BioOne COMPLETE

COVID-19 Pandemic and Water, Sanitation, and Hygiene: Impacts, Challenges, and Mitigation Strategies

Author: Desye, Belay

Source: Environmental Health Insights, 15(1)

Published By: SAGE Publishing

URL: https://doi.org/10.1177/11786302211029447

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Downloaded From: https://complete.bioone.org/journals/Environmental-Health-Insights on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

COVID-19 Pandemic and Water, Sanitation, and Hygiene: Impacts, Challenges, and Mitigation Strategies

Environmental Health Insights
Volume 15: 1–7
© The Author(s) 2021
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/11786302211029447

Belay Desye

Department of Public Health, College of Medicine and Health Sciences, Adigrat University, Adigrat, Ethiopia.

ABSTRACT

BACKGROUND: In order to protect public health during the outbreaks of infectious diseases including the pandemic COVID-19, provision of Water, Sanitation, and Hygiene (WASH) services is important. The challenges of inaccessible WASH services along with the pandemic COVID-19 in low-income countries can lead to a devastating problem.

METHOD: A systematic search of published articles was identified using PubMed, Web of Science, and Google Scholar, on relevant studies of COVID-19 and WASH services. Published articles were identified using abstracts and titles of the articles, followed by assessed for eligibility, and screening of the full text reports of relevant studies.

RESULTS: Electronic database search identified 798 articles from which 28 full text articles were included in the systematic review. A lack of access to WASH services in households, schools, health care facilities, and other public spaces were the main identified COVID-19 related public health risks. A lack of adequate data and financial shortages were the challenges for mitigating the problems of COVI-19 and WASH services.

CONCLUSION: This systematical review identified the impacts and challenges of COVID-19 in the provision of WASH services. The results implied that COVID-19 has significant impacts on WASH services that can affect the health of the public. Therefore, strengthening and ensuring access to WASH services are important for preventing COVID-19 and realizing human rights. Community engagement also can be used to support for prevention and control of COVID-19. Countries need to be expand their investment in WASH services as an important mechanism for mitigating COVID-19.

KEYWORDS: COVID-19, WASH, hygiene, sanitation, water, impacts, challenges, and strategies

RECEIVED: April 12, 2021. **ACCEPTED:** June 5, 2021.

TYPE: COVID-19 and Environmental Health - Review

FUNDING: The author received no financial support for the research, authorship, and/or publication of this article.

DECLARATION OF CONFLICTING INTERESTS: The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

CORRESPONDING AUTHOR: Belay Desye, Department of Public Health, College of Medicine and Health Sciences, Adigrat University, P. O. Box: 50, Adigrat, Ethiopia. Email: belaydesye.2001@gmail.com

Introduction

Coronavirus is an acute respiratory disease, which was emerged at the end of 2019. The World Health Organization's (WHO) declared the emerging Corona Virus Disease-2019 (COVID-19) as a public health emergency of global concern at the end of January 2020, and on 11th March declared it as a global pandemic. Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) is the main cause for COVID-19.[1] It has already been distributed in 223 countries and territories with greater than 134 million confirmed cases and over 2 million deaths globally have been reported at the beginning of April 2021.[2]

Current evidences suggests that COVID-19 is mainly transmitted through respiratory droplets passed either directly when close unprotected contact between an infected and a susceptible individual or indirectly through contaminated hands touching the mucosa of the eyes, mouth, or nose. The virus may also transfer from one surface to another via contaminated hands, which facilitates indirect transmission route as stated in Figure 1 below.[3–5] Due to this, WHO recommends good hygiene practice, keeping a physical distance, wearing masks, and avoiding crowds are considered to be public health measures for preventing infection with COVID-19 in community, schools, Health Care Facilities (HCF), and other public spaces.[6,7] To maintain good hygienic condition, it requires access to safe water, hand washing facility with soap, and hand washing knowledge and practice.[8,9]

Water, sanitation, and hygiene interventions and practices are crucial in the prevention of COVID-19.[10,11] Basic hygiene interventions such as Hand Washing with Water and Soap (HWWS) is the most simple and effective means of barrier for the transmission of infectious diseases.[10,12] For many low income countries, however weaknesses in the Water, Sanitation, and Hygiene (WASH) organization put millions of lives at higher risk to COVID-19.[13]

According to WHO, at the end of February 2021, at least 7 different vaccines have been rolled out in countries. Vulnerable populations like those with underlying medical conditions in all countries were the first priority for vaccination.[9] Due to limited supply of COVID-19 vaccine, vaccination only will not be sufficient to prevent community level transmission. Public health and social measures (ie, using face-masks and physical distance) should continue to be used. Before, during, and after vaccination, it is recommended to continue following standard precautions for Infection Prevention and Control (IPC).[14]

Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (https://creativecommons.org/licenses/by-nc/4.0/) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (https://us.sagepub.com/en-us/nam/open-access-at-sage).

Downloaded From: https://complete.bioone.org/journals/Environmental-Health-Insights on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

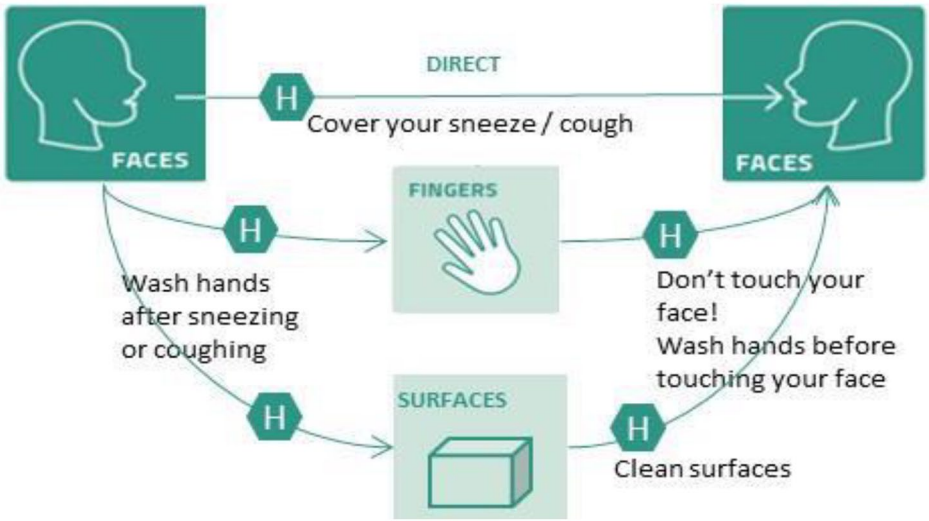


Figure 1. Mode transmission of COVID-19 related to WASH.[3]

The pandemic COVID-19 poses undeniable challenges to global public health in the 21st century. It has socioeconomic, public health, and political consequences, according to the WHO.[1] Therefore, the aim of this study is to compressively review COVID-19 pandemic and WASH services including its impacts, challenges, and mitigation strategies.

Method

Search approach and data extraction

This review was conducted following the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA).[15] A systematic search of articles was conducted using PubMed, Web of Science, and Google Scholar. Published articles were identified using abstracts and titles of the articles, followed by articles assessed for eligibility and screening of the full text reports of relevant studies as shown in Figure 2 below. The inclusion criteria for this review were published articles written in English language, studies conducted in COVID-19 and WASH, and accessed full-text report. The exclusion criteria were lack of relevant information, duplicated articles, and articles with no full text and abstracts.

The search strategy was used a combination of keywords and Boolean functions; "COVID-19" OR "WASH" OR "Hygiene" OR "Sanitation" OR "Water" OR "Impacts" OR "Challenges" AND "Strategies." Moreover, a direct Google search was also conducted. Finally, reference lists cited by each eligible article were assessed to identify additional articles. To manage the citation, an endnote X7 version citation manager software was used.

Method quality assessment

Two independent reviewers (BD and TT) independently extracted data using the criteria in the data extraction sheet. Inconsistent data between the 2 reviewers was managed by the involvement of a third reviewer and discussed together. After data extraction, the findings were grouped together into 3 main thematic areas, "COVID-19 and WASH," "impacts," and "Challenges." Finally, data was presented using texts. The quality of the study was assured using a predefined data extraction form. In addition, the review process was conducted according to the guidelines of PRISMA.

Results

Characteristics of the search process

The search strategy identified 798 articles as of 21 April 2021. After duplicated articles were removed, 155 articles were obtained. Following an assessment based on abstracts and titles, 67 articles were refined for further evaluation. After full-texts assessed for relevant data and information, 28 articles were assessed for eligibility. At the end, 28 articles were included in the systematic review (Figure 2).

COVID-19 and WASH

Adequate WASH services are critical in protecting against infectious diseases such as COVID-19.[16,17] Currently, many vulnerable populations are lacking access to WASH services.[18,19] The COVID-19 along with inadequate WASH services can lead to a devastating situation. Hand hygiene was the most simple and effective for COVID-19 prevention. However, in many low-income countries, WASH sectors were under funded and least prioritized.[17,19,20] In communities, schools, HCF, and other public spaces, the presence of adequate WASH services and facilities is rare.[19,21,22]

Impacts of COVID-19 on provision of WASH services

COVID-19 poses a significant impact on sustainability and continuity of WASH services.[21,23] The global pandemic COVID-19 causes socioeconomic and health service impacts.[1] Developing countries with humanitarian crises and vulnerable

Downloaded From: https://complete.bioone.org/journals/Environmental-Health-Insights on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

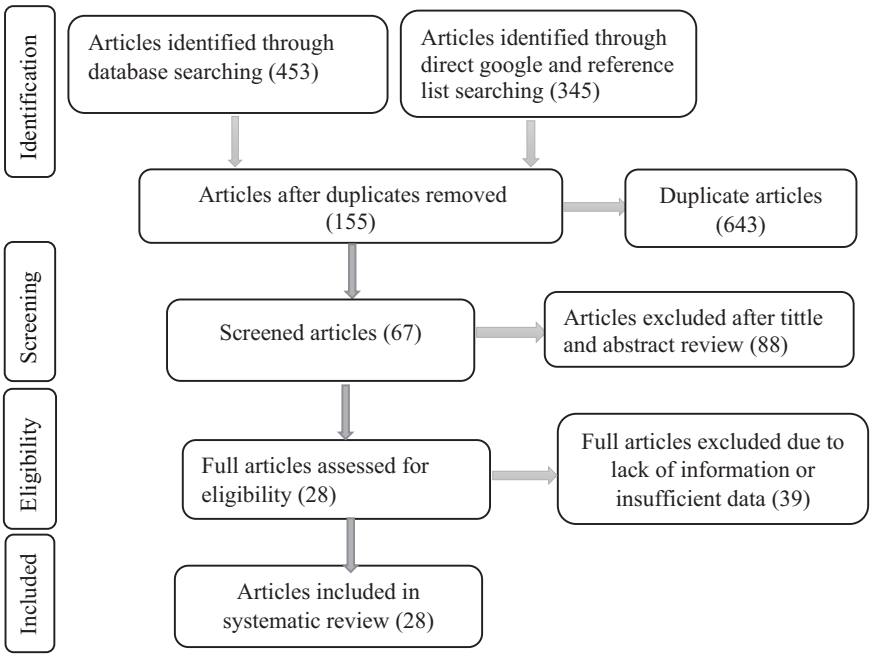


Figure 2. Schematically presentation of selection process of articles for systematic review.

populations are significantly affected by COVID-19. It poses also additional challenges to HCF due to waste management, because facilities produce more waste than usual.[21,22]

Challenges to provision of WASH services

In HCF, lack of Personal Protective Equipment (PPE) and inadequate WASH services can lead to a severe situation for COVID-19 transmission.[11,24,25] Lack of adequate data and financial shortage in communities and public facilities were a challenges to ensure and provide access to WASH services.[20,26,27]

Discussion

COVID-19 and WASH

In order to protect public health during the outbreaks of infectious diseases including the pandemic COVID-19, provision of safe water, improved sanitation, and good hygienic living and environmental conditions are essential.[16,17] However, access to WASH services is limited in low-income countries. Despite its significance to public health, socioeconomics, and being exposed to the risk of COVID-19, now a days a lot of the most vulnerable populations lack access to reliable WASH services.[18,19] This leads to a challenge of preventing and curbing transmission of potential pandemics of COVID-19 and future outbreaks. Frequent hand washing following hygienic standards requires a reliable supply of safe water, and sanitation systems that are well functional, including under challenging environmental conditions like climate change. The COVID-19 pandemic along with the inaccessibility to safe water, inadequate disposal of waste system, and poor treatment of wastewater in low-income counties can lead to severe situations. Awareness of maintaining good hand hygiene practice, risk management, and additional corrective actions needed to be implemented for individuals.[28] According to Kampf et al,[5] factors that can affect the survival duration of COVID-19 are temperature, type of surface, strain of the virus, and relative humidity.

Hand hygiene is a major element of the WASH framework program, that is, recommended by WHO as a protective measure to prevent COVID-19 transmission. However, in many low-income countries, WASH organizations are under funded and least prioritized despite its crucial for the control of infectious diseases and essential for economic growth.[17,20] In low-income countries, specifically in unplanned urban population and rural settlements, most populations face accessing WASH services.[19]

According to the joint report from WHO and UNICEF globally, 26% of HCF had no basic water services, 20% of HCF had no sanitation service, and 16.7% of HCF had no hygiene service in 2016.[16] WASH practices are crucial to preventive measures for slowing down the spread of the pandemic COVID-19. Currently there is no evidence reported on SARS-CoV-2 survival in potable drinking water and wastewater systems. Therefore, it is important to suggest that this is a good opportunity to think about COVID-19 to be present in these environmental components.[8]

In HCF and households, reliable water and sanitation services are vital for maintenance of hygiene conditions like hand washing, laundering, and environmental cleaning.[18,19] Frequent and effective hand sanitizer with alcohol is important to protect from COVID-19, however the toxicity may be leads to fatal; attributed by absorption through dermal contact and accidental ingestion.[29] WASH services are at a great risk of being disrupted by the pandemic, the response to it, and downstream effects. Great attention

Downloaded From: https://complete.bioone.org/journals/Environmental-Health-Insights on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

should be given to eating raw vegetables or fruits that might have been washed and contacted with untreated waste.[11] Ensuring services like drinking water and sanitation are continuously available is important to governance, economic growth, and preventing development backsliding.[30]

Basic WASH services such as good hygienic practice and regular HWWS are important public health interventions in response to infectious diseases. However, globally, 3 billion people lack access to water and soap at home level.[31] Therefore, governments and WASH practitioners should prioritize and enable the services of WASH for everyone in this time of the COVID-19 pandemic and give priority to those vulnerable populations and health care workers. To understand how these actions can be improved, it is crucial to know what countries have already put in place regarding hygiene policies and plans, finance, and targets.[23]

During the outbreak of Ebola in 2013 to 2016, inadequate management of waste was one of the attributing factors to the transmission of the disease and as a main factor for the deaths of thousands.[32,33] This indicated that the provision of WASH services is vital to preventing and controlling the present pandemic COVID-19. WHO recommended that functional hand washing facilities with water and soap should be present within 5 m of the toilets.[34] In a slum dwelling environment, obtaining a hand washing facility is difficult. It is estimated that around 67% of households in a slum dwelling environment share a water source. Hence, people living in a slum environment face difficult issues with obtaining adequate water and hand washing materials. The majority of people who live in slums have a poor economy and are engaged in daily work activities. As a result, they are not restricted from moving during the COVID-19 pandemic. Moreover, they have no basic knowledge and information about how to maintain good hygienic practice.[34]

Impacts of COVID-19 on WASH services

COVID-19 could pose a significant impact on sustainability and continuity of WASH services if not well taken mitigation measures. Fair distribution of WASH services and commodities for everyone is important to prevent and control the pandemic COVID-19. WASH services along with other protective measures like physical distance and self-isolation play an essential contribution in controlling the global pandemic COVID-19.[35] The global pandemic COVID-19 may cause an immediate socio-economic impact that could decrease the contribution of WASH services and commodities to controlling the disease. Low-income countries with humanitarian crises and vulnerable populations are significantly affected by COVID-19. It is critical for WASH organizations and the sector to be resilient and sustainable in the face of socioeconomic crises.[23]

In developing countries, it is estimated that 0.13% to 1% of the gross regional product (GRP) is needed to achieve SDG 6 targets of universal access to WASH service by 2020.[36] This will be significantly affected by COVID-19, which needs an urgent and additional budget. As a result, external development assistance would be required to assist WASH organizations during this critical period. Fair allocation of resources in the WASH organizations could include responding to the pandemic COVID-19.[37]

The present pandemic of COVID-19 causes an additional challenge to the quality and safety of laboratory diagnosis testing,[38] and in HCF due to the generation of more waste than usual.[20] In this pandemic time, HCF produces wastes like gloves, masks, and other PPE that could be infected with the virus.[22,39,40] As a result, a lack of appropriate waste management can infect patients, health care workers, and the general public with COVID-19, which can survive on surfaces in the HCF and inanimate objects.[28,41,42] WHO recommended that waste produced during the care of COVID-19 patients should be appropriately collected, treated, and disposed of.[11,22]

Insufficient access to WASH services and substantial interruption of WASH utilities will have a great influence on the service continuity and sustainability of the WASH organizations. This problem is devastating in countries with humanitarian crises and vulnerable populations. WASH equipment and material restrictions on entry and movement along with an increase in prices may influence individuals to maintain their hygienic condition and to control the pandemic. To solve the severity of the impact of COVID-19, urgent technical, financial, and material inputs are needed for the continuity of WASH services.[43]

Challenges to the provision of WASH services

COVID-19 patients in HCF have encountered difficulties in adhering to the recommended waste management procedures, which facilitates the possibility of COVID-19 transmission.[24,25] A major issue in proper management of PPE used to frontline health care workers at HCF handling and caring of COVID-19 patients. Health care workers are at high risk from the transmission of COVID-19 from patients. Waste generated from confirmed COVID-19 patients must be handled with caution and treated as a biohazard.[11,44] Furthermore, it needed separated latrines that should be disinfected and cleaned at least 2 times by a well trained cleaner using appropriate PPE.[25]

According to Ashinyo et al,[21] strong WASH service infrastructure in the treatment center of COVID-19 is important to effectively management of COVID-19 cases. There are gaps in the management of the treatment center on WASH. This brings challenges in implementing WASH services in COVID-19 treatment center. This is significantly important for protecting from the pandemic COVID-19, improving health service delivery, maintaining the safety of health care workers and patients. Such intervention is vital for the safety of service delivery and for building a resilient WASH service for improved quality.

Lack of access to basic sanitation services and infrastructures significantly affects the health of the community.[43,45] Across the world, 62% of fecal sludge and sewerage is not

Downloaded From: https://complete.bioone.org/journals/Environmental-Health-Insights on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Table 1. Framework of WASH programs for response of COVID-19.[51]

WASH PROGRAMS	TARGETS	RESPONSIBLE
Hand washing and hygiene promotion	Intensify awareness raising campaigns for HWWS and efficient water use at the household level	Household and institutions
WASH and IPC	Strengthen IPC at households and institutions	
Continuity and affordability of essential WASH services and products	Preserve the ability of all people, including the most vulnerable to meet their basic WASH needs	
	Guarantee the continuity, affordability, and safety of water and sanitation services	Utility
	Contribute financial and technical support to WASH sectors	

Table 2. COVID-19 and WASH services and response elements.[53]

WASH COMPONENTS	WASH RESPONSE ELEMENTS
WASH infrastructure and services	Capacity to maintain functionality of infrastructure and service deliver
WASH equipment's and consumables	Hand washing facilities, soap, disinfectant, cleaning materials, and hygiene kits materials
Messages of content and means	Customary support messages, logical messages, and short and long term campaign concepts
Outreach channels and modalities	Promote large scale campaigns, area and target group specific approaches, and individual communication

properly managed.[45] Moreover, inadequate access to toilet facilities in the living environment indicates that individuals are not self-sufficient to isolate themselves during the pandemic COVID-19.[27]

Absence of adequate data can cause problems for WASH service management, specifically in the areas of water scarcity, climate change, urbanization, and population growth. Ensuring access to drinking water will require well organized data and evidence for managed urban development, good governance, and improved WASH sectors.[26] To monitor the trend and to control service providers, donors, and governments need adequate data. However, many countries have a shortage of financial, institutional, and human power to analyze data to support and help governance.[46] Inappropriate settlements cause difficult situations to obtain adequate data about how many people use the services.[27]

Finance resources are a main challenge for extending access to WASH services and meet the SDG 6 targets, with estimates range from $28.4 billion to $114 billion needed annually between 2015 and 2030.[36] Financial resources are critical for capacity building, policies, and plans in order to sustainably extend and ensure access to WASH services. Many donors moved rapidly to disburse a great deal of funding. For example, the World Bank was provided more than $12 billion. In some phenomena, huge financing gaps happen in what is required to address targets of WASH and the funding present at hand. Interruption of the water system might be associated with lack of financial investment, political commitment, lack of energy, and WASH equipment. Well organized WASH service organizers and a sustained political environment are required to secure access to safe drinking water.[27,47]

Mitigation measures and strategies

Consistently used of HWWS and drinking potable water reduces the risk of infectious diseases.[48] This is also recommended by WHO to prevent and control the current pandemic COVID-19. Hand washing with soaps was 90% effective in reducing SARS transmission in many countries.[49] In low income countries, appropriately used and implementing of WASH services may bring many advantages. For instance in reducing the risks of water borne diseases like typhoid and cholera, and in increasing life expectancy and quality.[50] Response to the COVID-19 pandemic, according to UNICEF's WASH program, recommended intensifying awareness raising and training of communities and health care workers about HWWS, IPC, and PPE, as shown in Table 1 below.[51] According to Gilmore et al,[52] community participation and involvement strategies can be used to support for prevention and control of COVID-19. Inclusionary COVID-19 responses promote equitable access to WASH, which is critical for addressing inequalities and realizing human rights.[36]

Adequate amount of safe water should be present in HCF, especially at points of care (screening rooms, examination rooms, injection rooms, wards, treatment rooms, delivery rooms, and postnatal care rooms). Implementing of the IPC measure at household and HCF level is crucial for prevention of the transmission of COVID-19. Recommended cleaning and disinfection procedures in HCF should be followed consistently and appropriately. Surfaces and laundry in HCF should be routinely cleaned (at least once a day and when a patient is discharged). Providing reliable drinking water stations with pedal operated

Downloaded From: https://complete.bioone.org/journals/Environmental-Health-Insights on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

taps and devices to limit hand contact and reduce the risk of infection is also important.[3,35]

Uninterrupted supply chains and equitable access to all WASH services and commodities are essential to assure the exchange of products and goods, as shown in Table 2. This includes materials and supplies for the continuity of WASH services for households and HCF settings, and protection of service providers and assets without any restriction to the movement.[35]

Overall, ensuring WASH services for all will help to control pandemic transmission and to reduce other infectious diseases and mitigate other damage. Therefore, investing in public health facilities including WASH services can help as a protective measure to control the transmission of the COVID-19 virus, secure global health and strengthen the health system.[51]

Conclusion and Recommendations

This systematical review identified the impacts and challenges of COVID-19 in the provision of WASH services. The results implied that COVID-19 has significant impacts on the health of the public. The pandemic poses a significant impacts on sustainability and continuity of WASH services if not taken appropriate mitigation measures. Inclusive WASH services are critical for protecting and preventing public health from COVID-19. Ensuring universal access to WASH services for all is essential to tackling inequalities and realizing human rights. It needs to create a WASH user friendly environment that decreases opportunities for recontamination and facilitates good hygiene practice. Ensuring IPC measures are implemented and adhered to all HCF to reduce the pandemic COVID-19 and sustain WASH programs participation by active multi-sector coordination is needed. Community engagement also can be used to support for prevention and control of COVID-19. Therefore, countries need to expand their investment in WASH services as an important mechanism in mitigating the COVID-19 pandemic.

> *"We must work to prevent the spread of disease. Improved water, sanitation and hygiene in community, schools and health care facilities is critical to this effort"*

Author Contribution

BD designed the study concept, identifying relevant articles for the study, and writing report and manuscript.

Data Availability

All relevant data are included in the paper.

ORCID iD

Belay Desye https://orcid.org/0000-0001-5265-0994

REFERENCES

1. World Health Organization (WHO). Coronavirus disease 2019 (COVID-19): situation report. 2020:72. https://apps.who.int/iris/handle/10665/331685
2. World Health Organization (WHO). Coronavirus disease 2019 (COVID-19): situation report. 2021. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports
3. Global WASH cluster - COVID 19 response - guidance Note #02. 2020. Update April 15, 2020. https://reliefweb.int/sites/reliefweb.int/files/resources/77615.pdf
4. Ghinai I, McPherson TD, Hunter JC, et al. First known person-to-person transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in the USA. *Lancet*. 2020;395:1137-1144.
5. Kampf G, Todt D, Pfaender S, Steinmann E. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *J Hosp Infect*. 2020;104:246-251.
6. Otter JA, Donskey C, Yezli S, et al. Transmission of SARS and MERS coronaviruses and influenza virus in healthcare settings: the possible role of dry surface contamination. *J Hosp Infect*. 2016;92:235-250.
7. Abuzerr S, Nasseri S, Yunesian M, et al. Household drinking water safety among the population of Gaza Strip, Palestine: knowledge, attitudes, practices, and satisfaction. *J Water Sanit Hyg Dev*. 2019;9:500-512.
8. World Health Organization (WHO). Water, sanitation, hygiene, and waste management for SARS-CoV-2, the virus that causes COVID-19: interim guidance. 2020. Accessed July 29, 2020. https://apps.who.int/iris/handle/10665/333560
9. World Health Organization (WHO). Recommendation to member states to improve hand hygiene practices widely to help prevent the transmission of the COVID-19 virus. 2020:1-3. https://www.who.int/publications/i/item/recommendations-to-member-states-to-improve-hand-hygiene-practices-to-help-prevent-the-transmission-of-the-covid-19-virus
10. Mushi V, Shao M. Tailoring of the ongoing water, sanitation and hygiene interventions for prevention and control of COVID-19. *Trop Med Health*. 2020;48:47.
11. WHO. Water, sanitation, hygiene, and waste management for the COVID-19 virus: interim guidance. 2020. Accessed April 23, 2020. https://apps.who.int/iris/handle/10665/331846
12. Moncion K, Young K, Tunis M, et al. Effectiveness of hand hygiene practices in preventing influenza virus infection in the community setting: a systematic review. *Can Commun Dis Rep*. 2019;45:12-20.
13. Blake M, Glaeser AH, Kriticos S, Mutizwa-Mangiza N. *Water, Sanitation, and Hygiene Policy in the Time of COVID-19*. International Growth Centre Policy Brief; 2020.
14. Water Aid. How can we ensure everyone can wash their hands with soap and water, to protect lives from COVID-19? 2020. Accessed May 6, 2020. https://washmatters.wateraid.org/blog/how-to-ensure-everyone-can-washhands-to-protect-lives-from-covid19
15. Moher D, Shamseer L, Clarke M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev*. 2015;4:1.
16. Wang C, Horby PW, Hayden FG, Gao GF. A novel coronavirus outbreak of global health concern. *Lancet*. 2020;395:470-473.
17. Boisson S, Engels D, Gordon BA, et al. Water, sanitation and hygiene for accelerating and sustaining progress on neglected tropical diseases: a new global strategy 2015–20. *Int Health*. 2016;8:i19–i21.
18. World Health Organization (WHO) & United Nations Children's Fund (UNICEF). *WASH in Health Care Facilities: Global Baseline Report 2019*. World Health Organization and the United Nations Children's Fund (UNICEF); 2019. https://www.who.int/water_sanitation_health/publications/wash-in-health-care-facilities-global-report/en/
19. World Health Organization (WHO) & United Nations Children's Fund (UNICEF). *Progress on Household Drinking Water, Sanitation and Hygiene 2000-2017. Special Focus on Inequalities*. World Health Organization (WHO) & United Nations Children's Fund (UNICEF); 2019.
20. Roche R, Bain R, Cumming O. A long way to go estimates of combined water, sanitation and hygiene coverage for 25 sub-Saharan African countries. *PLoS One* 2017;12:e0171783.
21. Ashinyo ME, Amegah K, Dubik S, et al. Evaluation of water, sanitation and hygiene status of COVID-19 healthcare facilities in Ghana using the WASH FIT approach. *J Water Sanit Hyg Dev*. 2021;11:398-404.
22. Mekonnen B, Solomon N, Wondimu W. Healthcare waste status and handling practices during COVID-19 pandemic in Tepi General Hospital, Ethiopia. *J Environ Public Health*. 2021;2021: 6614565.
23. United Nations Children's Fund (UNICEF). COVID-19 and WASH: mitigating the socio-economic impacts on the water, sanitation and hygiene (WASH) sector. 2020. https://www.susana.org/en/knowledge-hub/resources-and-publications/library/details/3874
24. Nzediegwu C, Chang SX. Improper solid waste management increases potential for COVID-19 spread in developing countries. *Resour Conserv Recycl*. 2020;161:104947.
25. Rhee SW. Management of used personal protective equipment and wastes related to COVID-19 in South Korea. *Waste Manage Res*. 2020;38:820-824.

Downloaded From: https://complete.bioone.org/journals/Environmental-Health-Insights on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

26. Mitlin D, Beard VA, Satterthwaite D, Du J. *Unaffordable and Undrinkable: Rethinking Urban Water Access in the Global South*. World Resources Institute; 2019.
27. Social Science in Humanitarian Action (SSHAP). Key considerations: COVID-19 in informal urban settlements. March 2020. https://opendocs.ids.ac.uk/opendocs/bitstream/handle/20.500.12413/15185/SSHAP_COVID19_Key_Considerations_Informal_Settlements_final.pdf?sequence=3&isAllowed=y
28. Pandey D, Verma S, Verma P, et al. SARS-CoV-2 in wastewater: challenges for developing countries. *Int J Hyg Environ Health*. 2020;231:113634.
29. Mahmood A, Eqan M, Pervez S, et al. COVID-19 and frequent use of hand sanitizers; human health and environmental hazards by exposure pathways. *Sci Total Environ*. 2020;742:140561.
30. Wolf J, Johnston R, Hunter P, et al. A faecal contamination Index for interpreting heterogeneous diarrhea impacts of water, sanitation and hygiene interventions and overall, regional and country estimates of community sanitation coverage with a focus on low-and middle-income countries. *Int J Hyg Environ Health*. 2019;222:270-282.
31. World Health Organization (WHO) & United Nations Children's Fund (UNICEF). Joint monitoring programme (JMP) for water supply, sanitation and hygiene and UN water [Internet]. Accessed April 22, 2021. https://www.unwater.org/publication_categories/whounicef-joint-monitoring-programme-for-water-supply-sanitation-hygiene-jmp/
32. ACAPS. WASH in Guinea, Liberia, and Sierra Leone: The impact of Ebola. *Thematic note* 19 May 2015. https://www.acaps.org/sites/acaps/files/products/files/l_wash_in_guinea_liberia_and_sierra_leonemay_2015.pdf
33. Kalra S, Kelkar D, Galwankar SC, et al. The emergence of Ebola as a global health security threat: from 'lessons learned' to coordinated multilateral containment efforts. *J Glob Infect Dis*. 2014;6:164-177.
34. World Health Organization (WHO). *Considerations for Quarantine of Contacts of COVID-19 Cases. Interim Guidance*. World Health Organization; 2020.
35. World Health Organization (WHO). WASH COVID-19 response guidance. May 2020. https://www.humanitarianresponse.info/en/operations/occupied-palestinian-territory/document/wash-covid-19-response-guidance-may-2020
36. Hutton G, Varughese M. *The Costs of Meeting the 2030 Sustainable Development Goal Targets on Drinking Water Sanitation and Hygiene*. World Bank; 2016.
37. Donde OO, Atoni E, Muia AW, Yillia PT. COVID-19 pandemic: water, sanitation and hygiene (WASH) as a critical control measure remains a major challenge in low-income countries. *Water Res*. 2020;191:116793.
38. Lv J, Yang J, Xue J, et al. Detection of SARS-CoV-2 RNA residue on object surfaces in nucleic acid testing laboratory using droplet digital PCR. *Sci. Total Environ*. 2020;742:40370.
39. Vanapalli KR, Sharma H, Samal B, et al. Challenges and strategies for effective plastic waste management during and post COVID-19 pandemic. *Sci Total Environ*. 2021;750:141514.
40. Rupani PF, Nilashi M, Abumalloh R, et al. Coronavirus pandemic (COVID-19) and its natural environmental impacts. *Int J Environ Sci Technol*. Published online September 1, 2020. doi:10.1007/s13762-020-02910-x
41. Wang Y, Qiao F, Zhou F, Yuan Y. Surface distribution of severe acute respiratory syndrome coronavirus 2 in Leishenshan Hospital in China. *Indoor Built Environ*. Published online March 17, 2020. doi:10.1177//1420326X20942938.
42. Kumar H, Azad A, Gupta A, et al. COVID-19 Creating another problem? Sustainable solution for PPE disposal through LCA approach. *Environ Dev Sust*. 2020;23:1-15.
43. Rodriguez DJ, Serrano HA, Delgado A, Nolasco D, Saltiel G. *From Waste to Resource*. World Bank; 2020. https://openknowledge.worldbank.org/handle/10986/33436
44. Manigandan S, Wu M, Ponnusamy V, et al. A systematic review on recent trends in transmission, diagnosis, prevention and imaging features of COVID-19. *Process Biochem*. 2020;98:233-240.
45. Satterthwaite D, Beard VA, Mitlin D, Du J. Untreated and unsafe: solving the urban sanitation crisis in the global south. 2019. https://wriorg.s3.amazonaws.com/s3fs-public/untreated-and-unsafe.pdf
46. Rachel C. *Nature-Based Solutions and Water Security*. University of Birmingham. Accessed June 11, 2020. https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/1541
47. Rabie T, Curtis V. Hand washing and risk of respiratory infections: a quantitative systematic review. *Trop Med Int Health*. 2006;11:258-267.
48. World Bank. WASH (water, sanitation & hygiene) and COVID-19. *WASH interventions for effective COVID19 pandemic response*. 2020;101:1. Accessed April 11,2020.https://www.worldbank.org/en/topic/water/brief/wash-water-sanitation-hygiene-and-covid-19
49. Fung ICH, Cairncross S. Effectiveness of handwashing in preventing SARS: a review. *Trop Med Int Health*. 2006;11:1749-1758.
50. Curtis V, Cairncross S. Effect of washing hands with soap on diarrhoea risk in the community: a systematic review. *Lancet Infect Dis*. 2003;3:275-281.
51. United Nations Children's Fund (UNICEF). *WASH Programme Contribution to COVID-19 Prevention and Response*. UNICEF; 2020.
52. Gilmore B, Ndejjo R, Tchetchia A, et al. Community engagement for COVID-19 prevention and control: a rapid evidence synthesis. *BMJ Glob Health*. 2020;5:e003188.
53. GPW and SHA WASH. SDC working aid Covid-19 response for the water sanitation and hygiene (WASH) sector version 1. Accessed April 3, 2020. https://www.shareweb.ch/site/Water/resources/Documents/Covid-19%20WASH%20Working%20Aid_version%203%20April%202020%20%28003%29.pdf

Downloaded From: https://complete.bioone.org/journals/Environmental-Health-Insights on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use