

# Improper Disposal of Waste Water and Masks during COVID-19, and the Associated Increased Cycle of Infection to Human Health in Developing Countries: A Case Study of Tanzania

Honest Anicetus<sup>1\*</sup> , Samwel Manyele<sup>2</sup>, Josephat Saria<sup>3</sup>, Michael Habtu<sup>4</sup>, Grace Saguti<sup>4</sup>, Zabulon Yoti<sup>4</sup>, Yohana Lawi<sup>3</sup>, Innocent Messo<sup>3</sup>, Mathias Machugu<sup>5</sup>

<sup>1</sup>Ministry of Health, Community Development, Gender, Elderly and Children, Dodoma, Tanzania

<sup>2</sup>Department of Chemical and Mining Engineering, University of Dar es Salaam, Dar es Salaam, Tanzania

<sup>3</sup>Department of Environmental Studies, The Open University of Tanzania, Dar es Salaam, Tanzania

<sup>4</sup>World Health Organization (WHO), Tanzania, Dar es Salaam, Tanzania

<sup>5</sup>Muhimbili University of Health and Allied Sciences, Dar es salaam, Tanzania

Email: \*hanicetus@gmail.com, smanyeles@udsm.ac.tz, akiyunge@gmail.com, joseph.saria@out.ac.tz, habtum@who.int, saguti@who.int, zabulony@who.int, mazakwela78@gmail.com, lawiyohana3@gmail.com, mathias.muhochi@gmail.com

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## Abstract

Since COVID-19 was declared by the World Health Organization (WHO), wearing of protective equipment, hand washing using soap and frequent use of antiseptic solution are being applied globally to reduce the transmission rate. This study was intended to investigate handling of after wash waste water and masks among Tanzanian residents on the COVID-19 pandemic after it has been, declared by the World Health Organization (WHO) that, wearing of protective equipment, hand washing using soap and frequent use of antiseptic solution should be applied globally to reduce the transmission rate. The assessment of health care waste management in the facilities was conducted in all the 26 regions of Tanzania Mainland. A standardized checklist and tools were used to assess and monitor various aspects related to healthcare waste using open source software for collection (ODK). Data were analyzed using SPSS computer software. It has been indicated that before disposing the used mask, the best protocol is to spray 0.5% (5000 ppm) of chlorine disinfectant on the surface. In this study, about 46% consider used mask as normal municipal waste and 3% do not care they throw away the face masks in the street. Only 18% and 5% of reported to disposal as infectious and highly hazardous waste respectively. It is well documented that due to potential infectious disease like SARS-CoV-2, wastewater should be treated either on-site or conveyed off-site and treated in well-designed method or technology to kill the

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micro-organisms. The analysis revealed that majority of respondents (74.7%, 73.8%, 48.1% and 65% for healthcare center, district hospitals, regional hospitals and consultant hospitals respectively); dispose the waste in the open space. Continuous awareness creation programs about the negative impact of contaminated face masks and waste water on the health of individuals and introducing laws that can prohibit improper disposal are among the solutions that could help reduce the problem.

### Keywords

COVID-19, Waste Water, Environmental Pollution, Hand Washing, Masks

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## 1. Introduction

The considerable fraction of those hazardous wastes is generated from different healthcare facilities mainly from hospitals [1]. Hospitals are established with the main purpose of protecting the community from any disease [2]. Generally, the different types of medical wastes generated from hospitals are broadly grouped in two categories by World Health Organization [3]. Healthcare waste is classified as non-risk or general healthcare waste, which is comparable to domestic waste and as hazardous waste, which has the potential to pose a variety of health risks [3]. Healthcare waste generation depends on numerous factors such as type of healthcare facilities (HCF), hospital specialization, available waste segregation mechanism, seasonal variation, the number of hospital beds and out patients treated on a daily basis [4].

The outbreak of coronavirus disease 2019 (COVID-19) arisen from the SARS-CoV-2 virus, which occurred in Wuhan, Hubei Province, China [5]. The COVID-19 pandemic has triggered diseases and deaths, created immense confusion for the world and modified solid waste management profiles [6]. This pandemic changed the behavioral and consuming patterns of people, resulting in a sudden change in the generation amount, composition and disposal rate (timing and frequency) of municipal solid waste (MSW), depending on location. The rapid increase in the number of COVID-19 infected patients and the highly transmissible nature of the disease have led to a high number of hospitalizations. Thus, the generation of healthcare solid waste has rapidly increased.

With the rise in the number of COVID-19 infections, almost every region of the world has an expected increase in medical waste from healthcare facilities, such as hospitals, clinics, laboratories, temporary quarantine centres and research laboratories. Thus, it has become necessary to increase the handling capacity for healthcare waste [7], since improper management of the waste may cause further spread of the virus. Exposure to waste can easily infect waste management workers; thus, the necessary protective gear must be worn by these workers as well as by other front line workers, *i.e.* doctors and nurses [8]. The solid waste (*i.e.* sharps, PPE, and pathological waste) generated by COVID-19 positive patients and the doctors and nurses who treat them should be consi-

dered infectious waste.

A recent study [9], found that human corona viruses can remain active on inanimate hard surfaces (such as metal, glass or plastic) for up to nine days. In order to reduce contamination of COVID-19 virus, it is recommended [10] that PPEs like used masks (including triple layer mask, N95 mask, etc.) have to be discarded and collected in separate “yellow colour coded plastic bags” (suitable for biomedical waste collection). This has not been the case for majority of Tanzanian healthcare facilities (Figure 1).

Hand hygiene is essential to reducing the transmission of infection in health and other care settings and is a critical element of standard IPC precautions [11]. All staff, patients and visitors should decontaminate their hands with alcohol-based handrub when entering and leaving areas where care for suspected and confirmed COVID-19 patients is being delivered.

The question of handwashing is particularly important in low-income countries where over half of the population do not have access to a handwashing station in the home [12]. In developing countries like Tanzania, lack of water and sanitation services compromise efforts for hygiene [13], which in turn impacts prevention and control of COVID-19 spread in communities. Hand hygiene must be performed immediately before every episode of direct patient care and after any activity or contact that could result in hands becoming contaminated, including personal protective equipment (PPE) removal, equipment decontamination and waste handling [14] [15]. Inadequate WASH services can increase the risk of COVID-19 spread, along with other diseases such as diarrhea, cholera, typhoid, and hepatitis [16] [17]. Despite the importance of adequate WASH practices, protective equipment use and proper waste disposal are important concerns.

Along with outbreak of this threat, the problem of healthcare waste and wastewater disposal has caused widespread public concern. Wastewater has been known as a major source of pathogen transmission and pathogen contaminated water should carefully be treated [18]. Possibility of such transmission might be a major concern in areas that do not have adequate sanitation and water treatment facilities, as discharge of wastewater without appropriate treatment would expose the public for infection [19]. According to World Health Organization [20] good WASH practices along with proper waste disposal practices can help to prevent the COVID-19 transmission at the community level.

However, unfortunately till now, immediate response to the global pandemic



**Figure 1.** The used and untreated PPE found in waste zone of healthcare.

has focused primarily upon preventing person to person transmission. Potential threat from contaminated wastewater exposure has started to perturb the scientific community only recently, though not much importance is being given at ground level. Therefore, this study was intended to investigate water, sanitation and hygienic (WASH) behaviour, personal protective equipment use and their disposal practices among Tanzanian residents amid the COVID-19 pandemic.

## **2. Methodology**

### **2.1. Assessments Area**

The assessment of health care waste management in the facilities was conducted in all the 26 regions of Tanzania Mainland. From each region, at least four district/municipal/township councils were physically reached by the team of researchers and remaining councils were reached by mobile phones and email. In addition, at least one facility from each district/municipal/township council was assessed regarding the status of health care waste management.

### **2.2. Assessment Tools**

A standardized checklist and tools was used to assess and monitor various aspects related to healthcare waste. These were in form of ODK, which is open source software for collection, managing and using data in resource-constrained environments. The software was opted due to its ability to easily handle data, and it allows for offline data collection with mobile devices in remote areas. It also provides a room for data submission to a server when internet connectivity is available. There were three tools developed; a checklist for RHMT, a checklist for CHMT, and the survey tool for facility assessment.

## **3. Data Collection**

A team of National and Regional level Assessors was formed to assess regional and respective district hospitals including lower healthcare facilities within the region. This was then followed by facility assessment, using the survey tool in each of the facilities' departments. The survey tool was accompanied by direct observation, where several pictures were taken to complement the information collected through other tools.

### **Data Management and Analysis**

Since data sets were electronically prepared, they were coded with variable names, variable descriptions, variable format etc. Thereafter, data were entered into a Statistical Package for Social Sciences (SPSS) computer software, or EXCEL sheet for further processing. This was followed by data cleaning process. This process involved checking the data carefully for errors, accuracy, and identifying and handling missing values. The missing values were corrected by phone calls to respective personnel. Lastly, descriptive statistics such as frequencies, percentages, and means were performed and presented in tables and charts.

## 4. Results and Discussion

The study was conducted in all 26 regions of Tanzania Mainland, engaging a total of 156 councils including City Councils, Municipal Councils and District Councils. A total of 156 participants were also recruited to participate in the assessment; one from each facility assessed in each council. Summary of the findings for sex, facility level, facility ownership, and participants' position are summarized in **Table 1**.

The analysis revealed that male participants dominated their female counterparts (60.3%). With regard to the level of facilities, district hospitals out passed the remaining levels by 61.5%. As it was expected, public facilities outnumbered private facilities (89.1%). It was also anticipated that health officers (both at district and regional levels) dominated the assessment (42.9) followed by medical officers (32.1). This was perfect choice where 91% of the respondents have knowledge about healthcare waste management and issues related to COVID-19. This was corresponding with previous study [21], indicated that majority of healthcare workers who had training regarding healthcare waste management were 9.23 times more likely to safely practice HCWM compared to healthcare workers who did not have training. Another study [22] indicated that proportion of participants who were aware of COVID-19 in his study was 79.4%. In our study there were also other participants (09%) who included Quality Improvement Team members, Council Health Management Team members and Regional Health Management Team members.

**Table 1.** Profile of healthcare facilities and respondents.

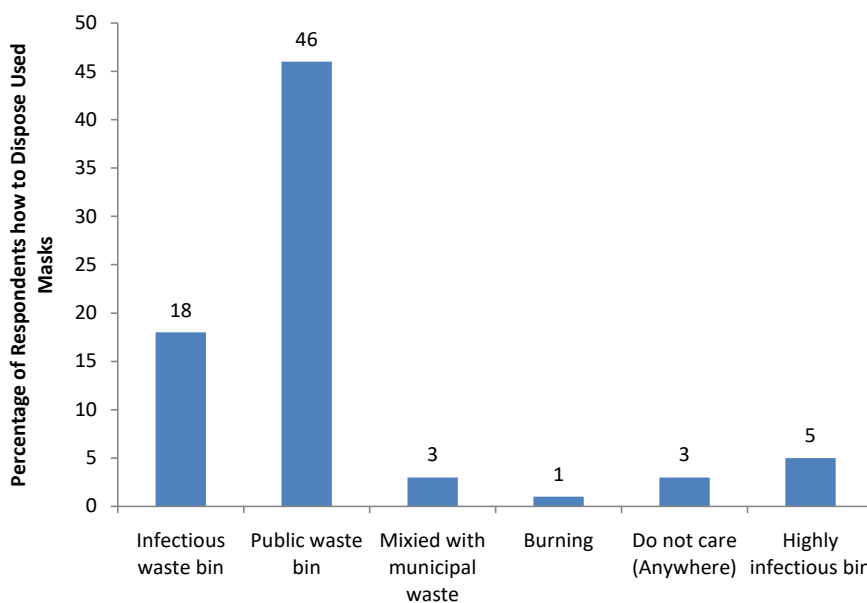
Item	Variable	N	%
Sex of respondents	males	94	60.3
	females	62	39.7
Facility level	regional	28	17.9
	district	96	61.5
	health center	31	19.9
	consultant	1	0.6
Facility ownership	private	17	10.9
	public	139	89.1
respondents position	clinical officer	4	2.6
	health officer	67	42.9
	matron/patron	25	16.0
	medical officer	36	23.1
	enrolled nurse	10	6.4
	others	14	9.0

#### 4.1. Handling of Healthcare Waste during COVID-19 and Compliance with Recommended Standards

Compliance to proper disposal of healthcare waste is among essential issues to ensure no infection occurs due to poor disposal of healthcare wastes. Proper disposal of healthcare waste at source, storage, and transportation are required not only to prevent negative health and environmental impacts, but also to maintain resource efficiency and material recovery. In this study disposal of wastewater and used masks has been shown to be a very challenging issue to different areas due to inadequate compliance of IPC protocol to healthcare workers and lack of education on proper disposal to the community.

Since the emerging of COVID-19 pandemic, wearing a mask and gloves for medical practitioners is important so as to tackle the spread of the virus and environmental perspective [23]. However, proper disposal of used protective equipment is equally important when considered the disposal of the used masks during COVID-19 indicated that it is important to pack them in a double-layered medical waste bags and treated as general medical waste by specific personnel, municipal solid waste workers and the company's special waste management department [24]. It is also suggested earlier [25], that used masks, gloves and other infectious wastes should be separately disposed properly by medical personnel so as to reduce the spread of virus and other infectious pathogens. Majority of respondents, about 46% consider mask as normal municipal waste after using (Figure 2).

This correspond with recent study [16] reported that about 70% of the respondents threw their discarded masks and gloves in house trash or trash bins after their first use. Only 18% of the respondents are reported to properly dispose of used mask by consider it to be infectious waste, while 5% consider used masks as highly hazardous which need special attention and 1% indicated that these



**Figure 2.** Disposing of used mask in healthcare facilities during COVID-19.

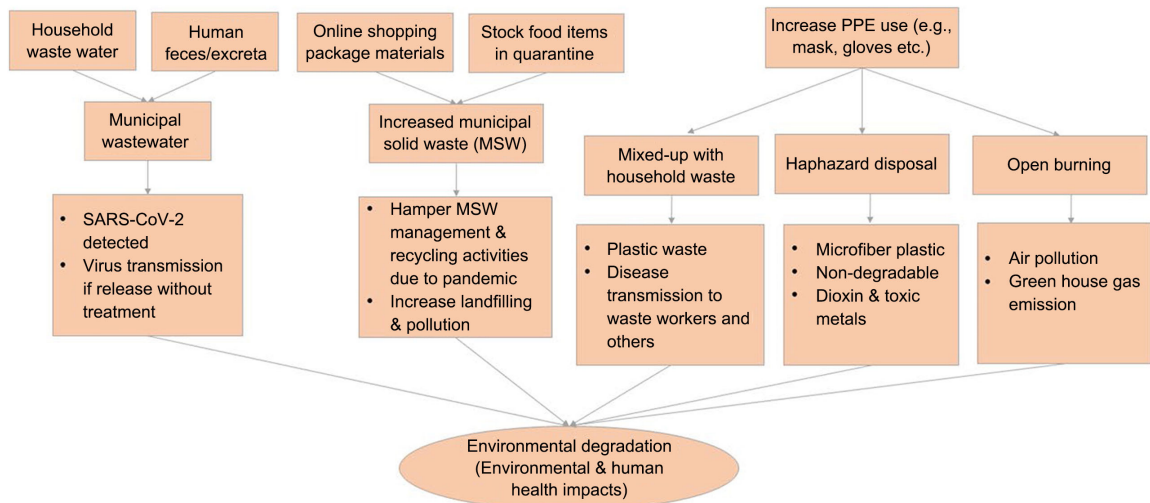
must be burnt completely. These three categories consider used masks can have infectious pathogens may easily infect waste collectors in the country, as they are often not well equipped to handle hazardous waste and they may not be aware of the spreading of the virus [26]. This was also indicated that effective and harmless treatment of medical waste related to COVID-19 has also become an important part of the fight against the pandemic [27]. Though, most of face masks contain plastics or other derivatives of plastics [28]. Therefore, this extensive usage of face masks generates million tons of plastic wastes to the environments in a short span of time. Burning to the open air also is dangerous to the environment as it add up dioxin and other toxic chemicals to the environment.

The serious issue is those 03% who indicated that they normally mixed with common waste. The value from this study is lower than the study conducted recently [28] whereas 19% individuals recklessly throw away the face masks in the street and 12% of people are washing and dispose the mask. All these have the potential to create the environmental issues due to its indecomposable nature.

The best protocol if we want to dispose used mask properly, identified earlier [29] is before placing the bag in the medical waste bucket for temporary storage on site, 0.5% (5000 ppm) chlorine disinfectant should be sprayed on the surface of the bag. Alternately, [30] indicated chlorine-based products (for example, hypochlorite) at 0.1% (1000 ppm) can be used for general environmental disinfection. However, chlorine solutions at lower pH have much shorter shelf lives. Thus, chlorine solutions (0.1% or 0.5%) should ideally be freshly prepared every day [31]. Therefore, after isolation and packaging in another double-layered medical waste bag, a chlorine-rich disinfectant was sprayed again to disinfect the waste.

In a recent study, researchers [32], indicated the handling of urban solid waste and hazardous medical waste, the pandemic has led to a significant challenge (Figure 3).

The collected hospital in most of healthcare facilities, face masks and other mixed waste are sent directly to the incineration and landfill. Due to the existence of the plastics in the mask, such protocol often has the potential to cause adverse environmental effects. Most plastics are chemically stable, resistant to corrosion and, difficult to degrade by microorganisms [33]. Public worries about dioxin and furan trace emissions can become troublesome. The transportation of those waste to relevant disposal site also consume energy and release greenhouse gases to the environment. Plastic is a significant continuing debate, which is not biodegradable material and induces further climate change pollution by affecting land and groundwater [34]. To overcome this issue, different management and assessment approaches have been used such as incineration and landfilling [35]. However, these are no longer preferred options to create the circular economy. Reduction of the plastic usage is completely not possible as it is an inevitable part of human behaviour, hence the search for another option to manage plastic waste is necessary.



**Figure 3.** Environmental and health perspective of WASH and waste disposal practices [32].

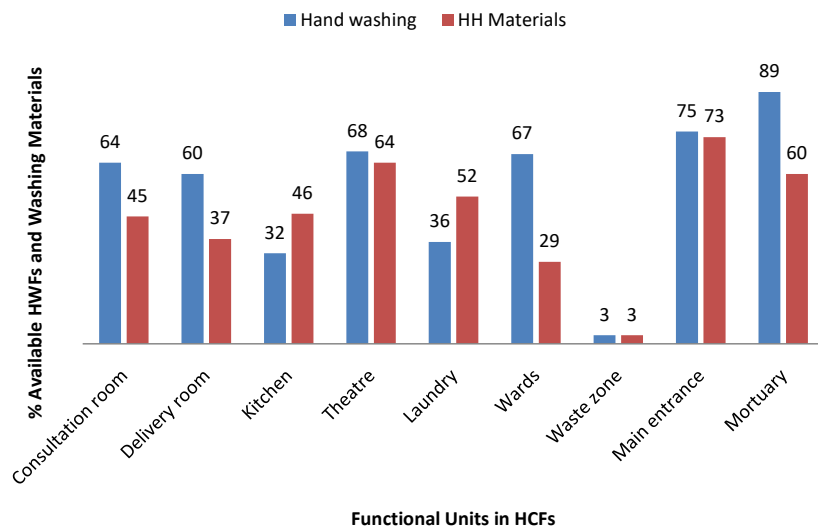
#### 4.2. Availability of Hand Washing Facilities in the Healthcare Facilities

In the healthcare facilities, patients may become infected during their stay especially in emergency situations like COVID-19 situation. Sometimes the healthcare facilities may quickly become overcrowded with injured people or people suffering from infectious disease. During the response to a disaster, it is important to restore and strengthen standards of WASH to avoid healthcare facilities becoming the epicenter of outbreaks of diseases [36]. **Figure 4** shows the general analysis of availability of hand washing facilities and materials like soap at different locations of the healthcare facility.

About 89% of the hand washing stations was available at mortuary unit followed by 75% at main entrance of the healthcare facilities and the lowest was 3% at waste zone area. Hand washing materials like soap main was found at theater (64%) followed by mortuary (60%) and last at waste zone. The discrepancy observed was inline with previous study [37], showing entry/exit points where hand washing was available, 36% of hand washing stations provided water that had been treated with detergent or chlorine. Of the stations with treated water, 79% also provided bar or liquid soap. About 24% of hand washing stations, provide non-treated water and bar or liquid soap. At all hospitals, individuals were more likely to wash their hands while entering the facility than while exiting (56% washed hands at entry vs. 19% at exit).

The missing of hand washing facility at waste zone where only 03% has water station and 03% indicated they have hand washing facilities is a critical issue. This could be due to healthcare poor maintenance attitude, funding challenges and erratic water supply. However, this is evident as it was observed earlier that healthcare workers are not conscious of acquiring infections from patients and the healthcare environment [37] and confirm that they tend to be more concerned about protecting themselves from acquiring an infection rather than protecting patients.





**Figure 4.** The average availability of hand washing stations in functional units of HCF.

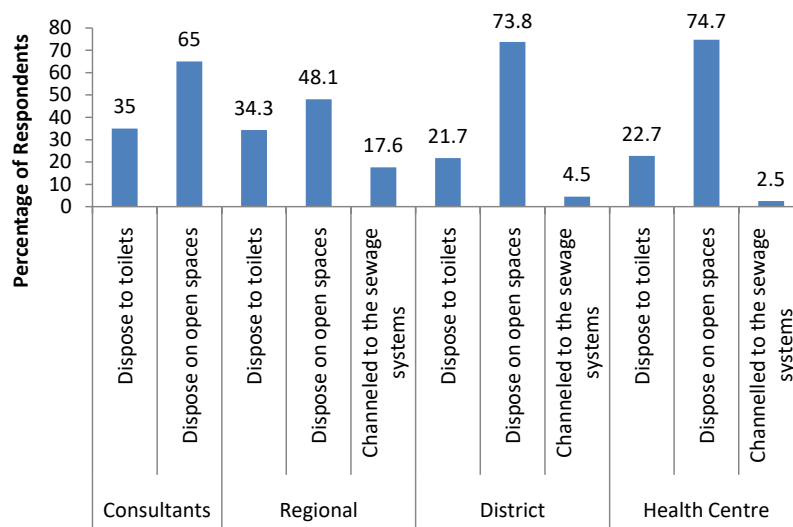
To avoid transfer of pathogens from waste zone to wards and other places by waste handlers, the waste zone must be supplied with water frequently. The quality of water used for hand washing does not need to meet drinking-water standards [3]. Evidence suggests that even water with moderate faecal contamination when used with soap and the correct technique can be effective in removing pathogens from hands [8]. However, efforts should be made to use and source water of the highest quality possible (e.g. at least an improved water source).

#### 4.3. Disposing of Waste Water from the Public Hand Washing Facilities during COVID-19

Due to potential infectious disease risks from excreta, including the potential presence of SARS-CoV-2, wastewater and sludge should be contained, and treated either on-site or conveyed off-site and treated in well-designed and managed wastewater and/or faecal sludge treatment plants [32]. **Figure 5** indicated the responses on how to handle waste water after hand washing in the public hand washing facilities.

In all four healthcare facilities, majority of respondents dispose in the open space. The highest in the healthcare facilities levels was detected in the healthcare facilities 74.7% followed by district level (73.8), consultant (65%) and the last Regional level (48.1%). Another means mentioned was by disposing in the toilets where the highest was detected in regional level (34.3%) and the last option was to direct into sewage system where the highest was detected in regional level 17.6%).

According to WHO/UNICEF [38], due to the potential infectious disease risks from excreta, including the potential presence of SARS-CoV-2, wastewater and sludge should be contained, and treated either on-site or conveyed off-site and treated in well-designed and managed wastewater and/or faecal sludge treatment plants.



**Figure 5.** Handling of waste water from the public hand washing facilities during COVID-19.

It is not recommended that untreated wastewater be released in water bodies or the environment by extension. Where this practice occurs, there must be adequate and appropriate signage and warning to the public to prevent the use of the contaminated areas [39].

In the study conducted in Tanzania on water, sanitation and hygiene situation in healthcare facilities in Tanzania mainland [40] indicated that 60.4% of surveyed health facilities are not connected with piped water supply, while 16.7% are not connected with piped water supply. However, it was alarming that, more than 50% of healthcare centres and dispensaries lacked connectivity with piped water supply.

There are varied and unacceptable densities of the physiochemical parameters of these effluents suggest that the activities of hospital wastes in the environment is a major health and environmental threat, which therefore call for a proper regulatory system on disposal of hospital effluents worldwide, especially in the developing countries like Tanzania. However, due to poor quality of water used in most of Tanzanian healthcare facilities, such waste effluents disposed to the open environment, may be loaded with heavy metals, toxic chemicals, and radioactive elements, and hence may endanger public health and welfare, and contribute to oxygen demand and nutrient loading of the water bodies and in the process promote toxic algae blooms and leading to a destabilized aquatic ecosystem, if discharged without treatments into water bodies [41].

## 5. Conclusion

This study demonstrated the real impact of disposal of COVID-19 PPEs and waste water in healthcare facilities. It can be concluded that extensive usage of face masks generates million tons of plastic wastes to the environments in a short span of time. Burning to the open air also is dangerous to the environment

as it add up dioxin and other toxic chemicals to the environment. Hospital wastewaters could not be regarded safe to be disposed off directly into the environmental water bodies and open spaces. These effluents can contaminate the surface and even underground water, thereby making it unfit for irrigation and drinking.

## 6. Recommendation

It is recommended that conditions of water supply, sanitation services and hygienic practices in Tanzania healthcare facilities requires urgent need for improvement to prevent cross contamination and transmission of infections. These observations reflect on a much broader picture of the situation of WASH/HCWM and IPC practices in healthcare facilities around the country.

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## Ethical Approval and Consent to Participate

The Tanzania Ministry of health commissioned the study. All the required ethical clearances and approvals were granted by the Tanzania Ministry of health. Also, none of the participants was coerced to participate. Some aspects of the data had been made available by the Ministry of health for public use by permission and authorization.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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