JKKI
SCIENTIA EST BASIC VITAE

Jurnal Kedokteran dan Kesehatan Indonesia

Indonesian Journal of Medicine and Health

Journal homepage: https://journal.uii.ac.id/JKKI

Urinary tract stones and well water consumption in patients at Zaenoel Abidin Hospital Banda Aceh

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Original Article

ARTICLE INFO

Keywords:
urinary tract
stones
well water
minerals

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DOI: 10.20885/JKKI.Vol13.Iss1.art6

History:
Received: June 21, 2021
Accepted: February 16, 2022
Online: May 31, 2022

ABSTRACT

Background: Several remote areas in Aceh lack proper water supply, leading to the citizens to consuming well water for daily needs. The water quality is determined by the concentration of minerals thus affected by location sources. Insufficient monitor of its quality poses risks of health problems, such as urinary tract stones.

Objective: This study investigated the incidence of urinary tract stones on patients seeking medical help in Zaenoel Abidin hospital and its association to well water consumption.

Methods: Respondents were patients visiting the urological surgery polyclinic at Zaenoel Abidin Regional Hospital and consenting to be research respondents. Sixty respondents were divided into two groups: the patient group suffering from urinary tract stones and those who did not. The disease status was determined based on the diagnosis of a urology specialist and the results of ultrasonography. Analysis of the relationship between well water consumption and the emergence of disease was analyzed statistically.

Results: the majority of respondents were from out the city's capital (Banda Aceh) (48, 80%), men (43, 71.1%), and 45 to 65 years old. Among the patients suffering from urinary tract stones, most of them (63.6%) consumed well water, while only a few of the control group, non-urinary tract stones patients, (36.4%) consumed well water. There is a relationship between well water consumption and the risk of disease (p = 0.038, OR = 3.5)

Conclusion: The use of well water for daily water intake contributes to developing urinary tract stones.

Latar Belakang: *Beberapa daerah terpencil di Aceh mengalami kekurangan pasokan air yang menyebabkan warganya mengkonsumsi air sumur untuk kebutuhan sehari-hari. Kualitas air ditentukan oleh konsentrasi mineral yang dipengaruhi oleh sumber lokasi. Pemantauan kualitas yang tidak memadai dapat menimbulkan risiko gangguan kesehatan seperti batu saluran kemih.*

Tujuan: *Penelitian ini menyelidiki kejadian batu saluran kemih pada pasien yang berobat di Rumah Sakit Zaenoel Abidin dan hubungannya dengan konsumsi air sumur.*

Metode: *Responden adalah pasien yang mendatangi poliklinik bedah urologi RSUD Zaenoel Abidin dan bersedia menjadi responden penelitian. Sebanyak 60 responden dibagi menjadi dua kelompok, yaitu kelompok pasien yang menderita batu saluran kemih dan yang tidak. Penentuan status penyakit berdasarkan diagnosis dokter spesialis urologi dan hasil ultrasonografi. Analisis hubungan antara konsumsi air sumur dan munculnya penyakit dilakukan dengan menggunakan statistik.*

Hasil: *Mayoritas responden berasal dari luar ibu kota, Banda Aceh (48, 80%), berjenis kelamin laki-laki (43,71.1%) dan berusia 45 sampai 65 tahun (34, 56.6%). Di antara pasien yang menderita batu saluran kemih, sebagian besar (63,6%) mengonsumsi air sumur, sedangkan yang tidak menderita batu saluran kemih hanya sedikit (36.4%) yang mengkonsumsi air sumur . Ada hubungan antara konsumsi air sumur dengan risiko penyakit (p = 0,038, OR = 3,5).*

Kesimpulan: *Penggunaan air sumur untuk asupan air sehari-hari berkontribusi terhadap perkembangan batu saluran kemih.*

INTRODUCTION

The urinary tract stones (urolithiasis) is a condition where one or more stones can be found in each part of the urinary tract.[1] Patients with urinary tract stones are common globally, with a different prevalence in developed and developing countries.[2] Over the last three decades, the prevalence of urinary tract stones has increased sharply in Europe, Asia and America.[3] Riskesdas 2013 data showed the prevalence rate of urinary tract stones throughout Indonesia of 0.6%. Aceh Province ranks second with the highest number of urinary tract stone cases, with a percentage of 0.9%.[4] Previously, in 2010, there were 133 cases of patients suffering from urinary tract stones in dr. Zainoel Abidin Banda Aceh and significantly increased in the next year to 319 patients.[5,6]

Intrinsic and extrinsic factors epidemiologically influenced the formation of urinary tract stones. Intrinsic factor is an influence from the individual's own body, such as heredity, age, and gender. Meanwhile, extrinsic factors are influences from outside the individual's body, including geographic/regional conditions, temperature, total fluid intake, diet, as well as the habit of consuming certain beverages containing high levels of sweeteners, oxalates, and large amounts of calcium.[7,8]

In Indonesia, especially in Aceh province, some areas do not have access to clean water services and people in these areas use well water (groundwater) to meet household needs, including as a source of drinking water for daily consumption.[8,9] Data from the Central Bureau of Statistics for Aceh province in 2013 showed that the number of households in Aceh using well water as a source of home drinking water is relatively high (46.18% of 8 other drinking water sources).[9]

The well water generally contains dissolved mineral compositions, such as calcium, magnesium, sodium, and zinc. An increase in mineral components in well water poses risk to the users. Calcium levels cause urinary calcium hyper excretion and super saturation, which is the initial process of urinary tract stones.[10,11] Research conducted in the working area of Puskesmas Magasari, Tegal district, showed a relationship between the hardness of well water and kidney stone disease.[12] In a case study conducted at three hospitals in Semarang, 59.09% of the case group used well water as a source for daily drinking.[13]

The incidence of urinary tract stones is the highest in the urological surgery polyclinic of Zainoel Abidin hospital every year. A large number of well water consumption might contribute to the high incidence. Therefore the authors are interested in investigating the effect of well water consumption on the occurrence of urinary tract stones in Zainoel Abidin Hospital.

METHODS

This is a case-control study conducted in the urological surgery polyclinic and inpatient room of urological surgery at RSUDZA Banda Aceh from October to December 2018. The population was all patients in the polyclinic and inpatient room for urological surgery at RSUDZA Banda Aceh. The respondents were divided into the case and the control group. The number of respondents taking well water or not were recorded.

The research used a purposive sampling method based on the inclusion and exclusion criteria in the respondent. The sample size was taken based on the sample size calculation formula for case-control studies to examine the hypothesis against the odds ratio, 30 respondents for each group, with a 1: 1 comparison of the case and control group, thus the minimum total sample size estimate was 60 respondents.

RESULTS

Baseline characteristics

This study involved 60 respondents who resided in Banda Aceh and outside Banda Aceh, the capital city of Aceh Province. Table 1 presents the characteristics of the respondents. The majority of respondents was 45 to 65 years old, male and came from outside Banda Aceh. Table 2 indicates that most respondents who suffer from urinary tract stones consumed well water.

Table 1. Distribution of gender and origin

Characteristics		Urinary Tract Stone		Total (N)
		Positive	Negative	
Age	< 45	11 (18%)	5 (8%)	16 (26.7%)
	45 – 65	15 (25%)	19 (31.6%)	34 (56.6%)
	65 >	2 (3%)	8 (13%)	10 (16.6%)
Gender	Male	21 (38%)	23 (38%)	43 (71.1%)
	Female	9 (15%)	7 (12%)	17 (28.3%)
Origin	Banda Aceh	5 (8%)	7 (23%)	12 (20%)
	Outside Banda Aceh	25 (42%)	23 (38%)	48 (80%)

Subject responses to the questionnaire

This study also administered a questionnaire to respondents related to the well water consumption and the responses are summarized in table 2.

Table 2. Respondents' statements related to the well water consumption

Respondent's statement		Urinary Tract Stone		Total	P-Value
		Positive	Negative		
Respondents who live in areas where there are limestone rocks	Yes	8	5	13	0.041
	No	13	7	20	
Respondents who live in coastal areas (close to the sea/beach)	Yes	12	7	19	0.004
	No	9	5	14	
Respondents who stated that there is white sediment in the well water reservoir	Yes	7	6	13	0.888
	No	14	6	20	
Respondents who heat/boil well water before consumption	Yes	21	11	32	1.805
	No	0	1	1	
Treating well water by adding alum in the well water reservoir	Yes	0	0	0	-
	No	21	12	33	
Treating well water by filtering it with rice husk ash	Yes	0	0	0	-
	No	21	12	33	
Treating well water by filtering it with zeolite sand	Yes	0	0	0	-
	No	21	12	33	
Treating well water by filtering it using activated charcoal	Yes	0	0	0	-
	No	21	12	33	
Treating well water by adding soda lime	Yes	0	0	0	-
	No	21	12	33	

Table 2 shows that from 33 respondents consumed well water, 12 respondents (36%) living in coastal areas (close to the sea/beach) were suffered from urinary tract stones, while 7 respondents (21%) were not. In addition, 8 respondents (24%) living in areas where limestone presents experienced urinary tract stones, while 5 respondents (15%) of them did not. Seven respondents (21%) who claimed that there were white deposits in the well water reservoirs were suffered from urinary tract stones, while six respondents (18%) were not. Also, 12 respondents (64%) heating or boiling well water before consumption were suffered from urinary tract stones, while 11 (42%) were not.

Association between well water consumption and urinary tract stone

Table 3 shows that 21 (35%) respondents consuming well water were suffered from urinary tract stones, while 12 people (20%) did not.

The Chi-Square test results in Table 4 show that there is a significant relationship between the type of well water consumption and the incidence of urinary tract stones, evidenced by the p-value = 0.038 (p <0.05), and the Odds Ratio value = 3.5 CI 95% (1,201-10,196), indicating that the respondents consuming well water have a chance of getting urinary tract stones by 3.5 times higher compared to respondents who do not consume well water.

Table 3. The analysis results of the effect of well water consumption on the incidence of urinary tract stones at RSUDZA Banda Aceh

Characteristics Respondents	Urinary Tract Stone Status			p-Value	OR
Well Water Consumption	Case	Control	Total		
Yes	21 (63.6%)	12 (36.4%)	33 (100%)	0.038	3.5 (1,201-10,196)
No	9 (33.3%)	18 (66.7%)	27 (100%)		
Total	30 (50%)	30 (50%)	60 (100%)		

Association between different gender, well water consumption and urinary tract stone

Table 4 shows that there are 14 male respondents (60.9%) taking well water and get urinary tract stones, and there are 10 female respondents (58.8%) taking drink well water and get kidney stones. It was found that there was a significant relationship between males taking well water and the incidence of kidney stones, evidenced by a P-Value of 0.043 (P<0.05. However, there is no significant relationship between females taking well water and the incidence of kidney stones, evidenced by the P-Value 0.263 (P<0.05). The odds-ratio found in males taking well water and the incidence of kidney stones is 3.63 95% CI (1,018 – 12,940), meaning that males taking well water had a 3.63 times higher probability of developing kidney stones than those males not drinking well water.

Table 4. The analysis results of the effect of different gender, well water consumption on the incidence of urinary tract stones at RSUDZA Banda Aceh

Gender	Well Water Consumption	Urinary Tract Stone		P-Value	OR
		No	Yes		
Laki-Laki	No	14 (70%)	6 (30%)	0.043	3,63 (1.018 – 12.940)
	Yes	9 (39.1%)	14 (60.9%)		
Perempuan	No	4 (57.1%)	3 (70%)	0.263	3,11 (0.414 – 23.393)
	Yes	7 (41.2%)	10 (58.8%)		

DISCUSSION

Regularly consuming well water as the main source of drinking water can cause health problems, one of which is urinary tract stones disease. Several studies have found an association between drinking well water and the incidence of urinary tract stones disease[13] . Previous research conducted by Sulistyawati[14] found that people consuming well water were 22.96 times more likely to develop kidney stones. Similar finding is reported in this study, someone consuming well water has 3.5 times higher probability than those who do not. Several factors contribute to increasing the incidence of urinary tract stones disease in people consuming well water, including mineral content[15–18] and the location of the well (near limestone, near the beach and/or sedimentation).

Siener[19] states that drinking well water with a high calcium concentration can be a risk factor for a person developing kidney stones. A previous study with 2295 patients in the United States found that those who drank well water were more likely to develop kidney stones. Likewise, in this study, out of 33 people who consumed well water, [21] people were suffered from kidney stones. Calcium levels in water can increase the risk of kidney stone formation. Regulation of the Minister of Health of the Republic of Indonesia No. 492 of 2010[20] states that water hardness above 500 mg/l is unsuitable for drinking water. WHO[16] also states that water is considered hard water if it contains calcium carbonate above 120 mg/l. Calcium is a promoter of kidney stones, where urine saturation with calcium can form calcium oxalate stones[21].

Areas with limestone rocks are more likely to have high hardness water and a reaction causes the hardness. The main constituent of limestone is calcium bicarbonate ($C_a(HCO_3)_2$), which will split when heated and dissolved by water into calcium carbonate, one of the minerals forming kidney stones[22]. Previous research conducted by Sulistyawati[14] showed that the high water hardness caused by limestone rocks around the residents' wells used as a source of drinking water was the main reason why the residents of Gendangsari were affected by kidney stones. This study reveals similar results; out of 21 people developing kidney stones due to consuming well water, at least eight people had wells in areas with limestone rocks. In addition, [13] people with kidney stones have water wells around the beach area and nine people have wells with sedimentation at the bottom of the water. Wahita et al.[23] researched on seawater intrusion that caused groundwater pollution in the Situbondo district and reported that seawater intrusion into well water around the coast could cause a lot of minerals from seawater to be trapped in the well water, increasing the hardness of the well water. The increase in the water hardness in the area close to the coast reached 360 $C_aCO_3\ L^{-1}$ at a distance of 300 meters from the sea. Sedimentation itself can be in the form of mineral accumulation at the bottom of the well, which will form marl rock, a combination of calcium carbonate. Sedimentation is an indicator and leads to high water hardness[24].

Several measures can be taken to reduce the hardness of well water by reducing the concentration of calcium dissolved in it. One of the most common measures undertaken by respondents was heating well water to boiling, carried out by 32 respondents. Heating water can reduce water hardness by releasing carbon dioxide that binds to calcium in calcium bicarbonate to precipitate the calcium carbonate[25]. Even so, heating will not be effective if the hardness occurs by calcium bicarbonate, which is not heat-sensitive. Thus, it cannot release carbon dioxide, meaning it does not reduce the hardness. In addition, heating should be accompanied by filtration using zeolite sand[25.] Research by Maran & Pare[25] on well water in the Mualafa sub-district found that heating hard water in a zeolite container for 40 minutes can reduce the hardness of well water from 460.41 mg/l to 240.7 mg/l, even when heated for 70 minutes, it can decrease up to 164.01 mg/l. Zeolite sand is a negative

compound that can bind calcium released in the pores of the zeolite filter. Zeolite can also release hydrogen-carbonic acid (HCO^{3-}), chloride (Cl^{-}), nitrate (NO^{3-}) and sulfate ($SO4^{2-}$) bonds to calcium (Ca^{2+}) to produce free hard water[26].

In addition to using zeolite, alum can be added to decrease the hardness. It will accelerate the deposition process of dissolved compounds in well water and lower the pH, thereby changing the ratio of carbonate (CO_3^{2-}) or hydrogen-carbonate (HCO^{3-}) salts to reduce water hardness[14,27]. Research conducted by Harefa et al[28] found that alum can absorb calcium and magnesium metals up to 42.25% and 62.12%, respectively. The use of soda-lime can reduce water hardness and even increase the effectiveness of alum which will increase the pH, which then precipitates phosphates and heavy metals, such as Pb, Fe, Zn, Co, Ni and Hg[29]. The addition of activated charcoal can reduce hardness by absorbing organic and inorganic compounds dissolved in water. [29] Research conducted by Paul et al[30] found that activated charcoal can reduce water hardness up to 4.2% and total dissolved solids up to 37.2%. In addition, rice husk ash can reduce water hardness as it contains potassium oxide that can precipitate Ca^{2+} and Mg^{2+} ions[31]. Research by Kharel et al[31] on the water in Nepal reported that rice husk ash could reduce water hardness with an efficiency of up to 55%, with a concentration of rice husk ash of 22.5 g/l.

Unfortunately, the respondents in this study only used heating to process well water and did not use other more effective methods to reduce water hardness. This method may greatly contribute to the incidence of kidney stones in those consuming well water.

CONCLUSION

To conclude, consumption of well water affects the incidence of urinary tract stones in dr. Zainoel Abidin Hospital Banda Aceh. The consumption of well water poses a 3.5 times greater risk of developing urinary tract stones.

CONFLICT OF INTEREST

This study has no conflict of interest.

ACKNOWLEDGEMENT

We are thankful to all who had contributed in this study.

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