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Analysis of blood calcium levels in calcium water consumers

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ABSTRACT

Introduction: Water is a primary and basic human need. One of the chemical parameters that must be met for drinking water needs is mineral content, such as calcium and magnesium. Water hardness is a condition in which there is excessive calcium and magnesium content, which is commonly known as calcareous water. High water hardness that exceeds normal limits can interfere with body health if consumed long-term. Specifically, excess calcium in the body can cause hypercalcemia, hyperparathyroidism, kidney stones, and muscle tissue damage (muscle weakness).

Objective: This study aims to determine blood calcium levels in individuals who consume calcareous healthy water.

Methods: The type of research used is descriptive-analytical, with blood calcium level analysis carried out using the Ion Selective Electrode (ISE) method through the Electrolyte Analyzer (CBS400).

Result: Based on the results of the study, it was obtained that blood calcium levels in 30 community respondents in Ranomeeto District (100%) were above the reference value, indicating high blood calcium levels.

Conclusion: blood calcium levels in people who consume lime juice indicate high blood calcium levels. Consuming water with a high lime content can hurt health. Therefore, people need to consider the quality of the drinking water they drink, especially those that have a high lime content, to maintain heart and kidney health in the long term.

Keywords: calcium water; blood calcium levels; high calcium water.

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INTRODUCTION

Water is one of the most essential sources of life for humans, animals, and plants. As the main component in the human body, about 80% of individual needs are obtained from fluids, including water, while the rest comes from food. Water can be obtained from various sources, including seawater, rainwater, surface water (swamps, rivers, and lakes), and groundwater. Groundwater is a significant source of fresh water, an essential natural resource, and the primary source of drinking water in many areas (Faraji and Shahryari, 2024). The properties and elements of the soil's surface layer influence groundwater's vulnerability (aquifers). Although groundwater generally has better quality than surface water, its quality can be affected by various factors, such as anthropogenic pollution (urbanization, industry, etc.), resource conditions, sanitation, intensive agricultural practices, and natural processes (D. Wang *et al.*, 2024).

Water is essential in everyday life, especially for drinking, bathing, cooking, and washing. The benefits of water for the human body include support in the digestive process, transport of nutrients, maintaining body temperature balance, and regulating metabolic processes (Patra *et al.*, 2024). The content of hardness contaminants, namely minerals such as calcium and magnesium, in clean water, drinking water, and water for sanitation and hygiene purposes is regulated in the Regulation of the Minister of Health of the Republic of Indonesia No. 32 of 2017 and the Regulation of the Minister of Health of the Republic of Indonesia No. 492/MENKES/PER/IV/2010, which states that the maximum calcium content in drinking water is 75 mg/liter without a minimum limit. Water sources must meet reasonable requirements for human needs, with drinking water quality criteria that include physical, chemical, bacteriological, and radioactive aspects. Changes in the appearance, taste, or odor of drinking water indicate that the quality of the raw water source has decreased. Total dissolved solids (TDS) and several other essential elements are needed to prevent chronic adverse health effects due to long-term water consumption (Duan *et al.*, 2024).

Calcium ions are essential for the body, and blood calcium levels must be carefully controlled. Daily calcium consumption should not exceed 500 mg. Hyperparathyroidism, a condition in which there is excessive production of parathyroid hormone, can be caused by excess calcium. Symptoms of hyperparathyroidism include the formation of kidney stones, increased frequency of urination, and bone fragility (F. Li *et al.*, 2024). The body uses calcium to perform various essential functions, including conducting nerve impulses, contracting muscles, clotting blood, and activating certain enzymes. Most body fluids have different electrolyte concentrations, and electrolytes are in the correct positions and amounts in a healthy state (Fadillah, 2022). Calcium-rich foods influence blood calcium levels (Bhanbhro *et al.*, 2024). Increased serum calcium levels occur when the body absorbs more calcium than is needed.

When calcium stones form, serum calcium concentrations also increase. Several researchers have analyzed the relationship between consumption of calcareous water and blood calcium levels. Data show a tendency for increased blood calcium levels in individuals who consume calcareous water (Y. Zhang *et al.*, 2023). Consumption of calcareous water for more than 10 years shows that the use of calcareous water significantly contributes to increased blood calcium levels in the group of subjects tested. Hypercalcemia, a condition in which the calcium concentration in the blood exceeds 10.40 mg/dl, is caused by increased calcium intake or absorption in the digestive tract (Setyawati, Nurasmi, and Irnawati, 2021). This excessive calcium intake can come from foods high in calcium. Severe and progressive hypercalcemia can be associated with significant volume depletion, acute renal insufficiency, and dramatic neurocognitive symptoms, ranging from altered mental status to coma (Rice *et al.*, 2024).

Hardness in the body at a certain level can provide health benefits; however, when hardness exceeds normal limits and is consumed over a long period, it can be detrimental to health. Specifically, excess calcium in the body can cause the formation of kidney stones (nephrolithiasis), hyperparathyroidism, and muscle tissue damage (muscle weakness) (Yin *et al.*,

2024). Hyperparathyroidism, which is caused by excess calcium, is a condition in which there is an increase in the production of parathyroid hormone in the blood. Symptoms of hyperparathyroidism include brittle bones (osteoporosis), kidney stone formation, and increased frequency of urination. Based on the description above, researchers are interested in analyzing blood calcium levels in individuals who consume calcareous water in the Ranomeeto District.

RESEARCH METHODOLOGY

This study is a descriptive-analytical study with a cross-sectional study design. Blood calcium levels are measured using an Electrolyte Analyzer. This study uses a descriptive-analytical approach with a cross-sectional design to measure blood calcium levels in respondents. In a cross-sectional design, data were collected at a specific time without intervention, which made it possible to see a picture of the relationship between high lime water consumption and blood calcium levels. Blood calcium levels are measured using the Electrolyte Analyzer, which allows for accurate and fast measurement of electrolyte levels, including calcium. This technique is beneficial in cross-sectional studies because it provides objective and reliable measurement results for analyzing variations in calcium levels in populations that consume high-calcium water.

RESULT

The respondents in this study were the people of Ranomeeto Village who consumed lime-containing water.

Table 1. Distribution of lime-containing water consumers based on gender

Gender	Number of respondents	Percentage (%)
Male	18	60
Female	12	40
Age		
20	6	20
30	9	30
50	15	50

Table 1 shows the total number of respondents who consume lime water in the Ranomeeto District. There are 18 male respondents (60%) and 12 female respondents (40%). Shows the distribution of the age range of consumers of lime-containing water in the Ranomeeto District from 30 respondents. Respondents aged 20 years old numbered six people (20%), 30 years old numbered nine people (30%), and 50 years old numbered 15 people (50%)

Table 3. Results of blood calcium level examination in consumers of lime water in Ranomeeto district based on duration of consumption

Duration of consumption (years)	Blood calcium level (mmol/L)	Number of respondents (people)	Percentage (%)
>10	7.26 – 7.56	6	20
>20	7.79 – 7.89	9	30
>40	6.73 – 6.92	15	50
Totally		30	100
Reference value: 2.10 – 2.70 mmol/L			

(*Primary data sources, 2024*)

The data in Table 3 shows that people who consume lime water for more than 10 years have blood calcium levels of 7.26-7.56 mmol/L, comprising six people (20%). People who drink for more than 20 years have blood calcium levels of 7.79-7.89 mmol/L, with nine people (30%). Meanwhile, people who consume more than 40 years have blood calcium levels of 6.73-6.92 mmol/L, comprising 15 people (50%).

DISCUSSION

This study analyzes blood calcium levels in people who consume lime water in the Ranomeeto District. The research design uses a descriptive-analytical method. Blood calcium levels were measured on 30 respondents who had consumed lime water for 10 to 40 years. Hard water, which contains calcium (Ca), is known as lime water and, if consumed continuously, can interfere with the calcium metabolism mechanism in the body. The people in Ranomeeto District use water from dug and drilled wells for various purposes, such as washing, bathing, and daily consumption. The water consumed is usually boiled first, which often leaves a white crust on the walls of the boiling pot, indicating that the water contains lime. Several studies have shown that residents in areas with high limestone content who consume groundwater have a higher incidence of urinary tract stones, even at a young age. Hard water, known as lime water, if consumed continuously, can disrupt the mechanism of calcium metabolism in the body. Long-term use of hard water can cause kidney disorders due to the accumulation of $CaCO_3$ and $MgCO_3$ deposits. The calcium absorption process, which occurs mainly in the upper part of the small intestine, is enhanced by 1,25-dihydroxycalciferol and other active metabolites of vitamin D and parathyroid hormone. Excess calcium can cause hyperparathyroidism, a condition in which there is excessive production of parathyroid hormone in the blood (Jaita *et al.*, 2024). The parathyroid functions to regulate calcium levels in the body, and excessive PTH production, which is not adequately suppressed by increased serum calcium concentrations, can cause calcium deposits in the kidneys and form kidney stones (X. Zhang *et al.*, 2023). Continuous consumption of drinking water containing manganese, iron, magnesium, calcium, and other metals in amounts exceeding the water quality threshold can cause accumulation of these metals in the body (M. Li *et al.*, 2024).

The effect of calcium water consumption on blood calcium levels has become a topic of concern in the health world, mainly due to the potential long-term health risks (Muliari *et al.*, 2024). As more research is done on the consumption of high mineral content, there is a deeper understanding of how excess calcium from the water we drink can affect body functions, particularly cardiovascular and kidney health (G. Li *et al.*, 2024). Several factors, including nutritional intake, control the high and low blood calcium levels. In addition, other influencing factors that affect blood calcium levels include 1,25-dihydroxycholecalciferol, parathyroid hormone (PTH), calciferol (vitamin D), phosphorus, magnesium, protein, and estrogen (Chu *et al.*, 2023). Consumption of lime-containing water for more than 10 years has significantly increased blood calcium levels in the subjects tested. Hypercalcemia, or high levels of calcium in the serum, is when the body absorbs more calcium than is needed for daily needs. Excessive calcium intake can come from foods or drinks that contain high amounts of calcium (Abdullah Tan *et al.*, 2024). Normal blood calcium levels are influenced by various factors, including an individual's lifestyle and physical activity, where a decrease in calcium absorption rate in the kidneys can contribute to a reduction in the rate of kidney stone formation (Sirkiä *et al.*, 2023). Blood calcium levels can be normalized if calcium metabolism is going well and no external factors affect these levels (Han *et al.*, 2024). Most people who consume water with high calcium levels show higher blood calcium levels than those with normal calcium levels. High calcium levels are at risk of leading to hypercalcemia, which is a condition in which calcium levels in the blood exceed normal limits (G. Wang *et al.*, 2024).

Water purifiers specifically designed to reduce calcium levels, such as ion exchange filtration, can help lower water hardness and reduce calcium exposure to consumers (Zou *et al.*, 2024). People at high risk or who have shown symptoms of hypercalcemia should have their blood calcium levels checked regularly to monitor the impact of high calcium water consumption. As we age over 50, the calcium content in our bodies tends to decrease (Zhou *et al.*, 2024). In the middle-aged phase, especially after age 50, a decrease in metabolism occurs, which can result in calcium loss from the bones. This contributes to increased bone vulnerability, known as osteoporosis (Fukui *et al.*, 2024). In addition, calcium deficiency can also result in osteomalacia and rickets in adults, conditions often caused by vitamin D deficiency and an imbalance in calcium intake. One of the main functions of vitamin D is to increase calcium absorption from the digestive tract (Mohammadpour *et al.*, 2024). Some people with osteoporosis show low

vitamin D levels in the body, which impacts decreasing calcium absorption from the intestines. The body's ability to activate vitamin D through the skin decreases with age and reduces estrogen levels (Ameen *et al.*, 2024). High calcium water consumption can potentially increase calcium levels in the blood, which, if left unattended, can trigger health problems such as heart disease and kidney stones. Regular monitoring and proper management can minimize this risk so that people can continue to consume safe and healthy water (Wu *et al.*, 2024).

CONCLUSION

It can be concluded that blood calcium levels in people who consume lime juice indicate high blood calcium levels. Consuming water with a high lime content can have adverse health effects, including increasing the risk of blockage of heart vessels (heart disease) and the formation of kidney stones (urolithiasis), which can cause stones in the urinary tract. Consumption of water with a high lime content, such as lime juice, which is rich in calcium, can affect blood calcium levels in the body. Therefore, people need to consider the quality of the drinking water they consume, especially those with a high lime content, to maintain heart and kidney health in the long term.

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Conflict of Interest

The authors declare that no potential conflicts of interest could influence the results or interpretation of this study.

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