

Knowledge, attitude and practice on water, sanitation and hygiene (WASH) and COVID-19 among households in rural Bangladesh

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Abstract

Enhanced water, sanitation, and hygiene (WASH) conditions can significantly reduce the incidence of communicable diseases and deaths related to diarrhea by up to 65%. The US Centers for Disease Control and Prevention (CDC) advocates regular handwashing with soap and water for at least 20 seconds as an effective measure to mitigate the spread of COVID-19. This study aims to assess rural Bangladeshi households' perceptions and knowledge concerning the COVID-19 pandemic, as well as their understanding, attitudes, and practices regarding water, sanitation, and hygiene. A cross-sectional study was conducted between June 2020 and December 2020 to evaluate knowledge and practices related to safe water, sanitation, personal hygiene, and COVID-19 in rural Bangladesh. Self-administered questionnaires, pre-tested for reliability, were utilized to collect self-reported data, which were subsequently analyzed descriptively. Of the study participants, 66.78% were female, with a mean age of 40. The majority (92.36%) demonstrated adequate knowledge of personal hygiene, although 66.78% had not received hygiene education, and a significant proportion reported low levels of hygiene practices (17.28%). Nearly all respondents (98%) reported having access to a pit latrine, either with or without a seal, yet 63.12% indicated that their toilets become unusable during floods, and 29% admitted to practicing open defecation. While nearly all respondents were aware of the ongoing COVID-19 outbreak, only 46% had a comprehensive understanding of its transmission dynamics. Moreover, knowledge about preventive measures against the pandemic was found to be limited. Despite understanding the importance of handwashing, reported hand hygiene practices were inadequate among rural households. Additionally, a majority reported inadequate management of child feces, household waste, and sludge tanks. While awareness of the COVID-19 pandemic was high, a substantial proportion of respondents lacked understanding of its transmission and prevention methods. Moreover, fewer respondents reported using hand sanitizer when venturing outside for work. Future research should explore the impact of these behaviors on health outcomes and propose targeted interventions to improve hygiene practices.

Key words: Water; sanitation; hygiene; COVID-19.

INTRODUCTION

Poor water, sanitation and hygiene conditions are the leading causes to spread of many communicable diseases including diarrhea (Berhe *et al.*, 2020; Vivas *et al.*, 2010). Improved WASH facilities and use of WASH in daily existence individuals can combat practically 30%-40% infection pervasiveness that are communicated through fecal-oral pathways (Berhe *et al.*, 2020). The fecal desecration into drinking water actually causes

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genuine sickness and demise each year from cholera, typhoid, and other diarrheal infections, albeit diarrheal illness is a more regular reason for under-5 child mortality in Bangladesh (Hanchett & Akhter, 2015).

In Bangladesh, poor water, sanitation, and hygiene (WASH) practices add to the passing of 20,000 under-five youngsters each year from diarrheal disease (Cravioto *et al.*, 2011). Periodical occurrence of diarrhea and chronic environmental enteropathy in early childhood alleviated development and cognitive function and impair school performance (Alderman *et al.*, 2006; Checkley *et al.*, 2008; Lorntz *et al.*, 2006; Niehaus *et al.*, 2002; Petri *et al.*, 2008). In the long run this can reduce income and add sufferings in life which perpetuating a cycle of poverty and ill health (Alderman *et al.*, 2006; Checkley *et al.*, 2008; Lorntz *et al.*, 2006; Niehaus *et al.*, 2002; Petri *et al.*, 2008). Most of the burden of diarrheal disease is thought to be preventable with improvements in sanitation, water quality, and hygiene (Ezzati *et al.*, 2003) and a combination of safe drinking water, sanitation, and good hygiene can reduce deaths due to diarrhea by 65 percent, approximately (Esrey *et al.*, 1991). Bangladesh has a wonderful improvement in sanitation, it is estimated that open defecation diminished from 42% in 2003 to 1% in 2015 (Chan *et al.*, 2016; Islam *et al.*, 2018; Sridhar *et al.*, 2020).

Securely oversee water, disinfection and hygiene (WASH) administrations are a fundamental piece of forestalling and ensuring human wellbeing during irresistible sickness flare-ups, including the momentum COVID-19 that showed up in December 2019 and quickly turned into a worldwide pandemic (Bates *et al.*, 2020; Tashiro & Shaw, 2020). Water, sanitation, and hygiene (WASH) are for the most part considered as the preeminent shield system against the irresistible infectious disease manifestation as well as ample and efficient WASH measures are extreme choice for general wellbeing advancement (Blake *et al.*, 2020; Donde *et al.*, 2020). The current perspective breaks down the latest proof on the presence, subsistence and fecal oral transmission of COVID-19 (Gwenzi, 2020) and discovered that transmission risk is actually high in developing world on account of their poor knowledge and practice of hygiene, poor drinking water quality, improvised waste management strategy and weak medical services framework and social insecurity (Gwenzi, 2020; Rahman *et al.*, 2021). World Health Organization has found strong association between broaden of the pandemic and maintaining hygiene (Organization, 2020a). Suitable WASH and waste administration rehearses locally and different work environments just as in medical services organizations can help to stop the immediate transmission of the sickness (Organization, 2020a, 2020b). In this study, among households in rural Bangladesh, we aimed to: assess the knowledge and practices on safe water, sanitation, hygienic and knowledge about the COVID-19 pandemic.

MATERIALS AND METHODS

Participants and procedure: We conducted a cross-sectional study among 301 households from four villages between June, 2020 and December, 2020. Individuals unwilling to participate were not included in the study. A well-structured pre-tested questionnaire was used to collect data from face-to-face interviews.

Sampling procedure: For the unknown population size, the sample size was calculated by Cochran formula which is,

$$n = z^2 pq / d^2$$

Where:

n = the desired sample size (target population was greater than 10,000)

z = the standard normal deviate at the required confidence level

p = the proportion in the target population estimated to have characteristics being measured.

$$q = 1 - p$$

d = the level of statistical significance set.

Hence the proportion of the target population has certain characteristic of .50, the z-static is 1.96 and the desired accuracy at 0.5 levels, the sample size was:

$$n = (1.96)^2 (.5) (1-.5) / (0.05)^2 = 384$$

Measures: The interview survey was conducted through Bangla questionnaire (as participants' first language is Bangla) containing informed consent, questions regarding socio-demographics, and personal lifestyle-related activities during COVID-19 as well as behavior change for the pandemic.

Socio-demographic information: Socio-demographic data includes gender, age, monthly family income, and educational status. Socio-economic conditions were classified into four categories: lower-class, lower middle, middle-class, and upper-class were based on monthly family income.

Knowledge, attitudes, and practices: Understanding hygiene and the frequency of practicing personal hygiene, sanitary condition, water source, type of latrine, level of knowledge and attitude about sanitation and hygiene in institutional form were investigated through the study. In COVID-19 section, we tried to gather knowledge of each participant regarding its mode of transmission, prevention way, importance of personal hygiene in preventing the disease and what kind of behavioral change was happen for the pandemic was questioned. Moreover, what is the most effective step to prevent the disease was also asked from the individual point of view.

Statistical analysis: For our demonstration variables, we defined personal hygiene as a conditions or practices conducive to maintaining health and preventing disease, especially through cleanliness, hygienic latrine include flush/pit latrines with water seal and no visible feces on slab or floor inside and not directly open to the environment, unhygienic latrine which is without lids or open feces to the environment. We also defined diarrhea as three or more times loose or watery stools in 24 hours, cholera is an acute diarrheal condition and dysentery is a condition of diarrhea containing blood or mucus. Shallow tube well has a depth of <250 feet and deep tube well depth is >250 feet.

SPSS statistical version-25.0 was used for data entry, editing, sorting, and coding. Data analysis was performed using STATA version-13. Descriptive statistics (frequencies, percentages, standard deviation and means) and first-order analysis (i.e., chi-square tests) were executed using STATA software.

Ethical considerations: Institutional ethical clearance was obtained from research and development committee of Jahangirnagar University, Savar, Dhaka-1342, Bangladesh. All participants gave their written informed consent. The consent form clearly documented the (i) nature and procedure of the study, (ii) aims of the study, (iii) anonymity and confidentiality of data, (iv) choice to participate in the study, (v) right to revoke data at any time from the study.

RESULTS AND DISCUSSION

General profile of participants: Among the 301 respondents, two third were female 66.78% and mean age of the respondents were 40 (SD = 7.5) (Table 1). Most of the respondents (58.47%) have primary education whereas only 1% respondents had graduate level education. Among the respondents 63.12% (n= 190) had a monthly family income between 5001-15000 taka. About 75.08% (n= 226) of the households had pit latrine and it was also found that still 3.32% (n= 10) household had unhygienic latrine (that actually have the feces without any covering something like drain which is opened to a bush or a small puddle that is open to the environment) (Table 1). About 53.16% (160) respondents used shallow tube well as their drinking as well as household's activities water source.

Table 1. Demographic characteristics of the enrolled households in rural Bangladesh, (N=301)

Characteristics	% (n)
Age of respondents, mean (SD)	40 (7.5)
Sex	
Male	33.22 (100)
Female	66.78 (201)
Educational categories of respondents	
No primary education	11.30 (34)
Primary	58.47 (176)
Secondary	11.30 (74)
Higher Secondary	4.32 (13)
Graduate	1.33 (4)
Family's monthly income	
< 5000 Taka	8.97 (27)
5001-15000 Taka	63.12 (190)
15001-30000 Taka	27.91 (84)
Latrine types	
Pit	75.08 (226)
Pit (with water seal)	21.59 (65)
Households with unhygienic ^a latrine	3.32 (10)
Source of drinking water	
Shallow tubewell ^b	53.16 (160)
Deep tubewell ^c	34.55 (104)
River	8.31 (25)

^aUnhygienic latrine which is without lids or open feces to the environment.

^bShallow Tubewell depth is about <250 feet.

^cDeep Tube well depth is >250 feet.

Most of the respondents (92.36%) had a good knowledge about handwashing whereas 66.78% (n=201) respondents had no knowledge about personal hygiene. Among the households, 43.52% (n=131) respondents reported having a hygienic latrine, whereas 43.19% (n=130) had no idea if their latrine were a hygienic latrine or not. About 79.07% (n=238) respondents had known that the disease-causing bacteria and pathogens can spread in the environment from open feces and the most common diseases reported by the respondents were diarrhea (40.86%) and cholera (18.27%)(Table 2). Poor hygiene practices were found among the respondents. Only 17.28% (n= 52) respondents reported always washed hands there with soap before eating or feeding their offsprings, while 27.57% (n= 83) reported never do so. About 55.48% (n= 167) respondents reported that sometimes they washed hand with soap after using latrine and 11.63% (n= 35) reported never practices this hand washing after using latrine (Table 2). In addition, 38.54% (n= 160) respondent reported disposing child feces in a pond that is usually behind of the house. A total of 52.16% (n= 157) respondents reported that their usual household wastes were disposed in a hole without cover, 63.12% (n= 190) respondents reported that their latrines became unusable during natural disaster specially flood and among those during that time 34.22% (103) used their neighbor's latrine and 28.90% (n= 87) did open defecation (Table 2).

Most of the respondents reported that they were aware about the ongoing pandemic of COVID-19 (91%) and half of the respondents (46%) had knowledge about how the covid-19 spread. Only 21% had knowledge about the duration of hand washing, whereas one-third respondent reported to use had sanitized while go outside (Table 3). We also found that male was more likely to know about COVID-19 compared to female (95% vs. 89%). However, knowledge about the spread of COVID-19 (48% vs. 43%), duration of hand washing (24% vs. 15%) and reported practice of using hand sanitizer (34% vs.30%) while went outside was more among female compared to male (Table 3).

About 27% respondents reported that hand washing is the most important to prevent the COVID-19 (including women as 25% and men 31%), whereas 18% (women 18%, men 19%) thought using mask is more important and 25% (women 27% and men 20%) reported about social distancing. 38% women and 35% men reported that there is a little in their every day's behavior due to the pandemic (Table 3).

In this study, the majority of households reported that they thought it is important to wash hand with soap before eating or feeding their children; suggesting that they had knowledge about hand washing and respondents think that washing hands properly with water should be the first thing to do for maintaining good family health. Approximately two thirds' respondents mention that they have knowledge that open feces can spread disease causing pathogens which demonstrate that respondents agreed that waterborne diarrheal diseases can be prevented largely through personal hygiene and proper sanitation. It was also found that two thirds of the respondents narrated that the family health condition is quite satisfying, and it was fairly good proved that every individual household is concerned about the family health which make themselves more aware about the proper sanitation and hygiene.

Table 2. Knowledge, attitude and practices on water, sanitation, and hygiene among households in rural Bangladesh, (N=301)

Characteristics	% (n)
Self-reported knowledge of respondents about	
Washing hands before eating or feeding	92.36 (278)
Personal hygiene ^d	33.22 (100)
Hygienic latrine ^e	43.52 (131)
Open feces spread bacteria and pathogens	79.07 (238)
Reported diseases that can be occurred by open feces pathogens	
Diarrhea ^f	40.86 (123)
Cholera ^g	18.27 (55)
Dysentery ^h	4.65 (14)
Reported family health status of the respondents	
Very good ⁱ	6.64 (20)
Fairly good ^j	70.10 (211)
Poor ^k	21.26 (64)
Reported hand-washing practices before eating or feeding	
Always	17.28 (52)
Sometimes	10.96 (33)
When remembered	44.19 (133)
Never	27.57 (83)
Reported handwashing practice after using latrine	
Always	16.94 (51)
Sometimes	55.48 (167)
When remembered	15.95 (48)
Never	11.63 (35)
Reported child feces disposal sites	
In the pond	38.54 (160)
In the sink	31.89 (96)
In open space	14.29 (43)
In the latrine	5.65 (17)
Reported household waste disposal sites	
Back side of the house (open)	46.84 (141)
In the pond	36.88 (111)
Reported pit empty practices	
Leave it open	3.99 (12)
Uncover hole/pit	52.16 (157)
Cover hole/pit	43.85 (132)
Latrine was in a state to use during flood	36.88 (111)
Reported practice when latrine became unusable during flood	
Use neighbor's latrine	34.22 (103)
Open defecation	28.90 (87)

^dHygiene include conditions or practices conducive to maintaining health and preventing disease, especially through cleanliness; ^eHygienic latrine include flush/pit latrines with water seal and no visible feces on slab or floor inside and not directly open to the environment; ^fDiarrhea is defined as three or more times loose or watery stools in 24 hours; ^gCholera is an acute diarrheal condition; ^hDysentery is a condition of diarrhea containing blood or mucus; ⁱVery good is a condition when a person is physically and mentally active, and this health condition is stable; ^jFairly good is a condition in which a person is physically active but not healthy condition is not stable or frequently suffers from different illness; ^kPoor health is a condition of inability to perform physically or have any disease.

Table 3. Reported knowledge about COVID-19 among the respondents of rural Bangladesh

Reported knowledge about COVID-19	Male N=100	Female N=201	Total N=301
	% (n)	% (n)	% (n)
Know about COVID-19	95 (95)	89 (179)	91 (274)
Have knowledge about how COVID-19 spread	43 (43)	48 (96)	46 (139)
Knowledge about duration of hand washing	15 (15)	24 (49)	21 (64)
Used sanitizer while go outside	30 (30)	34 (69)	33 (99)
Reported most important steps to prevent COVID-19			
Hand washing	31(31)	25 (50)	27 (81)
Using mask	19 (19)	18 (36)	18 (55)
Social distance	20 (20)	27 (54)	25 (74)
Nutrient food	10 (10)	9 (18)	9 (28)
Have no idea	20 (20)	21(43)	21 (63)
Behavior changes during the pandemic time	35(35)	38 (76)	37 (111)

A study in Northern Ethiopia also found a positive attitude on WASH where respondents agreed that waterborne diseases can be prevented through adequate WASH practice and consumption of safe water, and diarrheal diseases are caused by poor personal hygiene and sanitation, respectively (Berhe *et al.*, 2020; Vivas *et al.*, 2010). A cross-sectional study conducted in India found that majority of the participants perceived that the sanitation knowledge and practices and quality of water are most important thing in everyday healthy life, consistent with our findings (Kubera *et al.*, 2015). A study conducted in Pakistan is similar at this point and they also found majority (96.6%) of respondents believed that a lack of knowledge of hygiene had a negative impact on personal hygiene practices (Ullah *et al.*, 2020).

In this study, we found the hygiene practice is very vulnerable because almost one in six respondents practiced hand washing before eating or feeding and after using latrines or baby feces disposal events. We found that 97% households had an access to a latrine which is consistent with the nationwide estimation of open defecation, as defined by lack of latrine access, is 2% in Bangladesh (Alam *et al.*, 2014; Hanchett & Akhter, 2015). During flood about two-thirds of the toilets became unusable, we found that the actual situation was bigger description as among those 35% approached to their neighbors as an alternative but rest of the households reported defecating directly into water bodies and pollute the water. Our this findings is also consistent with a study conducted in the rural community of Bangladesh, they also found that in rural areas the sanitation condition two thirds households became severely disrupted during flood (Shimi *et al.*, 2010).

In our study, we found that majority of the respondents possess a good knowledge about the importance of safe water in maintaining proper health despite majority of the households used shallow tube well as their primary drinking water source without using any water treatment process; suggesting knowledge is not sufficient to ensure safe

drinking water. A study conducted in rural Mali, which also found that two thirds of people have access to safe drinking water (Telmo, 2002).

However, the majority of households reported unsafe disposal of child feces management, suggesting that open defecation by young children is common in this setting despite widespread access to on-site sanitation; suggesting that among households with young children, are more likely be at risk of pathogen disclosure from child feces in the household environment even though when a latrine is available. Our findings are consistent with other studies in rural Bangladesh that found 74% unsafe child defecation and 80% unsafe child feces (Ercumen *et al.*, 2018; Islam *et al.*, 2018), as well as three studies in India (Bauza *et al.*, 2020; Bauza *et al.*, 2019; Kuberan *et al.*, 2015) and one study in Ethiopia reporting unsafe child defecation in 54–80% and unsafe child feces disposal in 67–81% of households (Azage & Haile, 2015; Berhe *et al.*, 2020; Vivas *et al.*, 2010).

Majority of the respondents were aware of the ongoing pandemic of COVID-19 and half of them had knowledge about how the COVID-19 spread and one-third of them had a practice to use hand sanitizer while went outside for work. Our findings was consistent with a study conducted rural Thailand, where a it was found that majority had a knowledge about the disease in the rural area (Vicerra, 2021; Yue *et al.*, 2021). Although most of the respondents know handwashing is important but only one forth respondents think that handwashing is an important preventive step of the pandemic COVID-19. We also found that only a few respondents know about using masks and social distance as a preventive measure of the pandemic; suggesting that the respondents are still not well informed about the preventive strategies. Our finding was consistent with a study conducted in Thailand, found that the rural areas have lower levels of health literacy which can be detrimental to health status and lagged behind a large population in the race of COVID-19 prevention (Vicerra, 2021). Another study in India also found that one-fourth (25.2%) of the participants had moderately adequate and one-fifth (18.5%) of the participants had inadequate knowledge regarding prevention of COVID-19 in rural community and a study conducted in China also found that rural residents held a moderate level of COVID-19 knowledge and practice (Ranjan & Ranjan, 2020; Yue *et al.*, 2021); consistent with our findings.

This study is not beyond limitations which should be considered when interpreting the data. Firstly, the study took place in a particular district with a small number of samples. Therefore, this study could not be generalized over the entire population. Our analysis was observational and therefore susceptible to confounding.

Conclusion: In this study setting, we found that, despite having knowledge about benefits of hand washing, reported hand washing practice was poor. Moreover, unsafe child feces, household waste and sludge tank management were also reported by the majority of households in a rural household setting. Our findings also suggested that majority of the respondents were aware about the ongoing pandemic of COVID-19, despite most of them don't know how COVID-19 spreads and the practice of using hand sanitizer was less

among respondents while went outside for work. Studies should explore how much these contribute to health and should develop interventions to improve practices.

REFERENCES

- Alam, M., Halder, A. and Horng, L. 2014. Bangladesh national hygiene baseline survey preliminary report. *Dhaka, Bangladesh* 2014.
- Alderman, H., Hoddinott, J. and Kinsey, B. 2006. Long term consequences of early childhood malnutrition. *Oxford economic papers*, 58(3), 450-474.
- Azage, M. and Haile, D. 2015. Factors associated with safe child feces disposal practices in Ethiopia: evidence from demographic and health survey. *Archives of Public Health*, 73(1), 1-9.
- Bates, B. R., Villegas Botero, A. and Grijalva, M. J. 2020. Knowledge, attitudes, and practices towards COVID-19 among Colombians during the outbreak: an online cross-sectional survey. *Journal of Communication in Healthcare*, 13(4), 262-270.
- Bauza, V., Majorin, F., Routray, P., Sclar, G. D., Caruso, B. A. and Clasen, T. 2020. Child feces management practices and fecal contamination: A cross-sectional study in rural Odisha, India. *Science of The Total Environment*, 709, 136169.
- Bauza, V., Reese, H., Routray, P. and Clasen, T. 2019. Child defecation and feces disposal practices and determinants among households after a combined household-level piped water and sanitation intervention in rural Odisha, India. *The American journal of tropical medicine and hygiene*, 100(4), 1013.
- Berhe, A. A., Aregay, A. D., Abreha, A. A., Aregay, A. B., Gebretsadik, A. W., Negash, D. Z., Gebreegziabher, E. G., Demoz, K. G., Fenta, K. A. and Mamo, N. B. 2020. Knowledge, Attitude, and Practices on Water, Sanitation, and Hygiene among Rural Residents in Tigray Region, Northern Ethiopia. *Journal of environmental and public health*, 2020.
- Blake, M., Glaeser, A. H., Kriticos, S. and Mutizwa-Mangiza, N. 2020. Water, sanitation, and hygiene policy in the time of COVID-19. *International Growth Centre Policy Brief*.
- Chan, N. W., Roy, R. and Chaffin, B. C. 2016. Water governance in bangladesh: An evaluation of institutional and political context. *Water*, 8(9), 403.
- Checkley, W., Buckley, G., Gilman, R. H., Assis, A. M., Guerrant, R. L., Morris, S. S., Mølbak, K., Valentiner-Branth, P., Lanata, C. F. and Black, R. E. 2008. Multi-country analysis of the effects of diarrhoea on childhood stunting. *International journal of epidemiology*, 37(4), 816-830.
- Cravioto, A., Evans, T. G., Bhuiya, A., Khan, M. and Judd, G. 2011. Science to accelerate universal health coverage; abstract book [of the] 13th Annual Scientific Conference, 14-17 March 2011, ICDDR, B, Dhaka, Bangladesh.
- Donde, O. O., Atoni, E., Muia, A. W. and Yillia, P. T. 2020. COVID-19 pandemic: Water, sanitation and hygiene (WASH) as a critical control measure remains a major challenge in low-income countries. *Water Research*, 116793.
- Ercumen, A., Pickering, A. J., Kwong, L. H., Mertens, A., Arnold, B. F., Benjamin-Chung, J., Hubbard, A. E., Alam, M., Sen, D. and Islam, S. 2018. Do sanitation improvements reduce fecal contamination of water, hands, food, soil, and flies? Evidence from a cluster-randomized controlled trial in rural Bangladesh. *Environmental science & technology*, 52(21), 12089-12097.
- Esrey, S. A., Potash, J. B., Roberts, L. and Shiff, C. 1991. Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. *Bulletin of the World Health organization*; 69(5): 609.

- Ezzati, M., Vander Hoorn, S., Rodgers, A., Lopez, A. D., Mathers, C. D., Murray, C. J. and Group, C. R. A. C. 2003. Estimates of global and regional potential health gains from reducing multiple major risk factors. *The Lancet*, 362(9380), 271-280.
- Gwenzi, W. 2020. Leaving no stone unturned in light of the COVID-19 faecal-oral hypothesis? A water, sanitation and hygiene (WASH) perspective targeting low-income countries. *Science of The Total Environment*, 141751.
- Hanchett, S. and Akhter, K. R. 2015. Sanitation in Bangladesh: Past Learning and Future Opportunities. *Dhaka: UNICEF*.
- Islam, M., Ercumen, A., Ashraf, S., Rahman, M., Shoab, A. K., Luby, S. P. and Unicomb, L. 2018. Unsafe disposal of feces of children < 3 years among households with latrine access in rural Bangladesh: association with household characteristics, fly presence and child diarrhea. *PloS one*, 13(4), e0195218.
- Kuberan, A., Singh, A. K., Kasav, J. B., Prasad, S., Surapaneni, K. M., Upadhyay, V. and Joshi, A. 2015. Water and sanitation hygiene knowledge, attitude, and practices among household members living in rural setting of India. *Journal of natural science, biology, and medicine*, 6(Suppl 1), S69.
- Lorntz, B., Soares, A. M., Moore, S. R., Pinkerton, R., Gansneder, B., Bovbjerg, V. E., Guyatt, H., Lima, A. M. and Guerrant, R. L. 2006. Early childhood diarrhea predicts impaired school performance. *The Pediatric infectious disease journal*; 25(6): 513-520.
- Niehaus, M. D., Moore, S. R., Patrick, P. D., Derr, L. L., Lorntz, B., Lima, A. A. and Guerrant, R. L. 2002. Early childhood diarrhea is associated with diminished cognitive function 4 to 7 years later in children in a northeast Brazilian shantytown. *The American journal of tropical medicine and hygiene*, 66(5), 590-593.
- Organization, W. H. 2020a. *Water, sanitation, hygiene and waste management for COVID-19: technical brief, 03 March 2020*.
- Organization, W. H. 2020b. *Water, sanitation, hygiene, and waste management for the COVID-19 virus: interim guidance, 23 April 2020*.
- Petri, W. A., Miller, M., Binder, H. J., Levine, M. M., Dillingham, R. and Guerrant, R. L. 2008. Enteric infections, diarrhea, and their impact on function and development. *The Journal of clinical investigation*, 118(4), 1277-1290.
- Rahman, M. M., Bodrud-Doza, M., Shammi, M., Islam, A. R. M. T. and Khan, A. S. M. 2021. COVID-19 pandemic, dengue epidemic, and climate change vulnerability in Bangladesh: Scenario assessment for strategic management and policy implications. *Environmental research*, 192, 110303.
- Ranjan, R. and Ranjan, G. K. 2020. Knowledge regarding prevention of novel coronavirus (COVID-19): an electronic cross-sectional survey among selected rural community. *Int J Trend Sci Res Dev*, 4(3), 422-426.
- Shimi, A. C., Parvin, G. A., Biswas, C. and Shaw, R. 2010. Impact and adaptation to flood: A focus on water supply, sanitation and health problems of rural community in Bangladesh. *Disaster Prevention and Management: An International Journal*.
- Sridhar, M., Okareh, O. and Mustapha, M. 2020. Assessment of Knowledge, Attitudes, and Practices on Water, Sanitation, and Hygiene in Some Selected LGAs in Kaduna State, Northwestern Nigeria. *Journal of Environmental and Public Health*, 2020.
- Tashiro, A. and Shaw, R. 2020. COVID-19 pandemic response in Japan: What is behind the initial flattening of the curve? *Sustainability*, 12(13), 5250.
- Telmo, A. C. 2002. *A water supply and sanitation study of the village of Gouansolo in Mali, West Africa* Michigan Technological University.
- Ullah, P., Batool, Z. and Shabbir, M. 2020. Social Impediments of Personal Hygiene Practices Among Females in Rural Faisalabad, Punjab Pakistan. *Global Regional Review*, 2, 53-60.

- Vicerra, P. M. M. 2021. Knowledge-Behavior gap on COVID-19 among older people in rural Thailand. *Gerontology and Geriatric Medicine*, 7, 2333721421997207.
- Vivas, A., Gelaye, B., Aboset, N., Kumie, A., Berhane, Y. and Williams, M. A. 2010. Knowledge, attitudes, and practices (KAP) of hygiene among school children in Angolela, Ethiopia. *Journal of preventive medicine and hygiene*, 51(2), 73.
- Yue, S., Zhang, J., Cao, M. and Chen, B. 2021. Knowledge, attitudes and practices of COVID-19 among urban and rural residents in China: a cross-sectional study. *Journal of Community Health*, 46(2), 286-291.