



Original research article

The Amount of Water used to Wash Hands to Prevent The Spread of Covid-19

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ABSTRACT

Based on the WHO data updated on December 28, 2021, the global tally of COVID-19 cases for that year reached 281,808,270, with a reported 5,411,759 deaths worldwide. Specifically in Indonesia, the cases total 5,411,759, with 144,081 deaths by that date. To reduce the risk of transmission, practicing good hand hygiene is crucial. Regular hand washing with soap and water or using an alcohol-based hand sanitizer when soap isn't available helps remove pathogens from our hands, contributing to a cleaner and healthier lifestyle. Collecting rainwater in specially designed containers can be an effective and sustainable way to meet handwashing needs, supporting health protocols to prevent the spread of COVID-19. By providing an accessible water source for hand hygiene, communities, especially those with limited water access, can implement handwashing practices more consistently. This initiative is beneficial for promoting both environmental sustainability and public health, particularly in areas facing water scarcity. Additionally, filtration or disinfection processes can enhance rainwater collection systems to ensure safe water for handwashing, further supporting a cleaner and healthier environment. The result is that visitors wash their hands on average 5 times per day, with an average volume of 0.6 liters of water used in a one-time hand wash. With an interval of 6 days without rain, the maximum hand washing needs are 53.35 m³. The roof area in the market is 16,240 m², and the water volume from effective rain is 21.11 m³. If we use a reservoir of 1200 liters, we need 22 22-unit reservoirs for maximum water demand.

1. Introduction

According to the WHO data updated on December 28, 2021, there were 281,808,270 cases of Covid-19 in the world during 2021, with a total death of 5,411,759 people; in Indonesia, 5,411,759 cases and 144,081 deaths [1]. This virus is transmitted by droplets when talking, coughing, and sneezing from an infected person. In addition, this virus can be transmitted through physical contact, such as touch or handshake, with sufferers who are exposed to the coronavirus [2], [3], [4]. To avoid the spread of the Covid-19 virus, you can wash your hands to improve the behavior of a clean and healthy life [5], [6], [7].

Hand hygiene is often synonymous with handwashing, and it is the most important factor in preventing nosocomial infections by preventing contact and fecal-oral transmission of pathogens [8]. Hand washing is a simple yet effective way to prevent the spread of germs and maintain personal hygiene. Handwashing is one of the vital public health measures. It helps to prevent the spread of the Covid-19 pandemic [7]. However, water overuse during hand scrubbing with soap

and keeping the tap on may put enormous pressure on the already overstretched groundwater resources and households' economic well-being [6].

Handwashing standards are crucial for maintaining hygiene, particularly in settings like healthcare, food service, and general personal care [9], [10], [11]. Here are detailed guidelines for proper handwashing:

- Use clean, running water (preferably warm) and wet your hands and wrists thoroughly.
- Apply enough soap to cover all hand surfaces.
- Rub hands palm to palm to form a lather, scrub the back of each hand with the palm of the other hand with fingers interlaced, rub palm to palm with fingers interlaced, scrub the backs of your fingers to opposing palms with fingers interlocked, clean each thumb by rubbing it rotationally with the opposite hand, rub rotationally, backward and forwards with clasped fingers of the right hand in the left palm and vice versa, and scrub your wrists as well.
- Continue scrubbing for at least 20 seconds.
- Rinse hands and wrists under clean, running water to

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remove all soap and germs.

- Use a clean towel or paper towel, or air dry your hands. If using a towel, ensure it is clean to avoid contamination.

There are many reservoirs for washing hands in various public facilities, but they are often empty [12]. In this study, we measure how it is used for washing hands so that we can calculate how much water must be provided by the public facility manager. We surveyed market visitors in Banjarbaru City to measure how much handwashing water was used in October. We designed rainwater harvesting as a source of clean water that will be used for washing hands.

Rainwater harvesting is used to collect rainwater from building roofs, ground surfaces, roads, or rock hills and is used as a source of clean water supply [13], [14], [15]. A rainwater harvesting building is a building that collects rainwater that falls so much water that the collected water is accommodated in one container [13]. The stored water can be used for bathing, raw water, or other purposes [16]. Besides overcoming the threat of flooding in the future, rainwater harvesting can also overcome the clean water crisis in the dry season by functioning as a storage of clean water reserves. This rainwater harvesting is also an alternative to reduce flood discharge that enters the channel [17].

Rainfall runoff may be captured and stored for later use. Still, the quality of this water can be detrimental in some uses without the use of appropriately designed first-flush diverters. The rainfall-runoff water quality was measured on nineteen new small-scale and two aged commercial roofs near high-traffic highways. Roof coverings included asphalt shingles, sheet metal, clay tiles, tar, and gravel. Runoff samples were evaluated for polycyclic aromatic hydrocarbons (PAHs), phosphorus flame retardants (PFRs), and pyrethroid insecticides. Eighteen small-scale roofs were subjected to a range of simulated rainfall events, while natural runoff was sampled on the commercial roofs and one small-scale roof. Runoff was analyzed for pH, conductivity, turbidity, total suspended solids, boron, iron, copper, zinc, manganese, sodium adsorption ratio, nitrate-nitrogen, seventeen PAHs, tris(2-chloroethyl) phosphate, tris(1,3-dichloro-2-propyl) phosphate, bifenthrin, cypermethrin, and lambda-cyhalothrin. Samples from four natural storm events were also analyzed for total coliforms and *Escherichia coli*. In addition, soils below seventeen existing gutter downspouts were sampled to determine long-term pollutant accumulation. Atmospheric deposition was the main contributor to the pollutants in the roof runoff. Most samples fell within the U.S. EPA guidelines for non-potable urban and agricultural water reuse. Trace levels of PAHs, PFRs, and insecticides were detected, but all detections were three orders of magnitude below the USGS health-based screening level benchmark concentrations. Results indicate that diverting the first flush, based on turbidity, total suspended solids, or conductivity, can improve the overall water quality and reduce the concentrations of PAHs in harvested rainwater. Downspout soil sampling showed potential for the long-term accumulation of PAHs at concentrations exceeding the minimum human-health risk-based screening levels at these high runoff-loading locations [18].

The development of rainwater utilization strategies has relied on rainwater harvesting (RWH) systems for centuries to

alleviate the pressure on water resources. However, there are still significant knowledge gaps regarding the changes in water quality in RWH systems during long-term storage in non-rainy seasons. This study evaluated the water quality processes in RWH systems through static rainwater storage experiments for approximately 60 days. The results revealed that nutrients in rainwater accumulated in sediment during storage. Disturbance and redox conditions at the rainwater-sediment interface contribute to releasing sedimentary facies materials. The rainwater showed distinct DO stratification, with the biochemical reactions of sedimentary facies being the primary factor driving oxygen consumption. ORP and turbidity showed positive correlations with COD. The regulation of water quality and extension of the usage cycle were identified as critical factors influenced by DO. In addition, bacteria share similar ecological niche preferences. These findings provide scientific evidence for the high-quality reuse of rainwater in decentralized RWH systems during long-term storage in non-rainy seasons [19].

The hydrological cycle is the movement of water on earth in the form of liquid, gas, and solid, both processes in the atmosphere, soil, and water bodies that are not interrupted through the processes of condensation (condensation), precipitation (rain), evaporation and transpiration (evaporation). The heating of ocean water by sunlight is the key to the hydrological cycle process that can run continuously [20], [21]. In analyzing the rain-runoff relationship, the total rainfall must be converted into effective rainfall that produces direct runoff [22], [23].

Another influential activity is using masks properly and correctly and washing hands using soap and running water for visitors to the Bauntung Banjarbaru market. Hands are cleaned regularly with soap, running water, or an alcohol-based antiseptic/hand sanitizer. Maintain a distance of at least 1 meter from other people [24].

2. Method

Primary data is data obtained directly by observing and distributing questionnaires. The need for hand washing water is obtained by direct measurements and field interviews with a sample of market visitors. Secondary data are rain data for 20 years from 2000 to 2021 obtained from the Meteorology, Climatology and Geophysics Agency in Banjarbaru City.

A survey of market visitors and interviews on the use of hand washing water were conducted. The sampling time is from 06.00-13.00 GMT8, with 14 effective days at Bauntung Banjarbaru Market. Interviews and filling out questionnaires: One sample of market visitors was taken for one questionnaire with 56 people, 29 % women and 71 % men. The questionnaire was filled out by verifying respondents, namely visitors using water from the hand washing gallon provided to get a sample of the daily hand washing water needs at Bauntung Market, Banjarbaru.

Handwashing times usually before, during, and after preparing food, before eating, before and after caring for the sick person, using the toilet or changing the diaper, blowing your nose, coughing or sneezing, touching an animal, animal feed, or animal waste, handling garbage and wudhu for mosleem. Additional recommendations: If soap and water are unavailable, use a hand sanitizer containing at least 60%

alcohol. Apply the product to the palm of one hand and rub hands together until dry, covering all surfaces. Avoid touching your face with unwashed hands, especially the eyes, nose, and mouth. Keep nails short and clean to prevent germ buildup. Pay special attention to cleaning under fingernails during handwashing. Adhering to these standards ensures effective hand hygiene and minimizes the risk of spreading infections.

3. Results and Discussion

Result of a questionnaire survey of visitors to Bauntung Batuah Market. Table 1 shows that 32% have washed their hands 5 times a day, and 30% have washed their hands 3 times daily. During the coronavirus pandemic 2019 (Covid-19), the World Health Organization was followed by national organizations. For example, the Public Health Agency of Sweden recommended more thorough hygiene practices to prevent the virus from spreading. Adherence to these recommendations would lead to hand cleaning between 15 and 20 times per day, which can alter skin barrier integrity and lead to hand eczema. In a recently published systematic review, hand washing frequency of 8–10 times/day had a significantly increased relative risk of hand eczema (HE) of 1.51, and the corresponding relative risk of 1.66 was found for hand washing 15–20 times/day. Alcohol-based hand rubs did not increase the risk of hand eczema, even when used more than 20 times per day. It is also well-known that irritant contact dermatitis, following wet work and occupational irritants, gives a poor prognosis of hand eczema [25].

Table 2 shows the most visitors for 1 week were on Sunday, with 636 people using four wheels, 1293 people using two wheels, eight using three wheels, and a total of 1937 people. Market visitors by vehicle for 1 week at the beginning of the month, it is known that the maximum total market visitors are 1937 people, the minimum total market visitors are 825 people, and the average total market visitors are 1270 people. And from these results, a total average of 1270 market visitors was taken to calculate the need for hand washing water.

Table 3 shows the amount of water used for hand washing, which is a maximum of 1.4 liters per person, a minimum of 0.2 liters, and an average of 0.6 liters. The amount of water used to wash hands can vary based on several factors, including the method of washing, the flow rate of the faucet, and the duration of hand washing [6]. Here are some typical water usage estimates:

- Standard faucet with 20-second duration about 2.76 liter per minute.
- Water efficient faucet with a 20-second duration of about 1.89 liter per minute.
- Turning off the faucet while lathering about 0.47-0.68 liters per minute.

Turning off the tap while lathering can reduce water usage by up to 80%. This small action can lead to significant water savings, especially in high-frequency hand-washing environments like schools and workplaces. The user perception index showed that, although users perform good water conservation practices in their hygiene activities, their behavior can be improved and substantially reduce water consumption. The activities of food preparation and garden

watering had low rates, and there should be standardization of the procedures performed by users to avoid waste [26].

Rainwater harvesting is a clean water source used to wash hands. Therefore, estimating a series of non-rainy days is necessary so that water remains available for washing hands as long as there is no rain.

Table 4 shows that 3 days without rain have occurred 96 times in 20 years. Table 5 shows that the maximum water demand for 3 days without rain is 26.68 m³, and the average is 10.9 m³. Effective rain data from 2000-2021 can be obtained by 80% effective rain data at a rainfall of 1.3 mm in 20 years, which will be used in calculating the volume of water.

Safe hand-washing facilities guarantee the effect of hand hygiene. Clean objects and objects related to patients should not be placed within 1 m range near the water outlet of the faucet. Anti-splash baffles should be installed as much as possible when conditions permit to reduce the pollution caused by splash during hand washing [27].

The roof area in the market is 16,240 m², and the water volume from effective rain is 21.11 m³; if we use a reservoir of 1200 liter, we need 22 unit reservoir for maximum water demand.

Table 1. Hand washing times

Time	Person	Percent
2	1	1.79%
3	17	30.36%
4	7	12.50%
5	18	32.14%
6	6	10.71%
7	1	1.79%
10	5	8.93%
11	1	1.79%
Total	56	100.00%
Maximum		11
Minimum		1
Average		5

Table 2. Visitors by vehicle (persons)

Day	4W	2W	3W	Total
Friday	324	494	7	825
Saturday	555	868	6	1429
Sunday	636	1293	8	1937
Monday	437	650	4	1091
Tuesday	536	648	4	1188
Wednesday	505	694	5	1204
Thursday	552	663	3	1218
Average	506	759	5	1270
Minimum	324	494	3	825
Maximum	636	1293	8	1937
Total	3545	5310	37	8892

Table 3. The volume of water used

Water Used (cm)	Amount people	Volume of water (liters)
0.5	10	0.2
0.8	9	0.4
1	19	0.5
2	14	0.9
3	4	1.4
Maximum		1.4
Minimum		0.2
Average		0.6

Table 4. Series of days without rain for 20 years

Day without rain	Time	%	Cumulative
1	679	56.40%	56.40%
2	317	26.33%	82.72%
3	96	7.97%	90.70%
4	36	2.99%	93.69%
5	20	1.66%	95.35%
6	15	1.25%	96.59%
7	9	0.75%	97.34%
8	6	0.50%	97.84%
9	6	0.50%	98.34%
10	5	0.42%	98.75%
11	4	0.33%	99.09%
12	2	0.17%	99.25%
13	2	0.17%	99.42%
14	2	0.17%	99.58%
15	2	0.17%	99.75%
16	1	0.08%	99.83%
17	1	0.08%	99.92%
18	1	0.08%	100.00%
Total	1204	100.00%	

Table 5. Hand washing needs

Day	Maximum	Minimum	Average
3 days	26.68 m ³	3.81 m ³	10.9 m ³
4 days	35.57 m ³	5.08 m ³	14.61 m ³
5 days	44.46 m ³	6.35 m ³	18.27 m ³
6 days	53.35 m ³	7.62 m ³	21.92 m ³
7 days	62.24 m ³	8.89 m ³	25.57 m ³
8 days	71.14 m ³	10.16 m ³	29.23 m ³
9 days	80.03 m ³	11.43 m ³	32.88 m ³
10 days	88.92 m ³	12.70 m ³	36.53 m ³
11 days	97.81 m ³	13.97 m ³	40.19 m ³
12 days	106.70 m ³	15.24 m ³	43.84 m ³
13 days	115.60 m ³	16.51 m ³	47.49 m ³
14 days	124.49 m ³	17.78 m ³	51.15 m ³
15 days	133.38 m ³	19.05 m ³	54.80 m ³
16 days	142.27 m ³	20.32 m ³	58.48 m ³
17 days	151.16 m ³	21.59 m ³	62.10 m ³
18 days	160.06 m ³	22.87 m ³	65.76 m ³

4. Conclusion

Based on the analysis of the need for hand washing at the Bauntung Banjarbaru market, visitors wash their hands 5 times daily with an average volume of 0.6 liters of water used in one-time hand washing. With an interval of 3 days without rain, the average and maximum hand washing needs are 10,9 m³ and 26.68 m. With 6 days without rain, the average and maximum hand washing needs are 22.87 m³ and 53.35 m³. The roof area in the market is 16,240 m², and the water volume from effective rain is 21.11 m³. If we use a reservoir of 1200 liters, we need 22 units of reservoir for maximum water demand.

Author Declaration

Authors' contributions and responsibilities

The authors made substantial contributions to the conception and design of the study. The authors took responsibility for data analysis, interpretation and discussion of results. The authors read and approved the final manuscript.

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