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Megan R. Bias Date

An Introduction to Water, Sanitation, and Hygiene:
A Distance Learning Course

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An abstract of
A thesis submitted to the Faculty of the
Hubert Department of Global Health
Rollins School of Public Health of Emory University
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Abstract

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In recent years, public health workforce capacity training has become a focal point of institutions around the world. In order to create a more efficient and adaptable workforce, topic specific trainings outside of the learner's core expertise have been developed and delivered through online distance learning methods. While there are a few WASH related distance learning courses, there are not any courses that provide a comprehensive introduction to WASH topics.

The purpose of this special studies project is to develop an 'Introduction to WASH' distance learning course for deployment through the Africa CDC Institute for Workforce Development. This thesis describes the theoretical background that supports the development of online educational courses for adults, provides five module outlines for instructional use, and discusses the implications of the course at Africa CDC.

The course was designed as five module outlines covering water, sanitation, hygiene and the links between WASH topics. With adult learners as the target audience, various adult learning theories were reviewed and applied to the module design. In addition to WASH content, each module outline consists of specific learning objectives, key readings and discussion questions as well as additional resources for further study. The *water* module focuses on global water challenges, water infrastructure, water storage and water treatment options. The *sanitation* module covers global sanitation challenges, sanitation infrastructure, behavior changes related to sanitation, and wastewater surveillance of diseases. The *water and sanitation* module emphasizes the role of water scarcity in sanitation interventions as well as key diseases related to water and sanitation and disease prevention methods. The *hygiene* module introduces global hygiene challenges, hand hygiene infrastructure, and behavior changes related to hand hygiene. Lastly, the *sanitation and hygiene* module focuses on ways to break the fecal-oral transmission cycle and ways to identify and address menstrual hygiene management needs.

Together, these modules provide introductory knowledge on key aspects of WASH. This distance learning course will provide public health workers throughout Africa a way to increase crosscutting competencies and, therefore, increase public health workforce capacity.

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I would next like to thank my family, especially my husband and parents, and friends for the endless support and encouragement.

Finally, I want to thank the entire class of 2021 at Rollins School of Public Health. I am grateful for the opportunity to attend Rollins School of Public Health and for all of my amazing colleagues and mentors.

Table of Contents

I. Introduction

Increasing the training opportunities for public health professionals is necessary in order to create a skilled and adaptable workforce that is prepared for future public health needs (McKeever & Evans, 2017). Limitations in the availability, quantity, and accessibility of public health workers critically impacts community health outcomes because a limited workforce often means that only emergencies can be prioritized (Kwesigabo et al., 2012). These limitations can be addressed by increasing capacity of the public health workforce and expanding skill sets on a variety of public health topics and focus on disease prevention strategies (Brownson, Fielding, & Green, 2018). Online educational classes on public health topics provide a way for public health workers to build topic specific knowledge while also collaborating with other public health workers in their region.

Public Health Capacity Training

There are many types of public health workers such as physicians, nurses and community health workers. However, despite the variety of professionals, there is a significant shortage of workers. For example, in Tanzania, rapid population growth has not been matched by an increase in public health workers. The capacity of the public health system has been overwhelmed by insufficient numbers of public health workers, increased population and lack of preparedness for emerging and chronic diseases. (Ameme et al., 2016; Kwesigabo et al., 2012).

Optimizing the role of public health workers provides an opportunity to increase access to and availability of public health services to both urban and rural community members in many areas of the world. Availability and competency of public health workers is directly linked to effective health system functioning (Ameme et al., 2016). One way to increase the competency of public health workers is through increased training on specific topics including disease

prevention strategies. While finding a way to implement this continued training across multiple countries has been difficult, online learning courses provides a way to address the need of accessible and affordable training. (WHO, 2020b)

Intersection of Public Health Capacity Training and WASH

The intersection of public health workforce capacity building and digital learning has allowed for public health distance learning courses to increase specific skill sets across multiple communities (McKeever & Evans, 2017; Miner, Allan, & McKenzie, 2014; WHO, 2020b; World Health, 2020).(World Health, 2020b). One topic for which a public health professional educational course would be beneficial is Water, Sanitation, and Hygiene (WASH). According to CDC's Global WASH Fast Facts (2016), there are seven hundred and eighty million people worldwide that lack access to potable water sources (CDC, 2020b). A staggering two and a half billion people, more than thirty percent of the world's population, do not have access to improved sanitation. Regions impacted the most by lack of potable water and sanitation include sub-Saharan Africa with 30%of the population included in the above statistics (CDC, 2018b, 2020b). An increase in educational capacity related to WASH is key in developing a prepared and adaptable public health workforce. A WASH course that targets public health professionals would also provide the knowledge necessary to implement disease prevention strategies in communities. (Alexander, Canclini, Fripp, & Fripp, 2017; WHO, 2020b; World Health, 2020)

Currently, there are few WASH educational courses that provide an introduction to all WASH topics. The United Nations Children's Fund (UNICEF), the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and International Institute for Infrastructural Hydraulic and Environmental Engineering at Delft University (IHE Delft) all have developed different kinds of WASH trainings (CDC, 2020g; IHE, 2016). While these

trainings generally have a target population of community health workers, they do not all provide the opportunity to interact with other members of the class via distance learning classes. A distance learning "Introduction to WASH" course for community health workers is needed in order to improve public health capacity in relation to water, sanitation, and hygiene. (CDC, 2020g; IHE, 2016; UNICEF, 2012)

Africa CDC Institute for Workforce Development

The Africa CDC IWD aims to address the previously described shortcomings by strengthening the public health workforce capacity across African Union member states. The main goal of the Institute is to reduce global burden of disease, specifically infectious disease, by preventing, detecting, and responding to public health threats. The Institute of Workforce Development was established in partnership with the Rollins School of Public Health at Emory University in order to provide online trainings that are tailored to the needs of the region. (Burchard & Institute for Defense, 2020; A. CDC, 2020)

Online courses held so far at Africa CDC IWD include Transforming Public Health Surveillance, Introduction to Antimicrobial Resistance, Proposal Development for Public Health Research and Programs, and Leadership and Management. Two COVID-19 educational courses have also been launched in order to develop a clinical community of practice and increase risk communication knowledge. The courses that have been deployed at Africa CDC IWD, to this point, have had a broad health systems intervention approach. Each course has provided tailored trainings on a specific topic and have targeted public health workers within Africa CDC. Previous courses were held online for a varying amount of time based on course learning objectives. Africa CDC IWD is consistently expanding the number of courses that are offered. (A. CDC, 2020; Kumar et al., 2020)

From May 2020 until August of 2020, this writer worked with Africa Centres for Disease Control and Prevention (Africa CDC) Institute for Workforce Development (IWD) on courses targeted at public health capacity building. Objectives of the Applied Practicum Experience included identification of any knowledge gaps related to WASH in courses offered at Africa CDC IWD and the development of a course outline for a new WASH course. The writer was able to collaborate with others working at Africa CDC IWD in order to understand methods used for both course development and course deployment. Africa CDC IWD expressed a specific need for a WASH related course with a target audience of public health workers.

Purpose Statement

The purpose of this special studies thesis project is to develop an "Introduction to WASH" distance learning course for deployment through Africa CDC IWD. The development of this course will allow public health workers across Africa to learn about and collaborate on WASH topics that impact their own communities. This thesis project will describe the theoretical background that supports the development of the online educational course for the adult public health workers. It will detail the process for developing the online learning modules that includes an in-depth five module course outline as the final deliverable to Africa CDC IWD. The special studies project concludes with a discussion of the design and implementation of the course as well as implications for Africa CDC.

II. Literature Review

Even before the impact of the COVID-19 pandemic on online education, there was an increasing shift towards distance learning not only for school aged children, but also for adults. For example, in the United States, as of 2019, over three million people had taken at least one online course (Francis, Wormington, & Hulleman, 2019). This number has increased since the start of the pandemic as many institutions have shifted to only an online delivery method. Interest in and preference of online education formats has also increased. Specifically, adults have been shown to prefer online education options as they have the opportunity to complete the work at their own pace and interact with colleagues from other agencies (Archer, Berry, Bajwa, Kalda, & Di Ruggiero, 2020; Muflih et al., 2020).

History of Andragogy

The history and theory of adult learning is crucial to understanding the necessary aspects of developing an educational course for adults. In developing courses for adults, it is important to consider adult life experiences and the many aspects of learning that impact achievement and satisfaction in the course. While there is ample research supporting learning theory and teaching practices for children (also known as pedagogy), the research supporting adult education learning practices is limited. Andragogy, the science of adult learning aims to provide key assumptions of adult learning as well as provide a framework for adult education as a whole.

Andragogy arose from the desire of many educationists to have more active learning experiences. J. Dewey was an American psychologist, philosopher and educationists that focused on the concept of learner involved experiences within education and his research assisted with the development of the main assumptions of andragogy (Zmeyov, 1998). The theory of andragogy and the andragogical model of learning was further developed by Malcolm Knowles.

Knowles has continued to be a leader in the field of andragogy and has sparked many debates on the theory of adult learning.

It has been argued that andragogy and pedagogy do not differ in significant ways other than the aim at either adults or children, but that instead there are distinct differences in the way that information is passed on to learners. Pedagogy focuses more on set standards of information that needs to be presented to students and selects the most efficient way to present only that information. However, andragogy has a broader focus on the experience of the learner and gaining knowledge through interaction with others and application to the learner's own experiences (Holmes & Abington-Cooper, 2000). (Holmes & Abington-Cooper, 2000; Zmeyov, 1998)

Andragogical Theory of Learning

The andragogical theory has four main assumptions including changes in self- concept, the role of experience, readiness to learn, and orientation to learning (Knowles, 1972). The first pillar, changes in self-concept, assumes that as a person progresses through their educational career, they mature and become more independent. They become less dependent on instructors and more self-guided in their education. This assumption in particular takes place over many years as the learner develops and eventually fits into the "adult education" category. For adult learners, it is important that they feel that they are able to guide the course in the direction that best suites them and will provide them with the most achievement in the course. (Ellis & Bernhardt, 1989; Holmes & Abington-Cooper, 2000; Knowles, 1972; Uszler, 1990; Zmeyov, 1998)

The second assumption states that adult learners gain critical experience over time that causes them to be able to relate to the material in the course on a deeper level. In adult learning

courses, it is important to recognize the experience of the learners as it often defines how they learn and what they may already know about the topic. As experience level increases, the learners tend to prefer “action-learning techniques” (Knowles, 1972) that include discussions, simulations, and team projects. These learning techniques allow the learners to interact and build off of the differing experience levels in the course. (Holmes & Abington-Cooper, 2000; Knowles, 1972; Zmeyov, 1998)

The third assumption is that adult learners are more ready to learn topics that they need for professional development rather than things they feel that they should know in general. Educational courses for adults should take place in a time where the learners feel that they need to obtain that particular knowledge skill set in order to continue to develop as a working professional. (Holmes & Abington-Cooper, 2000; Knowles, 1972; Zmeyov, 1998)

The fourth assumption, orientation to learning, focuses on the fact that adult education is more goal oriented rather than subject oriented. The knowledge that adult learners gain in education courses is immediately applied to their work, therefore it is important to focus on content that focuses on specific issues within the field. (Holmes & Abington-Cooper, 2000; Knowles, 1972; Zmeyov, 1998)

As adult education is becoming increasingly more popular, it is important to take into account the andragogy learning theory and apply it to current learning methods. Online learning has been growing in popularity. While adult online learning classes can follow a similar format to in person classes, learning theories specific to online education should be considered as well. (Knowles, 1972; Uszler, 1990)

Moore's Interaction Framework

The learning theory proposed by Moore in 1989 includes varying types of interactions that occur in learning settings and is being used frequently in research related to online learning structures. Moore's learning theory consists of learner to learner interaction, learner-content interaction, and learner-instruction interaction. These types of interactions are key indicators for success and achievement in the course. They are critical in tailoring the course to adult learners and ensuring overall success in the course. (Ehrlich, 2002; Moore, 1989)

Learner to learner interaction is defined as the interaction between students in the course. In online courses, this is something that is more difficult to achieve. Learner to learner interaction allows students to collaborate in a way that supports sharing experiences and exchanging thoughts and ideas. In online learning, student to student interaction can occur either synchronously or asynchronously. Discussion boards are a frequent application of asynchronous learning to learner content. Adult learners have unique opportunities to collaborate on professional concerns and projects. (Ehrlich, 2002; Kuo & Belland, 2016)

Learner to learner interaction has been shown to have a positive correlation with achievement level in the course. While it is a predictor of achievement, it is negligible to course satisfaction (Kurucay & Inan, 2017). This is particularly interesting because course satisfaction is frequently linked with course achievement. In order for learner to learner interaction to be valuable to the course, it is important that clear expectations are set. In fact, most students actually prefer to work independently on problem-based activities during class. Without clear group expectations, unnecessary stress can be added to the class. (Kurucay & Inan, 2017; Sher, 2009)

While learner to learner interaction is not correlated with student satisfaction, interaction with the course content is a key predictor. This type of interaction is called learner to content interaction. Learner to content interaction allows students to engage with course content in a way that fosters critical thinking in order to apply the subject matter to personal life experiences (Bernard et al., 2009). In an online learning setting, this type of interaction can include projects, assignments, watching recorded lectures, and reading related literature. Out of the three types of interaction, learner to content interaction is most strongly correlated to satisfaction. This is likely due to the opportunity for the student to immerse themselves in the material in many different ways. (Bernard et al., 2009; Kuo & Belland, 2016)

The last type of interaction in Moore's model is learner to instructor interaction. This type of interaction occurs when students have contact with the instructor. For online learning, this can include emails, video chatting, response to discussion boards (Bernard, 2009). According to a study done in 2016 on interactions during distance learning, positive learner to instructor interaction is significantly related to perceived learning in the course as well as course satisfaction (Kuo & Belland, 2016). Effective learner to instructor interaction is necessary in order to establish learner and instructor expectations. In general, students feel more connected to the instructor during in-person learning (Ehrlich, 2002). There is questions as to if this applies to synchronous online learning with video usage during class. (Ehrlich, 2002; Kuo & Belland, 2016; Sher, 2009)

While further research is needed to efficiently apply these learning models to online learning, there is adequate evidence supporting the need for varying types of interactions during the course (Ehrlich, 2002; Kuo & Belland, 2016; Kuo, Walker, Schroder, & Belland, 2014; Kurucay & Inan, 2017). Adult learners need specific adaptations to courses in order to be able to

apply course content to professional experiences. Online learning is a delivery method that has been used for many years, but it is undergoing further development to adequately reflect key educational concepts.

Online Training

Online training allows for Public Health Workers to establish a learning community with others that are living in varying regions. As mentioned before, a key aspect of adult learning is having the ability to compare experiences and gain knowledge from others. Adult online training sessions allow for working professionals to participate in and communicate with other working professionals in the same field. In public health specifically, they are able to compare experiences that they have had and possible solutions to problems. Another benefit of online training sessions is that these working professionals are able to take less time off of work because they do not have to travel to the location of the training. This modality also makes the training more affordable by eliminating travel and other expenses as they can complete the training from their own office or home.

A concern with online training is availability and access to the necessary computing devices and internet connections. Participants in online training sessions have to have access to a computer and an internet connection in order to communicate with the instructor and peers. Participants must be able to designate an appropriate amount of time to learning the course material and participating in classes also. Overall, these pros and cons of online learning are something that the learner must take into account and should be considered in the development of online courses.

With the public health workforce facing challenges that have never been seen before, it is more important now than ever to provide a united training approach for public health workers. A

baseline set of knowledge is needed in order to provide adequate public health capacity building across many regions. As the population continues to increase, there is an increasing need for public health workers at the local, state, and national level in almost all regions of the world. These workers need to be trained in a large scope of public health issues (Kumar et al., 2020; Miner et al., 2014). However, it has been documented that many people working in the public health field have received little to no formal public health training prior to or during their careers (Miner et al., 2014). (Kumar et al., 2020; WHO, 2020b)

CDC Public Health Workforce Development

The Centers for Disease Control and Prevention has a Public Health Workforce Development plan that stresses the need to create and maintain a public health workforce that can deal with a broad scope of problems that impact health. The five main priorities of the plan are data for decisions, crosscutting competencies, quality standards for training, training decisions tools and access, and funding integration. (CDC, 2018b; Mumford, Young, & Nawaz, 2016)

Data for decisions consist of collecting necessary data about gaps and training needs in the workforce. By assessing overall needs and then region-specific needs of public health workers, a better informed and more efficient public health workforce can be developed through trainings to bring everyone to the same baseline knowledge level on many topics. (CDC, 2018b; Kumar et al., 2020)

The priority of crosscutting competencies focuses on forming training courses that include a wide range of knowledge on a topic that is applicable to many different fields. For example, the CDC Train WASH course (elaborated upon below) is a course that is meant to serve as an introductory course and is accessible to individuals working in varying areas of

public health. However, for these courses to be effective they need to be supported and encouraged by employers. By educating public health workers on content that is outside of their specific field, they will be better able to assist when deployed to work in other settings or with new collaborators. (CDC, 2018b, 2020g; Mumford et al., 2016)

The third CDC priority area, quality standards for training, focuses on using educational standards and ensuring that the educational material is available to those that need it. Quality standards for training are needed in order to meet the direct needs of the learners and provide the most impact from the course. Quality standards include ensuring that the training has accurate and impactful content and that the content is being delivered in a way that is most useful to the targeted learners.

The fourth priority of increasing training decision tools and access focuses on increasing the tools available for learners to choose the training that applies to them and increasing accessibility of online trainings. An example of a training decision tool is a training rating system that allows previous learners to rate and leave reviews of the training (CDC, 2018b). This will then allow prospective learners the chance to see if the training will be valuable to them before dedicating time and money to the training. This is needed in order to ensure that public health workers are able to access training that is outside of their specific expertise and participate in a training that they desire and/or need. (CDC, 2018b; Mumford et al., 2016)

The final priority, funding integration, ensures that training courses for public health professionals are incorporated into and accounted for in approved budgets. This is crucial in the continuation of public health workforce development. In some cases, such as Africa CDC, the training courses are funded by Africa CDC and then the participants do not have to pay a fee to

participate in the courses. This allows all public health workers the chance to participate in the interactive courses. (CDC, 2018b)

These five key priorities provide a starting point for future workforce development trainings. The concepts provide emphasis on the need for continued workforce development trainings that are applicable and accessible to all public health workers. (CDC, 2018b)

Analysis of Existing WASH Courses

In order to gain an understanding of how the previously described learning theories and CDC Public Health workforce priorities are applied to WASH specific courses, a few WASH courses were studied. WASH courses for public health trainees and professionals that currently exist include the IHE Delft WASH in Emergencies course, CDC Train WASH Introductory Training Module, and UNICEF WASH in schools course. These courses are delivered in various ways.

IHE Delft WASH in Emergencies

The IHE Delft Institute for Water Education has a course that is for WASH professionals working or interested in international humanitarian response. The class is limited to 32 people and is usually held in a face to face setting in Delft, the Netherlands. The goal of the training is to prepare participants to work in WASH roles during emergency deployment of humanitarian services. The objectives of the course include gaining an understanding of humanitarian settings, understanding priorities of different organizations in emergency settings and understanding the procedures and rules related to WASH in emergencies. The course is designed as a simulation exercise in which participants are given real scenarios and have the opportunity to apply the new material that they have learned. The course content focuses more on emergency setting preparedness and less on WASH principles. (IHE, 2016)

Based on CDC Public Health Workforce Development priorities, a benefit of the small number of participants in the course is that participants are able to interact more effectively and are able to share emergency response experiences with each other. The course is selective in admission and has a tuition cost which means that the course is not readily available to any public health professional interested in the content. The face to face nature of the course also means that there are travel fees associated with the course which some public health workers may not be able to afford. (IHE, 2016)

CDC Train Global WASH Course

The CDC Train Global WASH e-learning module is designed in a way that participants can complete the course content online at their own pace. The course is targeted for allied health professionals, epidemiologists, public health workers, and researchers. The course was created and is monitored by CDC's Division of Foodborne, Waterborne, and Environmental Diseases. It consists of five modules including module information, introduction to WASH, Diseases and Transmission, Principle of Water Quality, and Public Health Surveillance. Each unit has a pre-test and a post-test to monitor learning throughout the course. Each module is approximately one hour long and includes videos of course content.

While the CDC Train Global WASH modules allow the learners to complete the modules online at their own pace, they do not support development of a community of practice. According to the Moore interaction framework, adult learners need to be able to share professional experiences and connect with the material. Without building a learning community, learners are inhibited from having learner to learner interactions as well as learner to instructor interaction which, as discussed earlier, are shown to be predictors of success and satisfaction in the course. (CDC, 2020g; Kurucay & Inan, 2017; Moore, 1989)

UNICEF WASH in Schools

The UNICEF WASH in Schools course was developed by faculty from the Center for Global Safe WASH at Emory University to focus on material on WASH in schools interventions with local and national stakeholders. The course is intended for public health workers from a variety of educational backgrounds. It is the most comprehensive of the readily available WASH courses offered by UNICEF. The course is offered in a distance learning setting with modules consisting of readings, discussion board participation, group assignments, and case studies. The course consists of twelve modules that highlight existing problems with WASH in schools, behavior change models, and implementation of sustainable WASH in schools interventions. There is an assessment between modules at the end of the course that is open book without a time limit and allows learners to apply the material that they have learned in the course. (UNICEF, 2012)

This course offers students a way to engage with each other on discussion boards and during the module sessions. Students can also interact during the case studies and group assignments. The opportunities for learner to learner interaction and learner instructor interaction increase overall satisfaction with the course as well as achievement in the course (Ehrlich, 2002). The course also provides the adult learners a way to actively apply the course content to their own jobs as they go through the course. (Ehrlich, 2002; UNICEF, 2012)

These three courses give adult learners an opportunity to expand their current skill sets to WASH related topics. Although quite different in mode of delivery, the IHE Delft WASH in Emergencies and the UNICEF WASH in Schools course cover WASH topics in specific settings while the CDC Train Global WASH modules gives more of a rapid introduction to general WASH topics. At this point in time, there is no introductory WASH course that allows for student interaction, discussions, group assignments, and assessments. This “Introduction to

WASH" course designed for Africa CDC will provide African adult learners an opportunity to engage with course content and each other to expand their WASH knowledge.

III. Methodology

This thesis was developed by building on the writer's Applied Practicum Experience (APE), courses taken at Rollins School of Public Health, and through collaboration with Dr. McGriff and Dr. McNabb at Emory University. Dr. McNabb served as the link between Africa CDC and Emory University and provided expectations of the course content and deliverable. Dr. McGriff served as the Thesis Chair and provided content development and thesis writing recommendations through weekly meetings with the writer.

APE Experience

The writer's APE was completed with Africa CDC Institute for Workforce Development (IWD). The writer worked with the IWD to assess effectiveness of the five deployed courses at addressing public health related topics for target audiences throughout the countries in Africa. The writer also worked to define the gaps in educational content in order to propose new course content. A gap in WASH content was identified and so an introductory WASH course was recommended. The writer then began developing course competencies as well as specific course learning objectives. The work was then transitioned into the thesis process for the writer to continue development.

Final Deliverable

The writer referenced material that was presented in courses at Rollins School of Public Health to both develop the course content and write the thesis sections. The Evidence Based Policy, Programs, and Research (GH 501), Water and Sanitation in Developing Countries (GH 529), and Control and Food and Waterborne Diseases (GH 580) classes were the specific courses that provided the foundation for the writer. In GH 501, the writer learned the basis of analyzing current programs and providing recommendations for future programs based on stakeholder needs and policy gaps. In GH 529 and GH 580, the writer learned introduction to WASH content

as well as disease transmission through water, sanitation, and hygiene practices. The material learned in these courses was applied to the development of the IWD course. The writer also completed a comprehensive literature review in order gain insight into adult learning theory, online learning, and basis of WASH education.

Course Design

The course consists of five introduction to WASH modules that have been designed for adult learners. The final deliverable includes an introduction to the course, course objectives and competencies and full outlines, with reference resources, for each module. Learner individual activities for each module and key readings and videos are also included in each module. Adult learning theory was used to design activities that will build upon previous experiences to engage the learners and allow them to apply course content to their own communities. The design of the deliverable is similar to the WASH in Schools Distance Learning Course developed by Emory University and UNICEF in that it provides a framework for the course content through module outlines, activities, and readings.

Module Format

Each module has a standard layout that includes learning objectives, additional resources, key readings, and discussion questions. As shown in the picture below, each module begins with the learning objectives listed. These learning objectives are intended to provide an insight into the material that will be covered in the module.

Module 2.

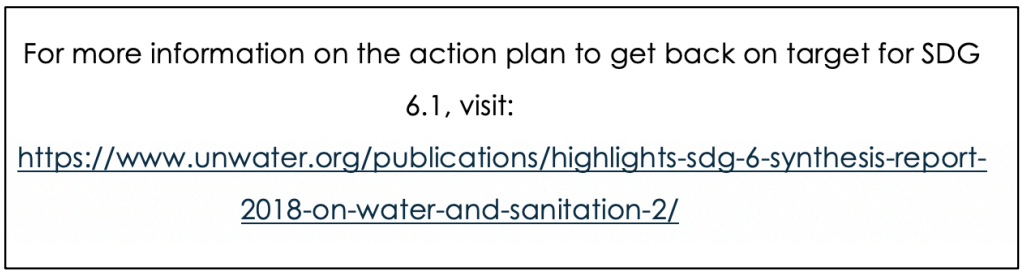
Sanitation

Learning Objectives

By the end of this module, participants should be able to:

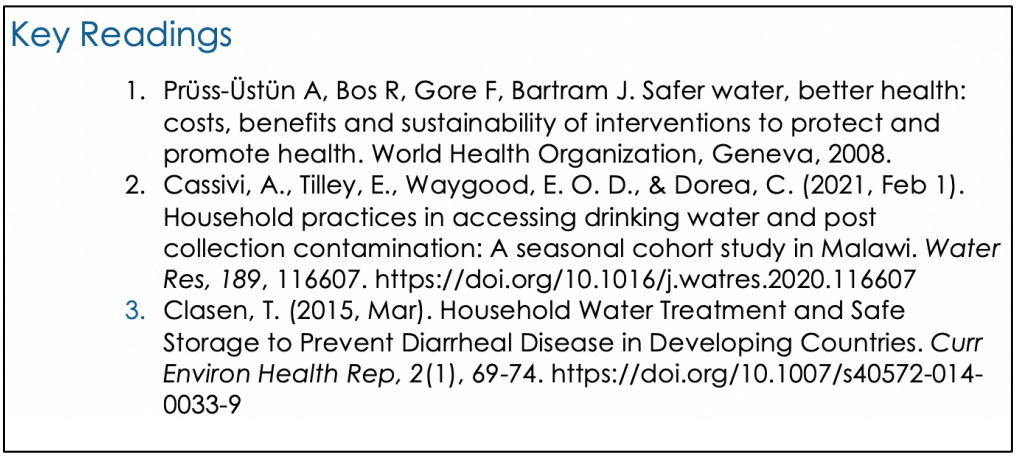
1. Understand global sanitation issues and challenges
2. Describe sanitation infrastructure and services
3. Identify behavior changes related to sanitation interventions
4. Understand wastewater surveillance for diseases such as COVID-19

Additional resources are provided for all major content areas. It is expected that the presenter for each module will do additional research on key topics and can use the hyperlinks provided. An example of the additional resource links is below.



For more information on the action plan to get back on target for SDG 6.1, visit:
https://www.unwater.org/publications/highlights-sdg-6-synthesis-report-2018-on-water-and-sanitation-2/

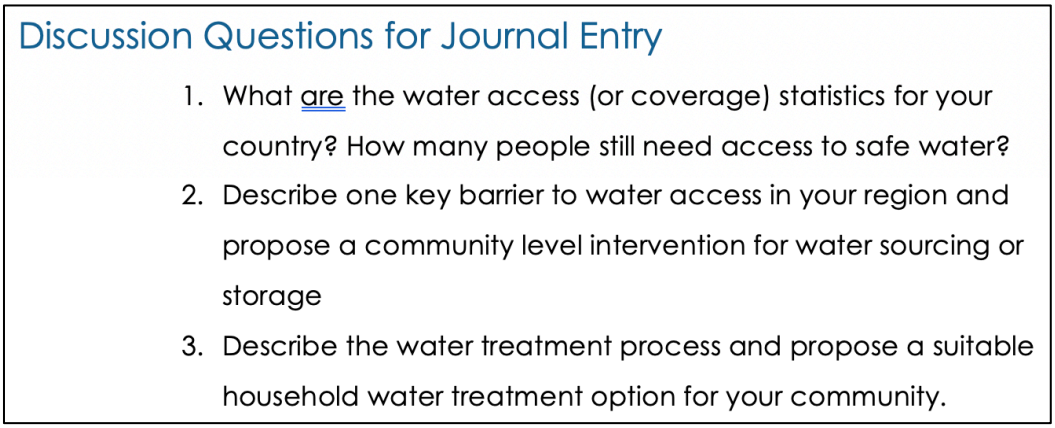
Key readings are provided on each major topic covered in the module and are meant to enhance the learning experience in the course. Examples of key readings provided are shown below (these readings refer to global water challenges and drinking water storage and treatment options).



Key Readings

1. Prüss-Üstün A, Bos R, Gore F, Bartram J. Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. World Health Organization, Geneva, 2008.
2. Cassivi, A., Tilley, E., Waygood, E. O. D., & Dorea, C. (2021, Feb 1). Household practices in accessing drinking water and post collection contamination: A seasonal cohort study in Malawi. *Water Res, 189*, 116607. https://doi.org/10.1016/j.watres.2020.116607
3. Clasen, T. (2015, Mar). Household Water Treatment and Safe Storage to Prevent Diarrheal Disease in Developing Countries. *Curr Environ Health Rep, 2*(1), 69-74. https://doi.org/10.1007/s40572-014-0033-9

Discussion questions are included at the end of each module and are intended to provide learners a way to reflect on the content learned in the module and apply it to their own countries and/or communities. Some of the modules ask students to post their answers to discussion questions on a group discussion board and encourage students to interact with each other in order to apply the material in the course. In the example below, discussion questions included in Module 1 are to be answered in an individual journal entry.



IRB Requirement

IRB approval was not necessary for the development of this course as there was no human subjects research being performed. Existing research on andragogy, pedagogy, course development, and WASH was reviewed in place of conducting a new study.

Plan for Deployment

The Introduction to WASH course at Africa CDC IWD is planned for deployment during Summer of 2021. The final deliverable for this thesis project will be used to develop PowerPoint Slides and recorded presentations that will be posted to the course site for participants to view. The course content will be presented by public health workers that are currently working in

communities throughout Africa. Participants will be able to enroll in the course and will be responsible for completing 75% of the course and the final test in order to receive a certificate of completion. Course completion status will be tracked through the course website.

IV. Module Outlines

Module Outline 1.

Water

Learning Objectives

By the end of this module, participants should be able to:

1. Understand critical global water issues and challenges
2. Understand basic water infrastructure and services for low resource settings
3. Identify safe water storage methods
4. Identify and select the most appropriate water treatment options at the household level

Module Outline

1. Critical Global Water Issues and Challenges

This section is critical in development of an understanding of issues with water access around the world.

In 2000, The Millennium Development Goals (MDG) were developed in order to track and bring awareness to areas for global improvement. Specifically, the main goal was to decrease the number of people in the world that are living in poverty. The MDGs were introduced in 2000 and goals were expected to be met by 2015. One of the goals, Goal 7 was related to water access. In specific, Target 7.C was to "halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation" (UN, 2015). Although, this goal was met, it is recognized that the MDGs were focused on solely gaining access to water and less focused on the type of water, specifically, safely managed water, being used. A shift in focus to safely managed water is necessary in order to assess overall potable water access. (McArthur, 2013).

For more information on the Millennium Development Goals, visit,
https://www.un.org/millenniumgoals/

While the MDGs did focus on decreasing service level inequalities, they did not provide goals directly related to inequalities both between and within countries. Some of these inequalities include differences between rural and urban areas and wealth inequalities. In order to

account for additional aspects of water access, including inequities in access, the Sustainable Development Goals (SDGs) were introduced in 2015.

The SDGS include 17 goals and 169 targets and are expected to be met by 2030 (UN, 2015). Income inequality and gender inequality are two of the inequalities addressed in the SDGs, as well as geographical inequality of rural and urban areas (specifically, SDG 10 discusses the objectives related to inequalities within and between countries.)

SDG 6 has a goal of "ensuring availability and sustainable management of water and sanitation for all" (UN, 2015). Compared to Target 7.C of the MDGs, SDG 6 is more measurable and specific with an aim of equitable and safely managed water and sanitation for all. Some of the key targets related to WASH include achieving "universal and equitable access to safe and affordable drinking water for all" as well as achieving "access to adequate and equitable sanitation and hygiene for all and end(ing) open defecation"(UN, 2015). SDG 6.1 of the 2030 Agenda for Sustainable Development focuses on ensuring universal and equitable drinking water to all and is monitored through the indicator of percentage of the population with access to safely managed drinking water services. (Griggs et al., 2014; UN, 2015).

For more information on SDGs, refer to:
https://sdgs.un.org/2030agenda

The Joint Monitoring Programme (JMP) developed by UNICEF and WHO was developed in 1990 to monitor global progress towards the MDGs. During the MDG period, the JMP monitored progress made on indicators related to water and sanitation (UN, 2016). During the transition from MDGs to SDGs, the JMP was adjusted to monitor progress towards meeting the SDG Goal 6.

The JMP reports on country, regional and global estimates of progress on drinking water, sanitation and hygiene that are monitored through specific indicators. These indicators include the proportion of the population using safely managed drinking water, safely managed sanitation and with access to handwashing stations. (JMP, 2020; UN, 2016)

In order to meet criteria as a safely managed drinking water source the water source must be:

- Improved (see definition of improved below)
- Accessible and close to the dwelling

- Available whenever water is needed
- Free from contamination

JMP classifies both water and sanitation services as either improved or unimproved and then divides into service levels (such as safely managed). Improved drinking water sources are those that have the potential to provide safe water by design. These include piped water, protected wells, and boreholes. Unimproved water sources include surface water and unprotected wells or springs. The service levels are described below. (JMP, 2020)

JMP Service Levels

In order to efficiently monitor progress toward SDG 6.1 and identify areas where improvement is needed, the JMP has developed a Drinking Water Ladder that has five levels including safely managed, basic, limited, unimproved, and surface water. (Columbia Center on Sustainable, Undp, Network, & World Economic, 2016; JMP, 2020)

The levels are defined as

- Safely managed, as defined above, is water that is easily accessible from the dwelling, available, and free from contamination.
- Basic drinking water is water from an improved water source that can be collected in no more than thirty minutes roundtrip from the dwelling.
- Limited drinking water is water that takes more than thirty minutes roundtrip to collect but is still from an improved water source.
- Unimproved water is from an unprotected well or spring.

The map below shows the percentage of the population using each service level discussed above.

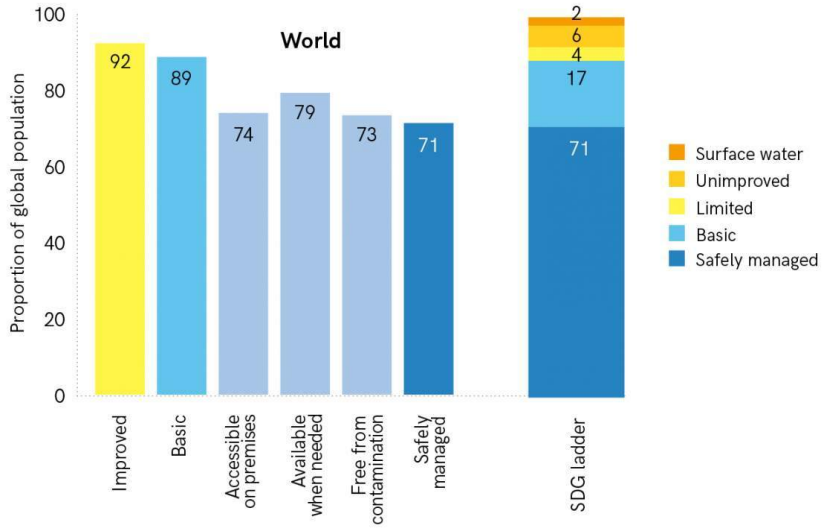


Figure 1. Retreived from: Figure 1. Retrieved from: JMP. (2017). Progress on Drinking Water, Sanitation, and Hygiene: 2017 update and SDG baselines. (pg. 23) https://washdata.org/sites/default/files/documents/reports/2019-05/JMP-2017-report-final.pdf

For more information about JMP and monitoring of SDG 6.1, refer to:
https://washdata.org/monitoring/drinking-water

Global Water Access

The map below represents percentage of the population using unimproved drinking water sources in 2015. In 2015, at the start of the SDGs, 844 million people still lacked basic water service with at least thirty percent of those individuals living in Sub-Saharan Africa. The map below also shows that the highest percentage of the population using unimproved drinking water sources is in Sub-Saharan Africa. (CDC, 2012b; JMP, 2017).

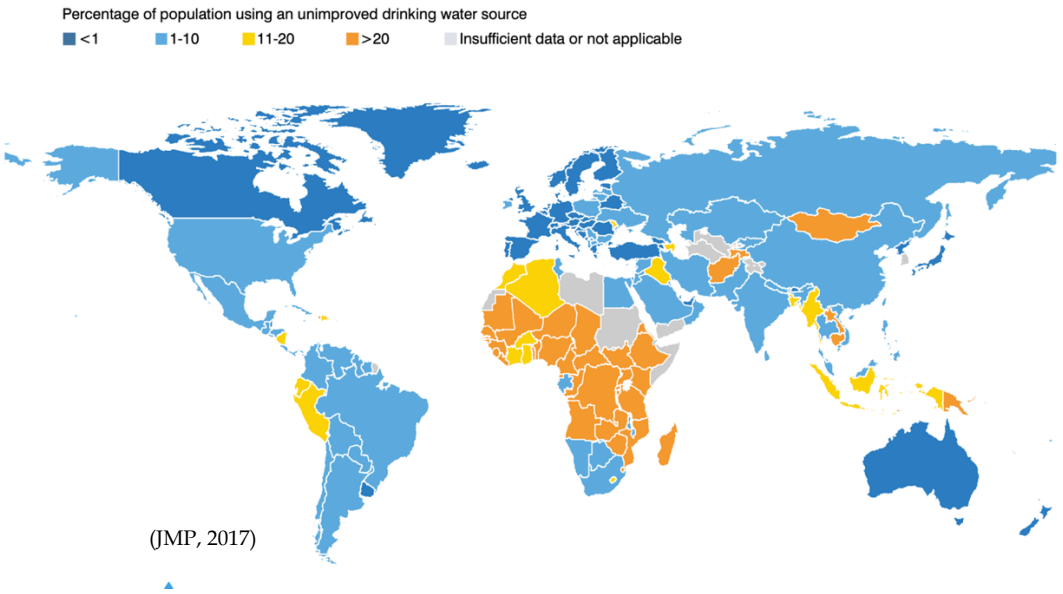


Figure 2. Retrieved from: JMP. (2017). Progress on Drinking Water, Sanitation, and Hygiene: 2017 update and SDG baselines. (pg. 3) *https://washdata.org/sites/default/files/documents/reports/2019-05/JMP-2017-report-final.pdf*

By the 2017 JMP progress report, 70% of the population of the world had water access that qualified as safely managed. In Sub-Saharan Africa only 26% of the population had access to safely managed water. The graph below shows the percent of the population with access to safely managed drinking sources. It also shows the discrepancies between rural and urban access to safely managed drinking water sources; specifically urban areas have significantly higher percent of the population with safely managed drinking water (85%) compared to rural areas (53%). (JMP, 2017)

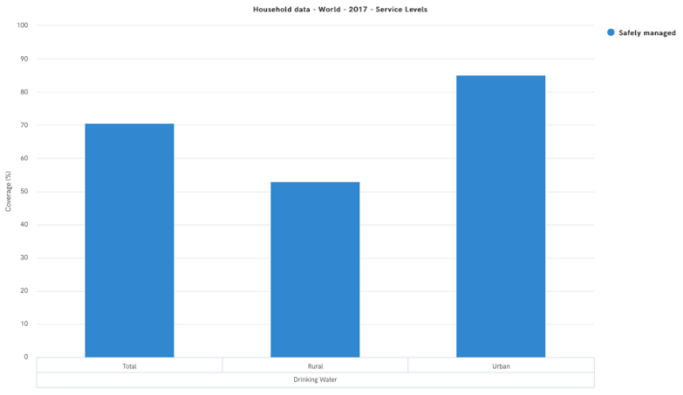


Figure 3. This figure was made on the JMP website with data from: JMP. (2017). Progress on Drinking Water, Sanitation, and Hygiene: 2017 update and SDG baselines.

Meeting SDG 6.1

In order for the SDG 6.1 to be met, there must be universal access to improved drinking water. Currently more than one third of countries must make progress at a faster rate in order to meet this goal by 2030 (JMP, 2017). implementation plans must be adapted to each country and within the different contexts including imbalances between drinking water access in urban and rural areas. Funding and other resources must be directed towards increasing improved water and infrastructure to allow for increases in the percent of the population using improved water. (UN, 2018)

For more information on the action plan to get back on target for SDG 6.1, visit: https://www.unwater.org/publications/highlights-sdg-6-synthesis-report-2018-on-water-and-sanitation-2/

2. Water Infrastructure and Services

The JMP monitors global progress to meeting SDG 6. Safely managed water, as defined above, is water that is easily accessible from the dwelling, available, and free from contamination. (Columbia Center on Sustainable et al., 2016; JMP, 2020)

Types of Water Sources

In many low resource settings, the main types of safe water sources include piped water, wells and boreholes, and springs.

Piped Water

Piped water is the least common type of water infrastructure as construction of piped water sources is time and resource intensive. Lack of funding for water infrastructure and increasing population size results in low access to piped water services. In addition, the high number of households that would require piped water infrastructure may exceed the capacity of most piped water systems and many households may be too far away from the central water service to be reached by piping. (MacAllister, MacDonald, Kebede, Godfrey, & Calow, 2020)

When available, piped water comes with a significant financial cost to the households and does not guarantee consistent water flow. However, a key benefit to piped water is access to a

safely managed drinking water source within the household. (Local Burden of Disease Wa, 2020; MacAllister et al., 2020)

Wells and Boreholes

Wells and boreholes are a more accessible form of water access and therefore are more common. In 2010 in Nigeria, over 80% of the population used water from either boreholes or wells (Kumpel et al., 2016). However, risk of contamination in wells and boreholes is high due to multiple households using the water source and lack of sanitation infrastructure in many of the areas. The water that is fetched from boreholes and wells must be treated through one of the household water treatment options described later in this module in order to be safe for consumption. (Kumpel et al., 2016)

In terms of type of wells, water from boreholes is generally safer than water from shallow, hand-dug wells as the boreholes are dug deeper preventing consumption of contaminated groundwater. While mechanized boreholes are convenient and take less effort to fetch water, hand pump boreholes are more reliable as they are easier to repair and do not require as much maintenance. (Kumpel et al., 2016; MacAllister et al., 2020)

A protected well is a well that is dug with a lining, has a mechanism for raising the water, and has a concrete cover to prevent contamination. Most wells are hand-dug and larger in diameter than boreholes. Wells are easier to construct as they can be hand-dug and do not necessarily require the more expensive drilling machines needed for borehole construction. If wells are not protected, they pose a significant risk of contamination from groundwater. (Kumpel et al., 2016; MacAllister et al., 2020)

Springs

Springs are freshwater sources that can be used as a safe drinking water if constructed in a way that qualifies it as protected. A protected spring has the water filtered through a layer of gravel to a discharge pipe that can be used for water collection. A benefit of protected spring water is that the water is generally free from contamination and can provide a high flow rate of water. However, it can be difficult to ensure that the water from a spring is free from contamination as latrines within the vicinity of the spring can contaminate the water. It is also

important that the spring is not subject to flooding as this could also cause contamination of the water. (WaterAid, 2013)

For more information on types of water supply and services, visit:
https://ppiaf.org/documents/3133/download

For information regarding construction of sustainable water infrastructure, visit:
https://www.wateraid.org/us/what-we-do/how-we-do-it and
https://www.cawst.org

3. Water Storage Methods

Once the water is obtained, a safe storage method is needed in order to limit the number of trips needed to the water source. Most water contamination occurs between collection and consumption (Cassivi, Tilley, Waygood, & Dorea, 2021). Even after water treatment, if water is not stored in a safe way, it can be re-contaminated. Safe storage will allow for multiple days of water to be stored in a manner that will prevent contamination. (CDC, 2014)

The sub-section on safe water storage should include:

- Explanation of guidelines of safe water storage containers including (CDC, 2014):
    - Small openings with a lid that prevents contamination from objects or hands.
    - A spigot to allow for access to the safe water supply in a way that prevents contaminated objects from coming into contact with the water.
    - An appropriately sized storage container that is suitable for the size of the household and for the water treatment method.

The following types of storage containers are containers that meet all of the previously listed requirements and are "model" storage containers. Each type of container and accessibility/usability of the container are discussed below.

Types of Water Storage Containers

Jerry Cans

Jerry Cans come in sizes ranging from 10L to 20L. The containers have a small enough opening that prevents recontamination by hands or utensils. In Sub-Saharan Africa, the cans are accessible as they are frequently used to transport cooking oils and then re-used as a water storage container. These containers are in ready supply and can be easily purchased in most regions. The cost of these used Jerry Cans range from $1-$5 USD at most markets. The picture below shows a Jerry Can. (CDC, 2012b)

Figure 4. Retrieved from: CDC. (2012). Safe Water Storage (Safe Water System, Issue. https://www.cdc.gov/safewater/storage.html

Oxfam Bucket

The Oxfam Bucket meets the requirements as a safe water storage container, but it is not widely accessible. The buckets hold 14L of water. There is a spigot on the front of the bucket that allows for easy access to the water and prevents recontamination. The Oxfam Bucket is considered expensive, costing $10 per bucket and must be ordered from England. The buckets must also be ordered in batches of 200 buckets. The price does not include shipping of the buckets from England to the area in need. So while, this type of storage container meets all the requirements, it is not the most feasible for low resource settings, in terms of availability and cost. (CDC, 2012b; OXFAM, 2016)

Figure 5. Retrieved from: OXFAM. (2016). 8 Things That Make Our Bucket Life-Changing. https://www.oxfamamerica.org/explore/stories/8-things-that-make-our-bucket-life-changing/

Modified Clay Pots

Modified clay pots are more difficult to regulate than the previously discussed water storage containers. Compared to the Jerry Cans and Oxfam Bucket, modified clay pots are usually used to store the water and not for the transport of water from the water source. These clay pots are made by local potters and involve adding a small top with a lid and a spigot to the front of the pot. A benefit of this water storage option is that it is generally available through local markets. Prices vary based on the region. (CDC, 2012b)

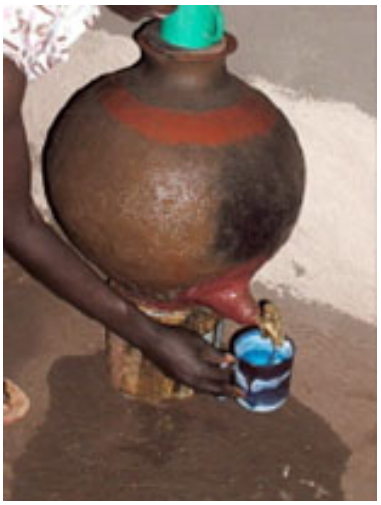


Figure 6. Retreived from: CDC. (2012). Safe Water Storage (Safe Water System, Issue. https://www.cdc.gov/safewater/storage.html

For more information on Safe Water Storage, visit:
https://www.cdc.gov/safewater/index.html

4. Water Treatment Options at the Household Level

The water supplies and treatment section should provide water treatment options at the household level and will discuss types of pathogens that the treatments are effective in removing. Household water treatment usually occurs as "Point of Use" treatment or treatment that is done in batches as the water is retrieved and returned to the dwelling. Currently there are a variety of water treatment products available. (CDC, 2020c)

Household treatment options include (CDC, 2020c)

Pre-Treatment

Pre-treatment of water may be necessary in order to support flocculation for better filtration. Flocculation happens when positively charged chemicals are added to the water in order to create floc. An example of this is the PuR sachets in which the sachet is added to water which then causes the clumping of particles (Lantagne & Clasen, 2012). Once flocculation is complete, sedimentation will occur; which means that the floc settles to the bottom of the container. After these pre-treatment steps, the following treatment methods can be used.

Filtration Systems

Success of filtration systems depends on the size of the filter and the size of the contaminants. Clear water at the top of the water container (after flocculation and sedimentation) is passed through filters in order to remove contaminants. Filters can include pieces of cotton or cheesecloth. The size of the filter will determine the functionality in removing bacteria, viruses, protozoa, and chemicals.

One type of filter is the ceramic filter. Ceramic filters can be produced locally and are made with colloid silver which makes them more effective at removing bacteria from the water and prevent growth of microbes in the stored water. Water is poured through the ceramic filtered and into a storage container. The picture below shows a ceramic filter that has been shown to improve water quality after use. (CDC, 2012a; Morris et al., 2018)

Figure 7. Retreived from: Morris, J. F., Murphy, J., Fagerli, K., Schneeberger, C., Jaron, P., Moke, F., Juma, J., Ochieng, J. B., Omore, R., Roellig, D., Xiao, L., Priest, J. W., Narayanan, J., Montgomery, J. M., Hill, V., Mintz, E., Ayers, T. L., & O'Reilly, C (2018). A Randomized Controlled Trial to Assess the Impact of Ceramic Water Filters on Prevention of Diarrhea and Cryptosporidiosis in Infants and Young Children-Western Kenya, 2013. The American Journal of Tropical Medicine and Hygiene, 98(5), 1260-1268. https://doi.org/10.4269/ajtmh.17-0731

Reverse Osmosis Systems

Reverse Osmosis removes contaminants by having the water flow through filters from more concentrated areas to less concentrated areas. This promotes the contaminants moving out of the desired drinking water source through a semi-permeable membrane. The extremely small, 0.0001 micron, pore size of the membrane allows for maximum effectiveness in removing microbes from the water. Similar to filtration, these systems may also need pre-treatment of the water in order to remove larger particles. Reverse osmosis is highly effective in removing viruses, bacteria, protozoa, and chemicals. However, household reverse osmosis systems come at a high cost and are not easily available in low-resource settings. (CDC, 2020c)

Distillation Systems

Distillation systems heat the water to a boil and then collects the water vapor. This process leaves the contaminants behind in the liquid water. Distillation is effective in removing viruses, bacteria, protozoa, and chemicals. Distillation systems require large equipment that is usually expensive to buy and maintain. The necessary equipment is not readily available at markets in most low-resource settings. This water treatment option is not feasible for low-resource settings. (CDC, 2020c)

Ultraviolet Systems

Ultraviolet systems use ultraviolet light to disinfect the water by removing microbes. Solar disinfection, or SODIS, consists of filling plastic water bottles with water, shaking them to oxygenate, and then placing them outside in the sunlight. Necessary time in the sun varies depending on the weather conditions and can range from 6 hours to 2 days. Pre-treatment of water is necessary in order to remove larger particles in the water. A drawback of the system is the amount of time needed to treat each bottle of water. Due to the low cost and availability of plastic bottles, SODIS is a feasible and frequently used water treatment method in many low-resource settings. This system is effective in removing viruses, bacteria, and protozoa, but is not effective in removing chemicals. (CDC, 2012c, 2020c)

The picture below shows the SODIS water treatment method being used by placing the plastic bottles of water on a rooftop in the sunlight.

Figure 8. Retrieved from: CDC. (2012). Safe Water System; Solar Disinfection. https://www.cdc.gov/safewater/solardisinfection.html

For more information on household water treatment methods, visit:
https://www.cdc.gov/healthywater/drinking/home-water-treatment/household_water_treatment.html

Water and COVID-19 Considerations

In relation to COVID-19, water treatment and storage recommendations have remained consistent. In fact, according to WHO, "existing WHO guidance on the safe management of drinking-water and sanitation services also applies to the COVID-19 pandemic" and continued treatment of water sources with the methods used prior to the pandemic is recommended (WHO, 2020d). However, increased water access is needed for recommended handwashing behaviors (discussed in Module 4). (WHO, 2020d)

For more information on drinking water and COVID-19, visit:
https://www.who.int/publications/i/item/WHO-2019-nCoV-IPC-WASH-2020.4

Key Readings

1. Prüss-Üstün A, Bos R, Gore F, Bartram J. Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. World Health Organization, Geneva, 2008.
2. Cassivi, A., Tilley, E., Waygood, E. O. D., & Dorea, C. (2021, Feb 1). Household practices in accessing drinking water and post collection contamination: A seasonal cohort study in Malawi. *Water Res, 189*, 116607. https://doi.org/10.1016/j.watres.2020.116607
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Recommended Video

SDG Baselines, Drinking Water Services-
https://www.youtube.com/watch?v=hwaaRgG7IUk&feature=youtu.be

Discussion Questions for Journal Entry

1. What are the water access (or coverage) statistics for your country? How many people still need access to safe water?
2. Describe one key barrier to water access in your region and propose a community level intervention for water sourcing or storage

3. Describe the water treatment process and propose a suitable household water treatment option for your community.

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Module Outline 2.

Sanitation

Learning Objectives

By the end of this module, participants should be able to:

1. Understand global sanitation issues and challenges
2. Describe sanitation infrastructure and services
3. Identify behavior changes related to sanitation interventions
4. Understand wastewater surveillance for diseases such as COVID-19

Module Outline

1. Global Sanitation Issues

This section focuses on access to improved sanitation at the community level. As described in Module 1, Sustainable Development Goal 6 focuses on clean water and sanitation for all. Sanitation access, specifically, falls under Sustainable Development Goal 6.2 which has the goal of access to sanitation and hygiene for all and ending open defecation. Specifically, the target aims to "achieve access to adequate and equitable sanitation and hygiene for all and end open defecation" by 2030 (JMP, 2017). The indicator for Goal 6.2 is the "percentage of the population using safely managed sanitation services" (JMP, 2017).

For more information on SDGs, refer to:
https://sdgs.un.org/2030agenda

As discussed in Module 1, the Joint Monitoring Programme through UNICEF and WHO monitors progress toward meeting SDG 6. Indicators have been developed in order to more appropriately track global progress. JMP uses the improved and unimproved definitions developed for the MDGs to and further defines them in the drinking water ladder (described below) to include "safely managed" sanitation. Improved Sanitation includes facilities in which human excreta is separated from human contact. One of the SDG 6.2 indicators includes the proportion of the population using safely managed sanitation facilities.

Criteria for safely managed sanitation include:

- Improved sanitation status

- Sanitation facilities that are not shared with other households
- Excreta that is transported for offsite treatment
- Excreta that is transported with wastewater through a sewer and is treated offsite

The bar chart below shows the total percent of the world population, and percent of populations in urban vs. rural areas using sanitation that is classified as safely managed.

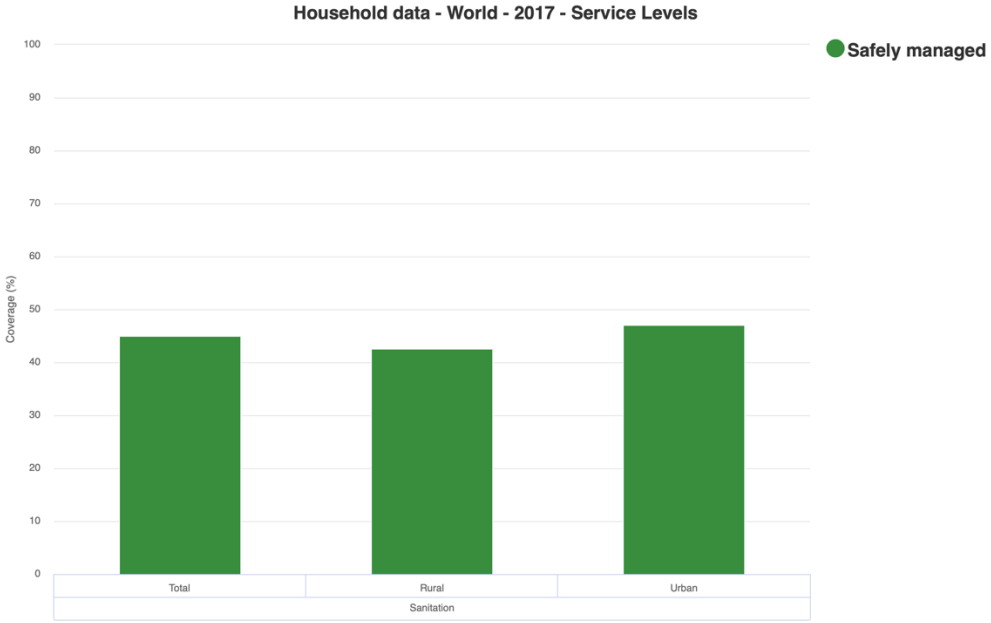

Figure 9. This figure was made on the JMP website with data from: JMP. (2017). Progress on Drinking Water, Sanitation, and Hygiene: 2017 update and SDG baselines.

Similar to water, JMP developed a ladder to categorize service levels. The JMP sanitation ladder includes the following levels: safely managed, basic, limited, unimproved, and open defecation. (Columbia Center on Sustainable et al., 2016; JMP, 2020; UN, 2015)

The levels are defined as:

- Safely managed is, as defined above, facilities that are not shared with other households and where excreta is either treated at the original place or transported and treated off site.
- Basic sanitation is defined as using the improved facilities but with excreta not necessarily managed in a safe way.

- Limited sanitation is use of the improved facilities, but the facilities are shared between more than one household.
- Unimproved sanitation is “use of pit latrines without a slab or platform, hanging latrines, or bucket latrines” (JMP, 2017).
- Open defecation is defined as disposal of feces in bodies of water, fields, or other open places.

  (JMP, 2020)

The image below shows the percent of the population using the different sanitation classifications:

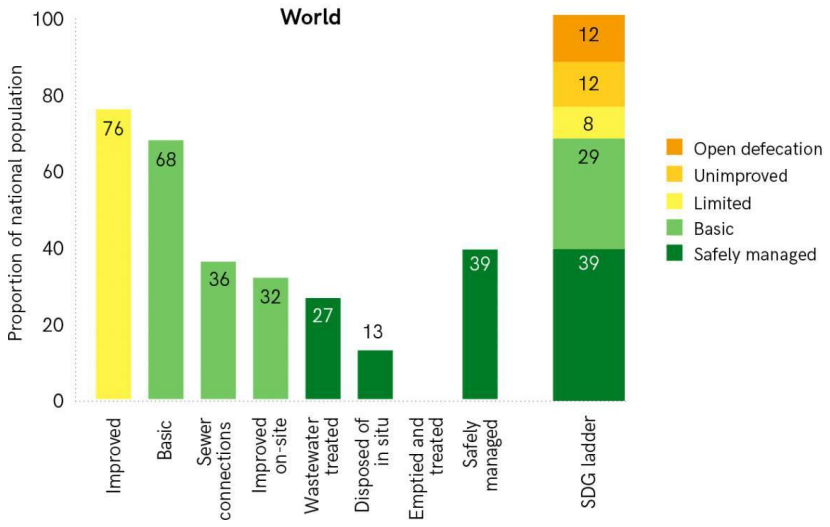

Figure 10. Retrieved from: JMP. (2017). Progress on Drinking Water, Sanitation, and Hygiene: 2017 update and SDG baselines.

For more information on classifications of sanitation infrastructure, visit:

https://washdata.org/monitoring/sanitation

According to JMP baseline estimates, 2.3 billion people lack access to safely managed sanitation services. The image below shows the percent of the population using basic sanitation

services. As depicted in the graph, Sub-Saharan Africa has less than half of the population using basic sanitation services as of 2015. (JMP, 2017)

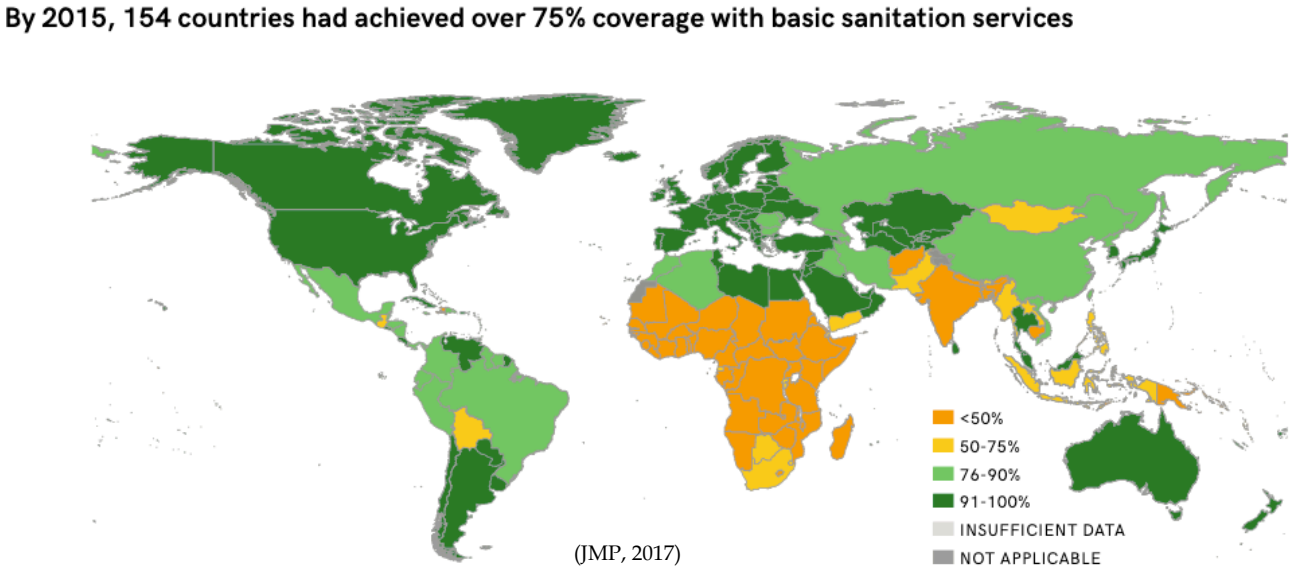

Figure 11. Retreived from: Figure 1. Retrieved from: JMP. (2017). Progress on Drinking Water, Sanitation, and Hygiene: 2017 update and SDG baselines. (pg. 4) https://washdata.org/sites/default/files/documents/reports/2019-05/JMP-2017-report-final.pdf

2. Sanitation Infrastructure and Services

This section should focus on the common types of sanitation infrastructure and fecal sludge management options. In order to effectively prevent disease spread, the sanitation infrastructure described below should be paired with hygiene infrastructure as described in Module 5.

Types of Sanitation Infrastructure

Types of sanitation include pit latrines, hanging latrines, bucket latrines, and flush toilets. Pit latrines and flush toilets will be discussed in this section. Pit latrines are the most common type of sanitation infrastructure in Sub-Saharan Africa. There are varying levels of pit latrines that determine the safety of the latrine. Pit latrines can be classified as basic, limited, or unimproved forms of sanitation depending on the construction of the latrine. (EAWAG, 2008; Ekane, Nykvist, KjellÉN, Noel, & Weitz, 2014; JMP, 2017; Nunbogu, Harter, & Mosler, 2019; Sibiya & Gumbo, 2013)

Description of pit latrines at the varying levels are below. (Nunbogu et al., 2019; UN, 2015)

- Basic: A basic pit latrine must have a slab that covers access to the pit. The latrine must also only be used by one household.
- Limited: A limited pit latrine must also have a slab that covers the majority of the pit and be limited to use by one household.
- Unimproved: An unimproved pit latrine is a pit latrine that does not have a cover and is shared between multiple households.

The images below show pit latrines at varying level of construction. The first picture shows the pit only; while the second picture shows a pit latrine with a superstructure that includes a roof and secured doors.

Figure 12. Retrieved from Nunbogu, A. M., Harter, M., & Mosler, H.-J. (2019). Factors Associated with Levels of Latrine Completion and Consequent Latrine Use in Northern Ghana. International journal of environmental research and public health, 16(6), 920. https://doi.org/10.3390/ijerph16060920

Figure 13. Retrieved from Nunbogu, A. M., Harter, M., & Mosler, H.-J. (2019). Factors Associated with Levels of Latrine Completion and Consequent Latrine Use in Northern Ghana. International journal of environmental research and public health, 16(6), 920. https://doi.org/10.3390/ijerph16060920

Flush toilets are considered safely managed sanitation as the waste from one user is washed away before use by the second user. These types of toilets limit odor and flies that can be a feature of pit latrines. There are two types of flush toilets:

1) The first is a pour to flush toilet. This system uses buckets of water to pour into the toilet after use to eliminate waste in the toilet. This method requires readily accessible water around the toilet and enough water to be used for flushing. A benefit of this system is that piped water is not necessary as water can be stored next to the toilet for flushing. The largest benefit is that waste is safely and successfully removed without having to be manually removed.
2) The second type of toilet is a flush toilet with piped water. This type of toilet provides the same benefits of the pour to flush toilet of eliminating waste of one user before use by another person. A limitation of this type of sanitation infrastructure is that it requires constant and reliable piped water. It also requires the necessary hardware and technical capacity to install and maintain. (EAWAG, 2008; Ekane et al., 2014; Sibiya & Gumbo, 2013)

For more information on sanitation infrastructure, visit:
https://sswm.info/sites/default/files/reference_attachments/EAWAG_SANDEC%20Sanitation%20Systems%20&%20Technologies_0.pdf

Fecal Sludge Management

The second sub-section should focus on fecal-sludge management. Fecal sludge management is important to include when discussing sanitation. Fecal sludge management is defined as or includes capturing, storing, transporting and treating (and possibly re-using) waste in a safe way (Foundation, 2010). Unsafe management of fecal sludge can result in increased spread of disease throughout communities through human contact with feces, water contamination and food contamination. Community dumping of fecal sludge in fields is linked to both contaminated water and food sources. (Balasubramanya et al., 2017; Odey, Li, Zhou, & Kalakodio, 2017)

Fecal sludge management can be broken down into centralized and decentralized services. Centralized services are most often in the form of tanker trucks that empty septic tanks or pit latrines. Decentralized services are usually done by household members and consist of pumping or manually emptying the pit latrines. Most fecal sludge management methods include pumping latrines (either manually or mechanically) and then transporting the fecal sludge by truck to the emptying site where all community fecal sludge is dumped (Balasubramanya et al., 2017). This dumping presents an opportunity for human contact and/or contamination of water sources as mentioned above. (Balasubramanya et al., 2017; Odey et al., 2017)

Implementing fecal sludge management programs can be costly to communities. For example, during a study in Bangladesh, it was found that it cost approximately $13 per latrine emptying event for both decentralized and centralized fecal sludge management and it was needed every 3-4 years. The cost was significantly lower when trucks were used for transport instead of tankers. With community level involvement in safe fecal sludge management, the estimated cost per year per household is $4. Therefore, the community approach and use of trucks for transport (vs. tankers) allows for fecal sludge management to be more affordable and accessible. (Balasubramanya et al., 2017)

Treatment and reuse of the fecal sludge is rare but is becoming more possible for communities with the development of specialized programs in fecal sludge management. (Odey et al., 2017)

For more information on Fecal Sludge Management, visit:
https://www.wsp.org/sites/wsp/files/publications/WSP-Fecal-Sludge-Management-Overview-Conference-Edition.pdf

Examples of possible Fecal Sludge Management solutions

Sanergy in Nairobi Kenya

Sanergy builds toilets, collects fecal sludge, and treats and reuses the excreta as fertilizers for farmers. The toilets are built at a low cost to the community and meet basic sanitation requirements. Handwashing stations and feminine hygiene disposal bins are also implemented with the toilets. This is a safe and affordable fecal sludge management program that also benefits the local agriculture market by increasing fertilizer accessibility and crop production. In urban slums, the Sanergy program works to ensure that pit latrines are emptied frequently and that waste is being managed safely at a low cost. (Snyder et al., 2020)

For more information on the Sanergy program, visit:
http://www.sanergy.com

SOIL in Haiti

SOIL was the first waste treatment center in Haiti and now use composting to turn human waste into compost that can be used for agricultural needs. The program staff install low cost household toilets and then collect waste weekly for transport to the SOIL compost plant. In the urban slums of Haiti, SOIL has also installed public toilets. Similar to the household program, the waste is also collected weekly. The waste that is collected is then turned into fertilizer at one of the SOIL facilities. The compost is sold at low cost to community farmers to increase crop production. Other benefits to this program includes providing jobs to community members and increasing access to safe sanitation services. (Piceno et al., 2017)

For more information on the SOIL Program visit:
https://www.oursoil.org

3. Behavior Change for Sanitation Interventions

Behavior change interventions around using improved sanitation methods are necessary in order to ensure that interventions are effective to reduce health risks. There are two main targets of sanitation behavior change: increasing latrine use and decreasing open defecation.

Access to latrines that are on the premises of the dwelling is an important factor associated with latrine use and ending open defecation. Latrines must also be maintained in order to increase use and be seen as a desirable alternative to open defecation. However, increasing latrine access does not necessarily mean that latrines are being used regularly. Previous studies in Sub-Saharan Africa have shown that installation of latrines without behavior change interventions show little improvement in latrine use. (Alemu, Kumie, Medhin, & Gasana, 2018; Lopez et al., 2019)

According to a study done in Ethiopia, the three main predictors of latrine use are perceived cleanliness of latrines, construction of latrines, and social norms associated with latrine use (Alemu et al., 2018). Perceived cleanliness of latrines is a significant determinant of latrine use as cleaner latrines are more likely to be used by community members (Lopez et al., 2019). For households, it is important to maintain the cleanliness of the facility to encourage the practice of latrine use. Proper maintenance of latrines includes hygienic disinfection and latrine emptying when necessary (Lopez et al., 2019). By keeping latrines clean and adequately maintained, latrine use in the community will likely increase. (Alemu et al., 2018; Lopez et al., 2019)

Behavior change interventions should also focus on constructing latrines that are private. Latrines constructed with doors and/or roofs are more likely to be used. A protected door and roof provide privacy for users and an increased sense of security; especially for women and children. (Alemu et al., 2018)

Social norms are the largest predictor of latrine use and ending open defecation. However, changing of social norms within a community can be difficult. One way to implement behavior changes in the community is through education of safe sanitation practices. This can be done through community workers delivering either verbal or written education to each household. Perceived consistent use of the latrines by other community members is also a consistent predictor of overall latrine use. One way to leverage this normative belief is through the Community-Led Total Sanitation initiative that is also used to target open defecation.(Alemu et al., 2018; Kar, 2008)

Behavior Change to End Open Defecation

Open defecation is reported more often in communities with both physical and social barriers to latrine use. As mentioned above, the physical barriers can include latrine proximity to the household and maintenance of the latrine. However, there are also significant behavioral considerations. One of the most common behavior change interventions for ending open defecation is the Community-Led Total Sanitation (CLTS) initiative. (Kar, 2008; Annette Prüss-Ustün et al., 2014)

The CLTS program has three phases:

1. Pre-triggering: involves choosing target communities and collecting baseline data on existing open defecation and latrine use behaviors within the community.
2. Triggering: community members are brought together in community meetings to focus on motivation to change sanitation habits and the use of shame as part of the intervention.
3. Post-triggering: returning to intervention sites to certify them as open defecation free.

This type of behavior change model was first used in India and was shown to significantly decrease open defecation practices. It has since been successful in other countries. (Kar, 2008)

For more information on this approach, refer to:
https://www.communityledtotalsanitation.org/page/clts-approach

4. Disease Surveillance Through Wastewater

In this section, wastewater-based epidemiology should be discussed in relation to COVID-19.

Wastewater surveillance has been used as an effective early detection method for many years on diseases such as polio (Aguiar-Oliveira et al., 2020; CDC, 2020h). Wastewater surveillance can be used when the disease of interest is present in excreta. Samples are taken of untreated wastewater and fecal sludge and tested in a laboratory for the presence of disease. This type of environmental surveillance can link disease isolates to specific communities and provide insight into the state of an outbreak in specific regions. During the polio response, wastewater

surveillance was used in order to predict future outbreaks in communities and activate the appropriate response methods once a case was identified. (Asghar et al., 2014)

For COVID-19, CDC, in collaboration with other agencies, has launched the National Wastewater Surveillance System in order to monitor COVID-19 cases in communities and provide early warning of outbreaks. Wastewater surveillance for COVID-19 can detect the presence of the virus earlier than case surveillance and can assist in monitoring trends of cases within a community that shares a sewer system. (CDC, 2020h)

For low- and middle-income countries without a centralized sanitation system, wastewater surveillance can be difficult due to wastewater mixing with environmental water sources and small populations served by pit latrines or septic systems(Aguiar-Oliveira et al., 2020). With decentralized sanitation systems, there is not an easily identifiable population associated with the wastewater. This creates barriers in predicting prevalence within a community and determining absence of the virus in a community. Wastewater surveillance can, however, determine the presence of the virus in the community through isolation of the virus in wastewater samples (CDC, 2020h). As of now, there is a need for more research in overcoming the barriers of wastewater surveillance of COVID-19 in low-and middle-income countries. (Aguiar-Oliveira et al., 2020; CDC, 2020h)

For more information on COVID-19 Wastewater Surveillance, visit:
https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/wastewater-surveillance.html

Key Readings

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2. Odey, E. A., Li, Z., Zhou, X., & Kalakodio, L. (2017, Oct). Fecal sludge management in developing urban centers: a review on the collection, treatment, and composting. *Environ Sci Pollut Res Int, 24*(30), 23441-23452. https://doi.org/10.1007/s11356-017-0151-7
3. Venkataramanan, V., Crocker, J., Karon, A., & Bartram, J. (2018). Community-Led Total Sanitation: A Mixed-Methods Systematic Review of Evidence and Its Quality. *Environmental health perspectives, 126*(2), 026001-026001. https://doi.org/10.1289/EHP1965
4. Aguiar-Oliveira, M. d. L., Campos, A., R Matos, A., Rigotto, C., Sotero-Martins, A., Teixeira, P. F. P., & Siqueira, M. M. (2020). Wastewater-Based Epidemiology (WBE) and Viral Detection in Polluted Surface Water: A Valuable Tool for COVID-19

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Recommended Video

SDG Baselines: Sanitation Services-

https://www.youtube.com/watch?v=bPsiPc_ZKO8&feature=youtu.be

Discussion Questions for Discussion Board

Answers to these questions should be posted on the module 2 discussion board for the class. Students are encouraged to interact and respond to posts from other students.

1. What are the Sanitation statistics for your county? What level of sanitation infrastructure is most common?
2. Do you think that the Community-led Total Sanitation initiative is ethical in the way that it relies on community disgust and shaming? What modifications can be made to the Community-Led Total Sanitation initiative to improve sanitation without shaming communities?

Module 2. References

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Module Outline 3.

Water and Sanitation

Learning Objectives

By the end of this module, participants should be able to:

1. Describe the role of water scarcity in sanitation interventions
2. Identify key diseases related to poor water and sanitation
3. Describe disease prevention methods

Module Outline

1. Water Scarcity and Sanitation

The number of water scarce and water stressed areas in the world is continuing to grow. While implementation of water and sanitation interventions is necessary in order to prevent a myriad of health issues, it is also important to consider the implications on water availability (Daigger, 2009). This section of the module should focus on water scarcity in relation to safely managed sanitation interventions.

For example, in urban slums, water is both scarce and required for sanitation behaviors. Keeping water close to the latrine or toilet for regular flushing has been shown to improve sanitation behaviors after toileting (Saxton et al., 2017). Water used for flushing can be stored for many days at a time in closed containers next to the latrines (Saxton et al., 2017). However, it is important to consider that needing this additional water puts stress on the collection process.

Water used for sanitation purposes does not need to be up to the same standards as drinking water. Grey water is water that has been previously used for washing clothes, handwashing, cooking, or bathing. Greywater can be collected in basins and treated to remove any harmful pathogens before reuse. After treatment, greywater can be used in the household for non-potable uses including crop irrigation or toilet flushing. The reuse of grey water provides a way for water scarce areas to maintain safely managed sanitation without increasing water demand or collection. (Leong, Oh, Poh, & Chong, 2017; Ren, Zhang, & Chen, 2020). In fact, early research is showing that with little cost to the household, overall water use is decreased (Oviedo-Ocaña, Dominguez, Ward, Rivera-Sanchez, & Zaraza-Peña, 2018)

For more information about greywater reuse, visit:
https://greywateraction.org/about/

2. WASH Related Diseases

Inadequate water and sanitation can lead to many diseases. In 2012, it was estimated that 502,000 deaths per year were attributed to inadequate water and 280,000 deaths per year were attributable to inadequate sanitation (Annette Prüss-Ustün et al., 2014).

Water and sanitation diseases can be broken down into diarrheal diseases soil-transmitted helminths, and other infectious diseases. Diarrheal diseases make up a large proportion of diseases caused by inadequate water and sanitation (A. Prüss-Üstün, Bos, Gore, & Bartram, 2008). In this section, the many types of water and sanitation related diseases should be displayed. Some of the diseases that can be included are:

- Hepatitis E
- Trachoma
- Schistosomiasis
- Cholera
- Typhoid Fever
- Guinea Worm
- Soil-Transmitted Helminths

Three of these previously listed diseases should then be discussed in regard to global burden and methods of transmission.

Hepatitis E

Hepatitis E infection is a viral infection that causes infectious hepatitis. The primary source of transmission is through contact with human feces, primarily through contaminated water sources (Hyams et al., 1992; WHO, 2020a). It is estimated by WHO that there are more than 20 million cases of Hepatitis E worldwide each year. Over half of these infections are asymptomatic leading to continued transmission through fecal shedding (WHO, 2017). Symptoms of Hepatitis E include fever, loss of appetite, abdominal pain, and jaundice. Symptoms typically last about a month with the person being contagious for the entire

symptomatic period. Hepatitis E has a low mortality rate and usually resolves itself without hospitalization. There is no direct treatment for Hepatitis E and there is no vaccine available at this time. (WHO, 2020a)

For more information about Hepatitis E, visit:
https://www.cdc.gov/hepatitis/hev/index.htm
https://www.who.int/news-room/fact-sheets/detail/hepatitis-e

Trachoma

Trachoma is a bacterial infection that causes inflammation and scarring of the eyes. Infection occurs when there is contact with contaminated water and then the infection spreads from person to person through flies, hands, and clothes (Center, 2021c; Taylor, Burton, Haddad, West, & Wright, 2014). Trachoma can be found in 44 countries and continues to be leading cause of blindness due to an infectious disease (Center, 2021c). In 2012, there were approximately 21 million active cases with many more people left with irreversible eye damage from infection (Stocks et al., 2014). Damage to the eye occurs through repeated infection that causes the eyelids to turn inwards and the eyelashes to scratch the cornea. Antibiotics can be used to treat infection. With programs like The Carter Center Trachoma Control Program, cases of Trachoma within the last three years have been decreasing. (Center, 2021c; Stocks et al., 2014)

For more information on Trachoma, visit:
https://www.cartercenter.org/health/trachoma/index.html
https://www.who.int/news-room/fact-sheets/detail/trachoma

Schistosomiasis

Schistosomiasis is a parasitic infection that is spread through snails living in fresh water. Infection occurs when a person is in contact with the contaminated water source. This can occur through washing clothes, bathing, or collecting water. The parasite is infectious after being released from the snail into the water. Symptoms of infection include blood in urine and feces and abdominal pain. The parasite can live in the human body for years releasing thousands of

eggs and continuing the transmission cycle through urination and defecation in water sources. The disease mostly impacts children and in Nigeria alone, there are 25 million infected people. Schistosomiasis can be treated with praziquantel but is difficult to control due to the number of eggs released by infected persons. (CDC, 2018a; Center, 2021b; Tchuem Tchuenté, Rollinson, Stothard, & Molyneux, 2017)

For more information on Schistosomiasis, visit:
https://www.cdc.gov/parasites/schistosomiasis/index.html
https://www.cartercenter.org/health/schistosomiasis/index.html

Cholera

Cholera is a bacterial infection that is caused by the bacterium *Vibrio cholerae.* Cholera is spread through contact with contaminated water or food sources. The infection spreads rapidly in population with limited access to safe water and sanitation. WHO estimates that there are between 1.3 and 4.0 million cases of Cholera each year (WHO, 2021a). Symptoms of cholera infection include acute watery diarrhea, abdominal pain, and vomiting. Dehydration is a serious concern with cholera infection and can cause death if not treated. Many infected people are asymptomatic and continuing the transmission cycle by shedding the virus in feces back into the environment. Cholera can be treated through antibiotics, but Oral Rehydration Therapy is the most important treatment. (CDC, 2020a; D'Mello-Guyett et al., 2020; WHO, 2021a)

For more information about Cholera, visit:
https://www.cdc.gov/cholera/general/index.html
https://www.who.int/news-room/fact-sheets/detail/cholera

Typhoid Fever

Typhoid fever is caused by the bacterium *Salmonella Typhi.* Infection is caused by contact with human feces. This contact can occur through direct contact or contaminated water sources. Symptoms of Typhoid Fever include fever, headache, vomiting and loss of appetite. Cases of Typhoid Fever in Sub-Saharan Africa are increasing(Kim et al., 2019). In 2010, there were an estimated 11.9 million cases of typhoid fever in low-middle income countries (Mogasale

et al., 2014). Increased Typhoid surveillance will provide more accurate representations of the burden of disease. Typhoid fever can be treated with antibiotics, however, antibiotic resistance in the *Salmonella Typhi* bacteria is increasing. (Brockett et al., 2020)

For more information on Typhoid Fever, visit:
https://www.cdc.gov/typhoid-fever/index.html
https://www.who.int/teams/immunization-vaccines-and-biologicals/diseases/typhoid

Guinea Worm

Guinea Worm is a parasitic infection. It is transmitted through consumption of water sources that have been contaminated with Guinea Worm larvae. Symptoms of infection can include nausea, vomiting, diarrhea, and fever. The larvae grow inside the human body and after about a year, they emerge from the body through a blister. In most cases, this blister is located on the lower limbs of the body. The pain of the worm emerging from the body causes people to seek relief in water sources which completes the transmission cycle as the worm then releases new larvae into the water source. The open wound from the worm poses an increased risk of infection and must be kept clean. Treatment of Guinea Worm infection includes wound care and safely extracting the worm from the body. Cases of Guinea Worm have reduced drastically in recent years and according to the Carter Center, there were only 27 cases in 2020 (Center, 2021a). The Carter Center leads the Guinea Worm Eradication program which has been successful but is seeing some challenges as cases of Guinea Worm have been found in animals now, dogs specifically. (Beyene et al., 2017; CDC, 2020e; Center, 2021a)

For more information on Guinea Worm, visit:
https://www.cartercenter.org/health/guinea_worm/index.html
https://www.cdc.gov/parasites/guineaworm/index.html

Soil-Transmitted Helminths

Soil-transmitted helminth infection is caused by a group of intestinal worms including Hookworm, Ascaris, and Whipworm. Soil-transmitted helminth infection is transmitted through contact with soil that has been contaminated with human feces. This contact can occur through

contaminated food, water, or hands. These types of infection are most common in areas with poor sanitation infrastructure. Symptoms of infection vary based on the intensity of infection and can range from no symptoms to diarrhea, abdominal pain, and overall malnutrition. Cases of soil-transmitted helminth infections are high as it is estimated that over 20% of the world's population are infected (WHO, 2020c). School aged children have a high prevalence of infection due to activities such as playing outside causing them to come into contact with contaminated soil directly. Treatment includes deworming medication. (Becker et al., 2018; CDC, 2020f; WHO, 2020c)

For more information on Soil-Transmitted Helminths, visit,
https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth-infections
https://www.cdc.gov/parasites/sth/

3. Disease Prevention Methods

WASH related diseases are preventable through water, sanitation, and hygiene interventions. Specifically, the combination of safely managed water and sanitation and improved hand hygiene can intervene with the transmission cycles. As mentioned above, some of the WASH related diseases have specific programs in place to control spread of the disease. Safely managed water and sanitation can limit the spread of WASH diseases by eliminating direct contact with feces and contaminated water. (Annette Prüss-Ustün et al., 2014; WHO, 2014)

Water

Household water treatment methods, described in Module 1, can interrupt the transmission cycle by eliminating pathogens in the water. Another way to limit WASH related diseases is through consumption of water that is from safe water sources. For diseases such as Schistosomiasis, it is important to limit contact with contaminated water sources while collecting water, and washing clothes and use clean water to bathe when possible. (Brockett et al., 2020; Annette Prüss-Üstün, Wolf, Corvalán, Bos, & Neira, 2016; WHO, 2014)

The picture below shows reduction in risk of infection associated with drinking water sources.

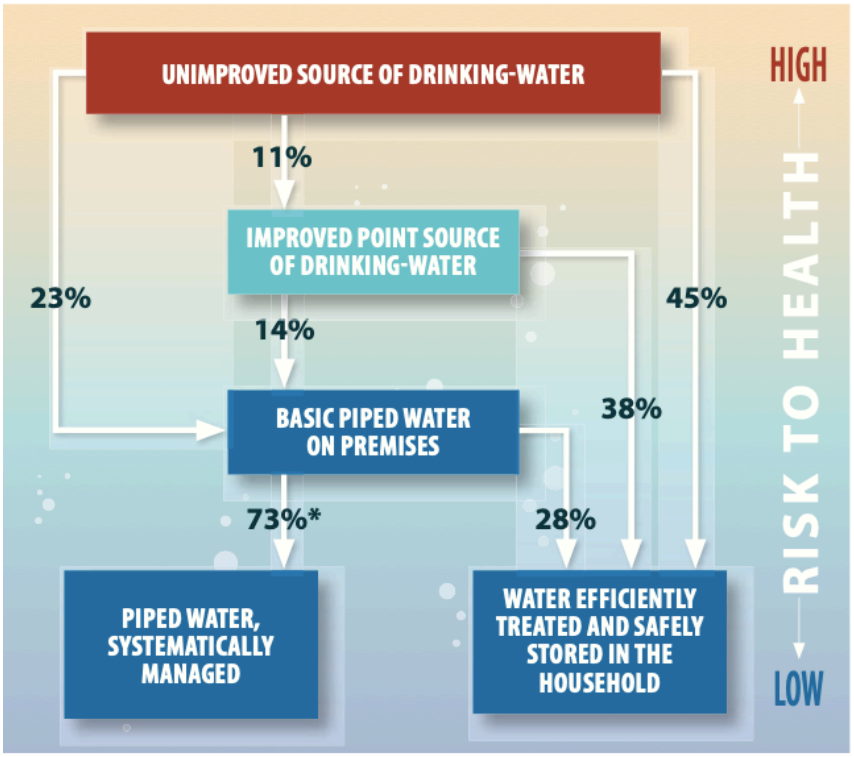

Figure 14. Retrieved from: WHO. (2014). Preventing diarrhoea through better water, sanitation and hygiene: exposures and impacts in low- and middle-income countries. (pg. 34) https://apps.who.int/iris/bitstream/handle/10665/150112/9789241564823_eng.pdf?sequence=1

Sanitation

Access to safely managed sanitation limits number of vectors such as flies that have contact with the human feces and can limit spread of diseases such as Trachoma. It also limits fecal-oral transmission by decreasing soil and water contamination from human waste. Many of the diseases described above are transmitted through direct or indirect contact with human feces and can be controlled through safely managed sanitation. (Oswald et al., 2017; Annette Prüss-Ustün et al., 2014; WHO, 2014)

The picture below shows reduction in risk of infection associated with sanitation levels.

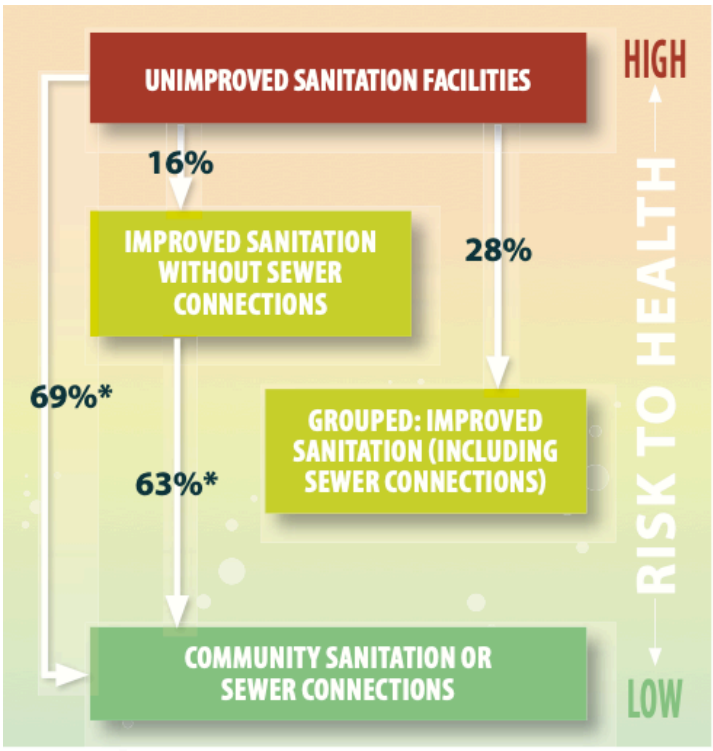

Figure 15. Retrieved from: WHO. (2014). Preventing diarrhoea through better water, sanitation and hygiene: exposures and impacts in low- and middle-income countries. (pg. 34) https://apps.who.int/iris/bitstream/handle/10665/150112/9789241564823_eng.pdf?sequence=1

Hygiene

Hygiene interventions such as handwashing can limit the spread of WASH related diseases. Handwashing and bathing with safe water are key interventions in decreasing transmission events. Handwashing is a way to interrupt fecal-oral transmission. Handwashing after toileting limits transmission by decreasing contact with fecal contaminants. Another important time to ensure that handwashing is occurring is in children after playing outside. Contact with contaminated water and soils while playing outside can lead to an increase in soil-transmitted helminth infections among others. Bathing in contaminated water sources increases disease transmission and can be prevented by using safe water. (Annette Prüss-Üstün et al., 2016; WHO, 2014)

For more information on WASH disease prevention strategies, visit:
https://www.who.int/water_sanitation_health/publications/gbd_poor_water/en/

Key Reading

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Discussion Questions for Discussion Board

Answers to these questions should be posted on the Module 3 discussion board for the class. Students are encouraged to interact and respond to posts from other students.

1. What is a water and sanitation related disease that is most prevalent in your community and what could be done to interrupt the transmission cycle?

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Module Outline 4.

Hygiene

Learning Objectives

By the end of this module, participants should be able to:

1. Identify global hand hygiene issues and challenges
2. Understand hand hygiene infrastructure and services
3. Describe behavior changes related to hand hygiene

Module Outline

1. Identify Global Hand Hygiene Issues

Hand hygiene is a topic that is sometimes overlooked by the development sector, while a larger focus is placed on water and sanitation. Improving global hygiene was not included in the Millennium Development Goals under Target 7.C . However, hygiene was included in the Sustainable Development Goals under SDG 6.2 which aims for sanitation and hygiene access for all. The inclusion of hygiene in the SDGs shows global progress towards recognition of the importance of hygiene for health and wellbeing. (UN, 2015)

For more information on hygiene within the SDGs, refer to:
https://sdgs.un.org/goals

As discussed in both Module 1 and Module 2, the Joint Monitoring Programme through UNICEF and WHO monitors progress toward SDG 6. One of the indicators used for hygiene is the proportion of people with handwashing stations, including soap and water, on the premises (JMP, 2020). Similar to water and sanitation, JMP has guidelines on classifications for hygiene infrastructure, specifically handwashing facilities. Handwashing facilities are defined as facilities that have water flow and regulation for handwashing (Brauer et al., 2020). (Brauer et al., 2020; JMP, 2017)

The JMP handwashing facilities classifications include (JMP, 2017):

- Basic: Basic handwashing is defined as having available facilities that have soap and water

- Limited: Limited handwashing facilities are facilities that do not have soap and water available.
- No Facility: This is the classification when there are no handwashing facilities available.

For more information on JMP for Hygiene visit:
https://washdata.org/monitoring/hygiene

The figure below shows the percentage of the population in Sub-Saharan Africa with basic hygiene service access.

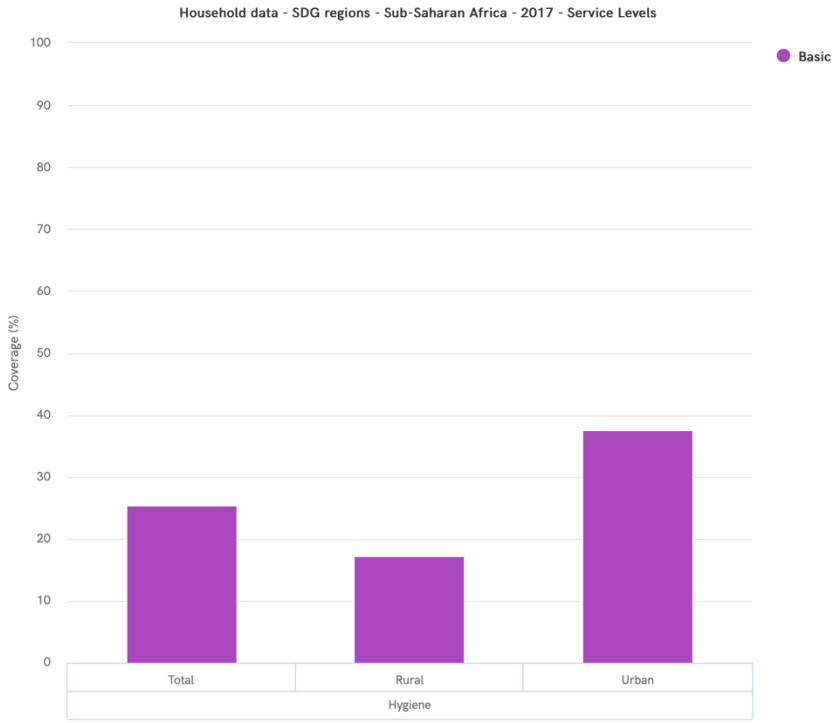

Figure 16. This figure was made on the JMP website with data from: JMP. (2017). Progress on Drinking Water, Sanitation, and Hygiene: 2017 update and SDG baselines.

In 2017, only 25% of people living in Sub-Saharan Africa had access to handwashing facilities with soap and water(JMP, 2017). Adequate representation of hand hygiene access is difficult due to the limited data available and underreporting of many countries. There is currently not enough data to make a broad global estimate of hygiene issues but it is estimated

that one in four people worldwide lack access to handwashing stations and only about 30% of fecal matter exposures are followed with handwashing (A. Prüss-Ustün et al., 2019).

The figure below shows the proportion of the population without access to handwashing stations with soap and water in 2019. As visible in the map, much of Sub-Saharan Africa has the highest proportion of people living without access to handwashing stations at 0.5 or higher.

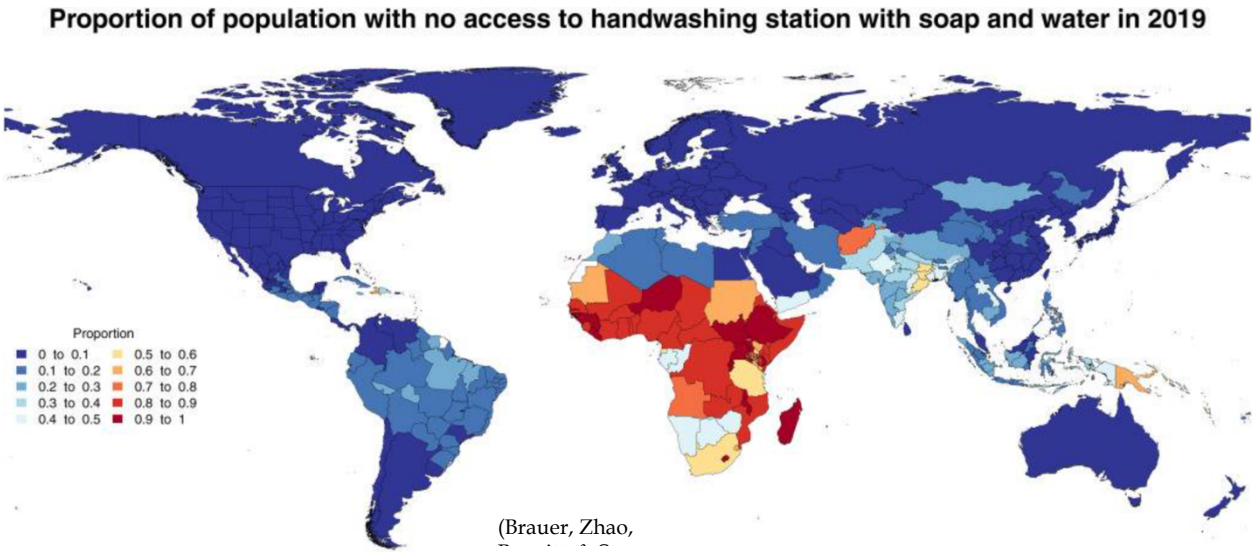

Figure 17. Retrieved from: Brauer, M., Zhao, J. T., Bennitt, F. B., & Stanaway, J. D. (2020, May). Global Access to Handwashing: Implications for COVID-19 Control in Low-Income Countries. Environ Health Perspect, 128(5), 57005. https://doi.org/10.1289/ehp7200

2. Understand Hygiene Supplies and Services

Hygiene infrastructure mostly consists of adequate handwashing stations that have soap and water available. The handwashing stations that are constructed must have consistent water supply in order to be considered basic hand hygiene services by the JMP. In a study done in Tanzania, it was shown that communities that have access to piped water are significantly more likely to participate in handwashing behaviors (Mshida et al., 2020). However, as mentioned in Module 1, many communities in Sub-Saharan Africa do not have piped water systems. This creates a barrier to handwashing as water then has to be collected, treated, and safely stored before it is readily available and safe to use for handwashing. (A. Prüss-Üstün et al., 2008)

Consistent access to soap is another area that must be considered when implementing handwashing stations. Soap is not widely available in Sub-Saharan Africa - with only 33% of households having reliable soap in 2018 (Jiwani & Antiporta, 2020). When soap is available at a community handwashing station, it is frequently taken to be used in an individual household (Whinnery et al., 2016). There are many programs in place to improve affordable distribution of soap products for handwashing yet there are still large inequalities in soap access.

For more information on handwashing after toileting, see Module 5.

Handwashing Solutions

One solution that does not require piped water or supervision of soap supply is the Povu Poa system. This system uses powdered soap that is mixed with the water and stored in the handwashing stations. The water is stored in buckets that use gravity to create a water flow. The water comes out of controlled taps that reduce overall water use. Mixing powdered soap with water prevents theft of the soap and ensures both water and soap access for an affordable price. This type of intervention costs about $1 for 15,000 uses for the soap which is available at most local markets in Sub-Saharan Africa. This cost of soap is significantly lower than the cost of a bar of soap (Wichaidit et al., 2019).

The soap foamer technology that Povu Poa uses costs approximately $3 and is currently available in Kenya but is in the planning stages for expansion to other countries. This type of system can be adapted for school aged children, as the height of the soap and water dispensers can be altered. (Whinnery et al., 2016; Wichaidit et al., 2019)

The picture below shows the model of the Povu Poa handwashing system.

Figure 18. Retrieved from: Wichaidit, W., Steinacher, R., Okal, J. A., Whinnery, J., Null, C., Kordas, K., Yu, J., Pickering, A. J., & Ram, P. K. (2019). Effect of an equipment-behavior change intervention on handwashing behavior among primary school children in Kenya: the Povu Poa school pilot study. BMC public health, 19(1), 647-647. https://doi.org/10.1186/s12889-019-6902-2

For more information on the Povu Poa system, see the article below:

Wichaidit, W., Steinacher, R., Okal, J. A., Whinnery, J., Null, C., Kordas, K., Yu, J., Pickering, A. J., & Ram, P. K. (2019). Effect of an equipment-behavior change intervention on handwashing behavior among primary school children in Kenya: the Povu Poa school pilot study. *BMC public health, 19*(1), 647-647. https://doi.org/10.1186/s12889-019-6902-2

Handwashing facilities must be constructed with the specific target area and population considered. There is no one solution or type of handwashing station for all environments (e.g., schools, public markets, healthcare settings). In developing handwashing stations, the number of people using the facility as well as space, and water/soap supply must be considered, as discussed above. (WaterAid, 2020)

WaterAid has implemented a variety of handwashing stations throughout Sub-Saharan Africa. Many of the systems have transitioned to use of a foot pedal to dispense both soap and water. Similar to the Povu Poa system, the use of powdered or liquid soap to form a soapy water

mixture is used to reduce the overall cost of soap as well as soap theft. The picture below shows a handwashing station that was implemented in Burkina Faso by WaterAid. (WaterAid, 2020)

Figure 19. Retrieved from: WaterAid. (2020). Technical Guide for Handwashing Facilities in Public Places and Buildings (pg. 20) https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/technical-guide-for-handwashing-facilities-in-public-places-and-buildings.pdf

For more information on construction of handwashing stations visit: https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/technical-guide-for-handwashing-facilities-in-public-places-and-buildings.pdf

3. Hygiene Behavior Change

While infrastructure is necessary to implement hygiene interventions, behavior change strategies must also be used to ensure proper use of the hygiene infrastructure. In some cases, social norms of the community around hand hygiene must be addressed in order to have an impact at the individual or household level. There are many times throughout each day where hands can become contaminated and behavior change strategies must promote handwashing behavior at each interval. (Partnership, 2020)

The CDC recommends that handwashing take place at several key times including(CDC, 2020i):

- Before, during, and after food preparation and consumption
- After using the toilet
- Before and after changing diapers or caring for something who has used the toilet.

The process of handwashing also has parameters for effective cleaning. There are five key steps to handwashing including: wetting the hands with clean water, lathering the hands with soap, scrubbing the hands for at least 20 seconds, rinsing the hands under clean water, and drying hands using a clean towel (cite). When soap and water are not available, alcohol-based sanitizers can be used to clean the hands. Of note, alcohol-based sanitizers are not as effective as soap and water and should not replace regular handwashing with soap and water. (CDC, 2020i)

For more information about recommended hand hygiene behaviors, visit:
https://www.cdc.gov/handwashing/when-how-handwashing.html

Hand Hygiene Campaigns

Hand hygiene campaigns are a common way to encourage hand hygiene. Following the implementation of hand hygiene campaigns, a significant increase in handwashing behaviors have been shown (Schmitz et al., 2014). CDC and WHO both have annual hand hygiene campaigns that consist of educational materials for distribution as well as increasing access to necessary water and soap (CDC, 2020d). WHO has an annual global handwashing campaign called "Save Lives: Clean Your Hands" that focuses on handwashing in healthcare settings (WHO, 2021b) while CDC has a hand hygiene campaign in the U.S called "Life is Better with Clean Hands" that targets handwashing behaviors in adults. (CDC, 2020d; WHO, 2021b)

For more information about the WHO Handwashing campaign, visit:
https://www.who.int/campaigns/world-hand-hygiene-day

For more information about the "Life is Better with Clean Hands" campaign, visit:
https://www.cdc.gov/handwashing/campaign.html

Global Handwashing Partnership

The Global Handwashing Partnership is an organization that works to improve global handwashing. Specifically, they promote handwashing campaigns through Global Handwashing Day events that include educational materials on building handwashing stations and encouraging advocacy for increased handwashing. The Handwashing Handbook that was developed by The Global Handwashing Partnership provides insight into behavior change interventions around handwashing and the need to continue to increase handwashing behavior. (Partnership, 2020)

For more information on design of The Handwashing Handbook, visit: http://globalhandwashing.org/wp-content/uploads/2020/10/GHP_Handwashing-Handbook_FINAL.pdf

****COVID-19 and Hygiene***

As described above, consistent access to clean water, soap, and handwashing stations is a challenge for many lower income countries. This creates an inability to interrupt the transmission cycle of COVID-19. COVID-19 spreads through close contact with an infected individual. Exposure to respiratory droplets from the infected person cause infection when they are inhaled or come into contact with the nose or mouth. This includes contact with surfaces that have been contaminated by respiratory droplets. Contact with the nose or mouth, leading to infection, can occur through touching of the face with contaminated hands. Handwashing is one way to limit transmission of the virus. (CDC, 2021a)

The lack of handwashing stations with soap and water could lead to disproportionate impact of COVID-19 in low-middle income countries. Many programs have been put in place in order to increase availability of handwashing stations in low-resource settings including the Aurum Institute's mobile handwashing stations in South Africa. In June and July of 2020, the Aurum Institute implemented 15 mobile handwashing stations and an additional 35 stations in August of 2020 throughout high traffic communities in order to increase access to handwashing stations and with the hope of decreasing the spread of COVID-19. These handwashing stations hold 600 liters of water, providing consistent access to clean water for handwashing (CDC, 2021b). So far, the handwashing stations have been used frequently by community members and appear to be increasing handwashing practices in these areas. (CDC, 2021b; Institute, 2020)

Other African governments have prioritized hand hygiene during the pandemic by drilling boreholes and distributing soap and buckets for water (Amegah, 2020). Access to new water supply and hand hygiene materials as well as mobile handwashing stations has increased significantly since the beginning of the COVID-19 pandemic in 2019, but there is still room to improve.(Amegah, 2020; CDC, 2021a, 2021b)

Guidance on handwashing steps recommended by CDC are displayed in this flyer and can be freely distributed:

Figure 20. CDC. (2021). COVID-19; Handwashing. https://www.cdc.gov/coronavirus/2019-ncov/global-covid-19/handwashing.html

For more information on Hygiene and COVID-19, visit:

https://www.cdc.gov/coronavirus/2019-ncov/global-covid-19/handwashing.html

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Discussion Questions for Discussion Board

Answers to these questions should be posted on the Module 4 discussion board for the class. Students are encouraged to interact and respond to posts from other students.

1. What, if any, hand hygiene campaigns are used in your community and what are the benefits and drawbacks of the program? If there are not any current campaigns, what type of program do you think would work in your community and why?
2. What type of handwashing stations are in your community? Is there consistently soap and water available at those stations? Why or why not?

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Module Outline 5.

Sanitation and Hygiene

Learning Objectives

By the end of this module, participants should be able to:

1. Identify ways to break the fecal-oral transmission cycle and prevent infection
2. Identify and assess menstrual hygiene management needs

Module Outline

1. Breaking the Fecal-Oral Transmission Cycle

This section should focus on fecal-oral transmission and ways to interrupt the transmission cycle. Fecal-oral transmission can occur when there is fecal contamination of food, hands, fomites, flies, or water supply. The diagram shown below demonstrates how feces of an infected individual can contaminate fields and floors, water, fomites, and hands. Flies can carry microbes from feces and then transfer them to food or a new host, causing infection and beginning the transmission cycle again. (de Graaf et al., 2017)

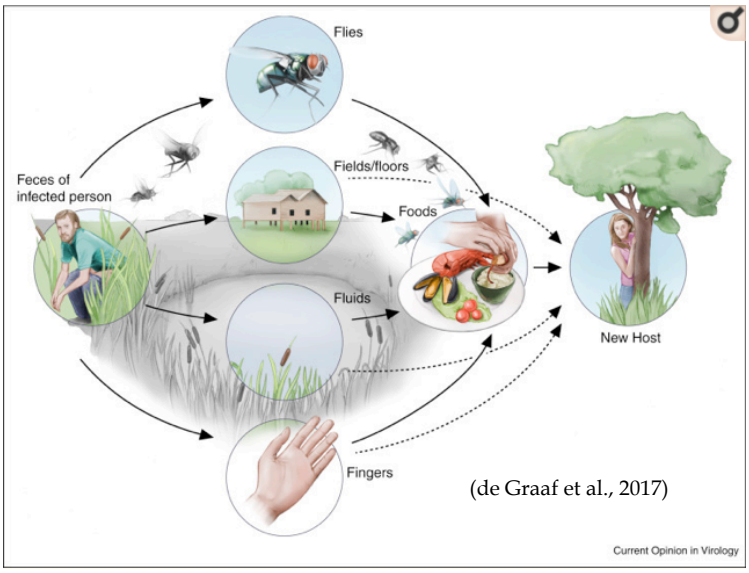

Figure 21. Retrieved from: de Graaf, M., Beck, R., Caccio, S. M., Duim, B., Fraaij, P. L. A., Le Guyader, F. S., Lecuit, M., Le Pendu, J., de Wit, E., & Schultsz, C. (2017). Sustained fecal-oral human-to-human transmission following a zoonotic event. Current opinion in virology, 22, 1-6. https://doi.org/10.1016/j.coviro.2016.11.001

Preventing contamination of the water supply, as stated in previous modules, can occur at many different points. Ensuring that water sources remain safe through elimination of open defecation is one way to prevent consumption of contaminated water. Another way to break the fecal-oral transmission cycle is through consistent handwashing, especially after contact with contaminated surfaces. As mentioned in Module 4, handwashing should be done after toileting (discussed below) or changing diapers, and before, during, and after food preparation. (Kamm et al., 2014; Whinnery et al., 2016)

Soil Contamination and Agriculture

Fecal-oral transmission can also be interrupted by preventing contact with contaminated soil. This contact can occur outside or inside the household. Children are at especially high risk of fecal oral transmission related to soil due to mouthing behaviors (Reid et al., 2018). This contact can be prevented by ensuring that the floors of household dwellings are frequently cleaned and that the children are not playing in contaminated soil while outside (de Graaf et al., 2017; Reid et al., 2018). If the floor in the household dwelling is a dirt floor, then there should be designated hygienic play areas where there is limited contact with the dirt floor. Caregivers of the children should also frequently wipe the hands of the children (Parvez et al., 2019). (de Graaf et al., 2017; Parvez et al., 2019; Reid et al., 2018)

Contamination of agriculture can occur through contaminated water sources, soil, hands, and tools. Instances of food related illnesses have been increasing in recent years. Part of the risk is attributed to contamination of the food source prior to purchase. In an agricultural setting, hands have been shown to carry and transfer the most microbes to fresh produce (Bartz et al., 2017; Newman et al., 2017). In a study done at the U.S-Mexico border, a significant, positive correlation was found between microbes on the farmworkers' hands and microbes on samples of the produce. As mentioned in previous modules, handwashing should occur before, during, and after food preparation. Hand hygiene is also important for farm workers to prevent food contamination. (Bartz et al., 2017; Newman et al., 2017)

Irrigation with contaminated water sources is another way for agriculture to be contaminated prior to consumption. Agriculture requires significantly more water than personal hygiene, and in areas where water access is limited, this can result in the use of unsafe water for irrigation (Bhagwat, 2019). Wastewater is being used more often by farmers in recent years for irrigation

of crops as it provides the soil with desired nutrients at a low cost. Safe use of wastewater for irrigation can be supported by fecal sludge management programs (reference Module 2). However, unsafe irrigation practices with wastewater can lead to soil contamination and transmission of disease from crops to consumer. (Bhagwat, 2019; Khalid et al., 2018)

In order to limit microbe transmission through contaminated food, it is important that produce be washed thoroughly with clean water before consumption and that frequent handwashing occurs when handling food. (Bhagwat, 2019; Khalid et al., 2018)

Hand Hygiene after Toileting

This section should focus on handwashing behaviors after using the toilet. Handwashing behavior is determined by the available resources and the thought processes behind handwashing (Hulland et al., 2013). As discussed in Module 4, availability of supplies and services for handwashing play a large role in determining handwashing behavior. These resources can be placed at handwashing stations throughout the community and it is has been shown that proper placement alone can determine the frequency of handwashing after toileting (Hulland et al., 2013). In fact, combining sanitation and hygiene interventions leads to increased use of both interventions. Specifically, placing handwashing stations near latrines increased both use of latrines and handwashing stations (Hulland et al., 2013; Mshida et al., 2020).

"Nudges" are another way to encourage handwashing after toileting. Nudges assist in habit formation by triggering handwashing behavior through unconscious cues in the environment (Dreibelbis, Kroeger, Hossain, Venkatesh, & Ram, 2016; Partnership, 2017). A study done in Bangladesh in 2015 found that handwashing nudges used at two different schools increased handwashing after toileting by about 30%. The nudges that were used in the study were brightly marked footprints from the latrine to the handwashing station.

The pictures below show the final construction including the addition of nudging. (Dreibelbis et al., 2016; Partnership, 2017)

Figure 22. Retrieved from: Dreibelbis, R., Kroeger, A., Hossain, K., Venkatesh, M., & Ram, P. K. (2016). Behavior Change without Behavior Change Communication: Nudging Handwashing among Primary School Students in Bangladesh. International journal of environmental research and public health, 13(1), 129. https://doi.org/10.3390/ijerph13010129

For more information on nudging behavior change for handwashing, visit: https://globalhandwashing.org/wp-content/uploads/2017/11/Using-Nudges-to-Encourage-Handwashing-with-Soap.pdf

2. Menstrual Hygiene Management

This section should focus on menstrual hygiene management in resource poor settings. This can include emphasis on school aged girls. Menstrual hygiene management is a topic that can be "taboo" for some communities. While the topic has gained more recognition within the WASH community, there may still be barriers for discussion in some regions. It is advised to consult with community leaders and stakeholders about how to discuss the importance of menstrual hygiene management and associated adverse health effects in women and girls who do not have adequate infrastructure, supplies and resources. (Boosey, Prestwich, & Deave, 2014)

Adequate menstrual hygiene management is defined as girls and women having access to clean menstrual hygiene supplies to absorb or collect blood and having the ability to change these items with privacy whenever needed. It also includes having access to soap and water to wash the body and a place to safely dispose of used hygiene items. In low resource settings, these requirements are frequently not met due to lack of separate or private bathrooms, limited

soap and water, and insufficient menstrual hygiene supplies. (Boosey et al., 2014; Kuhlmann, Henry, & Wall, 2017)

Inadequate menstrual hygiene management can create barriers for girls attending school. Girls in school have increased absences during their menstrual cycle as they are unable to manage menstrual bleeding at school. For example, in Malawi, girls that reported lack of privacy in the bathrooms had twice as many absences during their menstrual cycle compared to those that had private bathrooms (Grant, Lloyd, & Mensch, 2013). The SWASH+ project implemented by CARE was one of the first to show the significant impact of inadequate sanitation and hygiene facilities on school aged girls. The program showed that in Kenya, adequate hygiene and water treatment programs can reduce absenteeism in school aged girls by over 50% (CARE, 2019). Similar reports have come from girls in Ethiopia and Uganda (Boosey et al., 2014; Tegegne & Sisay, 2014). Lack of soap and water also significantly contributed to absences among menstruating girls. (CARE, 2019)

Increasing privacy around toilets and soap and water access within schools can improve menstrual hygiene management and decrease barriers to education for girls in school. Menstrual Hygiene Management was incorporated into the SDGs and is addressed in SDG 3, 4, 5, 6, 8, and 12. SDG 4.1 has a specific goal of ensuring that all children are able to complete primary and secondary education without barriers such as gender disparities.

UNICEF also works to improve menstrual hygiene management through “social support, knowledge and skills, facilities and services, and materials and supplies”(UNICEF, 2019). This program works under the SDGs described above to help meet global goals related to menstrual hygiene management.

See the table below to see the specific SDG targets related to Menstrual Hygiene Management (UNICEF, 2019)

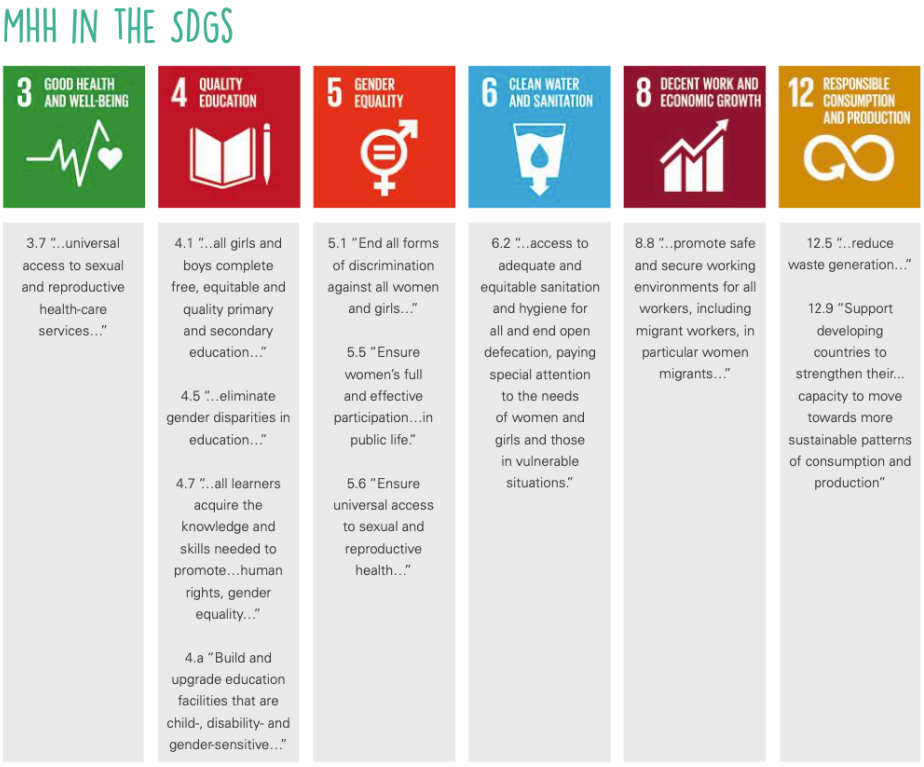

Figure 23. Retrieved from: UNICEF. (2019). Guidance on Menstrual Health and Hygiene. https://www.unicef.org/wash/files/UNICEF-Guidance-menstrual-health-hygiene-2019.pdf

For more information on UNICEF's menstrual hygiene management program, visit: https://www.unicef.org/wash/files/UNICEF-Guidance-menstrual-health-hygiene-2019.pdf

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Discussion Questions for Journal Entry

1. Are there menstrual hygiene management programs in place in your community?
2. What is another idea for handwashing nudging and how would that program be implemented?

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V. Discussion

The five "Introduction to WASH modules" were developed as a distance learning course for the Africa CDC Institute for Workforce Development (IWD). During development of the course, three main considerations were taken in order for the course to align with both Africa CDC's expectations and the learning theories discussed in the literature review of this thesis. These priorities were the audience of the course, the importance of the global context, and course accessibility.

Audience

The audience of the courses of Africa CDC IWD include adults that are working in the public health field. Many of these adults are working professionals that are expanding their knowledge outside of the specific skillset that they already have. The andragogical learning theory was critical in the planning and development of the modules so that they would be impactful for adult learners. The modules were designed to present material in a way in which learners can apply the content to their own experiences. Responses to the discussion questions at the end of each module are designed for a group discussion board format or to be answered by the learner in their own journal for the class. The andragogical theory emphasizes the need for the course content to be designed in a way in which the learner can gain knowledge from the experiences of others and also apply the material to their own experiences (Holmes & Abington-Cooper, 2000; Knowles, 1972). The two methods of answering the discussion questions supports this by allowing learners to reflect on and do further research into implications of the material in their own communities, but also to learn from the experiences of others in the class.

Moore's interaction framework was also considered in order to account for the varying types of interaction included in a successful course. As discussed above, there is ample

opportunity in the course for 'learner to learner' interaction to occur through the discussion boards. The discussion boards will allow learners to build a learning community by building off of the interactions with others in the class. 'Learner to content' interaction was considered throughout the course development to foster critical thinking. This was done through presentation of the current state of and possible solutions to improve water, sanitation, and hygiene access. Suggestions and evaluation of possible solutions were included and learners were then asked in the discussion questions to apply the material that they learned in the modules to suggested programs for their communities. (Bernard et al., 2009; Ehrlich, 2002; Moore, 1989)

In developing the learning objectives for each module, Bloom's Taxonomy was taken into account to ensure the material was presented in an appropriate way (Armstrong, 2010). Since this is an introductory level course and aimed at public health workers with little to no experience with WASH interventions, the lower levels of first defining, remembering and then understanding were prioritized (Armstrong, 2010). The third level of the taxonomy, applying the information, was addressed in the discussion questions where learners were asked to apply the material to their own countries or communities. (Armstrong, 2010)

Global Context

Ensuring that the learners are able to place what they have learned and potential future activities into a global context was a main priority during course development. Therefore, the water, sanitation, and hygiene modules all started with a discussion of the current global situation and global goals. This included introduction to the Sustainable Development Goals, specifically SDG 6, and the Joint Monitoring Programme (JMP). Resources were provided for learners to reference both the SDGs and JMP to track their country or region's progress. The targets related

to water, sanitation, and hygiene were reviewed and global progress towards meeting those goals was assessed.

These global goals are important in order to increase efficiency in public health action and ensure proper resource allocation through global collaboration. By being aware of these global goals, learners can assess their country's alignment with the goals set by the United Nations. Involvement in interventions and national alignment to meet these global goals is crucial in order to receive resources needed for the communities. If a country is misaligned or not aware of the goals, they may be left out of the resource chain. Informing the learners of the global goals, current monitoring systems, and common interventions, related to WASH empowers them to be leaders within their communities and ensure progress towards equitable access to water, sanitation, and hygiene resources.

Course Accessibility

The last major priority during course development was accessibility of the course. This training course intends to increase public health workforce capacity through training public health workers on content that is outside of their specific area of expertise. While there are many training courses for public health workers, there are still gaps in the content areas. One of these gap areas includes WASH topics, specifically introductory WASH courses. This course provides and introduction to WASH content and therefore can be taken by any public health worker without prerequisite knowledge of WASH.

This course is recommended to be given as a distance learning course. Africa CDC IWD is the ideal dissemination point for this course as they have already established rapport with the community and have offered five other courses. The courses offered through Africa CDC IWD are widely available to public health workers throughout Africa and are available online (A.

CDC, 2020). By offering this course online, the target audience can be expanded to include those that are not able to travel - which is ideal during the current COVID-19 pandemic as travel to and within regions Africa is limited.

VI. Impact Statement

This thesis was designed to develop an Introduction to WASH course for Africa CDC IWD. The goal of the thesis was to deliver module outlines that could be used to develop PowerPoint Slides and recorded lectures for the course participants. The intended instructors will be given the module outlines and additional resources used in order to prioritize the information that will be presented. Upon completing course activities such as journal entries and discussion board interaction, the participants will be able to apply the learned content to their own careers in public health.

Through a brief introduction to water, sanitation and hygiene, it is intended that the participants feel comfortable assessing the current state of WASH in their communities and can identify areas for intervention to improve WASH and work towards meeting global goals. The distance learning format also allows for collaboration between public health workers in many regions giving them the chance to share concerns and successes related to WASH. Finally, the content learned in the course can also be passed on to other public health workers in the area in order to have the largest community level impact.

VII. Literature Cited

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