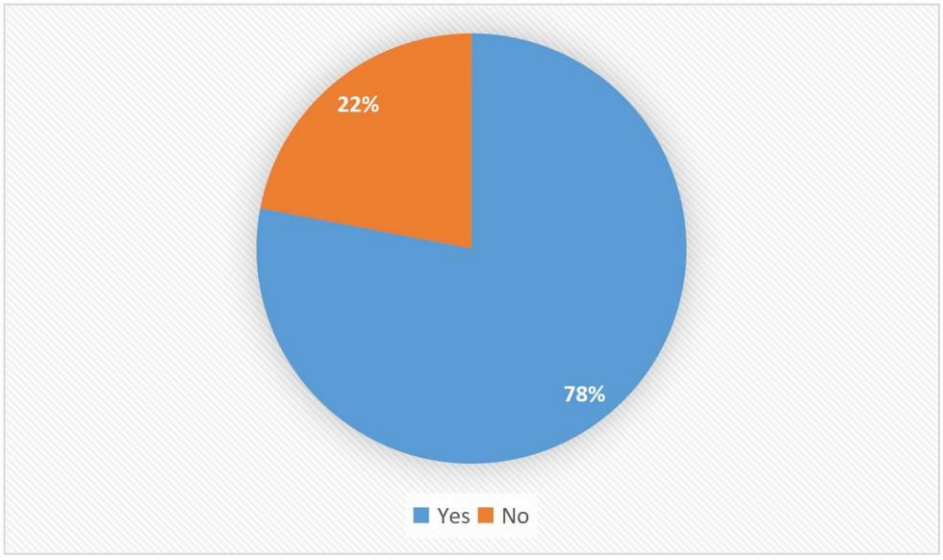

Fig. 1. Aluminium vessels most frequently used by participants.

3.2. Reasons for use of aluminium vessels

Of the total 500 participants, The majority of 35.2% have said that aluminium vessels are easily available in the market, and 22.4% have said that they are available at a cheaper cost, 7.2% for easy to clean, 14.4% for easy to maintain in the home kitchen, 19% of participants said that cooking food for fast, and 1.8% of participants said that they don't know why. (Fig.2).

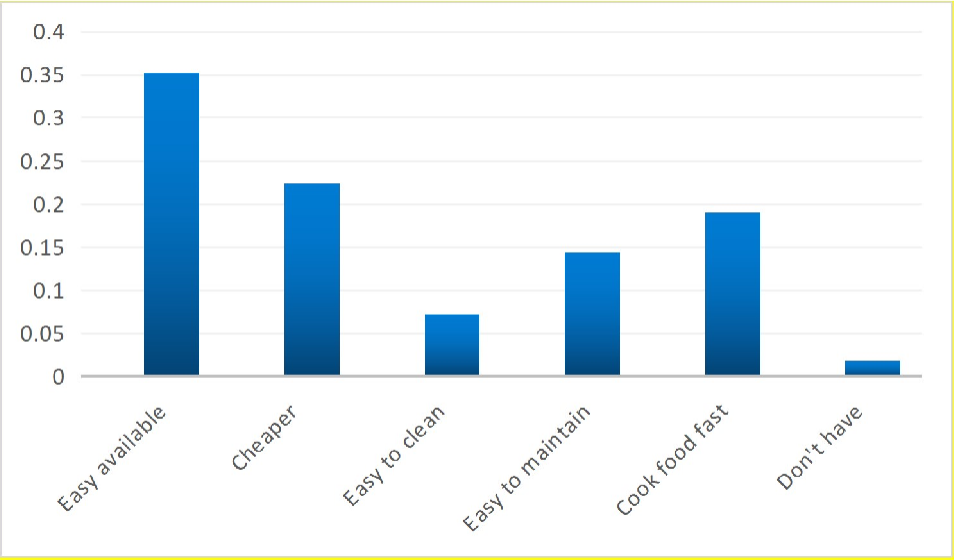

Fig. 2. participant's reasons for using aluminium vessels.

3.3. Purpose of aluminium vessels

Out of a total of 500 participants, 38.6 for cooking rice, 5% for boiling drinking water, 55% of participants said that making curry, and 1.4% of fewer people don't use aluminium vessels. (Fig.3).

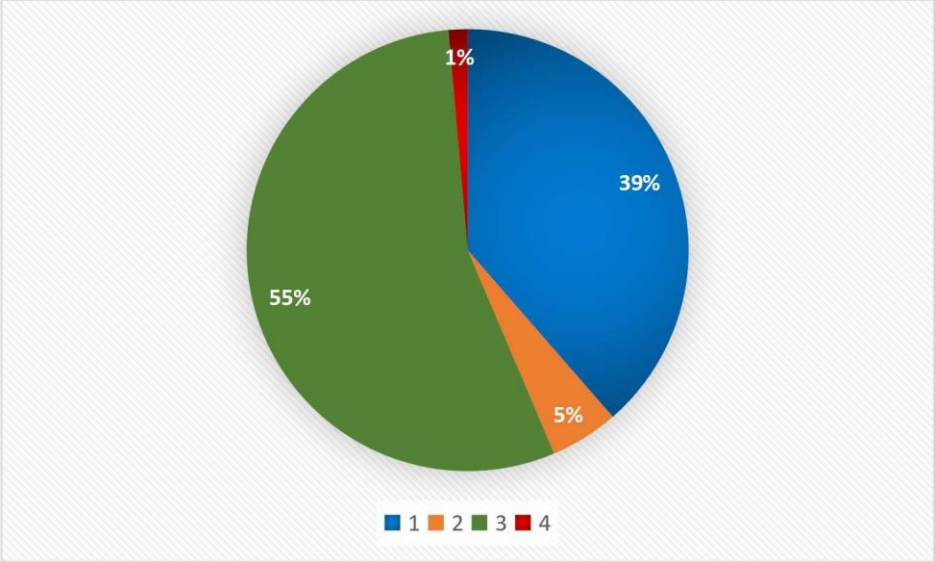

Fig. 3. Graphical representation of frequency of purpose of aluminium vessels by participants.

3.4. Vessels used to store cooked food

Of the total 500 participants, 35.8% used aluminium vessels to store cooked food; 50.8% used stainless steel vessels; 2.6% used hard anodized; 10.8% used nonstick. (Fig.4).

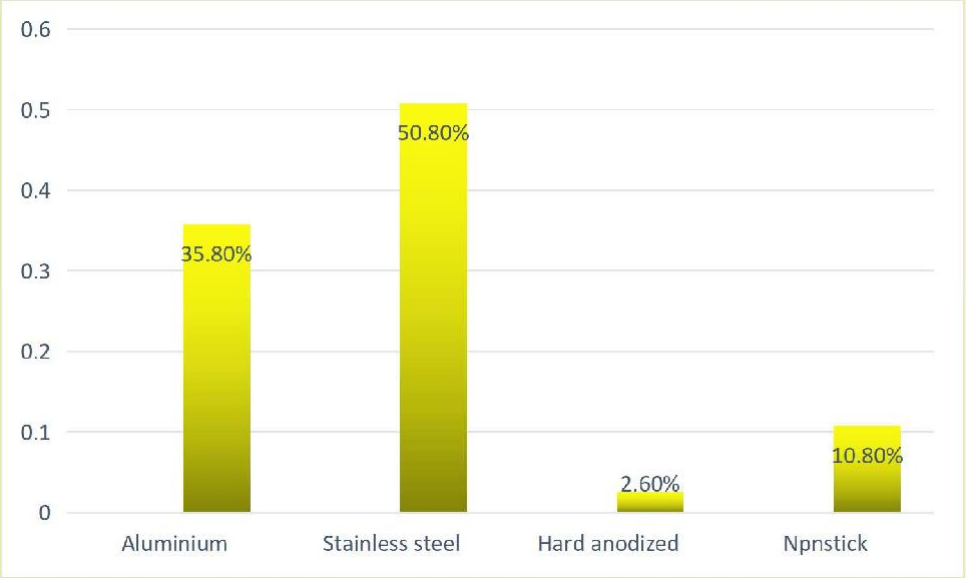

Fig. 4. Different vessels utilize and store cooked food by individuals.

3.5. Usage of aluminium foil

Out of a total of 500 participants, 37% of participants use aluminium foil to wrap chapati, 34.4% pack of food items, 17.2% bake of food, and 11.4% of don't use it in their lifestyle. (Fig. 5).

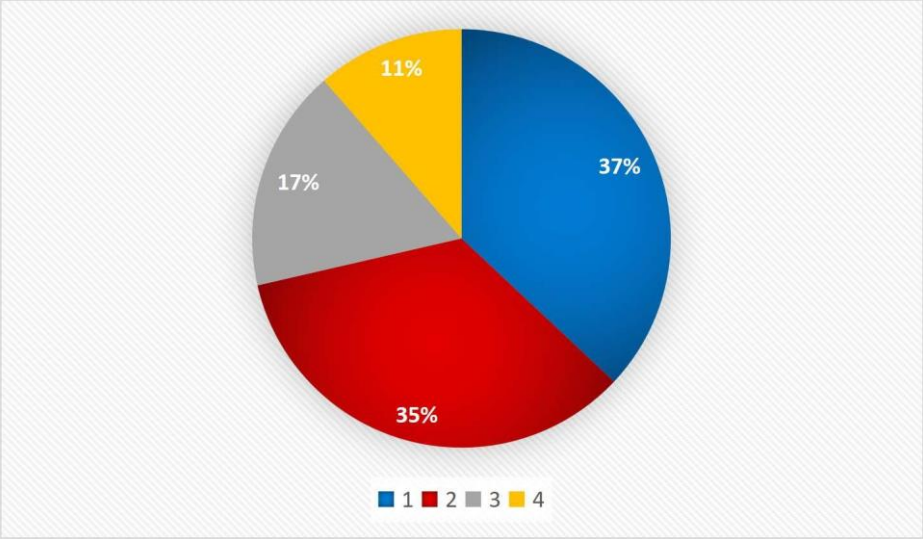

Fig. 5. Graphical representation of frequency of usage of aluminium foil by participants.

3.6. Durability of aluminium vessels

A maximum score of 10 was allocated for durability. Out of a total of 500 participants, 27.4% of them had fair knowledge on the durability of aluminium vessels. Moreover, 0.2% of the respondents were unaware of the same. Seen someone using, on a scale of 1 to 10, with 1 being the worst and 10 being the best. (Fig.6).

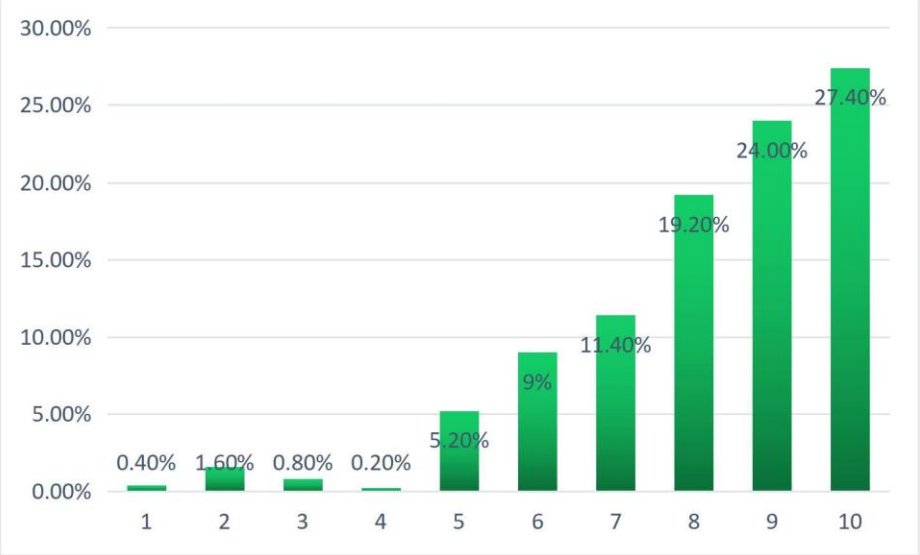

Fig. 6. Graphical representation of durability of aluminium rating by participants

3.7. Experienced adverse effects with aluminium vessels

Of the total 500 participants, 57.2% experienced side effects or adverse effects, 25.4% observed no side effects, and few people said maybe. (Fig. 7).

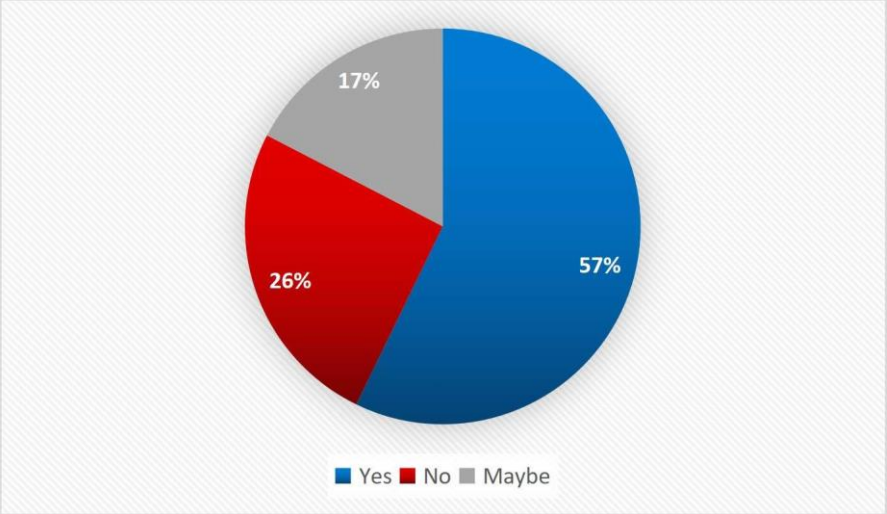

Fig. 7. Graphical representation of frequency of experienced adverse effects with aluminium vessels by participants.

The majority of 35.2% have specified some side effects with aluminium vessel. Those are abdominal pain, acidic reactions, leg pains, muscle weakness, headache, diarrhoea. (Table. 2).

Table. 2. Specified some side effects with aluminium vessels by participants.

Utensils made by	Side effects	Effected organ
Aluminium	Anxiety	Brain
	Acidic reactions	Stomach
	Indigestion	Stomach
	Abdominal pain	Stomach, gallbladder
	Headache	Brain tissues
	Leg pains	Joints, lower spine
	Muscle weakness	Brain, nerves, muscles
	Diarrhoea	Intestine

3.8. Knowledge about aluminium toxicity

Out of a total of 500 participants, 7.4% are reading in print and electronic media. 2.4% of people studied as part of their curriculum. 90.2% of people had a lack of knowledge about aluminium toxicity or aluminium poisoning to the human's body. (Fig. 8).

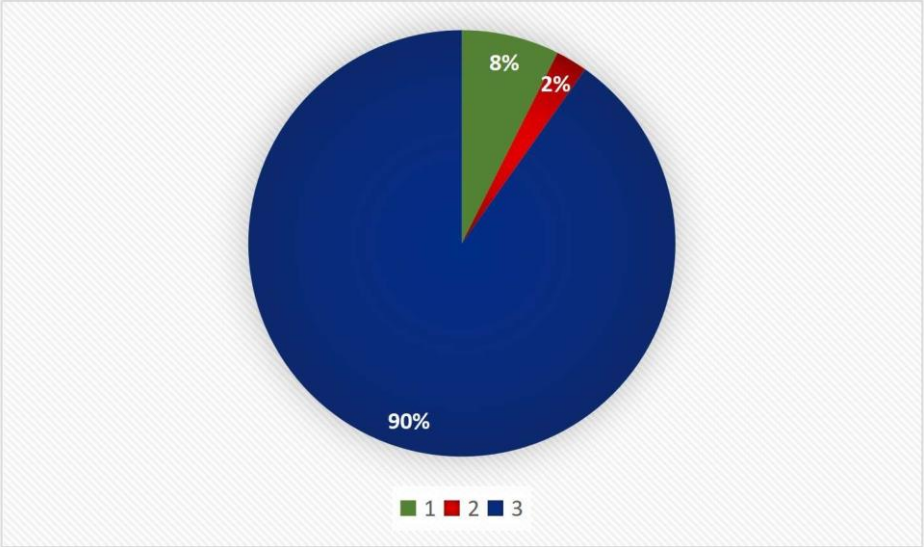

Fig. 8. Graphical representation of lacking knowledge of aluminium toxicity by participants.

3.9. Aware of safety concerns with aluminium toxicity

Of the total 500 participants, 92% were not aware of safety concerns with aluminium toxicity and the science involved in the metal toxicity. Only 8% of people have awareness safety concerns. (Fig. 9).

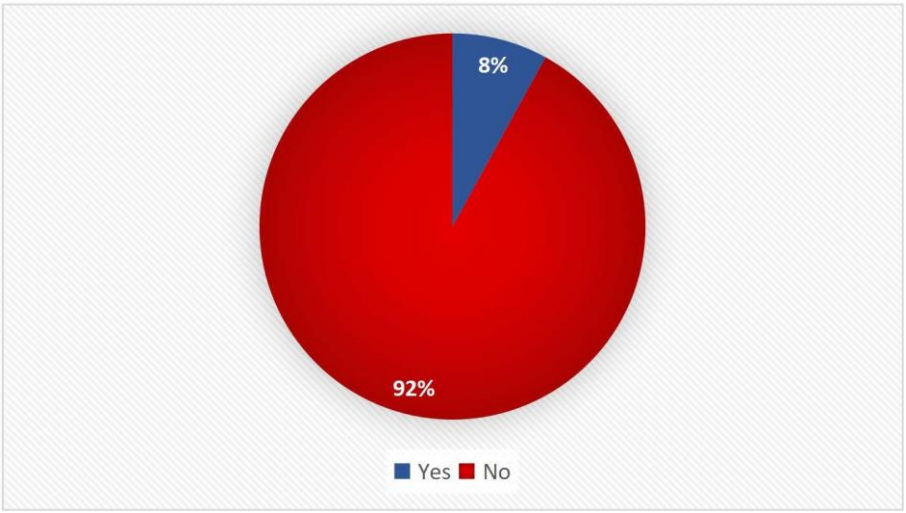

Fig. 9. Graphical representation of awareness of safety concerns with aluminium toxicity by participants.

3.10. Awareness programs about aluminium toxicity

Participants suggested and indicated that different awareness programs about aluminium toxicity, such as advertisements, social media, promotions, electronic and print media, and the conducting of seminars, decrease production of aluminium utensils and its products.

4. DISCUSSION

“Exposure to aluminium comes from different sources, such as cooking utensils, food additives, drinking water, and leaching” [2]. “Evidence suggests that cooking in aluminium utensils or using aluminium foil is not harmful” [14, 15]. “But some studies explain aluminiummay lead to toxic levels in human beings” [16, 17]. “Storing and cooking food in aluminium foils is a major source of aluminium exposure in developed countries. The levels of aluminium leaching in fish fillets baked and grilled in aluminium foils were estimated” by Ranau et al. [14].

“However, the authors studied the leaching of aluminium during the preparation of various traditional Indian foods and found that it was negligible in hard anodized aluminium utensils, showing the advantage of using such type of vessels for food preparation over simple aluminium and indalium utensils” [18]. “Different studies have been taken up to support the harmful effects of aluminium in humans, like its role in neural toxicity, cancer, Alzheimer’s, and osteomalacia” [19].

“Generally, specific effects of aluminium are often going to be associated with particular target organs, such as the brain, and stomach, and the body burden may not accurately predict such toxicity. Aluminium expose and an individual's body burden of aluminium is a system's biology problem and will require data derived from the environmental” [20].

“Similarly, other things that contribute to the aluminium metal toxicity in our body can also bereplaced. Aluminium foil for wrapping chapati and food can replace a cotton cloth, and its coagulant can be replaced by Moringa seed powder for water treatment” [21]. “The aluminium level in seafood and aquatic organisms can accumulate aluminium in their bodies due to water being contaminated with a high level of aluminium metal” [22].

This survey also provided us with specific, significant correlations between the age, groups, and responses. A total of 500 responses were included in the study among Kadapa City. People are using the aluminium vessels more frequently and are storing cooked food in them. Moreover, aluminium utensils, which enhance the aluminium leaching, which means chemical dissolution, further into food, showed different types of side effects.

5. CONCLUSION

The findings of this study suggest that the aluminium toxicity, which means aluminium poisoning, exposure comes from the usage of aluminium vessels for cooking, baking, and storing food in the Indian home kitchen, and immediate replacement of aluminium vessels will play a crucial role in reducing the aluminium metal in the human body. We still need to be vigilant about other aluminium-containing products, which we often use. The government of India needs to conduct awareness programs on the use of aluminium vessels and their adverse metal reactions. However, aluminium toxicity causes health problems such as anxiety, acidic reactions, indigestion, abdominal pain, etc. Hence, it can be consolidated that knowledge and awareness of safety concerns can help in curtailing the daily aluminium consumption by exploring the alternatives for aluminium-based products.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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Details of the AI usage are given below:

1.

2.

3.

APPENDIX-1

Questionnaire

1. Do you use aluminium vessels?

   Yes/No

2. Can you please give the reason for using aluminium vessels?

   Easy available

   Cheaper

   Easy to clean

   Easy to maintain

   Cook food fast

   Don't have

3. Do you have aluminium vessels for

   Cooking rice

   Boiling drinking water

   Making curry

   Don't use

4. Which vessels do you use to store cooked food?

   Aluminium

   Stainless steel

   Hard anodized

Nonstick

5. Do you use aluminium foil for

To wrap Chapathi

For Packing

For baking purposes

I don't use

6. How will you rate the durability of aluminium vessels? That you used or saw someone using, on the scale 1 to 10, with 1 being the worst and 10 being the best.

1 2 3 4 5 6 7 8 9 10

7. Can you please give the reason behind the rating?

Reason _____

8. Have you ever experienced or observed any adverse effects with aluminium vessels?

Yes

No

Maybe

9. If yes, can you please specify what the side effects were?

_____

10. Do you have any knowledge about aluminium toxicity?

Yes, I keep reading about it in print and electronic media.

Yes, I have studied about it as part of my curriculum.

I don't know

11. Are you aware of safety concerns with aluminium toxicity or poisoning?

Yes /No

12. What are your suggestions to increase awareness about aluminium toxicity?

Suggestions _____

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