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Research Article

Analysis of Drinking Water Quality and Environmental Health Risks Due to Exposure to Lead (Pb), Cadmium (Cd), and Iron (Fe) at Refill Drinking Water Depots in the Work Area of the Kadolomoko Community Health Center, Baubau City

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Abstract: Heavy mental contamination in drinking water can be toxic to the body, this is because the metal is not needed by the body. Cadmium (Cd) and lead (Pb) (non-essential heavy metals) are dangerous heavy metals because they cannot be broken down by the body and can accumulate in the environment, forming complex compounds at the bottom of the water while Iron (Fe) (essential metal) is needed by the body, but in excessive amounts will cause poisoning. The high use of refilled drinking water has the risk of increasing waterborne diseases. This study aims to determine the content of Lead (Pb), Cadmium (Cd), Iron (Fe) and environmental risks due to exposure to drinking water at the Refill Drinking Water Depot in the Kadolomoko Health Center area of Baubau City. This study uses a descriptive observational method with a design of the Environmental Health Risk Analysis method at the Refill Drinking Water Depot in the Baubau Health Center working area of Baubau City. The population is all the number of Refill Drinking Water Depots and tested using the Atomic Absorption Spectrophotometer (AAS) method and 6,497 people who consume drinking water from the Depot with samples using Slovin totaling 96 respondents with questionnaire instruments and univariate tests. The results of chemical parameters in drinking water at the Refill Drinking Water Depot in the working area of the Kadolomoko Health Center are in accordance with the standard quality standards based on Permenkes No. 2 of 2023 and the results of the Intake Risk Analysis of ingestion exposure in the next 5 years, the ECR value of Lead (Pb) = mg / l / day and the RQ value of Cadmium (Cd) = 0.12 mg / l / day and Iron (Fe) = 0.00043 mg / l / day while in the next 30 years the ECR value of Lead (Pb) $= 1{,}26 \times 10^{-6} 7{,}56 \times 10^{-5}$ mg/l/day and the RQ value of Cadmium (Cd) = 0.12 mg/l/day and Iron (Fe) = 0.0004 mg/l/day does not exceed the quality standard, namely ECR ≥ E-4 (10^{-4}) and RQ ≥ 1 Conclusion Refill drinking water at the depot in the Kadolomoko Community Health Center work area is safe for consumption for up to 5 years and 30 years into the future.

Keywords: Drinking Water; Environmental Risk; Heavy Metals; Metal Contamination; Water Depot.

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1. Introduction

Clean water is a basic human need that significantly impacts public health. This issue is a global focus in the Sustainable Development Goals (SDGs), particularly goal three, a healthy and prosperous life, and goal six, clean water and adequate sanitation (Indonesian Audit Board, 2022). Achieving these goals underscores the urgency of providing reliable sources of clean water to prevent the spread of infectious and waterborne diseases such as cholera, dysentery, and diarrhea (Alum et al., 2024). Reliable clean water supplies directly reduce morbidity and mortality rates by breaking the transmission chain of these illnesses. Moreover, improved water quality supports better maternal and child health, enhances nutritional outcomes, and fosters socioeconomic development by allowing communities to focus on education and economic activities rather than coping with illness (Ugwu et al., 2015). By 2030, the world is targeting a significant reduction in the number of deaths due to exposure to hazardous chemicals, pollution, and contamination of water, air, and soil (Ministry of National Development Planning/Bappenas, 2021). This target calls for integrated efforts-ranging from the development of sustainable water infrastructure and robust regulatory frameworks to community education on water conservation and pollution prevention. Meeting these benchmarks will not only safeguard public health but also contribute to environmental sustainability and resilience against climate change (Corvalan et al., 2020).

One of the major challenges in ensuring clean water is heavy metal contamination. Lead (Pb) and cadmium (Cd) are two toxic heavy metals that are not needed by the body and have the potential to accumulate in the environment (Bouida et al., 2022). Exposure to these heavy metals can cause various serious health problems, ranging from growth disorders and infections to death. The WHO reports that nearly 40% of fatal diseases worldwide are linked to poor water quality, with approximately 2.6 million deaths annually resulting from consumption of unsafe water (Sudarman et al., 2021). Historically, cases of "itai-itai disease" in Japan due to cadmium pollution from mining activities are clear evidence of the dangers of heavy metals in water (Girikallo et al., 2022).

In Indonesia, the production of bottled drinking water (AMDK) began in 1972. However, the rising price of bottled drinking water has led people to seek cheaper alternatives, namely refillable drinking water produced by drinking water depots (Samudra et al., 2019). While practical and economical, refillable drinking water does not always guarantee quality. Substandard processing can increase the risk of waterborne diseases such as diarrhea, cholera, typhoid, and hepatitis (Toalu et al., 2023; Yushananta et al., 2022). This condition aligns with data on the still high prevalence of diarrhea in several areas, including the Kadolomoko Community Health Center, which recorded 418 cases (12%) in 2023, ranking among the top ten most common diseases (Kadolomoko Community Health Center Profile, 2023).

Baubau City had 3,436 drinking water facilities in 2022, but only 765 (22.26%) were inspected. Of these, most were classified as low to moderate risk, but laboratory testing was not performed due to limited reagents and the COVID-19 pandemic (Baubau City Health Office, 2022). In the Kadolomoko Community Health Center (Puskesmas) work area, there are 9 registered refillable drinking water depots, with 7 still actively using raw water from drilled wells or the Regional Water Company (PDAM). A total of 6,497 residents still rely on refillable drinking water depots for their daily needs. However, none of these depots have ever undergone laboratory testing for the quality of their water (Kadolomoko Community Health Center Profile, 2023).

This situation highlights serious challenges in ensuring the safety of drinking water for the public. The lack of quality oversight and the absence of laboratory testing at refillable drinking water depots in the Kadolomoko Community Health Center area pose potential public health risks. Therefore, research on the quality of refillable drinking water is crucial, not only as a scientific basis but also as a basis for policy-making in public health protection efforts.

2. Research and Method

In this section, you need to describe the proposed method step by step. Explanations accompanied by equations and flow diagrams as illustrations will make it easier for readers to understand your research.

This study uses a descriptive observational method with an Environmental Health Risk Analysis (ARKL) approach which was carried out at 7 Refill Drinking Water Depots (DAMIU) in the working area of the Kadolomoko Health Center, Baubau City, in November–December 2024. The ARKL stages include: a.) dentification of the hazards of heavy metals lead (Pb), cadmium (Cd) and iron (Fe) based on laboratory test results and compared with Minister of Health Regulation No. 2 of 2023. b.) Exposure analysis to estimate metal intake through calculation of concentration, intake rate, frequency, duration, body weight and exposure period. c.) Dose-response analysis using Reference Dose (RfD), Reference Concentration (RfC), or Slope Factor (SF) values according to the literature. d.) As well as risk characterization using Excess Cancer Risk (ECR) for Pb because it is carcinogenic and Risk Quotient (RQ) for Cd and Fe because they are non-carcinogenic.

The study population comprised nine depots, but only seven were active, with 6,497 residents using the seven DAMIUs. From this total population, a sample of 96 respondents was selected using the Slovin formula, with a 10% error rate, and purposive sampling.

The types of data in this study consist of primary and secondary data. Primary data were obtained directly through drinking water sampling at 7 Refill Drinking Water Depots (DAMIU) in the working area of the Kadolomoko Community Health Center, which were then stored in labeled bottles and analyzed at the Mathematics and Natural Sciences Laboratory of Halu Oleo University using an Atomic Absorption Spectrophotometer (AAS) to determine the levels of lead (Pb), cadmium (Cd), and iron (Fe). Other primary data were obtained through questionnaires for environmental health risk analysis. Meanwhile, secondary data were obtained from the Baubau City Health Office Profile, the Kadolomoko Community Health Center Profile, data on the number of DAMIUs, data on the community using refill water, as well as various relevant literature and journals.

The data obtained from the laboratory test results were then analyzed using regression to determine the effect of lead (Pb), cadmium (Cd) and iron (Fe) metals on the quality of refilled drinking water with reference to the mandatory parameters of drinking water according to Minister of Health Regulation No. 2 of 2023. In addition, environmental health risk analysis was carried out using univariate analysis to describe the characteristics of environmental risks based on the intake of community drinking water exposure.

3. Results and Discussion

3.1. Univariate Analysis

a. Characteristics of Individuals in the Community Who Consume Refilled Drinking Water Based on Gender

Table 1. Characteristics of Individuals in the Community Who Consume Refilled Drinking Water Based on Gender.

Gender	**People who consume refilled drinking water**	
	N	**%**
Man	**32**	**33.3**
Woman	**64**	**66.7**
Total	**96**	**100**

Based on the above, it can be seen that the number of respondents who consume refilled drinking water are women (66.7%) and men (33.3%).

b. Characteristics of Individuals in the Community Who Consume Refilled Drinking Water Based on Activity Patterns

Table 2. Characteristics of Individuals in the Community Who Consume Refilled Drinking Water Based on Activity Patterns.

Variable	**N**	**Mean**	**Med.**	**Elementary School**	**Min**	**Max**	**p Value**
Age Resp.	96	43.23	40.50	11,422	26	70	0,000
Weight	96	59.18	57.50	9,084	44	89	0,000
Display Duration	96	8.84	8	3,045	18	2	0,000
Display Frequency	96	3.10	3	1,192	6	1	0,000

Based on the table above, it can be seen that the results of the Kolmogorov-Smirnov test that have been conducted on 96 community respondents who consume refilled drinking water at 7 Depots in the working area of the Kadolomoko Health Center, Baubau City, obtained normally distributed data with a p value = 0.000, therefore, in the respondent's age variable with an average age of respondents, namely the oldest age is 43 years and the youngest age is 23 years, the weight variable with an average of the heaviest is 57 kg and the lightest is 18 kg, the duration variable with an average of the most is 84 times and the lowest is 8 times, and the frequency variable with an average of consuming the most drinking water is 10 glasses per day and the lowest is 8 glasses per day.

c. Characteristics of Individuals Who Consume Refilled Drinking Water Based on Health Problems in the Last Month

Table 3. Characteristics of Individuals Who Consume Refilled Drinking Water Based on Health Problems in the Last Month.

Health Problems in the last 1 month	DAMIU User Community	
	N	**%**
There isn't any	96	100
Body aches	0	0
Dizzy	0	0
Headache	0	0
Diarrhea	0	0
Health Problems in the last 1 month	**DAMIU User Community**	
	N	**%**
Nauseous	0	0
Respiratory disorders	0	0
Total	**96**	**100**

Based on the table above, there are 96 (100%) respondents in the category of having no health problems due to consuming refilled drinking water from the Refill Drinking Water Depot in the working area of the Kadolomoko Health Center, Baubau City.

3.2. Environmental Health Risk Analysis of Lead (Pb), Cadmium (Cd) and Iron (Fe) Metal Content at Refill Drinking Water Depots in the Kadolomoko Community Health Center Work Area

a. Hazard Identification

In this study, samples were taken from 7 Refill Drinking Water Depots in the working area of the Kadolomoko Health Center, then examined at the Mathematics and Natural Sciences Laboratory of Halu Oleo University using the Atomic Absorption Spectrophotometer (AAS) method to determine the concentration of Lead (Pb), Cadmium (Cd), and Iron (Fe) metals in the drinking water.

1. Lead (Pb) Metal Concentration at Refill Drinking Water Depots in the Kadolomoko Community Health Center Work Area

Table 4. Lead (Pb) Metal Concentration at Refill Drinking Water Depots in the Kadolomoko Community Health Center Work Area.

Sample	Pb concentration examined	Lead Standards Based on Minister of Health Regulation No. 2 of 2023
Aquanissa Depot	< 0.001 mg/l	0.01 mg/l
Ratu RO Depot	< 0.001 mg/l	0.01 mg/l
Adzikra RO Depot	0.002 mg/l	0.01 mg/l
Mekar Water Depot	< 0.001 mg/l	0.01 mg/l
Manguilo Depot	0.001 mg/l	0.01 mg/l
Surya Agung Depot	0.001 mg/l	0.01 mg/l
Science Depot	0.001 mg/l	0.01 mg/l

Based on the table above, it is known that the concentration of Lead (Pb) metal in 7 Refill Drinking Water Depots in the Kadolomoko Health Center Working Area of Baubau City is not greater than the maximum concentration of Lead (Pb) metal permitted based on Minister of Health Regulation No. 2 of 2023, namely 0.01 mg/l.

2. Cadmium (Cd) Metal Concentration at Refill Drinking Water Depots in the Kadolomoko Community Health Center Work Area

Table 5. Cadmium (Cd) Metal Concentration at Refill Drinking Water Depots in the Kadolomoko Community Health Center Work Area.

Sample	The concentration of Cd metal examined	CD Standards Based on Minister of Health Regulation No. 2 of 2023
Aquanissa Depot	0.0015 mg/l	0.003 mg/l
Ratu RO Depot	0.0013 mg/l	0.003 mg/l
Adzikra RO Depot	0.0015 mg/l	0.003 mg/l
Mekar Water Depot	0.0017 mg/l	0.003 mg/l
Manguilo Depot	0.0019 mg/l	0.003 mg/l
Surya Agung Depot	0.0019 mg/l	0.003 mg/l
Science Depot	0.0021 mg/l	0.003 mg/l

Based on the table above, the concentration of Cadmium (Cd) metal in 7 Refill Drinking Water Depots in the Kadolomoko Health Center Working Area of Baubau City is not greater than the maximum concentration of Cadmium (Cd) metal permitted based on Minister of Health Regulation No. 2 of 2023, namely 0.003 mg/l.

3. Concentration of Iron (Fe) Metal at Refill Drinking Water Depots in the Kadolomoko Community Health Center Work Area

Table 6. Concentration of Iron (Fe) Metal at Refill Drinking Water Depots in the Kadolomoko Community Health Center Work Area.

Sample	The concentration of Fe metal examined	Fe Standards Based on Minister of Health Regulation No. 2 of 2023
Aquanissa Depot	0.02 mg/l	0.2 mg/l
Ratu RO Depot	<0.001 mg/l	0.2 mg/l
Adzikra RO Depot	<0.001 mg/l	0.2 mg/l
Mekar Water Depot	<0.001 mg/l	0.2 mg/l
Manguilo Depot	<0.001 mg/l	0.2 mg/l
Surya Agung Depot	<0.001 mg/l	0.2 mg/l
Science Depot	0.001 mg/l	0.2 mg/l

Based on the table above, the concentration of Iron (Fe) metal in 7 Refill Drinking Water Depots in the Kadolomoko Health Center Working Area of Baubau City is not greater than the maximum concentration of Iron (Fe) metal permitted based on Minister of Health Regulation No. 2 of 2023, namely 0.2 mg/l.

The concentrations of the three metals mentioned above, namely Lead (Pb), Cadmium (Cd), and Iron (Fe), at the Refill Drinking Water Depot did not exceed the quality standards stipulated in the Indonesian Minister of Health Regulation No. 2 of 2023 concerning Drinking Water Requirements, so that the quality was declared safe. Risk analysis with projections for the next 5 years and 30 years also showed that the refill drinking water is still suitable for consumption. This finding is in line with the opinion of Mulyati et al. (2023) who emphasized that risk analysis is not only relevant to parameters exceeding quality standards, but is also important to be carried out for low concentrations that are continuously exposed throughout life, because this is the basis for efforts to engineer and resolve environmental health problems.

b. Does Response Analysis

After carrying out hazard identification, the next step is to carry out a dose response analysis, namely looking for the RfD and/or CSF values.https://iris.epa.govSpecifically, the metals Lead (Pb), Cadmium (Cd), and Iron (Fe) pose environmental health risks. The RfD and CSF values for these three metals are shown in the following table:

Table 7. RfD and CSF Value Analysis.

Chemical Parameters (Heavy Metals)	**Mark *ReferenceDose*(RfD)**	***Cancer Slope Factor*(CSF)**
Lead (Pb)	0.004 mg/l/day	0.042 mg/l/day
Cadmium (Cd)	0.0005 mg/l/day	-
Iron (Fe)	0.3 mg/l/day	-

c. Does Response Analysis

Ingestion exposure (ingested/entering the body) of metals based on personal exposure concentration (intake), namely the amount of drinking water consumed with an average sample per body weight (kg) of samples per day.

1. The rate of drinking water consumption is sourced from the Refill Drinking Water Depot in the working area of the Kadolomoko Health Center.

Table 8. Rate of drinking water consumption is sourced from the Refill Drinking Water Depot in the working area of the Kadolomoko Health Center.

Variables	**N**	**Mean**	**Med.**	**Elementary School**	**Min**	**Max**	***P*Value**
Ingestion Rate	96	7.86	8.00	0.902	4	9	0,000

Ingestion rate in this study is defined as the amount of drinking water consumed from the Refill Drinking Water Depot in the Kadolomoko Community Health Center working area. Safe limits are set according to Minister of Health Regulation No. 2 of 2023, namely lead (Pb) 0.01 mg/L, cadmium (Cd) 0.003 mg/L, and iron (Fe) 0.2 mg/L. The results of the Kolmogorov-Smirnov test showed that the data were not normally distributed (p=0.000), so the calculation of the ingestion rate used the median value, which is 8 glasses per day with a standard deviation of 0.902.

2. Intake Values of Lead (Pb), Cadmium (Cd) and Iron (Fe)

The intake calculations in this study were adjusted based on the type of metal in the samples, using carcinogenic intakes for lead (Pb) and non-carcinogenic intakes for cadmium (Cd) and iron (Fe). This analysis was conducted to estimate the public health risks of consuming refilled drinking water in the Kadolomoko Community Health Center (Puskesmas) area of Baubau City over the next five and 30 years.

Table 9. Intake Values of Lead (Pb), Cadmium (Cd) and Iron (Fe) Metals for the Next 5 Years.

Notation	**Mark**
C average Lead (Pb) content	0.0012 mg/l
C average content of Cadmium (Cd)	0.0017 mg/l
C average Iron (Fe) content	0.0037 mg/l
Body weight (Wb)	57 kg
Frequency of exposure (fE)	365 days
Duration of exposure (Dt)	5 years
Notation	Mark
Ingestion rate (R)	2 liters/day
Notation	Mark
t_{AVG}	5 years x 365 days

Based on the table above, the results of the intake of Lead (Pb), Cadmium (Cd) and Iron (Fe) metals for the next 5 years are as follows:

a. *Intake*Exposure to ingestion of lead metal (Pb) is carcinogenic as follows:

$$I_k = \frac{C \times R \times fE \times Dt}{W_b \times t_{AVG}}$$

$$= \frac{0{,}0012 \times 2 \times 365 \times 5}{57 \times 5 \times 365}$$

$$= \frac{4{,}38}{104025}$$

/day= 0,0003 mg/l

= 3x10-4/daymg/l

b. *Intake*exposure to ingestion of Cadmium (Cd) metal isnon-carcinogenicas follows:

$$I_k = \frac{C \times R \times fE \times Dt}{W_b \times t_{AVG}}$$

$$= \frac{0{,}0017 \times 2 \times 365 \times 5}{57 \times 5 \times 365}$$

$$= \frac{6{,}205}{104025}$$

= 0,00006 mg/l

c. *Intake*exposure to ingestion of iron (Fe) metal isnon-carcinogenicas follows:

$$I_k = \frac{C \times R \times fE \times Dt}{W_b \times t_{AVG}}$$

$$= \frac{0{,}0037 \times 2 \times 365 \times 5}{57 \times 5 \times 365}$$

$$= \frac{13{,}505}{104025}$$

= 0,000126 mg/l

d. Intake Values of Lead (Pb), Cadmium (Cd) and Iron (Fe) Metals for the Next 30 Years

Table 10. Intake Values of Lead (Pb), Cadmium (Cd) and Iron (Fe) Metals for the Next 30 Years.

Notation	Mark
C average lead (Pb) content	0.0012 mg/l
C average cadmium (Cd) content	0.0017 mg/l
C average iron (Fe) content	0.0037 mg/l
Body weight (Wb)	57 kg
Frequency of exposure (fE)	365 days
Duration of exposure (Dt)	30 years
Ingestion rate (R)	2 liters/day
t_{AVG} Lead (Pb)	70 years x 365 days
t_{AVG} Cadmium (Cd) and Iron (Fe)	30 ears x 365 days

Based on the table above, the results of the intake of Lead (Pb), Cadmium (Cd) and Iron (Fe) metals for the next 30 years are as follows:

a. Intake of carcinogenic Lead (Pb) metal exposure is as follows:

$$I_k = \frac{C \times R \times fE \times Dt}{W_b \times t_{AVG}}$$

$$= \frac{0{,}0012 \times 2 \times 365 \times 30}{57 \times 30 \times 365}$$

$$= \frac{26{,}28}{624150}$$

$$= 0{,}000042 \text{mg/l/day}$$

= 4.2 x 10-5 /daymg/l

b. Intake exposure to non-carcinogenic Cadmium (Cd) metal is as follows:

$$I_k = \frac{C \times R \times fE \times Dt}{W_b \times t_{AVG}}$$

$$= \frac{0{,}0017 \times 2 \times 365 \times 30}{57 \times 30 \times 365}$$

$$= \frac{37{,}23}{624150}$$

$$= 0{,}00006 \text{ mg/l/day}$$

c. Intake of non-carcinogenic iron (Fe) metal exposure is as follows:

$$I_k = \frac{C \times R \times fE \times Dt}{W_b \times t_{AVG}}$$

$$= \frac{0{,}0037 \times 2 \times 365 \times 30}{57 \times 30 \times 365}$$

$$= \frac{81{,}03}{624150}$$

$$= 0{,}00012 \text{ mg/l/day}$$

d. Risk Characteristics

The risk characteristics in this study are calculated by determining the level of risk to the health of the community who consume drinking water from the Refill Drinking Water Depot in the working area of the Kadolomoko Health Center, Baubau City, where the ECR and risk magnitude (RQ) can be calculated as follows:

1. Risk Characteristics of Drinking Water Ingestion Over the Next 5 Years

   a. ECR value for Lead (Pb) metal

$$ECR = I \times SF$$
$$= 0{,}0003 \times 0{,}042$$
$$= 1{,}26 \times \frac{\frac{10^{-6}\text{mg}}{\text{l}}}{\text{hari}}$$

$b.$ RQ value for Cadmium (Cd) metal

$$RQ = \frac{I}{RfD}$$
$$= \frac{0{,}00006}{0{,}0005}$$
$$= \frac{0{,}12\frac{\text{mg}}{\text{l}}}{\text{hari}}$$

$c.$ RQ value for Iron (Fe) metal

$$RQ = \frac{I}{RfD}$$
$$= \frac{0{,}000129}{0{,}3}$$
$$= \frac{0{,}00043\frac{\text{mg}}{\text{l}}}{\text{hari}}$$

2. Risk Characteristics of Drinking Water Ingestion Over the Next 30 Years

$a.$ ECR value for Lead (Pb) metal

$$ECR = I \times SF$$
$$= 0{,}00018 \times 0{,}042$$
$$= \frac{7{,}56 \times 10^{-5}\frac{\text{mg}}{\text{l}}}{\text{hari}}$$

$b.$ RQ value for Cadmium (Cd) metal

$$RQ = \frac{I}{RfD}$$
$$= \frac{0{,}00006}{0{,}0005}$$
$$= \frac{0{,}12\frac{\text{mg}}{\text{l}}}{\text{hari}}$$

$c.$ RQ value for Iron (Fe) metal

$$RQ = \frac{I}{RfD}$$
$$= \frac{0{,}00013}{0{,}3}$$
$$= 0{,}0004 \text{ mg/l/hari}$$

The risk estimation results indicate that exposure to Lead (Pb), Cadmium (Cd), and Iron (Fe) metals in refilled drinking water in the Kadolomoko Community Health Center work area is still in the safe category for the next 30 years, with an ECR Pb value of <10^(-4) and RQ Cd and RQ Fe <1. This finding is consistent with previous studies, including Khairunnisa & Indirawati (2021) who reported that the RQ value of lead was still <1 for a period of 950 years, Girikallo et al. (2022) who found that all respondents were safe from non-carcinogenic risks due to Cd exposure, and Agustina (2019) who showed that consuming drinking water with chemical agent concentrations below the threshold did not pose a health risk to at-risk adult groups. Thus, it can be concluded that the quality of refilled drinking water at the study location does not have the potential to cause long-term health impacts.

e. Risk Management

Risk management in this study is a follow-up if the results of risk characteristics indicate unsafe values, namely ECR <1/10,000 for carcinogenic or RfD ≤1 for non-carcinogenic. The analysis results show ECR values of lead (Pb) of 1.26×10-6 mg/L/day (5 years) and 7.56×10-5 mg/L/day (30 years), as well as RQ values of cadmium (Cd) of 0.12 mg/L/day and iron (Fe) of 0.0004 mg/L/day in the 5 and 30 year periods. All of these values are in the safe category, so risk management is not necessary, although control strategies still focus on regulating the concentration of risk agents, the amount of consumption and exposure factors.

4. Conclusion

Based on the research results, the metal content of Lead (Pb), Cadmium (Cd), and Iron (Fe) in refilled drinking water in the Kadolomoko Community Health Center working area is still below the threshold set in the Minister of Health Regulation No. 2 of 2023 concerning Environmental Health. The results of the analysis of health risk characteristics through the calculation of Intake values indicate that in the next 5 years the estimated ECR value for Pb and the RQ value for Cd and Fe will not exceed the quality standard limit (ECR $\leq 10^{-4}$ and RQ ≤ 1). Similarly, in the 30-year estimate, the ECR and RQ values for the three heavy metals are still in the safe category.

Thus, the refilled drinking water from the studied depots can be categorized as not posing a health risk due to ingestion exposure in the medium or long term. These results also indicate that risk management efforts are not necessary, given that the heavy metal concentrations, consumption amounts, frequency, and duration of exposure remain at safe levels. However, regular water quality monitoring remains essential to ensure consistent drinking water safety and prevent potential future increases in risk.

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