

## RESEARCH ARTICLE

## ATTITUDES TOWARD EFFECTIVE HAND WASHING AND A NEW LOW-COST HAND WASHING DEVICE TO REDUCE THE SPREAD OF COVID-19 CASES IN CENTRAL AND SOUTHEASTERN BANGLADESH

Haider Mannan<sup>a</sup>, Sayed Koushik Ahamed<sup>b,c\*</sup>, Uthpall Kumar Roy<sup>b</sup>, Md. Kouser<sup>b</sup>, Md. Rabiul Alam<sup>d,e</sup>, Pradip Debnath<sup>b</sup>, Sangita Chakraborty<sup>b</sup><sup>a</sup>Translational Health Research Institute, Western Sydney University, Campbelltown, NSW 2560, Australia<sup>b</sup>Department of Pharmacy, Comilla University, Koatbari, Cumilla-3506, Bangladesh.<sup>c</sup>School of Psychological Sciences, College of Health and Medicine, University of Tasmania, Launceston Tas 7250, Australia.<sup>d</sup>Department of Chemistry, Comilla University, Koatbari, Cumilla-3506, Bangladesh.<sup>e</sup>Department of Applied Chemistry and Life Science, Toyohashi University of Technology, Japan\*Corresponding Author Email: [kousikahmad88@gmail.com](mailto:kousikahmad88@gmail.com)

This is an open access article distributed under the Creative Commons Attribution License CC BY 4.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

## ARTICLE DETAILS

## Article History:

Received 02 September 2022

Revised 07 October

Accepted 11 November 2022

Available online 17 November 2022

## ABSTRACT

**Background:** During the Covid-19 pandemic, the risk is high for people to contact the virus. The risk multiplies at crowded places. To combat the problem in a country like Bangladesh, where hygienic practices are poor, we manufactured a user-friendly hand washing device. The public use of this device will ensure a hygienic lifestyle for people. **Methods:** Manufactured in Bangladesh's Cumilla and unveiled on August 15, 2020, this "Foot Press Hand Washing Device" is a system requiring only a foot pressing to operate. It was designed based on the hydraulic pressure of the air pump having two operational aspects- soap ejection and water outlet. An online cross-sectional survey on 450 individuals in three cities and a face-to-face survey in a Bangladesh village were conducted to assess users' satisfaction. **Results:** A total of 73.1% and 70.1% respondents in two surveys used a hand washing device in the past six months, 71.8% and 73.8% prioritized 20-second hand washing, 37.6% and 68.7% voiced importance of health hygiene against Covid-19. A total of 71.0% and 78.1% found the device unique while 71.2% and 74.7% believed it useful against Covid-19, 68.0% and 73.3% believed it suitable for rural people, 71.8% and 73.6% believed that it could be placed in a crowded place, 44.4% and 65.1% found it user-friendly for rural people. **Conclusions:** The device helps restrict virus transmission by washing hands with soap water in public places. This low-cost device can be produced using locally available materials. Future studies are needed to assess its effectiveness to prevent Covid-19 and hygiene-related infections.

## KEYWORDS

Hygiene, Microorganisms, Foot Press Hand Washing Device, Pandemic, Hydraulic Pressure, Satisfactory Level.

## 1. INTRODUCTION

The practice of washing one's hands with the use of water or without water or even by using other liquids or using soap or instance ash is referred as hand hygiene which purpose is to the removal of grime, dirt, or microorganisms (Lal, 2015). To prevent the outbreaks of food borne (1980), swine flu (2009) and currently the COVID-19 pandemic, many countries have attempted to increase awareness of hand washing with soap and water (Shoaib, 2020). Every year on October 15, the Global Hand washing Day is celebrated worldwide. The goal of this day is to make everyone around the world aware of the importance of hand washing and to inspire them to wash their hands. The primary function of staying healthy is to wash one's hands thoroughly before eating, using soap or any other antiseptic. Hands should be washed with soap for a minimum of 20 seconds all together by rinsing and lathering (Washing, 2002). As this hand washing technique is considered as the most effective way to get rid from the most crucial pandemic situation, therefore this method has been recommended by WHO specially after starting COVID-19 pandemic situation (WHO, 2020). Sanitation interventions as a part of water and hygiene (WASH) programs can be combined with hand washing (Cairncross et al., 2010). Almost about 30 percent of different diarrhea-

related diseases can be prevented by proper way hand washing process, whereas incase of respiratory infections like cold infections the percentage is about 20 percent (Ejemot-Nwadiaro et al., 2008; Rabie and Curtis, 2006). Almost about 3.5 million of children die in every year due to diarrhea and pneumonia diseases (UNICEF, 2008).

However microbial infections are rapidly growing on day by day. For example in skin researchers found two major types of microorganisms respectively flora of resident and flora of transient (Durani and Leaper, 2008). But the flora of resident cannot expose their pathogenic potency unless and until they get access to enter into body tissues by accident or trauma or by any medical instruments like intravenous catheters (Pittet, 2001). On the other hand, the transient flora which is liable for many infections arises from cross-transmission in hospital can easily be detached by hand washing process (O'Donnell et al., 2015).

Therefore for the removal of harmful germs transmission and the prevention of pathogenesis microbes spreading into body, this hand washing technique is considered as the most important process (Kapil et al., 2015). It is also considered that this hand washing technique helps to interpose the cycle of infectious diseases transmission. Moreover many

## Quick Response Code



## Access this article online

Website:  
[www.jhcdc.com.my](http://www.jhcdc.com.my)

DOI:  
10.26480/jhcdc.02.2022.26.34

studies reported that in public community when hand hygiene become improve then the rate of infectious illnesses is also decreased (O'Donoghue et al., 2019). A recent research showed that hand washing practice is responsible for reducing the spread of transmission of the COVID-19 virus (Beale et al., 2020). A study in Bangladesh has found that the estimated number of cases of COVID-19 has grown at a slower rate in areas where hand washing practice with soap or detergent is quite high, for example, there was low number of COVID-19 cases in Meherpur district which had the highest rate of the practice (86.8%) among the districts in October 2020, and in Northern Bangladesh which had the highest rate of the practice among the regions during this period (Ahmed and Yunus, 2020).

Generally, in Bangladesh, the effectiveness of hand washing practices is poor. In one data it has been found that almost about 85 percent of women who lives in over populated area and 41 percent of women who lives in their respective native village area wash their hands by using only water (Hoque, 2003). On the other hand there are some women who even cannot afford to buy soap and they use only clay for their hand washing. In 2014 a survey on national hygiene conducted in Bangladesh reported that only 40 percent people get the opportunity to use water and soap for hand washing whereas more than 66.67 percent of householders had the access to use hand washing facilities in the toilet. Therefore in many cases hand washing practice with soap is not available and that's why proper advertisement about the importance of hand hygiene practice is needed. These initiatives include hand washing device and hand sanitizer. However, there are some locally available hand washing devices which are used with running water can make a great opportunity among students to become accustomed to this practice (Mbakaya et al., 2020). Although in the developing countries like Bangladesh the cost of hand washing device practices high compared with the soap practice, but after the corona virus pandemic this devices become available in the local market of Bangladesh.

For example, the cost of a locally made hand sanitizer containing alcohol bears three times greater cost than a bar of soap. Also, if we just compare hand sanitizer with soap water or a mixture of detergent and water then we will see that the hand sanitizer will be approximately 30 times costlier than the others. Recently, during the COVID-19 pandemic situation the soap water had been suggested as an alternative use of hand washing sanitizer by WHO and UNICEF. However on these backdrops, we developed a cost effective hand washing device which uses soapy water for this purpose. The specialty of this device is that it doesn't require the use of hand for its operation, only foot pressing is enough to run the device. For checking the effectiveness of the device we conducted an online survey by randomly selecting people of different ages from Cumilla, Dhaka and Chattogram cities of Bangladesh, where particularly in Dhaka, there was an upsurge of COVID-19 cases during the time of this study (IEDCR, 2020).

## 2. MATERIALS AND METHODS

The fundamental progress of the "Foot Press Hand Washing Device" is done by slightly modifying the method section developed for "Press Tap" hand washing device. The original difference between our device and the "Press Tap" is that the theoretical development of our device is based on the air pressure created by the air pump which forces the water from container to flow through the air pipe in the upper.

We used convenience sampling to select the respondents from a village (Koatbari) in Cumilla, Bangladesh for face-to-face interviews as well as to collect the online primary data of 450 people based on different ages and sex from Cumilla, Chittagong and Dhaka regions where prevalence of COVID-19 was high (Figure 1) (Tiruneh et al., 2016). The sample size for face-to-face interviews was calculated using Slovin's formula (Slovin, 1960).

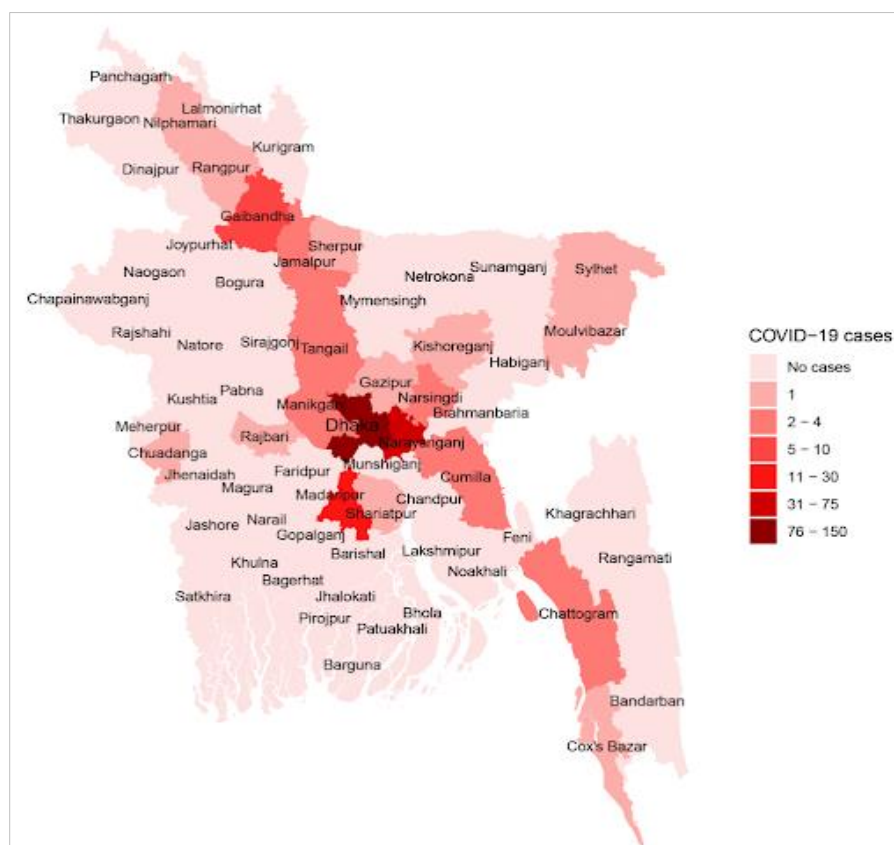


Figure 1: Clustering of COVID-19 areas in Bangladesh

### 2.1 Conceptual Development of Foot Press Hand Washing Device

Generally, this device is run by exerting a force on the foot pedal. Two types of pedals are used. Pedal-1 is inserted for hand wash which generates tension on the iron wire. As a result fluid soap emanates from the hand wash. On the other hand, pedal-2 is put on an air pump which consists of two valves. When pedal-2 presses the air pump, pressure inside the pump is decreased due to constriction and positive air pressure is created which helps to pull out the air from inside. When pedal-2 is loosened the air pump again expands due to negative pressure and immediately it is filled by water. Then when again pedal-2 is pressed the

air pump becomes constrict and water comes out from the pump due to positive pressure and passes through the rubber pipe and comes out from the water tap. Then due to tension, the ropes pull the press woods towards each other which results in pressing the container. In this way due to pressing action air pump pulls the water and passes it through the rubber pipe. The schematic diagram of the "Foot Press Hand Washing Device" is shown in Figure 2.

The complete design of the "Foot Press Hand Washing Device" facility is provided in the following figure (Figure 3).

Its mechanism of action can be explained as follows: we know that,

$P=F/A$ .....(1)

Where P= Pressure,

F=Force or Tension,

A=Area.

From this equation (1) we can see that the pressure is directly proportional to the tension. So when pressure will be increased then the tension will be also increased.

When pressure is imposed on the pedal then contraction and expansion occurs to the air pump which aid the water to flow through the pipe (Figure 4).

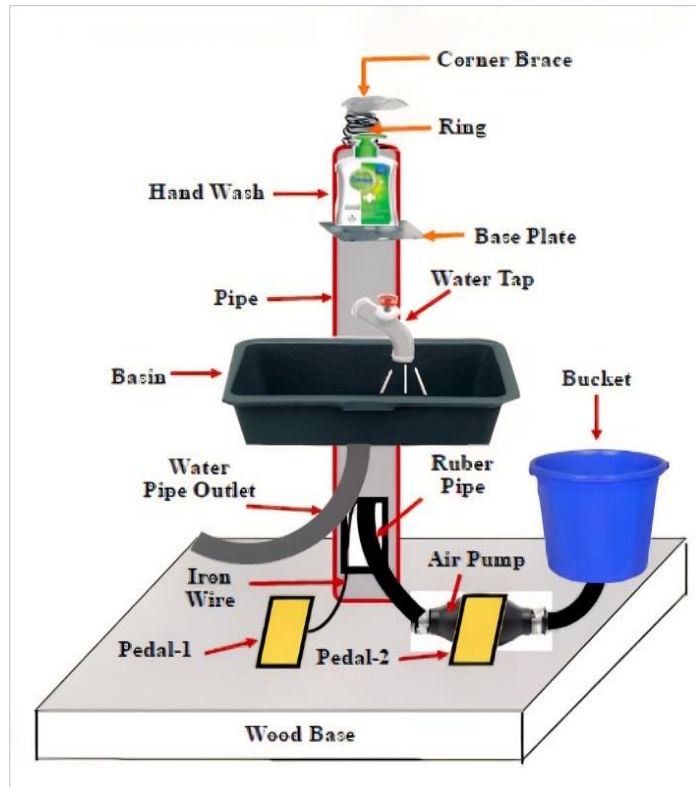


Figure 2: Schematic diagram of the “Foot Press Hand Washing Device”

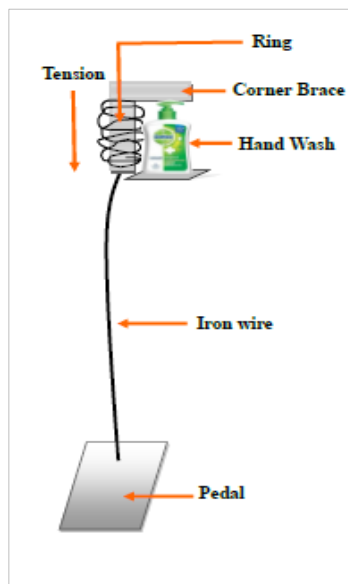


Figure 3: Pressures acting on the Pedal-1 of the “Foot Press Hand Washing Device”

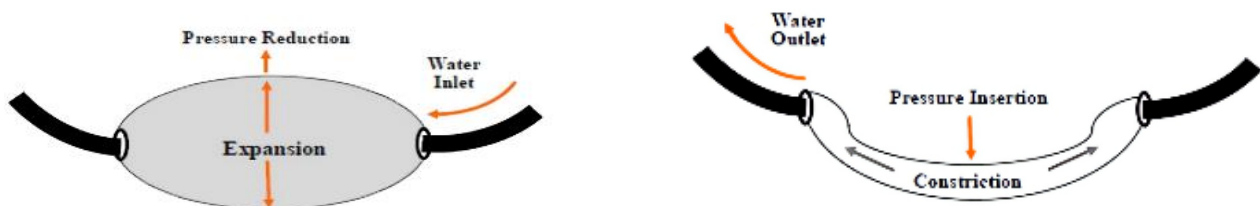


Figure 4: Expansion and Contraction of Pressure pump due to pressing on the pedal-1 of the “Foot Press Hand Washing Device Hand Washing Device” device

The mechanism of the air pump's constriction and expansion is based on the following equations: we know that,

$$P = h\rho g$$

$$\Rightarrow P = h\rho g/v \text{ [As, } \rho = m/v \text{]}$$

$$\Rightarrow P \propto m$$

If the rate of water flow is m/t then we can write,

$$m/t \propto P \dots\dots\dots(2)$$

Equation (2) shows that as long as the pressure is increased the rate of water flow will increase. Table 1 below shows the data for this:

Table 1: Data Table of The Different Flow Rates of Water Against Different Air Pressure	
Pressure inserted on Air Pump (P) (N/m <sup>2</sup> )	Flow rate of water(m/t) (ml/s)
0	0
3	5
5	8
8	12
10	15
12	18

Figure 5 below shows the graphical representation of this theory:

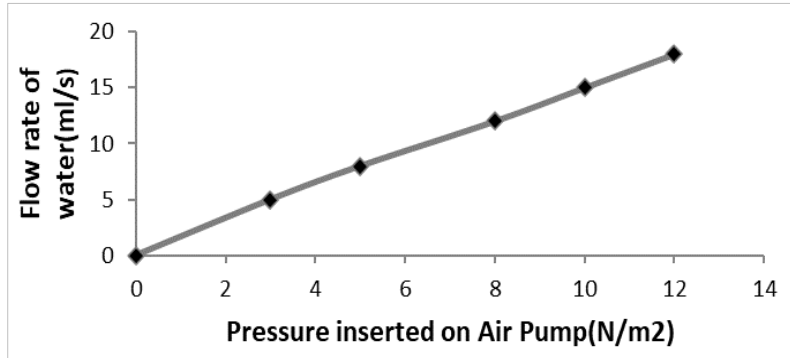


Figure 5: Data Curve of Flow rate of Water Against Different Pressure Inserted on The Air Pump

**2.2 Construction of the Foot Press Hand Washing Device**

The construction of the Foot Press Hand Washing Device was done by using locally available materials. Figures 6-10 demonstrate the construction of the "Foot Press Hand Washing Device" facility.

**Step 1: Construction of Wooden Base**

Figure 6 below describes the construction of the wooden Base of the "Foot Press Hand Washing Device". Here there is a wooden supporting frame that actually acts as a basement for the whole device. It's actually 25 inches in wide, 30 inches in length and 5 cm in thick.

**Step 2: Attachment of Pipe with the Wooden Base**

Figure 7 actually indicates the attachment of a PVC pipe with the wooden base. Corner Brace helps to attach the pipe with the base. The pipe is 2 inch in wide and 48 inches in length. A rectangular hole has been created at the

bottom of the pipe.

**Step 3: Attachment of Corner Brace and Pedal**

In the case of Figure 8, a corner brace is attached with a pedal via an iron wire. A ring is attached to the corner base for its easy movement. When the pedal is pressed it exerts a tension which actually helps to drag the corner brace.

**Step 4: Air Pump Setting**

In Figure 9 the air pump set is constructed. Two rubber pipes are attached from two sides of the air pump via super glue. When Pedal-2 presses the air pump it constricts the pump and as a result, a positive pressure is created which removes the air from inside. On the other hand, when the pedal is relaxed then the pump expands and as a result, a negative pressure is created which helps to flow the water through the pipe.

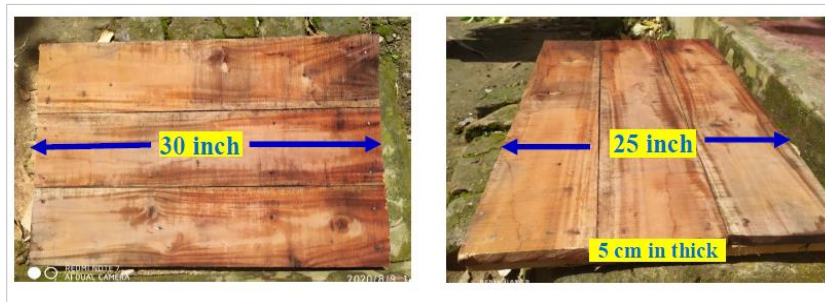


Figure 6: Wooden Base of the "Foot Press Hand Washing Device"



Figure 7: Attachment of pipe with the wooden base





Figure 8: Attachment of Corner Brace and Pedal



Figure 9: Air Pump Setting



Figure 10: Final setting of the "Foot Press Hand Washing Device"

### Step 5: Final Setting

Figure 10 describes the final setting of the "Foot Press Hand Washing Device". Here a bucket has been attached to the rubber pipe from which water passes through the pump and flows through the pipe above. A basin with a water tap is also attached to the pipe.

## 3. RESULTS

### 3.1 Online Survey

The results of online survey are shown below in Table 2.

### 3.2 In Person Interviews

The response to the small scale survey in rural areas using interviews

comprised both males and females of ages 15 to 75 years. There were equal numbers of females and males. Mostly (64%) were 50 years and above, while 16.3% were between ages 15 and 29 and 19.7% between ages 30 and 49. Mostly were farmers (22%) followed by housewives (17%), teachers and government employees (both 15%), students, retirees, bankers and doctors (5% each) and engineers (3%). When we presented the hand washing device in front of the villager's and explained the importance of using it, most of them (89%) expressed their strong desire to use it, where 9% also showed their moderate interest and only 2% expressed no interest at all to use it.

In comparison to the online survey in urban areas, the respondents for the interview in a village of Cumilla as described above were slightly older (64% vs 59.8% aged 50 years and above). Among the occupational categories there were farmers which are expected for a rural community in Bangladesh.

**Table 2: The Distribution of Demographic Variables and Response to Questions Related to Hand-Washing and Use of the Device in 5-Point Likert Scale**

Variable	N (%)
<b>Age</b>	
15-29	59(13.2%)
30-49	122(27.0%)
50-75	269(59.8%)
<b>Gender</b>	
Males	244(54.2%)
Females	206(45.8%)
<b>Occupation</b>	
Housewives	68(15.0%)
Students	65(14.4%)
Teachers	64(14.2%)
Businessmen	59(13.2%)
Government Employees	46(10.2%)
Bankers	43(9.6%)
Doctors	32(7.0%)
Retirees	21(4.6%)
Engineers	21(4.6%)
Pharmacist	21(4.6%)
Police	12(2.6%)
Others	37(8.2%)
<b>Use of any Hand Washing Device in Past 6 Months</b>	
(No)	134(29.9%)
Yes	316(70.1%)
<b>Uniqueness of Foot Press Hand Washing Device</b>	
Strongly Agreed	176(39.2%)
Just Agreed	143(31.8%)
Neither Agreed Nor Disagreed	60(13.3%)
Disagreed	39(8.7%)
Strongly Disagreed	32(7.0%)
<b>Effectiveness of Using Soap and Water for Hand Washing for Minimum 20 Seconds</b>	
Strongly Agreed	186(41.3%)
Just Agreed	137(30.5%)
Neither Agreed Nor Disagreed	53(11.7%)
Disagreed	38(8.4%)
Strongly Disagreed	36(8.1%)
<b>Suitability of the New Device for Rural People</b>	
Strongly Agreed	172 (38.2%)
Just Agreed	134 (29.8%)
Neither Agreed Nor Disagreed	63 (13.9%)
Disagreed	41 (9.2%)
Strongly Disagreed	40 (8.9%)
<b>Placement of Foot Press Hand-Washing Device in A Crowded Place</b>	
Strongly Agreed	175 (38.9%)
Just Agreed	145 (32.3%)
Neither Agreed Nor Disagreed	53 (11.8%)
Disagreed	39 (8.6%)
Strongly Disagreed	33 (7.4%)
<b>Significant role of The Device in the Prevention of Covid-19 in Bangladesh</b>	
Strongly Agreed	183(40.6%)
Just Agreed	138(30.6%)
Neither Agreed Nor Disagreed	58(12.9%)
Disagreed	39(8.7%)
Strongly Disagreed	32(7.2%)
<b>Reasons Why Hand-Washing Is Important</b>	
Health Hygiene and Ensuring Safety	212(47.0%)
Maximum Number of Diseases Spread Through Hand	172(38.2%)
Health Hygiene	29(6.4%)
Ensuring Safety	38(8.4%)
<b>Reasons Why Using Soap and Water for Hand Washing for A Minimum of 20 Seconds is Important</b>	
Health Hygiene and Its Protection Against Covid-19	169(37.6%)
Hand-Washing is Important For Killing All The Microorganisms	153(34.0%)
To Protect Against Covid-19	92(20.4%)
Health Hygiene	35(7.8%)
<b>Device is Cost-Effective</b>	
Strongly Agree	176(39.2%)
Just Agreed	147(32.6%)
Neither Agreed Nor Disagreed	57(12.6%)
Disagreed	38(8.4%)
Strongly Disagreed	32(7.0%)
<b>Reasons Why Rural People Can Easily Use the Device</b>	
It Has a Very Simple Structure, is Cost Effective and Its Transportation is Very Easy	44.4%
Other	55.6%

The following questions relate to the hand washing device and the responses to questions 2 through 6 are in 5-point Likert scale:

#### Q1. Have You Used Any Hand-Washing Device in the Last Six Months?

70.1% responded positively and 29.9% negatively to this question.

#### Q2. Do You Agree That This "Foot Press Hand Washing Device" is Unique From the Other Hand-Washing Devices in the Market?

64.3% strongly agree and 13.8% just agree that this device is unique from other devices in the market, while 7.9% neither agree nor disagree. On the other hand, 7.1% disagree and 6.9% strongly disagree in this regard.

#### Q3. Do You Agree That Using Soap and Water for Hand Washing for Minimum 20 Seconds is Very Effective?

62.4% strongly agree and 11.4% just agree that this device is unique from other devices in the market, while 9.3% neither agree nor disagree. On the other hand, 8.8% disagree and 8.1% strongly disagree in this regard.

#### Q4. Do You Agree that this Device is Suitable for Rural People?

62.0% strongly agree and 11.4% just agree that this device is unique from other devices in the market, while 9.3% neither agree nor disagree. On the other hand, 8.8% disagree and 8.1% strongly disagree in this regard.

#### Q5. Should A "Foot Press Hand-Washing Device" With A Disinfectant Tunnel Be Placed in A Crowded Place?

60.8% strongly agree and 12.9% just agree that this device is unique from other devices in the market, while 8.9% neither agree nor disagree. On the other hand, 9.0% disagree and 8.5% strongly disagree in this regard.

#### Q6. Do You Agree that this Device Can Play a Significant Role in the Prevention of COVID-19 in Bangladesh?

58.7% strongly agree and 16.0% just agree that this device is unique from

other devices in the market, while 11.4% neither agree nor disagree. On the other hand, 7.4% disagree and 6.6% strongly disagree in this regard. Figure 11 shows the ordered responses for questions 2 through 6.

#### Q7. Why Do You Think That Hand-Washing is Important?

59.2% think that hand-washing is important both for health hygiene and ensuring safety, whereas 20.8% think that the device is important as maximum number of diseases spread through hand while 10.7% and 9.3% think that the device is important for health hygiene and ensuring safety respectively.

#### Q8. Why Do You Think That Using Soap and Water for Hand-Washing for A Minimum Of 20 Seconds Is Important?

The maximum number of people (64.8%) think that hand-washing for a minimum of 20 seconds is important both for health hygiene and its protection against Covid-19, whereas 14.9% think that hand-washing is important for killing all the microorganisms. On the other hand, 10.7% and 9.6% think that hand-washing for a minimum of 20 seconds is important just to protect against Covid-19 and for health hygiene.

#### Q9. Do You Agree That This "Foot Press Hand Washing Device" is Cost-Effective?

We found that 64% strongly agree and 12.3% just agree that this device is unique from other devices in the market, while 8.8% neither agreed nor disagreed. On the other hand, 7.7% disagree and 7.5% strongly disagree in this regard.

#### Q10. Why Rural People Can Easily Use "Foot Press Hand-Washing Device"?

65.1% of rural people think that they can easily use the device because it has a very simple structure, it is cost effective and overall its transportation is very easy.

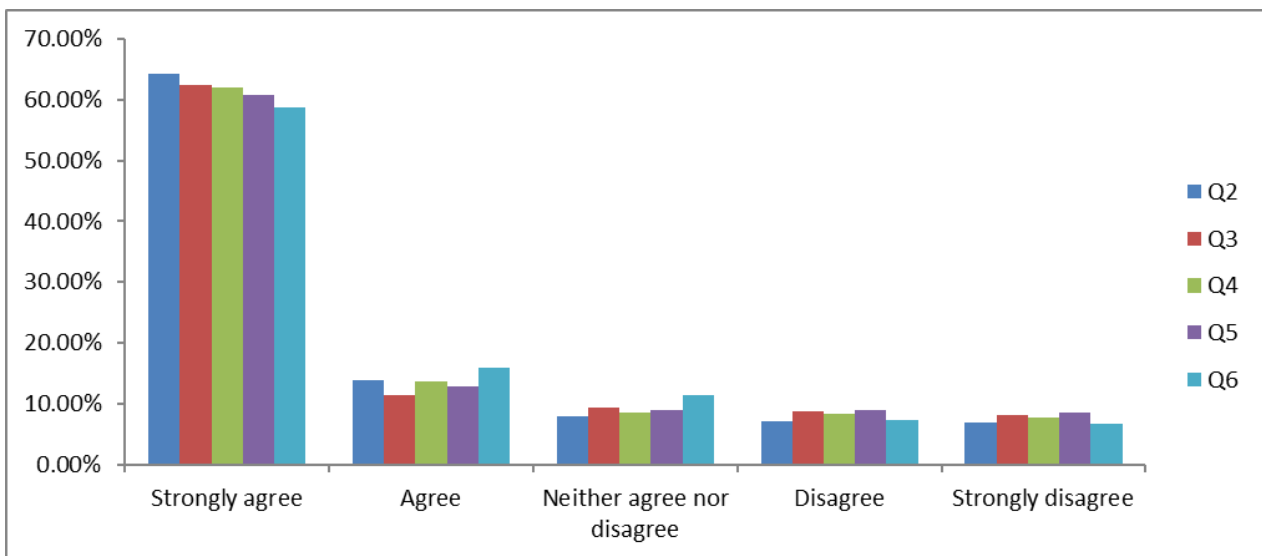


Figure 11: Graphical Representation of survey questions from 2 to 6

## 4. DISCUSSION

In this article we have described an excellent device for hand washing for low and middle income countries. Since infectious diseases caused by various viruses and bacteria are spread through hands, this device is very useful for preventing infectious diseases. For public use the device can be easily installed in various corporate workplaces, markets, schools or educational institutions. Since all its components are readily available, it can be manufactured very easily. Moreover, it is not difficult to understand all the details of making this device. The few problems which may arise in association with using this device can be easily overcome by following the simple user guidelines we have discussed in section 2.1.

The air pressure created by the air pump forces the water from the container to flow via the air pipe in the higher tap, which is the basis for the conceptual development of the device. We can use a suitable amount of water and avoid wastage of water by exerting pressure with our feet. A 25-liter water holding container with a capacity of 100 people may be used with 250 mL of water for every hand wash. If more water is required for washing, the gadget can easily be modified to meet this need by adding a

larger water holding container. The facility demands that the container be filled on a regular basis.

The online survey of 450 persons in urban areas of Cumilla, Dhaka and Chittagong, comprised mostly males (52.0%) and among professional categories, mostly housewives, students, teachers and businessmen. The age range was 15 to 75 years, with almost 60% between ages 50 and 75 years. There were 73.13% who used a hand washing device in the past 6 months while 41.3% and 30.5% strongly agreed and just agreed that hand washing with soap and water is very effective. Regarding hand washing for 20 seconds, most or 37.6% believed that hand-washing is important for health hygiene and its protection against Covid-19, followed closely by 34.0% who believed that hand-washing is important for killing all the microorganisms while 20.4% and only 7.8% believed that it is important just to protect against Covid-19 and health hygiene respectively. There were 71.0, 71.2, 68.0, 71.8 and 44.4% respectively who either strongly or just believed: the device is unique from other devices, very useful for preventing COVID-19; suitable for rural people; can be placed in a crowded place; can be easily used by rural people because of its simple structure; cost-effectiveness and transportability.



The in person interview of 375 persons in a village of Cumilla (due to limited internet connection the online survey couldn't be performed) showed that 70.1% used a hand washing device in the past 6 months and 62.4% and 11.4% strongly and just agreed that hand washing with soap and water is very effective. Regarding hand washing for 20 seconds, most or 64.8% believed that hand-washing is important for health hygiene and its protection against Covid-19 followed by 12.3% who believed that hand-washing is important for killing all the microorganisms, 10.7% and 9.6% believed that it is important just to protect against Covid-19 and health hygiene respectively. There were 78.1, 74.7, 73.3, 73.6 and 65.1% respectively who either strongly or just believed: the device is unique from other devices, very useful for preventing COVID-19; suitable for rural people; can be placed in a crowded place; is cost-effective and very transportable; can be easily used by rural people because of its simple structure; is easy to construct and the materials are available and cheap.

The operation of the "Foot press Hand-washing Device" is done by forcing on a foot pedal which makes the device disinfected and unique. It is also possible to combine soap with the hand washing facility. It can be used to reduce the risk of diseases like diarrhoea, cholera, and more recently the COVID-19 pandemic and associated premature deaths. An effective Foot Press Hand Washing Device with soap programming can lead to reduced healthcare costs, as well as improved productivity and economic growth. This facility can be installed in different user settings including provision as a group hand washing facility such as in schools.

The COVID-19 outbreak emphasizes people to develop the habit of frequent hand washing (Pogrebna and Kharlamov, 2020). Although this is encouraging, we must be wary of the possibility of transmission from various sources. For example, the virus can be transferred by touching hand pumps or using mugs to pull water from buckets. Furthermore, using tube wells or mugs necessitates the use of one hand to pour the water. This is not only uncomfortable, but it may also be ineffective in terms of reducing the risk of COVID-19 infection because the clean hand is then used to pour water by contacting the hand pump or the surface which may already have been contaminated. Hand washing is required at entry and exit points in densely populated urban slums to prevent the spread of COVID-19, however this is challenging owing to lack of suitable and appropriate facilities, which will raise the cost of hand washing devices. To prepare these types of devices, a minimum of 5,000-10,000 Taka or 57.2-114.4 US dollar (see Table 3) is required. On the contrary, we spent only 800 Taka to create these gadgets, and these only demand a little amount of space.

	Cost in BD Taka	Equivalent Cost in US Dollar
Market Price of Similar Device	5000-10000	57.2-114.4
Our Device Cost	800	9.15

As this device is executed by a foot pedal, sometimes children may try to play with the device or spend too much time hand washing as fun. So this device requires to be kept at a safe distance from children. Also, due to the lack of proper education and training, some users may inappropriately tamper with the container. Long-time use of the device may hamper the air pump which may then require repairing. As the project was self-funded, we were only able to distribute the device to a few regions of Bangladesh particularly to some urban areas of Cumilla, Chattogram, and Dhaka and a village in Koatbari, Cumilla.

There are certain strategies which can be adopted to make this device popular in the market. In resource-restricted communities, where availability of soap is difficult to maintain at hand washing stations, promotion of our hand washing device should be assessed as an effective option. Also, customers need to have a clear idea about why they should use the device compared to other similar devices available in the market. This includes media promotion of the various features and advantages of using the device. For the first hundred customers, we intend to give a special discount for the purchase of this device. Above all, we need to make a very effective presentation of this device in the market.

We were not able to conduct a full scale survey pertaining to the hand washing device in rural areas. Future research needs to direct attention to conducting a full scale survey in rural areas in this regard to understand the utility of the device in all parts of the country. Moreover our hand washing device should be explored in a broader contexts for improving hand hygiene practices. Finally, research can be conducted to find the direct link between the practice of the hand washing device and subsequent reduction in risk of contracting the COVID-19 virus in at least the central and southeastern regions of Bangladesh.

## 5. CONCLUSION

The development of the "Foot Press Hand washing Device" has created a great opportunity to improve hand hygiene of the rural and slum-dwelling people in developing countries due to its simple operational technique as well as its low cost using locally available materials. Its operational system is so hygienic that one doesn't need to use his or her hands for opening and closing the tap, rather one can operate the device simply by exerting force on the foot lever. The children can comfortably use this device under adult supervision. The online survey of 450 individuals using proportional cluster sampling in Dhaka, Chittagong and Cumilla cities of Bangladesh and a face to face interview of 375 individuals in a village of southeastern Bangladesh using convenience sampling showed positive awareness and perception regarding hand washing with soap and water. A high percentage of the respondents have also practiced hand washing using any device in the past six months. There was positive awareness and perception regarding the new hand washing device. Finally, it can be expected that if the project is fully implemented in Bangladesh, most of its people will be benefited. With all kinds of necessary support and logistics, the device is expected to be used in every nook and corner of the country. Once it is used across the population, it will be important to establish how these devices are common within the community or how effective they are in reducing infections associated with poor hand hygiene. More experimental studies are needed to provide a good understanding of the use, adoption, and effectiveness of the hand washing device.

## ACKNOWLEDGMENTS

We would also like to thank all members of our research innovation team who endowed their diligence in our Pharmacy lab for the fundamental and conceptual development of our hand washing device.

## AUTHOR CONTRIBUTIONS

HM supervised the research including the surveys and wrote the final manuscript; SKA and PD conceptualized the study; UKR helped design and construct the device, contributed to data analysis and the initial draft; MK contributed to data analysis and the initial draft and SC contributed to data collection.

## REFERENCES

- Ahmed, M.S.; Yunus, F. M. 2020. Trend of COVID-19 spreads and status of household hand washing practice and its determinants in Bangladesh—situation analysis using national representative data. *International Journal of Environmental Health Research* 2020, 1-9.
- Beale, S.; Johnson, A.M.; Zambon, M.; Hayward, A.C.; Fragaszy, E.B.; Group, F.W. 2020. Hand and respiratory hygiene practices and the risk and transmission of human coronavirus infections in a UK community cohort. *SSRN Electron J.* 2020, doi:10.2139/ssrn.3551360.
- Cairncross, S.; Hunt, C.; Boisson, S.; Bostoen, K.; Curtis, V.; Fung, I. C.; Schmidt, W. P. 2010. Water, sanitation and hygiene for the prevention of diarrhoea. *International Journal of Epidemiology* 2010, 39(suppl\_1), i193-i205.
- Durani, P.; Leaper, D. 2008. Povidone-iodine: use in hand disinfection, skin preparation and antiseptic irrigation. *International Wound Journal* 2008, 5(3), 376-387.
- Ejemot-Nwadiaro, R. I.; Ehiri, J. E.; Meremikwu, M. M.; Critchley, J. A. 2008. Hand washing for preventing diarrhoea. *Cochrane database of systematic reviews* 2008, (1).
- Hoque, B.A. 2003. Handwashing practices and challenges in Bangladesh. *Int J Environ Health Res.* 2003, 13 Suppl 1:S81-S87. doi: 10.1080/0960312031000102831. PMID: 12775383.
- Institute of Epidemiology Disease Control and Research (IEDCR). 2020. Bangladesh Covid-19 update [internet] [Accessed 2020 June 15] www.iedcr.gov.bd
- Kapil, R.; Bhavsar, H.K.; Madan M. 2015. Hand hygiene in reducing transient flora on the hands of healthcare workers: an educational intervention. *Indian J Med Microbiol.* 2015, 33(1), 125-8. Doi: 10.4103/0255-0857.148409. PMID: 25560015.
- Lal, M. 2015. Hand hygiene.
- Mbakaya, B.C.; Kalembo, F.W.; Zgambo, M. 2020. Use, adoption, and



- effectiveness of tippy tap handwashing station in promoting hand hygiene practices in resource-limited settings: a systematic review. *BMC Public Health* 2020, 20: 1005.
- O'Donoghue, M.; Ho, J.M.; Pittet, D.; Suen, L.K. 2019. Acceptability and tolerability of alcohol-based hand hygiene products for elderly residents in long-term care: a crossover study. *Antimicrobial Resistance & Infection Control* 2019, 8(1), 1-10.
- O'Donnell, J.A.; Safdar, A., 2015. in Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases (Eighth Edition), 2015 Volume 1, 2015, Pages 452-462.e2.
- Pittet, D. 2001. Improving adherence to hand hygiene practice: a multidisciplinary approach. *Emerging infectious diseases* 2001, 7(2), 234.
- Pogrebna, G.; Kharlamov, A. 2020. The impact of cross-cultural differences in hand washing patterns on the COVID-19 outbreak magnitude. *Regulation and Governance*.
- Rabie, T.; Curtis, V. 2006. Hand washing and risk of respiratory infections: a quantitative systematic review. *Tropical Medicine & International Health* 2006, 11(3), 258-267.
- Shoaib, M. 2020. Coronavirus Disease 2019 Pandemic: Epidemiology, Pathogenesis and Challenges. *Journal of Medical Case Reports and Reviews*, 3(03).
- Slovin, M.S. 1960. Slovin's Formula: What is it and when do I use it? Retrieved from Statistics How To: <https://www.statisticshowto.com/how-to-use-slovins-formula>.
- Tiruneh, A.T.; Ndlela, W.N.; Heikkilä, J. 2016. Development of "Press Tap" Hand washing Technology: Design, Construction and Operational Aspects. *International Journal of Science, Technology and Society* 2016, 4(3), 48.
- UNICEF. 2008. The state of the world's children 2009: maternal and newborn health (Vol. 9). UNICEF.
- Washing, H. 2002. Reducing the Risk of Common Infections. Canadian Centre for Occupational Health and Safety. URL: [https://www.ccohs.ca/oshanswers/diseases/washing\\_hands.html](https://www.ccohs.ca/oshanswers/diseases/washing_hands.html) [Erişim Tarihi: 0.
- World Health Organization. 2020. Coronavirus disease (COVID-19) technical guidance: infection prevention and control/WASH [Internet]. [accessed 2020 Jun 22]. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/infection-prevention-and-control>.

