University of Dar es Salaam

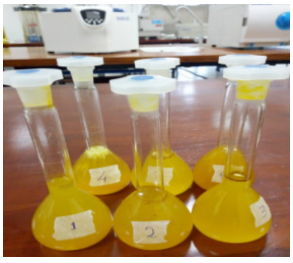
POLICY BRIEF

2020

1 RAISING AWARENESS IN SUPPORT OF LOCAL PROCESSORS IN THE PRODUCTION OF ORGANIC SANITIZERS USING PLANT EXTRACTS

Author's name: Lillian Daniel Kaale*a
Institution: aUniversity of Dar es Salaam, Dept. Food Science and Technology, Dar es Salaam, Tanzania
*Corresponding author E-mail:
P. O. Box 35134, Dar es Salaam, Tanzania
Phone number: +255 713 133030;
Fax number: +255 2410114






Summary

This policy brief focuses on raising awareness in support of local processors in the production of organic sanitizers (OS) using local raw materials against the backdrop of poor strategies in promoting our local industries due to poor infrastructures and lack of an enabling environment. As a result, there is a need to establish good infrastructure in technology, financing, policy framework, and administration to boost the growth and transformation of local industries. After all, lack of value addition due to over-dependence on importations has significantly affected the growth and transformation of local industries. The value addition is very crucial in promoting local manufacturing industries, encouraging sustainability, catalysing economic empowerment, and creating jobs. On the other hand, insufficient hygiene results in morbidity and mortality in the country due to pandemic and endemic infections. In low- and middle-income countries this problem has resulted in harm and several deaths. Therefore, the hygienic process can be implemented by developing low-cost infection prevention and control interventions (LIPCI) such as the production of organic sanitizers using locally-available raw materials. The government should intervene by establishing conducive infrastructures and enabling environments, for example, through the introduction of incentives for local manufacturers or processors of organic sanitizers using locally-available raw materials.

Background

In Africa and Tanzania in particular, most of the industrial products are imported as the continent is not fully utilising its raw materials by ensuring that it establishes industries that produce products using locally-available materials. In addition, the continent does not generally prioritise products produced locally, hence making the community rely on imported products. On the other hand, the response to COVID-19 in Tanzania has illustrated that the country can have recourse to locally available sanitizers and other facilities such as hand wash tanks, face masks etc. What has emerged from this experience is that the country can set up a good tool and framework for controlling and regulating the community on how to utilise local raw materials and establish industries to produce various products locally.

It is indisputable that the outbreak of SARS-CoV-2 has overwhelmed health systems, created economic turmoil, and disrupted supply chains around the world (Thomson and Bullied, 2020). During the outbreak, the world continued reeling from the sheer weight of the epidemic; it faced a hard time in the face a severe scarcity of products with which to control the disease such as gloves, face masks, and sanitizers. The sanitizers had the most effect in the response to COVID-19 because hand-sanitizers are alcohol-based formulations containing 60%– 95% of alcohol capable of denaturing the proteins of microbes and inactivating viruses (Jing et al., 2020).

In particular, hand hygiene is important as hands can easily be contaminated during direct contact with airborne microorganism droplets from coughs and sneezes. In situations such as the COVID-19 pandemic outbreak, it is crucial to interrupt the transmission chain of the virus by practising proper hand sanitization (Jing et al., 2020). Washing hands often with soap and flowing water for at least 20 seconds is essential. When

soap and water are not readily available, alcohol-based hand sanitizers or rubs are acceptable. However, all the sanitizers in the country have been either imported as finished products or the raw materials i.e. alcohol, glycerine and hydrogen peroxide. The importation of sanitizers or associated raw materials pushes the price up, hence making the sanitizers unaffordable to most Tanzanians in the poor brackets. Thus, there is a need to consider producing alcohol-based hand sanitizers locally using resources available.

It is against this backdrop that the University of Dar es Salaam (UDSM) through the Department of Food Science and Technology embarked on this study on developing organic sanitizer using *Aloe vera,* instead of glycerine, which serves as a skin moisturizer. In the meantime, essential oil extracted from orange peels serve as a substitute for hydrogen peroxide.

Findings

The emergence of the COVID-19(CoronavirusDisease-2019) pandemic is a serious global public health concern, which has led to extensive use of hand disinfectants such as soap with water, and sanitizers. Sanitizers are substances that act as both cleaning and disinfecting agents. A hand sanitizer is a liquid used generally for sanitizing animate articles (Singla and Saini, 2019). Alcohol-based sanitizers usually contain some combination of *iso propanol*, *ethanol* or *n- propanol*, *glycerine* and *hydrogen peroxide*. Hand sanitizers are effective against bacterial and fungal infections, as well as enveloped viruses, such as the common cold, COVID-19 and flu viruses and in preventing nosocomial infections caused by different opportunistic microorganisms (Patankar and Chandak, 2018). Different studies have been carried out to develop sanitizers using plant extracts. Singla and Saini (2019), for example, developed sanitizers using eucalyptus, rose extracts and glycerine. Patankar and Chandak (2018), on their part, developed three sanitizers lemon, lemon-neem and neem sanitizer. To the best of researcher's knowledge, there is no industry or government institution that produces organic sanitizers in Tanzania.

Production of sanitizers using local raw materials

Production of products such as sanitizers using local raw materials can conserve resources, enhance biodiversity, and maintain the ecosystem for sustainable production. Moreover, production of sanitizers using locally-available raw materials present different advantages such as cheaper procurement of hand rubs for resource-rich communities that can easily procure the raw materials. Moreover, such production using locally-available materials can serve as a catalyst for encouraging sustainability, enhancing economic empowerment and generating jobs. However, for this development to become a reality there is a need unwavering national support, particularly through leadership in prioritizing infection prevention as a key to halting and reducing preventable diseases, targeting resources towards establishing systems that would support hand hygiene and enlightenment, and foster cultural acceptance of the practice by health workers.

Conclusion

Overall, there is a need for the government to revise its policy on the transformation of local industries to promote local manufacturing industries, encourage sustainability, boost economic empowerment and create jobs. Indeed, a sustainable hygienic process needs to have effective demands, government financing and cost recovery coupled with dynamic operations and maintenance. Ultimately, the production of products such as sanitizers using local raw materials, particularly during the outbreak of COVID-19 is highly encouraging in Tanzania since such production can conserve resources, enhance biodiversity, and maintain the ecosystem for sustainable production. Eventually, such production would also significantly reduce morbidity and mortality in the country.

Acknowledgment

"This work was carried out with the aid of a grant from UNESCO and the International Development Research Centre, Ottawa, Canada. The views expressed herein do not necessarily represent those of UNESCO, IDRC, or its Board of Governors".

Reference

Thomson, E. L and Bullied, A. R (2020). Production of ethanol based hand sanitizer in breweries during the COVID-19 crisis. MBAA TQ, 57(1), 47-52.

Jing, J. L. J., Yi, T. P., Bose, R. J. C., McCarthy, J. R., Tharmalingam, N and Madheswaran, T (2020). Hand Sanitizers: A Review on Formulation Aspects, Adverse Effects, and Regulations. International Journal of Environmental Research and Public Health, 17, 1-17.

Singla, D and Saini, K (2019). Formulation of an Herbal Substitute for Chemical Sanitizer and its Evaluation for Antimicrobial Efficiency. International Journal of ChemTech Research, 12(3), 114-120.

Patankar, R. S and Chandak, N (2018). Formulation of Herbal Sanitizers and Determining Their Antimicrobial Activities Against Skin Pathogens. International Journal of Innovative Science and Research Technology, 3(8), 169 – 177.

2 REPURPOSING OF DRUGS AND OTHER REMEDIES: A LESSON FROM COVID-19

Stephen S Nyandoro[1], Geradius Deogratias[1,2], Daniel M Shadrack[2,3] John- Mary Vianney[2], Hulda S Swai[2], Lucy W Kiruri[4]

[1]Chemistry Department, College of Natural and Applied Sciences, University of Dar es Salaam, P.O.Box 35061, Dar es Salaam, Tanzania

[2]Department of Health and Biomedical Sciences, School of Life Science and Bioengineering, The Nelson Mandela African Institution of Science and Technology, P.O. Box 447, Arusha, Tanzania.

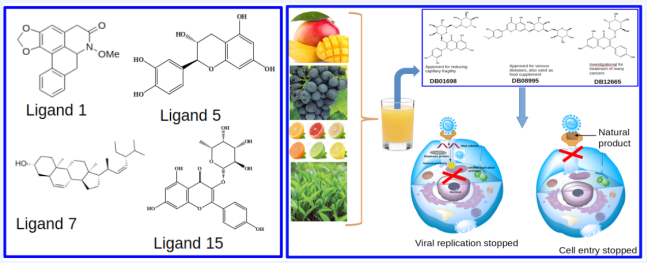
[3]Department of Chemistry, Faculty of Natural and Applied Sciences, St. John's University of Tanzania, P.O. Box 47, Dodoma, Tanzania

[4]Department of Chemistry, Kenyatta University, P.O. Box 43844-00100, Nairobi, Kenya

Key Messages:

- The recent outbreak of SARS-CoV-2 is responsible for high morbidity and mortality rate across the globe. It required and still requires an urgent identification of drugs and other interventions to overcome the disease.
- Computational drug repurposing represents an alternative approach to providing an immediate solution for handling the outbreak of COVID-19 and other infections.
- Using computational methods, selected antiviral natural products from Tanzania's medicinal plants were screened and, based on their hits, a similarity search of FDA-approved drugs was done.
- Drugs obtained from the similarity search namely *diosmin* (DB08995), *isoquercetin* (DB12665) and *rutin* (DB01698) were assessed for their stability and inhibition against SARS-CoV-2 targets.
- *Diosmin* was found to be a promising drug that works by preventing viral replication and viral fusion into the host cell whereas *isoquercetin* and *rutin* work by inhibiting viral replication and preventing cell entry, respectively.
- These computationally identified SARS-CoV-2 inhibitors and other similar flavone glycosides being aplenty available from natural sources, they could serve as cheap alternative remedy to combating COVID-19 once their clinical efficacy is validated.

- Such computational screening approach can be extended in terms of training, capacity-building and searching for other potential molecules for the remedies of COVID-19 and other infections. Thus, the government through its institutions responsible for health should provide policy and guidelines for drug repurposing strategies including both modern and indigenous (traditional) based remedies.



Graphic Summary: Overview:

The outbreak of the severe acute respiratory syndrome novel coronavirus (SARS-nCoV-2) pandemic has called for worldwide attention among scientists and physicians searching for effective drugs to combat it. Covid-19 has caused the deaths of hundreds of thousands of people worldwide with higher cases reported in the United States (US), Italy, the United Kingdom (UK), France, Spain and Brazil. In Africa, many countries including our own country, Tanzania, were hit by the infection at varying rates. This called for an urgent identification or development of drugs to treat the disease.

Generically, drug repurposing/repositioning involves identifying existing drugs for the purpose of treating a new disease. The drugs identified have known pharmacological properties and can be tested in clinical settings without necessarily going to pre-clinical trials. Thus, today, many drugs approved to treat known diseases are repurposed to treat new diseases [1]. A similar approach is deployable in traditionally used remedies, whereby indigenous medicines that have been in use for a given disease are extended to treat a new disease just breaking out.

Our project used a computational approach as a means for identifying possible already approved drugs for treating other ailments to be re-routed to combating COVID-19. Computational drug repurposing is an effective, cost-effective and faster process used in modern drug discovery and development [2]. This approach entails employing different strategies such as gene expression similarity, repositioning based on chemical similarity, drug side-effects similarity, and virtual screening through docking scoring functions. Such computational deductions are effective in screening large libraries of drugs to identify new drug candidates. Though these computational methods require high computing systems, they are relatively cheaper and reduce experimental costs. In addition, they provide more insights into understanding the interaction of materials at the molecular level where experiments have limitations. Thus, the aim of this project was to perform drug repurposing from natural products with antiviral properties and WHO-approved drugs utilising different computational methods to identify new drugs to treat COVID-19. We did our initial work to screen drug-like molecules from two medicinal plants in Tanzania using COVID-19 causing virus main protein structure available in the protein data bank. The preliminary results are very promising warranting further work.

Findings:

Identified drugs potential for repurposing against COVID-19

To identify new drug to fight the SARS-CoV-2 which causes COVID-19, a combination of computational methods was applied. Three FDA-approved glycosylated flavonoids, namely *diosmin* (DB08995), *isoquercetin* (DB12665) and *rutin* (DB01698) showed effective inhibition against SARS-CoV-2 targeting different proteins. DB12665 is an investigational drug for treating kidney cancer and thromboembolism of vein in pancreatic cancer [3]. This drug has also shown promising antiviral activities against influenza A & B viruses [4]. Thus, it could be a potential candidate to be repurposed for SARS-CoV-2 targeting viral replication. DB01698 is an approved drug used to reduce capillary fragility. The drug is also reported to have different pharmacological benefits including antiretroviral and antiviral activities [5]. This drug could also be repurposed against SARS-CoV-2 targeting viral fusion inhibition entry to host cells. DB08995 is an approved drug for venous disease and serves as a food supplement. The molecule appears to target SARS-CoV-2 through two different mechanisms: Inhibiting viral replication and fusion into host cells. This drug could be repurposed for SARS-CoV-2. These findings

provide evidence that warrants public health policy formulation that encourages computational insights into identifying drug agents.

Natural sources of the identified FDA approved drug potential for repurposing

The FDA-approved drugs identified to have potential for repurposing are natural products belonging to the group of sugar-containing flavonoids. DB08995 is found mostly in green tea and Rosemary herbal. It is also found in juices and orange wines [6]. DB01698 is found in many plants including green tea, passion flowers, apple, and buckwheat [4]. Finally, DB12665 is found in mango [7], tea [8] and in the leaves of custard apple [9]. These computationally identified SARS-CoV-2 inhibitors may serve as cheap alternative remedy to combating COVID-19 once their efficacy is clinically proven since they are aplenty in natural sources.

Recommendations

- The computationally identified SARS-CoV-2 inhibitors and other similar flavone glycosides should be subjected to clinical trials for validation of their efficacy. Such drugs are plenty available from natural sources; hence they could serve as cheap alternative remedy to combating COVID-19 once their clinical efficacy is proven. Therefore, the Ministry responsible for health should improve or formulate policies and guidelines for clinical trials to include computational based methods of drug discoveries.
- Such computational screening approach can be extended in terms of training, capacity building and searching for other potential molecules for the remedies of COVID-19 and other infections. As such, existing drugs and other drug agents with potential to treat COVID-19 can be identified using a similar approach. Thus, soliciting for funds to buy powerful computers (workstations) alongside training in computational science in drug discoveries and related fields for further research endeavours is highly recommended.
- To extend the screening of natural products with potent antiviral activities from medicinal plants available in the library of or reported by the Natural Products Research Group (NPRG), Chemistry Department, the UDSM, and other institutions for providing chemical agents for medicinal chemistry geared towards drug discovery. The natural product drug agents identified from such work could entice their re-isolation for further wet laboratory testing towards drug development discovery as their value addition initiatives.
- Enhancement of higher learning and research institutions intra- and inter-linkages with industries and, for this case, with pharmaceutical industries. Such linkages could enrich computational scientific knowledge in drug developments through continuous exchange of ideas and resources between institutions and industries with different expertise and other resources/facilities.

References

Chopra, S., et al., *Repurposing FDA-approved drugs to combat drug-resistant Acinetobacter baumannii.* Journal of antimicrobial chemotherapy, 2010. **65**(12): p. 2598-2601.

Sanseau, P. and J. Koehler, *Computational methods for drug repurposing*. 2011, Oxford University Press.

D. S. Wishart, Y. D. Feunang, A. C. Guo, E. J. Lo, A. Marcu, J. R. Grant, T. Sajed, D. Johnson, C. Li, Z. Sayeeda, et al., \Drugbank 5.0: a major update to the drugbank database for 2018," Nucleic acids research, vol. 46, no. D1, pp. D1074-D1082, 2018

A. Ganeshpurkar and A. K. Saluja, \The pharmacological potential of rutin," Saudi Pharmaceutical Journal, vol. 25, no. 2, pp. 149-164, 2017.

A. Staniewska, \Safety of treatment and dietary supplementation with diosmin in daily doses up to 2000 mg a day," 2016

G. L. Hostetler, R. A. Ralston, and S. J. Schwartz, \Flavones: Food sources, bioavailability, metabolism, and bioactivity," Advances in nutrition, vol. 8, no. 3, pp. 423-435, 2017.

U. Singh, D. Singh, M. Singh, S. Maurya, J. Srivastava, R. Singh, and S. Singh. Characterization of phenolic compounds in some Indian mango cultivars," International journal of food sciences and nutrition, vol. 55, no. 2, pp. 163-169, 2004.

H. Sakakibara, Y. Honda, S. Nakagawa, H. Ashida, and K. Kanazawa, \Simultaneous determination of all polyphenols in vegetables, fruits, and teas," Journal of Agricultural and Food Chemistry, vol. 51, no. 3, pp. 571-581, 2003.

S. Panda and A. Kar, \Antidiabetic and antioxidative effects of annona squamosa leaves are possibly mediated through quercetin-3-*O*-glucoside," Biofactors, vol. 31, no. 3-4, pp. 201- 210, 2007.

3 DESIGN AND DEVELOPMENT OF SYSTEMS FOR CONTROLLING SPREAD OF COVID-19

By: Simon I. Marandu, Mathias Halinga, and Mussa I. Mgwatu,

1. Introduction.

1.1 Summary.

As the COVID-19 pandemic spreads across the globe, millions of people are heeding the advice of health experts to wash their hands. Handwashing is one of the most effective ways of preventing the transmission of disease, not just the coronavirus—COVID-19. Safely managed water, sanitation, and hygiene (WASH) services are an essential in preventing and protecting human health during outbreaks of infectious diseases, including the current COVID-19 pandemic. One of the most cost-effective strategies for increasing pandemic preparedness, especially in resource-constrained settings of developing countries, is investing in core public health infrastructure such as water and sanitation systems. Good WASH and waste management practices, that are applied consistently, serve as barriers to human-to-human transmission of the COVID-19 virus in homes, communities, healthcare facilities, schools, and other public spaces (Bank W. , 2020)

1.2 Background.

Frequent and thorough hand washing with soap and flowing water plays a crucial role in preventing the spread of infectious diseases such as COVID-19. The COVID-19 pandemic has affected people's lives in many ways and its spread and contamination is still a challenge. Frequent handwashing with soap has emerged as the simplest practice for avoiding contracting the disease. In fact, when used properly, soap effectively dissolves the fatty membrane that surrounds the corona virus particle, hence their disintegration and inactivation. In this regard, WHO recommends the following design features for handwashing facilities for public use (WHO, 2020):

- **Turning the tap on/off:** This mode should be sensor-controlled, foot pumped or installed with a large handle for the tap to be turned off using an arm or elbow.
- **Soap dispenser:** For liquid soap either sensor-

controlled or large enough to operate with the lower arm, for a bar soap, a soap dish should be well draining without the soap getting soggy.

- **Grey water:** Ensuring the grey water is directed to and collected in a covered container if not connected to a piped system.
- **Drying Hands:** Paper towels and a bin should be provided and, when this is not possible then air drying for several seconds is necessary.
- **Materials:** Generally, the materials should be easily cleanable and repairable; preferably the replacement parts should be sourced locally.
- **Accessible:** There is a need for universal accessibility for users, including children and those with limited mobility.

The College of Engineering and Technology of (CoET) of the University of Dar es Salaam, through its Technology Development and Transfer Centre (TDTC) has designed and fabricated automatic, foot-operated handwashing machines, multi-hand washing facilities in response to the government directive on handwashing using running water and soap to prevent the spread of COVID-19. Moreover, the Production section of the Department of Mechanical and Industrial Engineering designed and developed an Automated Spray Disinfectant machine for a whole-body spray of disinfectants to combat the spread of COVID-19

2. Handwashing Machines.

Based on the features presented in section 1.2, the TDTC embarked on the innovative design of handwashing machines for public use. Subsequently, it developed three types of handwashing machines to cater for different community needs depending on the number of people. They include Automatic Handwashing Machine and Multi-hand washing systems.

2.1.1 Foot-Operated Hand Washing Machine

This type of handwashing machine (see Figure 1) allows a user to wash hands without touching both the water tap and liquid soap. TDTC has designed, fabricated, assembled and installed two types of foot-operated hand washing machines. The first one is a Single-Tap Handwashing Machine and the other is a Double-Tap Handwashing Machine.

2.1.1 Single-Tap Foot-Operated Handwashing Machine.

This foot-operated handwashing machine is operated by pressing its two-foot pedals: The left one is for soap discharging and the right one is for water discharging. When a left pedal is pressed down at once, a metal rod connected to the pedal is pushed upward and, as a result it also pushes a handle which presses the soap bottle cap and discharges liquid soap from the bottle onto the user's hands. The release of the foot pedal pulls a helical spring attached to the pedal back to its default position.

Similarly, water is discharged from the right-side foot pedal, when pressed, pushing the rod connected to the pedal upwards and driving a handle to operate the water tap. This allows the water to flow from the tank to the user's hands via the tap. The release of the pedal retracts the helical spring pulls to its default position, thereby, closing the water tap.

This hand washing system comprises several parts/ components (Figure 2) which include:

a) The body frame.
b) Water tank.
c) Water lever.
d) Soap lever.
e) Water tap.
f) Soap base.
g) Basin holder.
h) Helical spring.

Figure 1: Single-Tap foot-operated handwashing machine.

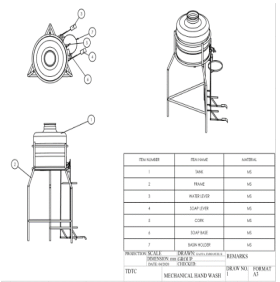


Figure 2: Technical drawing of a Single unit foot operated machine.

2.1.2 Double Tap-Hand Washing Machine

The double-tap handwashing machine (Figure 3) works similarly as the single tap handwashing machine except it has two taps, thus allowing two users to wash hands simultaneously. To accommodate this function, the frame has four legs instead of three as the single-tap handwashing machine.

Figure 3: *Double-tap Foot-operated Handwashing Machine.*

2.1.3 Multi-tap Hand Washing Facility.

The operational mechanism of this facility is the same as that of foot-operated handwashing machines. The difference is that, in this multi-unit handwashing facility, six or more users can wash their hands at a time. Each washing station, as Figure 4 illustrates, has a soap reservoir with a pump driven by a foot pedal and a system for collecting grey water and discharging to a common sewage system. The facility (see Figure 5) can be fitted with a station for disabled people to wash their hands by discharging soap using their elbows.

The main parts of the multi-tap handwashing facility are:

1. Machine frame and body
2. Water tank
3. Water lever
4. Soap lever
5. Water tap
6. Soap reservoir and pump
7. Hand washing sink
8. Gray water collection system

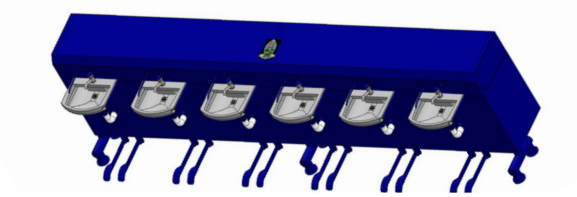


Figure 4: *Schematic representation of Multi-tap foot-operated facility.*

Figure 5: *A Multi-tap foot-operated machine*

2.1.3 Automatic Handwashing Unit.

In the automatic hand washing system (AHWS) presented in Figure 6 soap and water flow when users place their hands just below the soap and water tap outlets. It uses infra-red (IR) sensors to detect the presence of hands for either soap or water to flow. It does not need mechanical linkages to discharge water and soap.

The AHWS design is based on operational amplifier (OPAMP), which is a voltage comparator that compares voltage from the IR sensors and potentiometer to provide a control signal for triggering a relay to either open or close a tap.

When the IR receiver does not receive a signal, the potential at the inverting terminal of OPAMP goes higher than that of non-inverting terminal of the OPAMP and, hence, its output goes low and the LED does not glow. On the other hand, when the IR receiver receives a signal, the output of the OPAMP goes high and the relay is energized to transmit from normally close to normally open, hence making the centrifugal pump (for soap) or solenoid valve (for water) and the 12 V DC supply to allow the pump or solenoid to operate and discharge soap and water, respectively. In so doing, the system realises a zero-infection handwashing practice.

This handwashing system is composed of several parts/components as follows:

1. Machine frame

2. Control box with electric circuits, solenoid valve and centrifugal pump
3. Water tank
4. Water pipe (Right)
5. Soap pipe (Left)
6. Soap gallon
7. Gray water system

Figure 6: Automatic Handwashing Machine on site.

3. Automated Spray Disinfectant Machine.

This electromechanical sanitizer spraying machine requires a person to be in a confined booth. The machine sprays sanitizer in vapour form to the entire body of a person passing through the booth to disinfect harmful organisms. It is designed purposely to prevent and combat the spread of COVID-19.

The machine (see Figure 8) has three main systems:

1. Sanitizer tank
2. Sanitizer pumping
3. Electrical and auto-sensing parts

These parts have a programmed computer system (controller) for automatic operations. The input signal is activated via a sensor mounted on the machine; once the signals is activated, the controller drives the pump, thus spraying the sanitizer from the reservoir through a set of nozzles mounted on the booth. Primarily, the machine is installed and operates at service centres with multitude of people such as hospitals, schools, banks, bus terminals, and supermarkets.

Figure 8: Automatic Spray Disinfectant Booth

4. Conclusions and Recommendations.

4.1 Conclusion

The handwashing technology has proven to be robust and durable for extended use and can withstand any harsh environment. In addition, the technology has been vital not only in the fight against COVID-19, but also in upholding good hygienic practices. Furthermore, cleaning and periodic maintenance of the handwashing machines and sanitizer disinfectant booth is crucial in ensuring sustainability and continue usage.

4.2 Recommendations

The authors call for the sustainability of the handwashing facilities by making their development and use an integral part of the Sanitation and Hygiene Policy in Tanzania. As such, the installation of these facilities ought to be mandatory in schools, health facilities, and in public areas such as markets, churches, and community centres. This development could ensure that people wash their hands before eating, coming from toilets or any other time as deemed necessary. Under such circumstances, a milestone would emerge in fighting other diseases related to sanitation and hygiene such as cholera, diarrhoea, typhoid, ringworms, and scabies.

References.

Bank, W. (2020, 04 16). *COVID-19 Makes Handwashing Facilities and Promotion More Critical Than Ever*. Retrieved from https://www.worldbank.org/en/news/feature/2020/04/30/covid-19-makes-handwashing-facilities-and-promotion-more-critical-than-ever

Bank, w. (2020, 4 6). *WASH (Water, Sanitation & Hygiene) and COVID-19*. Retrieved from WASH (Water, Sanitation & Hygiene) and COVID-19: https://www.worldbank.org/en/topic/water/brief/wash-water-sanitation-hygiene-and-covid-19

WHO. (2020). *WASH and Waste Management for the Covid 19.* Geneva: WHO.

Wilikinson, M., Moliwa, N., & Taylor, B. (2004). *the Design and Development of a Sanitation Hand washing Dispenser* . Lao: WEDC International Conference.

Ministry of Health and Social Welfare. (2008). *The National Environmental Health, Hygiene and Sanitation Strategy (NEHHSAS): 2008 - 2017.* E. H. a. Sanitation. Dodoma, Tanzania.

4 DO SCARCITY AND COLLECTIVE CULTURE MATTER? AN EXPLORATION OF PREVENTIVE MEASURES AGAINST THE COVID-19 PANDEMIC IN TANZANIA

By: Thomas Ndaluka, Nandera Ernest Mhando, Vendelin Simon, Jacqueline Mgumia, Alfred Msasu, Magolanga Shagembe and Jonas Kinanda

Key Messages

- 98.4% of the people in Tanzania have a high level of knowledge on the preventive measures against COVID–19, as reflected in the practices of several preventive measures. For example, 81.7% of these respondents reported avoiding crowded places and 95.3% used soap and hand sanitizers. Thus, cultural context and affordability of the proposed measures is necessary for the smooth adoption of the preventive measures by the people.
- 75.9% of the people reported that COVID-19 is dangerous but 89.9% believed it was preventable and treatable. The multi-sectoral and multi-disciplinary approaches were significant. However, preventive measures adopted (adapted) should consider the socio-cultural context, including traditional options and prevailing religious beliefs.
- Level of people's satisfaction declined from 42% before COVID-19 to 14.2% in the post COVID-19 outbreak; thus, the recovery intervention should be introduced to assist households negatively affected by the outbreak through the introduction of income generating activities for those who have lost their means of income, provision of soft loans and grants to business people, and institution of other poverty recovery strategies.

Introduction and Context

The COVID-19 pandemic is one of the most adverse public health calamities of the 21st century and the greatest concern of humankind, policymakers, the international community, and governments alike. Preventive measures against COVID-19 have been proposed by the World Health Organisation (WHO, 2020) and adopted by different countries, Tanzania inclusive (MoHCDGEC, 2020).

The pandemic was first reported in Wuhan city in China in December 2019. It rapidly spread globally. On 26th July 2020, there were 15,581,009 confirmed cases of COVID-19 and 635,173 reported deaths globally (WHO, 2020) as summarised in Figure 1:

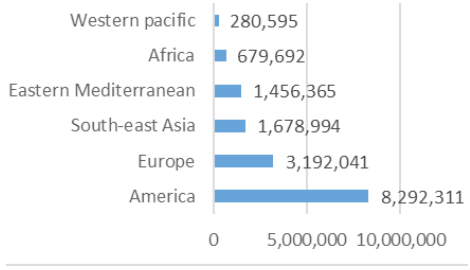


Figure 1: Confirmed cases by region worldwide – July 2020.

Source: WHO (2020).

The outbreak of COVID-19 in Tanzania was officially confirmed by the Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) on 15th March 2020 with the first case reported in Arusha region (MoHCDGEC, 2020). Recent statistics indicate that Tanzania by May 2020 had 509 COVID-19 confirmed cases and 21 Corona-related deaths as well as 183 recoveries (MoHCDGEC, 2020). Figure 2 details the COVID -19 cases in Tanzania. In the face of these developments, the government introduced preventive measures such as closure of schools, social distancing, wearing of masks, hand sanitisation and frequent hand-washing. The rate and level of compliance with these measures varied based on the scarcity and collective culture. Figure 2 shows the trend of COVID -19 in Tanzania:

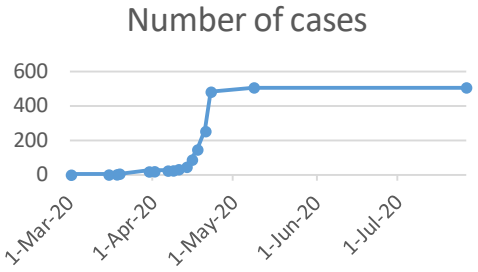


Figure 2: Trend of COVID-19 cases in Tanzania – July 2020.

The understanding of the social ramifications of the preventive measures adopted in Tanzania needed exploration, because in times of global pandemics of the COVID-19 magnitude, socio-cultural sensitive interventions are important in addressing the unique needs of the population. In this regard, we explored the preventive measures against the COVID-19 pandemic in the context of scarcity and collective culture in Tanzania. Consequently, we highlight what Tanzanians know, believe, and practice when it comes to the prevention against the COVID-19 pandemic that forms the benchmark for decision makers' vetting and consultation. We aim to furnish decision makers with justified and empirical evidence in the context of scarcity and the collective culture of Tanzania.

Knowledge on preventive measures

Knowledge on the preventive measures of COVID-19 was found to be extremely high (98.4%). For instance, Tanzanians know that, although infection to COVID-19 does not discriminate in terms of age, gender, race, and education status, the elderly are more at risk of contracting the virus than other age-groups. Awareness on how COVID-19 is transmitted was also extremely high.

Many respondents were also aware that preventive measures such as the use of masks (69.1%), washing hand using soap and running water and sanitizers (93%), social distancing (94.2%), avoiding crowded areas

(93%), avoiding people with flu-like symptoms (91.1%), avoiding public transportation (63.6%), and avoiding large social gathering reduced the chance of contracting COVID-19 (71.7%). The details are provided in Figure 3:

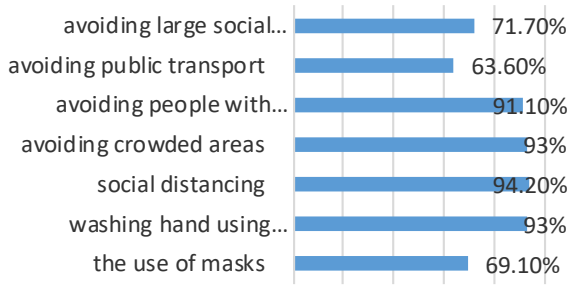


Figure 3: Knowledge on preventive measures against COVID – 19.

The results show that 85.5% of the respondents were aware that COVID-19 is ebbing in the country, and attributed the decline to the comprehensive preventive measures that used an amalgamation of modern protocol, religious beliefs, prayers, and traditional treatment.

Television was a dominant channel for information dissemination followed by radio and social media, respectively. This finding suggests that preventive measures channelled through television, the radio, and social media are accessible to many people and contributed to the high level of knowledge among Tanzanians.

Attitude towards preventive measures against COVID-19 in Tanzania

As Figure 4 (below) illustrates, 75.9% of the respondents believed that COVID-19 is dangerous but preventable and treatable. Another 50.8% of the respondents reported that the government should not shut down areas with large masses such as educational centres (kindergartens, schools, and universities), churches, mosques, bars and clubs) and, instead, should not adopt the lockdown as one of the preventive measures against COVID-19. This implies that individuals would continue to engage in economic and social-cultural activities outside their homes that would have been closed had lockdown been implemented. What the government is supposed to do is to quarantine COVID-19 patients in special hospitals to avoid further spread of the pandemic.

Furthermore, mask wearing in public places was supported by 91.1% of the respondents. Another 60.1% of the respondents reported that they were less vulnerable to COVID-19 infections. Also, 74.6% of the respondents had a positive attitude towards COVID-19 vaccine discovered by Africans. This suggests that preventive measures against COVID-19 require acknowledge and recognition of the local experts. Figure 4 details the specifics regarding this issue:

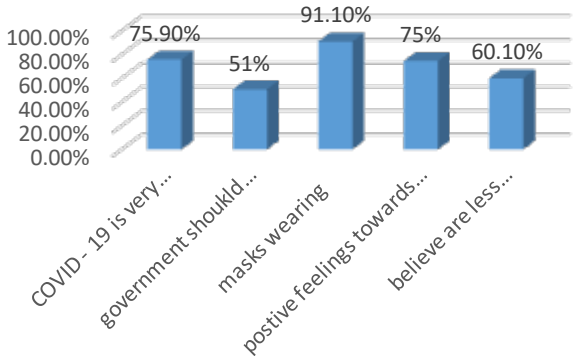


Figure 4: Knowledge on preventive measures against COVID – 19.

COVID-19 Preventive Measures and Practices in Tanzania

Practice in the prevention against COVID - 19 infection entails washing hands regularly with water and soap in addition to using hand sanitizers (94.2%); avoiding travelling to affected countries or places (90.7%); avoiding going outdoors (82.9%); shunning overcrowded places (81.7%); skipping large social gatherings (81.7%), as well as not touching eyes, the nose, and mouth or face (67.7%). Figure 5 presents these results.

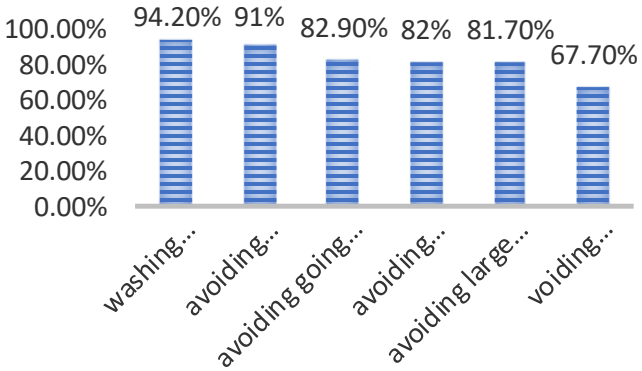


Figure 5: COVID-19 Preventive Measures Practices.

The results presented in Figure 5 corroborate with the level of knowledge about COVID-19 explained in previous sections. On the other hand, most of the respondents were selective in practising some preventive measures, especially those incongruent with their collective culture, or those which could result in social ramifications. For instance, 82.9% of the respondents did not practise staying at home; 43.6% did not avoid public transportation; and 56.6% did not avoid going to the hospital. Staying at home was not practised because of perceived negative impacts on household income and, thus, going to work prompted most of them to use public transportation. The paradox behind practising preventive measures against the pandemic was whether to stay at home and/ or avoid public transportation, on the one hand, and suffering economic difficulties and other social ramification, on the other.

Impact of COVID-19 on household livelihoods

People's levels of satisfaction with their lives decreased from 42% to 14.2% after the outbreak of COVID-19. Impliedly, COVID-19 has negatively affected them, hence the need for intervention. Moreover, fewer (4.7%) respondents changed the type of work after

COVID-19. Nevertheless, those who changed their businesses (48.5%) mentioned that COVID-19 caused a decline in customers, forcing them to change the type of business they operated, and as a result they concentrated on items in demand. They also used the internet for marketing or closed their business down. Before COVID-19, on average they would attend to their work places regularly (64.0%). During and after the outbreak of COVID-19 this performance dropped by 38.1% in a week. Due to the impacts of COVID-19, most of the respondents reported being compelled to improve their jobs or businesses and resorted to establishing online markets, lessening of commodities in the shop, closing of the shop and self-employment.

The impact of COVID-19 on the family was largely positive in terms of improving sanitation, enhancing dietary intake, adhering to healthy regimes, and creating more quality time for marriage partners and children to be together.

Recommendations

Recommendations for the government

- The government should strengthen its research institutions such as the University of Dar es Salaam (UDSM), National Medical Research (NIMR), Ifakara Health Institute (IHI), Muhimbili University of Health and Allied Science (MUHAS) and others by providing laboratory space and equipment, and research funds to facilitate research on possible animal and bird pathogens that can affect human beings in the future.
- The government should subsidise pharmaceutical industries in the country so that they can produce medicine for outbreaks in the country.
- In the context of scarcity and collective culture, research on traditional medicines should be enhanced to supplement modern treatment methods of diseases/ outbreaks in collaborative manner between the government and other stakeholders such as traditional specialists, private companies, the mass media, social networks, and informal sector by increasing funding and recognition of this branch.
- The government should have its own protocol/ guidelines and strategies on preventive measures against disease outbreaks to ensure that all government authorities and departments customise the guidelines based on the Tanzania's socio-cultural context.

Recommendation for non-state organisations

- Non-state organisations should ensure that their activities such as researches and training on preventive measures against pandemics are for the benefit of and are in line with the culture and value of the Tanzanian society.
- Non-state organisations should assist the government to enable research institutions with disease outbreak preparedness through funding and technical/capacity support.

Recommendations for research institutions and the University of Dar es Salaam

- Improvement of research capacity by allocating enough funds on management of disease outbreak.
- Enhancement of their epidemiology and virology laboratories to make them capable of identifying future pathogens threats to human beings.
- Building new and enhancing the existing industries that produce homemade health equipment and facilities, ventilators, hand sanitizers, masks, hand-washing equipment, and testing kits.
- The government should apply a multidiscipline approach involving sociologists, anthropologists, psychologists, social workers, public health experts, virologists, medical and epidemiologists in designing and executing preventive measures against pandemics such COVID-19.

Conclusion

This policy brief shows that preventive measures against COVID-19 employed in Tanzania, to a large extent, reflected the collective cultures of Tanzanians and were feasible with the available resources. Overall, the success of the proposed preventive measures are in line with people's ways of life, whereby the self is defined in relation to collective and, consequently, the expected social ramifications of the preventive measures were mitigated by accommodating Tanzania's socio-cultural setting. This policy brief highlights what is known, believed in and practised by Tanzanians. This information would help policymakers, planners, and the government to establish current and future pandemic intervention strategies based on empirical evidence.

References

Ministry of Health, Community Development, Gender, Elderly and Children (2020). Mwenendo wa ugonjwa wa corona (COVID-19) inchini. MoHCDGEC. Dar es Salaam. https://www.moh.go.tz/en/covid-19-info.

World Health Organization, (2020). WHO coronavirus disease (COVID-19) dashboard. Geneva; https://covid19.who.int/

World Health Organisation. Coronavirus disease (COVID-2019) situation reports. 2020. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports.

World Health Organisation. The 2019-nCoV outbreak is an emergency of international concern 2020. http://www.euro.who.int/en/health.

AUTHORS AND CONTACT PEOPLE

Lead investigator and contact person: Dr. Thomas Joseph Ndaluka (Department of Sociology and Anthropology, University of Dar es Salaam; Thomas.j.ndaluka@gmail.com)

Co-authors: Dr. Nandera Ernest Mhando (Department of Philosophy and Religious studies, University of Dar es Salaam; nanderam2013@gmail.com), **Dr. Vendelin T. Simon** (Department of Sociology and Anthropology, University of Dar es Salaam; vendelin.simon@yahoo.com), **Dr. Alfred Msasu** (University of Dar es Salaam Health Centre; dra_msasu@udsm.tz), **Dr. Jacqueline H. Mgumia** (Department of Sociology and Anthropology, University of Dar es Salaam; jhm11@albion.edu), **Mr. Magolanga Shagembe** (Department of Sociology and Anthropology, University of Dar es Salaam; smagolanga@gmail.com) and **Mr. Jonas J. Kinanda** (Department of Sociology and Anthropology, University of Dar es Salaam; kinandajj@gmail.com)

Funding Source: University of Dar es Salaam

Disclaimer: The views expressed here are those of the authors and do not necessarily reflect the policies of the University of Dar es Salaam and/ or the Government of Tanzania. Any shortcoming herewith is attributable solely to the authors.

5 THE USE OF PROPER FABRIC MASKS TO IMPROVE PEOPLE'S HEALTH IN TANZANIA DURING THE COVID-19 PANDEMIC

By Dinnah Enock, Department of Creative Arts, University of Dar es Salaam

Summary

Since the first reported case of the Coronavirus (Covid-19) in Tanzania on 16 March 2020, the use of masks was one of the measures the government and health sectors had issued to prevent further spread of the disease. The government and other stakeholders also provided directives on how to produce and use fabric masks not only to meet the high demand for these safety attire by the time but also to protect people from being infected by the virus. The use of locally designed fabric masks was not only well-received by people in the country, but also made possible for the populated versions of fabric masks worn in the country (see, for example, Fig 1 and 2). However, how effective the fabric and their uses in Tanzania became the major concern of the current study. The study used electronic sources (YouTube, Twitter, Facebook, and online related documents) to collect data related to the production and use of fabric masks. In all, 50 images of fabric masks and 10 documents were gathered and analysed in terms of the type of fabric used to make the masks and examine how people wear and sell them. The study findings indicate that different types of fabrics used to create these masks, and most of them had been sold in streets (risk areas for virus-contamination) by street hawkers popularly known as *wamachinga* without any protective measures on people's health. The study also observed different styles of wearing masks (some masks are appropriately worn by covering the recommended parts of the face whereas others were not). Moreover, the study found that, apart from the official directives given on the use and production of fabric masks, there was no follow-up action to establish the extent to which these directives were being implemented by both producers and users of fabric masks, to improve people's health in the country during pandemics of viral-respiratory related diseases such as COVID-19. With such observation, the current study, therefore, proposes that, Government should develop quality standards for manufacturing

of fabric masks in Tanzania by using scientifically approved fabrics and techniques for fabric mask production for COVID-19 pandemic and other related diseases. (Edwards, E. 2020; Johnson, 2020; Konda et el, 2020 and Verma, S. 2020). This will

Figure 1: "Kitenge fabric mask" https://www.tanzaniaschoolfoundation.org/product/kitenge-face-mask/

Figure 2: Fabric masks vendors in Dar es Salaam https://www.youtube.com/watch?v=wqDyPGzjyhQ

Figure 3: Version of fabric masks worn differently in Dar es Salaam https://www.youtube.com/watch?v=wqDyPGzjyhQ

Background

Since there is no confirmed cure for COVID- 19 in the world, various studies have recommended the use of fabric masks as one of one of the protective measures against the virus, with surgical and medical masks capable of serving the medical purpose. The recommended fabric masks, however, should not only make the wearer comfortable but also to safe from being infected. Some scholars have even recommended the types of fabric to use and how to sew the mask so that wearer will be both protected and comfortable with the mask. The ideal protective fabric masks need three layers of different fabric such as hydrophilic, polypropylene, and polypropylene, fabrics that could absorb, filter and repel droplets, respectively (WHO, 2020). One evening in mid-May 2020, the researcher was surprised by a TV news item from one of the television stations in the country, when a *daladala* conductor was responding to the TV presenter on why some people refused to wear masks when on the public commuter bus. The conductor said that people refused to wear masks because they were uncomfortable with them and they were not breathable. And that marked the beginning for the current study aimed to establish why the fabric masks made people uncomfortable during the Corona pandemic. This study, therefore, was conducted to assess the proper production and use of fabric masks to improve people's health in Tanzania during the COVID- 19 pandemic and any other related diseases pandemic.

Findings

Data for this study was collected randomly from WhatsApp, twitter, Facebook, YouTube and documentary sources from May - August 2020. KiSwahili words were written on each search engine to ensure the capture of data from Tanzania. Examples of the key words include *ushonaji barakoa* (mask sewing), *barakoa za kitambaa* (fabric masks) and *uvaaji barakoa* (wearing of fabric masks). Cumulatively, 50 (100%) fabric masks were collected and analysed in terms of how the masks are worn particularly whether the mouth and nose were covered to enhance mask-fit. Moreover, data related to the types of fabric and numbers of fabric layers from 20(100%) mask producers were examined.

The use of fabric masks

The table below indicates data on how the masks are worn and their coverage of a person's face (N=50).

Table 1: Use of Fabric Masks

How are fabric masks worn in Tanzania?		
By covering mouth and nose %	*By covering other body parts %*	*Total 100%*
35 (70%)	15 (30%)	50 (100%)

Out of the 50 collected images of people wearing masks, 35 (70%) show people covering their nose and mouth properly. This indicates that, health directives on proper the use of fabric masks to protect people from virus infection have been well-understood in Tanzania (see fig 6). However, the remaining 15 (30%) people with fabric masks covered their chin and part of their nose as shown in figures 3,11,12,13 and 14, which suggests that the masks were not both comfortable, let alone breathable because they were either produced using unrecommended fabric such as plastic or they had been produced without adhering to proper standards (See, for example, fig 9, of masks produced using plastic). Additionally, such observation implies that more education on how to wear fabric masks is still necessary.

Production of fabric masks

The table below indicates data obtained from 20 fabric masks producers on how the masks were produced.

Table 2: Production of fabric masks

How are fabric masks produced in Tanzania?			
Using three layers of fabric	*Using two layers of fabric*	*Using one layer of fabric*	*Total*
2 (4%)	30 (60%)	18 (36%)	50 (100%)

As the table above illustrates, only 2 (4%) of the masks observed had three layers of fabric. This rather small percentage suggests that fabric mask producers still need education on why they should use three layers of fabric to produce masks. Most of the fabric masks (30; 60%) observed had two layers, followed by a significant proportion of single-layer masks (18; 36%). However, in the YouTube video (fig 8 and fig 6), the mask producers explained why they used more than one layer of fabrics in producing their masks but they remained silent on the why they did so. On the other hand, the second producer of three layers fabric masks—the College of Engineering of the University of Dar es Salaam—stated the reasons behind the use of different layers[1]. In fact, the Tanzania Bureau of Standard (TBS) recommends a fabric mask of not less than four layers for use in Tanzania to combat Covid-19.[2]

Types of fabrics mask producers use in Tanzania

The table below presents data obtained on 50 fabric masks produced in Tanzania:

Table 3: Production of fabric masks

Which types of fabric are used to produce masks in Tanzania?		
Cotton materials	*Non-cotton materials*	*Total*
48 (96%)	2 (4%)	50 (100%)

Out of the 50 collected masks, 48 (96%) were made of cotton materials. Only 2 (4%) were of non-cotton material (plastic) as shown in fig. 9. These findings imply that Tanzania local fabric mask producers heeded the researchers' endorsement of cotton material for protection against the Covid-19 virus infection (WHO, 2020 and Edwards, 2020). As for the remaining 2 (4%) made of plastic material, this study recommends that, the government take immediate stern action to stop production of such masks with unrecommended material as they could endanger people's lives.

Figure 4: Danford Tamba demonstrates how he makes fabric masks using a single layer of fabric. https://www.youtube.com/watch?v=ihkKua37epk

Figure 5: Making double layers kanga mask. https://www.youtube.com/watch?v=BuBNejY7c_Q

1 "The contribution of UDSM against COVID-19" https://www.udsm.ac.tz/web/index.php/schools/soed/announcements/mchango-wa-chuo-kikuu-cha-dar-es-salaam-katika-mapambano-dhini-ya-korona. Retrieved on 26th July 2020.

2 https://fullshangweblog.co.tz/2020/05/19/tbs-yatoa-mwongozo-kwa-wa-naotengeneza-barakoa-za-vitambaa/

Figure 6: Ana Peter produces double layered Kitenge masks. ttps://www.youtube.com/watch?v=J6f4zdp08VU

Figure 7: Nyambili Kiula in Arusha, with a mask made from course sweater material. https://www.youtube.com/watch?v=xOJal7QH6Qg

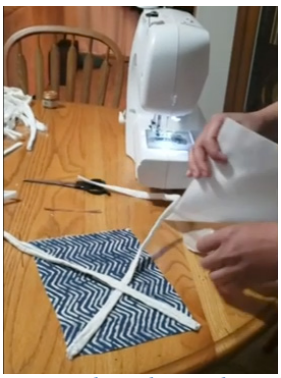


Figure 8: Creating a three-layered mask. https://www.youtube.com/watch?v=8rIQoFLkbic&t=81s

Figure 9: Examples of plastic masks: https://www.youtube.com/watch?v=2S_fJupuVYM

Recommendations

Figure: 10. Mwanza Region Commissioner argues for quality fabric masks https://www.youtube.com/watch?v=IKiRvzNXuDQ

Figure :11 ACP Barnabas Mwakalukwa speaks with a pulled to the neck position. https://www.youtube.com/watch?v=i3XsPhMdnI8

Figure 12: An assortment of mask wearers, with some without them in the background. https://www.youtube.com/watch?v=i3XsPhMdnI8

Figure 13: A tailor with the nose uncovered at Karume in Dar es Salaam. https://www.youtube.com/watch?v=gOHN3e8ZU0c

Figure 14: A loose fitting mask in Dar es Salaam. https://www.youtube.com/watch?v=nYtFlwbi8Dc

Based on the study findings, there is a need for the Tanzania government to develop quality standards for manufacturing fabric face masks to serve for as a guide both producers and users of these masks. After all, failure to follow proper directives for producing and wearing fabric masks prove to be counter-product in the face of Covid-19. On the other hand, the use of proper fabric in producing masks, which are and layered accordingly, coupled proper wearing of these masks could promote good health.

Conclusion

This policy brief advocates for the use of proper fabric masks to improve people's health in Tanzania during the COVID-19 pandemic. As such, there is a need to develop a new policy that will guide both fabric mask producers and users to improve health using proper and recommended fabric masks. Such a policy should explicitly state penalty for those going against the rules and guidelines.

Reference

"Barakoa za vitambaakukinga Corona." (http://www.dar24.co.tz/naibu-waziri-afafanua-barakoa-za-vitambaa-kukinga-corona/ Retrieved on 15th June 2020

"Pamoja na kutuletaadha COVID-19" https://www.un.org/africarenewal/sw/news/pamoja-na-kuleta-adha-covid-19-pia-imenisadia-silali-njaa-fundi-beatrice. Retrieved on 29 May 2020

Edwards, E. (2020). Making your own face mask? Some fabrics work better than others, study finds. Some fabrics were found to work better at filtering small particles than medical grade masks. https://www.nbcnews.com/health/health-news/making-your-own-face- hmask-some-fabrics-work-better-others-n1175966

Greenhalgh T, Schmid MB, Czypionka T, et al. Face masks for the public during the COVID-19 crisis. BMJ 2020;369:m1435.10.1136/bmj.m1435 - DOI - PubMed . Retrieved on 14thJuly 2020

Konda, A., Prakash, A., Moss, G. A., Schmoldt, M., Grant, G. D., & Guha, S. (2020). Aerosol filtration efficiency of common fabrics used in respiratory cloth masks. ACS nano, 14(5), 6339-6347. https://pubs.acs.org/doi/abs/10.1021/acsnano.0c03252. Retrieved on 11thJuly 2020

Liang M, Gao L, Cheng C, Zhou Q, Uy JP, Heiner K, Sun C. Travel Med Infect Dis. Efficacy of face mask in preventing respiratory virus transmission: A systematic review and meta-analysis. 2020 May 28:101751. doi: 10.1016/j.tmaid.2020.101751. Online ahead of print. PMID: 32473312Free PMC article. Retrieved on 11thJuly 2020

Shakya KM, Noyes A, Kallin R, Peltier RE. J Expo Sci Environ Epidemiol. Evaluating the efficacy of cloth facemasks in reducing particulate matter exposure. 2017 May;27(3):352-357. doi: 10.1038/jes.2016.42. Epub 2016 Aug 17. PMID: 27531371.Retrieved on 11thJuly 2020

Verma, S. (2020). Visualizing the effectiveness of face masks in obstructing respiratory jets. Physics of Fluids, 32(6), 061708. https://www.researchgate.net/publication/342571914_Visualizing_the_effectiveness_of_face_masks_in_obstructing_respiratory_jets

"Version of fabric masks". https://www.youtube.com/watch?v=wqDyPGzjyhQ Retrieved on 21st March2020

World Health Organization. Recommended fabric mask materials and composition (2020). https://www.who.

int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/when-and-how-to-use-masksto. Accessed 10 April 2020.

"The contribution of UDSM against COVID-19" https://www.udsm.ac.tz/web/index.php/schools/soed/announcements/mchango-wa-chuo-kikuu-cha-dar-es-salaam-katika-mapambano-dhini-ya-korona. Retrieved on 26th July 2020.