iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** IV **Month of publication:** April 2024

DOI: https://doi.org/10.22214/ijraset.2024.60622

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue IV Apr 2024- Available at www.ijraset.com

Potential Health Impacts of Hard Water: A Review of Literature

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Abstract: ***Over the past five decades, accumulating evidence suggests that the hardness of drinking water, particularly its magnesium and calcium content, may influence mortality, especially cardiovascular mortality. Epidemiological studies have linked hard water to various health issues like cardiovascular disease, growth retardation, and reproductive failure. Additionally, the acidity of water affects the reabsorption of calcium and magnesium in the kidneys. Other constituents in water also impact different aspects of health. The review aims to explore these health effects, emphasizing the need for quality and quantitative assessment of drinking water to ensure its safety, especially considering that water with a total dissolved solid greater than 500 ppm may pose health risks upon prolonged consumption.***
Keywords: Alzheimer's disease, calcium, cancer, cardiovascular disease, diabetes, hard water, magnesium, reproductive health.

I. INTRODUCTION

The literatures discuss the importance of water for life and various uses, highlighting its critical role in food preparation, sanitation, and hygiene. It emphasizes the necessity of ensuring access to safe water for human health, with statistics indicating significant portions of the global population lacking access to safe water sources. Hard water, characterized by high concentrations of calcium and magnesium ions, is identified as a significant factor contributing to various health issues worldwide, including cardiovascular problems, diabetes, reproductive failure, neural diseases, and renal dysfunction. Hardness in water can be attributed to various dissolved metals, including calcium, magnesium, aluminum, barium, strontium, iron, zinc, and manganese. The passage distinguishes between two types of hardness: carbonate hardness, caused by metals combined with alkalinity, and non-carbonate hardness, resulting from metals combining with substances other than alkalinity. While temporary hardness (carbonate) can be removed by boiling water, permanent hardness (non-carbonate) persists despite boiling. Scientific studies suggest that minerals present in hard water can react with soaps, leading to skin and hair issues such as dryness, eczema, and dandruff. The passage also references Kobayashi's research, which first described the relationship between water hardness and vascular disease. Sources of drinking water in India, including wells, hand pumps, bore wells, tube wells, and surface water sources like rivers and lakes, are identified. Hard water in India is primarily caused by the high levels of dissolved minerals and impurities picked up as water travels through the ground, including calcium and magnesium salts, other metal salts, bicarbonates, silicates, and sulphates. Water hardness is categorized into temporary and permanent hardness. Temporary hardness, caused by soluble calcium and magnesium bicarbonates, can be removed by boiling water. In contrast, permanent hardness, attributed to soluble chlorides, calcium, magnesium, and sulphates, persists despite boiling. Various methods, such as the Calgon method, ion exchange method, and soda bath method, are suggested for removing permanent hardness from water.

II. POTENTIAL HEALTH EFFECTS

The literatures discuss various potential health effects associated with hard water, particularly focusing on its mineral content, calcium, and magnesium. It highlights that the World Health Organization (WHO) has stated at its Geneva Conference that hard water has no known adverse health effects and may even provide supplemental calcium and magnesium intake. However, it also acknowledges potential health implications due to the salts dissolved in hard water.

1) *Cardiovascular Disease:* Large-scale studies suggest an inverse relationship between water hardness and cardiovascular disease, though some studies show no association. The role of magnesium in hard water is proposed as having anti-stress actions against coronary heart disease.
2) *Cancer:* Studies indicate a negative statistical association between various types of cancer and water hardness, particularly concerning gastric, colon, rectal, and pancreatic cancer. Magnesium intake from water is suggested to have a protective effect against certain types of cancer.

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3) *Cerebrovascular Mortality:* Magnesium intake from drinking water is linked to a significant protective effect against cerebrovascular disease. This is attributed to magnesium's role in enzyme activation, energy metabolism, and vascular regulation.
4) *Malformations of Central Nervous System:* The hardness of water is speculated to influence the incidence of neural tube malformations, although the exact mechanism remains unclear. Regional variations in mortality from central nervous system malformations are correlated with water hardness.
5) *Alzheimer's Disease:* While aluminum's role in Alzheimer's disease remains contentious, regions with higher aluminum concentrations in water have been associated with increased risk of Alzheimer's disease.
6) *Diabetes:* Hard water with high magnesium levels may contribute to decreased serum magnesium concentrations, which is linked to metabolic syndrome and type 2 diabetes. Magnesium supplementation may improve glycemic control.
7) *Childhood Atopic Dermatitis:* Exposure to hard water is considered a risk factor for atopic dermatitis. Higher water hardness is associated with increased prevalence of atopic eczema among children.
8) *Kidney Stones:* Hard water, containing calcium and magnesium salts, may contribute to urinary stone formation, although the evidence is inconclusive.
9) *Reproductive Health:* Studies suggest mixed effects of hard water constituents, with excess calcium possibly leading to reproductive failure in men. Magnesium sulfate in hard water is indicated to prevent eclampsia in pregnant women.
10) *Digestive Health and Constipation:* Hard water with calcium and magnesium may alleviate constipation due to their laxative effects.
11) *Bone Mineral Density:* High calcium water is associated with increased spine mineral density in certain populations, suggesting a potential benefit to bone health.

Overall, while hard water may have some potential health benefits due to its mineral content, it also poses risks, particularly regarding its influence on various health conditions and diseases. The exact impact of hard water on human health requires further research and consideration of multiple factors.

III. CONCLUSION

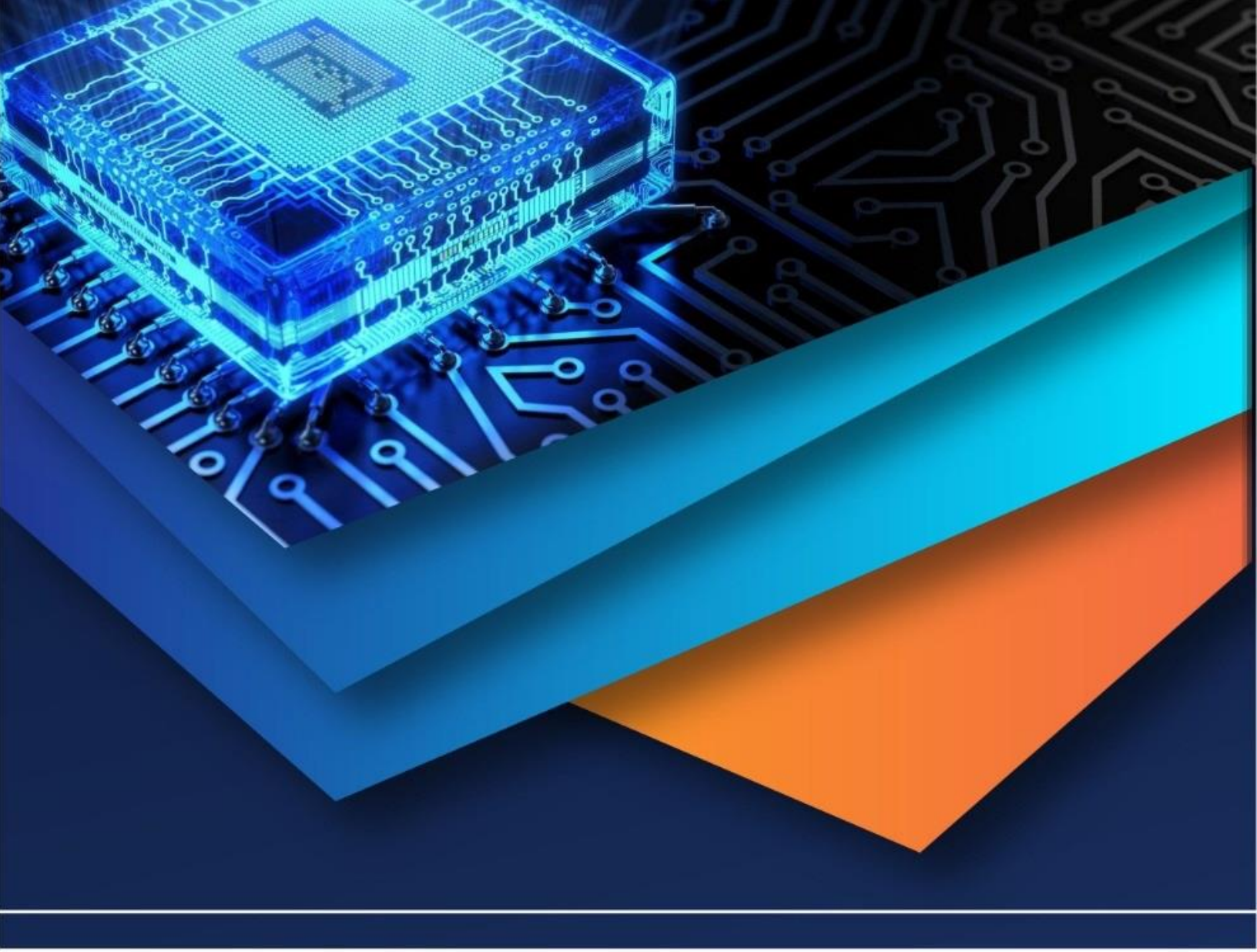
The conclusion emphasizes the importance of addressing water pollution as a critical environmental issue that impacts human health. While compounds like calcium and magnesium present in hard water are essential for living organisms, their excess and inorganic origin can be harmful. Government and non-government initiatives are underway to address water crises.

Regarding hardness in drinking water, it's noted that while some epidemiological studies suggest a protective effect of magnesium or hardness on cardiovascular mortality, the evidence is debated and doesn't establish causality. Further research is ongoing. However, drinking water can contribute to calcium and magnesium intake in the diet, particularly for those with marginal intake levels. Recommendations include informing consumers about the mineral composition of their water, especially if altered by suppliers or treatment devices. When considering changes in water supply, the contribution of drinking water minerals to nutrition should be taken into account. Currently, there are no proposed guideline values for mineral concentrations due to insufficient data.

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