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Research Article

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Environmental Risk Factors Contributing to the Transmission of COVID-19 in Zambia: A Cross-Sectional Study in Lusaka District

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Abstract
Background: *A propagative increase in SARS-CoV-2 transmission has been witnessed in Zambia since the index case was reported in March 2020. Although sociocultural factors including movement patterns, people's livelihood, and way of life have been demonstrated to influence SARS-CoV-2 transmission dynamics, the role of environmental risk factors has not been adequately documented. The aim of the study was to investigate environmental risk factors contributing to the transmission dynamics of SARS-CoV-2 in Zambia using a cross-sectional study*
Results: *The positivity rates were 10.5 % cell phones, 5.3% door knobs, 2.7% remote controls and 2.6% beddings. All the other surfaces came out negative. The sex proportion of the respondents was 55% and 45% males and females respectively. Regarding occupancy density, 37.5% (15/40) resided in a 2 to 3-roomed house, 32.5% (13/40) resided in a 4 to 7 roomed house and 30% (12/40) resided in > 7-roomed house. Of the 40 respondents, 75% (30/40) used recyclable face masks while 25% (10/40) used non-recyclable face masks. For the non-recyclable face masks, 30% of the respondents indicated incineration as a disposal method. A correlation coefficient of 0.25 was documented for the association between occupancy density and surface contamination.*
Conclusions: *The study revealed that most environmental surfaces particularly mobile phones were rarely disinfected and were most likely to contribute to the transmission of SARS-CoV-2 in the community. Furthermore, the majority of the respondents used recyclable face masks which are easily washable. However, those who used non-recyclable face masks disposed of them indiscriminately which has the potential of contaminating the environment and further lead to the transmission of SARS-CoV-2.*

Keywords: Environment, Households, Risk Factors, SARS-COV-2

Background

The COVID-19 pandemic, caused by the highly contagious SARS-COV-2, is a global public health problem and has caused a devastating impact on the immediate environment due to its quick spread from person to person [1]. Transmission occurs mainly via inhalation of respiratory or aerosol droplets from an infected person, produced via coughing and sneezing. Consequently, due to its rapid spread, a meeting held on January 30, 2020, as per the International Health Regulations (IHR, 2005), World Health Organization declared the outbreak as a disease of Public Health Emergency of International Concern (PHEIC) as it had spread to 18 countries with four countries reporting human-to-human transmission. An additional landmark occurred on February 26, 2020, as the first case of the disease, not imported from China, was recorded in the United States (US) [2].

Evidence suggests that environmental factors play a significant role in influencing SARS-CoV-2 transmission though there is still limited information regarding its spread into the environment. The major environmental factors that can lead to a quicker spread of SARS-CoV-2 include water, air, faecal matter, handling of used face masks, and other medical wastes according to the World Health Organisation [1].

Even though most enveloped viruses are not usually excreted in faeces or urine, there is increased evidence that SARS-CoV-2, or at least their genomes, are excreted in faeces [3]. If infective viruses are excreted into the environment, faecal contamination could be a major transmission route and people could be exposed by interacting with water contaminated with untreated faecal matter [4]. Discarding face masks and empty bottles of hand sanitizers together with tissue papers results in a huge pile of medical waste in the environment (Hellewell et al., 2020). Discarding of face masks and empty bottles of hand sanitizers together with tissue papers results in a huge pile of medical waste in the environment (Hellewell et al., 2020). Workers involved in the collection of garbage and maintaining the city clean on a daily basis are at high risk of contracting the virus from respiratory shed droplets that could be on discarded masks [5].

Arising from this fact, it is therefore, imperative to explore the various environmental characteristics that would drive the transmission of SARS-CoV-2 through a One Health approach and also identify potential environmental foci and how it may enhance the rapid spread of the infection among the human population. The potential environmental factors identified would enable policy-makers to plan for sustainable collaborative environmental intervention strategies.

Lusaka being centrally located has the potential to drive the spread of SARS-CoV-2 to other parts of the country if effective and efficient sustainable interventions are not in place. Although socio-cultural factors including movement patterns, people's livelihood, and way of life have been demonstrated to influence SARS-CoV-2 transmission dynamics, the role of environmental risk factors had not yet been documented. Against the evidence from the literature indicating environmental contamination, it was important to investigate the contribution of environmental risk factors in the transmission dynamics of SARS-CoV-2 in Zambia.

Aim of the study

The aim of this study is to investigate environmental risk factors contributing to the transmission dynamics of SARS-CoV-2 in Zambia.

Methods

A cross-sectional study was conducted in selected SARS-CoV-2-affected households in the Lusaka district from September-December, 2020. A purposive sampling technique was used to select SARS-CoV-2 affected households from Zambia National Public Health Institute (ZNPHI) database following positive SARS-CoV-2 diagnosis. The rationale for selecting the affected households was to maximize the chances of identifying contaminated surfaces that played a critical role in the transmission of the virus and also describe the methods of disposal used for face masks. Furthermore, the Lusaka district was one of the epicenters having recorded a high number of SARS-CoV-2 cases Environmental samples were collected from door knobs/handles, taps, light switch, floor surfaces, work top surfaces, beddings, remote controls and mobile phones using the DaAnGene® (2020) sample collection, transport, and processing procedure for tissue and cytopathological analysis specimen preservation. In order to increase the positive predictive value of the environmental sampling process, multiple swabs were taken for each sampling area. The samples were triple packaged and transported to the University of Zambia, School of Veterinary Medicine, BSL3 Virology Laboratory within 24 hours after collection.

Total RNA was extracted from the environmental samples using QIAamp Viral RNA Mini Kit (QIAGEN) according to the manufacturer's instructions. Real-time RT-PCR assays were carried out using The DaAnGene® (2020) detection procedure was utilized to identify the presence of SARS-Cov-2 according to the manufacturer's instructions. To ensure the safety of research assistants and research team members during the training, travel, and data collection process, the use of appropriate PPE and physical distancing was practiced. Extraction of RNA was done in a biosafety level -3 laboratory.

Epidemiological data were collected using a pre-tested close-ended questionnaire to capture exposure risk factors that could lead to household contamination such as the type of dwelling, household size, age, gender, occupation, and cultural practices such as funerals and religious gatherings. Further, the respondents were asked to provide information on methods of disposal of used face masks. Participants were identified by codes to ensure anonymity Data were analyzed using the statistical software package SPSS version 21 and all the statistical tests were determined at a 5% significance level. The proportion of infected households was determined by dividing the number of positive households by the total number of households tested similarly, the percentage contamination of surfaces or articles was estimated using the same approach.

Results

A total of 40 respondents as shown in table 1 from SARS-CoV-2 affected households were interviewed with a breakdown of 55% (22/40) representing males while 45% (22/40) representing females. From this total, 37.5% (15/40) resided in a 1-3 roomed house, 32.5% (13/40) resided in a 4 to 7 roomed house and 30% (12/40) resided in > 7 roomed house. A breakdown of face mask use was: 75% (30/40) disclosed using recyclable face masks while 25% (10/40) none recyclable face masks. Of the 38 pooled environmental surfaces swabbed and analysed, 21.05% (8/38) were positive for SARS-CoV-2 contamination. The breakdown was as follows: - cell phones at 10.53% (4/38), door knobs at 5.26% (2/38), the beddings and remote control were 2.63% (1/38) and 2.63% (1/38) respectively. A correlation coefficient of 0.25 was documented for the association between occupancy density and surface contamination.

Table 1: Sociodemographic Characteristics and SARS-CoV-2 Environmental Contamination

Variable	Mean (SD)/n (%)
Age	28.43 (13.13)
Gender	
Males	22 (55%)
Females	18 (45%)
Marital status	
Single	8 (20%)
Separated	6 (15%)
Married	25 (62.5%)
Widow	1 (2.5%)
Number of Occupants per Household	
1-3 Roomed House	9 (32.1%)
4-7 Roomed House	11 (39.2%)
Greater than7 Roomed House	8 (28.6%)
Type of Face Mask used	
Recyclable	30 (75%)
None recyclable	10 (25%)
Disposal Method for None Recyclable	
Incineration	3 (30%)
Indiscriminate	7 (70%)
Positive Environmental Surfaces	
Remote control	1 (2.63%)
Beddings	1 (2.63%)
Door knob	2 (5.26%)
Cell phone	4 (10.53%)

Discussion

SARS-CoV-2 was detected in only 21.05% of all environmental samples tested. Among the environmental surfaces swabbed, mobile cell phones were more prominently significant to contain SARS-CoV-2SARS-CoV-2 compared with the other environmental surfaces. These results show that there is a risk of transmitting SARS-CoV-2 via mobile cell phones if the appropriate SARS-CoV-2 health guidelines of hygiene are not maintained. A study conducted by Chin et al. (2020) reported that SARS-CoV-2 was viable in the environment at 4 °C for a long time however this reduced with a raise in temperature, and at 70 °C the virus was inactivated in 5 minutes. This therefore shows that the environment and human behavioural conditions, have a critical role in transmitting the virus. Thus, the risk of transmitting SARS-CoV-2 from one person to another via contaminated environmental surfaces can be higher if appropriate disinfection measures are less rigorously respected and not adequately conducted upon detection of SARS-CoV-2 cases from different households.

Solid waste materials generated from households with infected or suspected SARS-CoV-2 cases may contain traces of SARS-CoV-2 and could be a source of infection for people within and outside the households. As recently discovered, SARS-CoV-2 can stay on hard surfaces for long periods of time, specifically, 72hours on plastic, 48 hours on stainless steel and 24 hours on paper and cardboard. Therefore, a 72-hour-delay in the collection does not seem to be sufficient to ensure safety and may lead to SARS-CoV-2 infection amongst solid waste collectors. A poor management of solid waste can possibly increase the chances of SARS-CoV-2 spread in the environment due to transmission of the SARS-CoV-2 through respiratory means and physical touch. Apart from human-to-human transmission, droplets may also stay active on surfaces where the virus could remain viable. Thus, the immediate environment of an infected individual can serve as a source of transmission [1].

The study had revealed that the majority of the respondents were using recyclable face masks. The research further established that almost all the closer contacts of SARS-CoV-2 cases at household level were putting on face masks to prevent any possibility of contracting and spreading the virus. This is in agreement with a study conducted by Nzediegwu and Chang (2020) which noted that the total number of face masks used during the SARS-CoV-2 outbreak had increased and this depended on the number of contacts closer to SARS-CoV-2 cases, number of occupants per household, face masks acceptance rate (per cent) and average daily face masks per capita This research established that most of the SARS-CoV-2 cases were reported in both densely and low densely populated subdistricts and that most of the transmissions occurred between household members as described by Hui et al., 2020. Most of the SARS-CoV-2 cases were residing in a three-roomed household structure with an average family size of nine. The occupancy density was noticed to be higher particularly in densely populated households thereby increasing the chances of SARS-CoV-2 transmission rates. The findings clearly show the importance of testing close contacts of SARS-CoV-2 cases to promptly identify and isolate infections in the incubation period. This would also be appropriate if the lower estimated transmission probability of SARS-CoV-2 during the illness period than during the incubation period could be partially attributed to self-distancing within households when the primary cases developed symptoms. The estimated probability of daily SARS-CoV-2 transmission was higher in households of six people or less than in larger households (more than six people).

Study Limitations

This study was only done in Lusaka and particularly targeted households with affected cases of COVID-19. The results of this study cannot be generalized to the whole Zambian population however, the study provides initial scientific baseline data regarding the environmental risks contributing to the transmission of COVID-19 factors. This can help in refining policies that will target the prevention of potential environmental surfaces that would enhance the further spread of COVID-19 in the population.

Conclusion

There is a need to ensure that active case finding and isolation in conjunction with comprehensive contact tracing and quarantine are instituted for preventing infected contacts from spreading the virus during their incubation periods. The positive samples documented were indicative of the presence of SARS-CoV-2 on environmental surfaces. It is thus, plausible to conjecture that the environment could have played a role as a source of infection for SARS-CoV-2 in Zambia. There is a need to also explore the long-term association of environmental and climate indicators with the SARS-CoV-2 pandemic and to study the inter-district and provincial responses towards the SARS-CoV-2 outbreak to provide a better outlook for understanding the spread of SARS-COV-2. Furthermore, we recommend that bank notes should also be investigated as environmental surfaces which significantly contribute to the transmission of SARS-CoV-2 in Zambia [1-18].

List of Abbreviations

BSL3: Biosafety Level 3
COVID-19: Coronavirus disease 2019
PPE: Personal Protective Equipment
QRT-PCR: Quantitative real-time polymerase chain reaction
RNA: Ribonucleic acid
SARS-COV-2: Severe Acute Respiratory Syndrome Coronavirus 2
SPSS: Statistical Package for the Social Sciences
WHO: World Health Organization

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Authors' Contributions

KC and LL Conceived and designed the research. RMV, HKK and TH developed the data collection tool, KC, LL and FNB analysed and interpreted the data. KC, LL, and FNB wrote the manuscript. All authors read and approved the final manuscript.

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Availability of Data and Materials

Data available by request from Eden University, School of Medicine, Department of Research and Grants, P.O. Box 37727, Lusaka, Zambia. Authors may be contacted at eden@university.com

Ethics Approval and Consent to Participate:

Ethical clearance was sought from ERES Converge IRB (Registration No. 00005948) for the collection of environmental samples and epidemiological data. Approval for the study was obtained from the National Health Research Authority (NHRA). The District Health Office was also notified about the research so that they would be aware that sampling would be taking place in their area of jurisdiction. Consent was further sought and obtained from the study participants before enrolment into the study. Confidentiality was maintained by the use of identification codes rather than names; information collected was securely kept. In order to access the required data from ZNPHI, a non-disclosure agreement was made between Eden University and ZNPHI to ensure confidentiality.

Consent for publication:

Not applicable

Conflict of interest:

All the authors gave approval and no conflict of interest was declared.

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