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Descriptive Finding

Knowledge, risk perceptions, and behaviors related to the COVID-19 pandemic in Malawi

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Abstract

BACKGROUND
Behavioral changes are needed to limit the spread and mitigate the impact of the COVID-19 pandemic.

OBJECTIVE
We measured knowledge and behaviors related to COVID-19 during the early stages of the pandemic in Malawi (Southeast Africa).

METHODS
Using lists of phone numbers collected prior to the COVID-19 pandemic, we contacted a sample of adults by mobile phone in the six weeks after the first confirmed cases of COVID-19 were recorded in the country. We interviewed 619 respondents (79.5% response rate).

RESULTS
Approximately half of respondents perceived no risk or only limited risk that they would become infected with the novel coronavirus. Contrary to projections from epidemiological models, a large percentage of respondents (72.2%) expected to be

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severely ill if they became infected. Increased hand washing and avoiding crowds were the most frequently reported strategies used to prevent spreading SARS-CoV-2. The adoption of other protective behaviors (e.g., face masks) was limited. Respondents in urban areas had more accurate knowledge of disease patterns and had adopted more protective behaviors than rural respondents.

CONCLUSIONS
In the first weeks of the pandemic, the adoption of preventive behaviors remained limited in Malawi, possibly due to low perceived risk of infection among a large fraction of the population. Additional information campaigns are needed to address misperceptions about the risk of infection with SARS-CoV-2 and the likelihood of severe illness due to COVID-19.

CONTRIBUTION
This study provides early data on behavioral responses to the COVID-19 pandemic in a low-income country.

1. Introduction

Within a few months of the emergence of SARS-CoV-2, confirmed cases of COVID-19 have been recorded in all African countries (Africa CDC 2020a). Epidemiological models project that close to 25% of Africa's population could become infected with SARS-CoV-2 during the first year of the pandemic, resulting in increased morbidity and mortality (Cabore et al. 2020). The disruption of economic activities and health systems induced by the pandemic could lead to additional excess mortality (Roberton et al. 2020; Weiss et al. 2020). There are concerns that progress toward the Sustainable Development Goals, and other global or local objectives, might stall or even reverse (UN-DESA 2020).

In the absence of effective and widely available vaccines, behavioral changes are essential for limiting the diffusion of the pandemic. According to the World Health Organization (WHO), controlling the spread of SARS-CoV-2 in local communities requires adopting preventive behaviors that (a) reduce contact between population members or (b) limit the likelihood that the coronavirus will be transmitted if contact occurs (WHO 2020). This includes maintaining an increased physical distance between individuals, enhancing hand hygiene, or limiting social gatherings. Wearing face masks is also recommended to limit the emission of infective droplets (Africa CDC 2020b).

The adoption of such behaviors requires adequate information about disease dynamics. According to the health belief model (Rosenstock, Strecher, and Becker 1988), implementing preventive measures also depends on whether individuals perceive

themselves as susceptible to acquiring a new disease and whether they consider that this disease would have serious consequences for their health (Reintjes et al. 2016).

We investigate behavioral responses to the COVID-19 pandemic in Malawi, one of the last countries in Africa to record a confirmed case of COVID-19 (Ministry of Health and Population 2020). We describe sources of information, knowledge, and risk perceptions related to COVID-19 among a sample of Malawian adults. We then measure the adoption of preventive behaviors during the first six weeks of the pandemic in the country.

2. Methods

Study setting: Malawi is a low-income country in Southeast Africa with a population of approximately 18 million people (National Statistical Office 2019) and an estimated life expectancy of 63.4 years (United Nations 2019). Prior to the COVID-19 pandemic, Malawi has made progress toward major population health objectives, including reaching the Millennium Development Goal related to child mortality (Government of Malawi 2017; Kanyuka et al. 2016). The pandemic could, however, affect well-being in the country in multiple ways. A WHO model thus projected that COVID-19 could lead to approximately 70,000 hospitalizations and more than 2,000 deaths in Malawi in 2020 (Cabore et al. 2020). Economic forecasts and surveys suggest that several sectors of activity (e.g., agriculture, services) might experience lasting contractions (Baulch, Botha, and Pauw 2020; Chikoti et al. 2020; National Planning Commission 2020).

In response, the government of Malawi declared COVID-19 a national disaster and adopted several measures, including closing schools and universities, implementing COVID-19 screening at operating border posts, and restricting attendance of public events. The Ministry of Health encouraged the adoption of protective behaviors such as increased hand washing, physical distancing, using face masks, and working from home. A national lockdown was announced on April 18; however, its implementation was prevented by an order of the Malawi High Court.

The first case of COVID-19 was recorded in Malawi on April 2, 2020. In the following weeks, sporadic transmission clusters emerged in large cities, and additional importations of COVID-19 cases occurred among migrants returning primarily from South Africa, which was the African country with the largest documented outbreak at the time. The recorded incidence of SARS-CoV-2 then increased in June and July before starting to decline in August. Malawi has recorded 5,783 confirmed COVID-19 cases and 179 deaths as of October 5, 2020. Seroprevalence surveys indicate, however, that SARS-CoV-2 might have spread more broadly in some settings (Chibwana et al. 2020). The

districts with the most confirmed cases are those where the country's main cities are located (i.e., Lilongwe, Blantyre).

Study design: Our study was nested within the Karonga Health and Demographic Surveillance Site (KHDSS), a data collection system located in northern Malawi (Crampin et al. 2012). Since 2002, KHDSS continuously records births, deaths, and migrations that occur within a population of approximately 47,000 individuals. Prior to the COVID-19 pandemic, several studies on the measurement of mortality have been conducted in KHDSS (e.g., Amoah et al. 2020). During these pre-COVID-19 studies, respondents were interviewed about the survival of their relatives (e.g., siblings) and about their own health behaviors related to HIV and noncommunicable diseases. The mobile phone numbers of (some) participants were also collected for recruitment and follow-up purposes. We used these lists of phone numbers to enroll participants in a study of knowledge and practices related to COVID-19 ("COVID-19 study" thereafter).

Sampling: The sample of the COVID-19 study is not representative of the populations of Karonga district or Malawi as a whole. Instead, phone numbers were available for three groups of participants in pre-COVID-19 studies: (a) former KHDSS residents, (b) current KHDSS residents, and (c) referred siblings. Former residents were randomly selected among individuals who have been registered in KHDSS datasets but have now moved out of KHDSS area. Their mobile numbers were obtained from members of their last known KHDSS household. Former residents were contacted and interviewed in person in December 2019. Current residents were randomly selected among the population of several villages of the KHDSS. Their mobile numbers were obtained during in-person interviews in February 2020. Residents were then asked to refer their adult siblings to the study and to provide the phone numbers of those who were interested in participating. In February and March 2020, these referred siblings were contacted and interviewed by mobile phone. Some former KHDSS residents and referred siblings were dispersed throughout Malawi.

Individuals who were aged 18 years and older and who resided in Malawi were eligible for the COVID-19 study. The oldest age of current and former residents recruited during pre-COVID-19 studies was 49 years old for women and 54 years old for men, similar to criteria used during Demographic and Health Surveys (Corsi et al. 2012). There was no upper limit to the age of referred siblings however. The COVID-19 study thus included a small number of participants aged 55 years and older. Additional details about the sample selection process are provided in the Appendix.

Data collection: All data collection took place between April 23 and May 22, 2020. During that time, the number of recorded cases of COVID-19 increased from 33 to 83 cases in Malawi, affecting 13 districts. In Karonga district, only one confirmed case was recorded during that period (on April 26). Due to health risks posed by in-person interviews during the COVID-19 pandemic (World Bank 2020), all data collection

occurred remotely. Interviewers conducted phone interviews from their own home. Supervision procedures included daily calls between the supervisor and interviewers, as well as continuous review of completed study forms.

We obtained oral consent of each respondent prior to interview. The questionnaire covered sociodemographic characteristics, sources of information, knowledge, and preventive behaviors related to COVID-19. Questions were adapted from instruments used in high-income countries (Atchison et al. 2020) and from HIV-related surveys previously conducted in Malawi (Anglewicz and Kohler 2009; Smith and Watkins 2005). After each completed interview, we provided information about COVID-19, including toll-free numbers they could call if they had questions about the disease. Respondents were given 1,200 Malawian Kwachas in mobile phone credit (about 1.50 US dollars) for their participation. Study interviewers made up to 10 contact attempts per potential respondent.

Data analysis: We created binary variables with a value of 1 if a respondent reported hearing about COVID-19 from a specific source of information (e.g., radio) and 0 otherwise. We described respondents' knowledge of the course of COVID-19 using six survey questions, and their knowledge of the transmission of the novel coronavirus using five survey questions. These questions asked respondents whether they agree with specific statements about the disease. We explored respondents' self-perceived risk of becoming infected with SARS-CoV-2 using categories ranging from "no chance at all" to "almost certain." We also investigated their expectations about the severity of symptoms if they were to become infected themselves. We asked respondents to assess their expectations according to five categories: "no expected symptoms," "mild," "moderate," "severe," or "life-threatening." Finally, we described the behaviors that respondents reported using to prevent the spread of SARS-CoV-2 in the past month. We created binary variables with a value of 1 if a respondent reported a specific behavior (e.g., wearing masks) and 0 otherwise. We present the distributions of these categorical variables in our sample. Due to the earlier spread of SARS-CoV-2 in cities in Malawi, we conducted all analyses separately by current place of residence (urban vs. rural).

3. Results

In the COVID-19 study, 779 individuals were eligible, including 221 former residents, 105 current residents, and 453 referred siblings. Out of that, 619 participants completed an interview (79.5%). Close to 60% of respondents were women (Table 1). Among rural dwellers, 94.3% resided in the Northern Region of Malawi. Among urban residents 31.1% and 16.7% resided in the Central and Southern Regions, respectively. Outside of Karonga district, respondents' districts of residence are described in Figure A-2. Almost

one in five respondents was aged 18 to 24 years old, whereas about 2% were aged 55 years and older.

Table 1: Characteristics of study participants

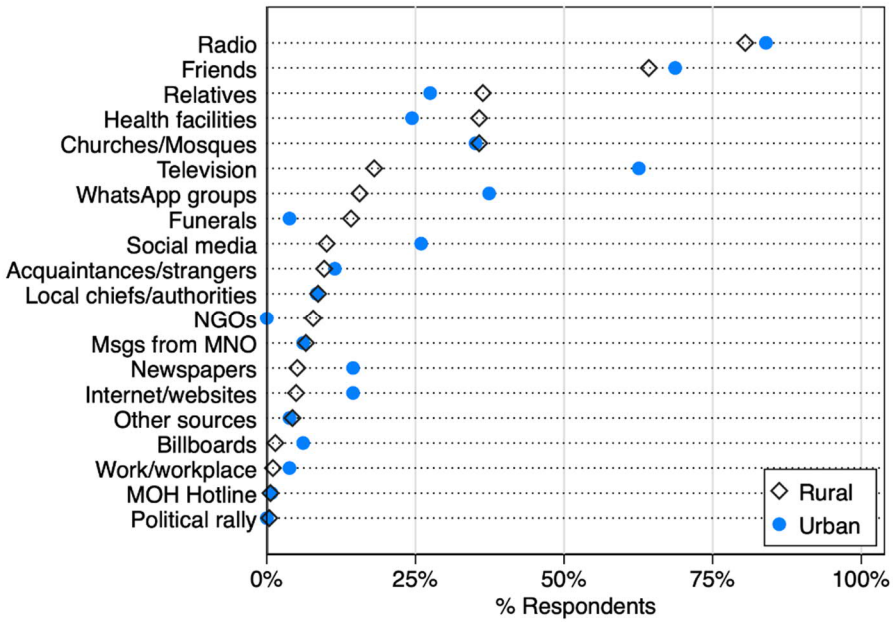
	Rural residents		Urban residents	
	N	% (95% CI)	N	% (95% CI)
Gender				
Men	203	41.7 (37.6 to 45.9)	52	39.4 (30.9 to 48.5)
Women	284	58.3 (54.1 to 62.5)	80	60.6 (51.5 to 69.1)
Region of residence				
Northern	459	94.3 (91.3 to 96.3)	69	52.3 (43.4 to 61.0)
Central	15	3.1 (1.7 to 5.5)	41	31.1 (23.0 to 40.5)
Southern	13	2.7 (1.6 to 4.5)	22	16.7 (10.6 to 25.3)
Recently moved in HH?				
Yes	27	5.5 (3.8 to 8.0)	5	3.8 (1.6 to 8.9)
No	460	94.5 (92.0 to 96.2)	127	96.2 (91.2 to 98.4)
Age				
18–24	93	19.1 (15.6 to 23.1)	25	18.9 (13.2 to 26.4)
25–34	172	35.3 (31.0 to 39.9)	44	33.3 (25.8 to 41.9)
35–44	149	30.6 (26.8 to 34.6)	45	34.1 (26.7 to 42.4)
45–54	60	12.3 (9.2 to 16.4)	16	12.1 (7.2 to 19.6)
≥55	13	2.7 (1.4 to 5.0)	3	1.5 (0.4 to 5.8)
Marital status[1]				
Currently married	313	64.4 (60.2 to 68.4)	72	54.6 (45.9 to 63.0)
Separated	61	12.6 (9.9 to 15.8)	7	5.3 (2.4 to 11.4)
Divorced	22	4.5 (3.0 to 6.7)	5	3.8 (1.6 to 8.9)
Widowed	21	4.3 (2.8 to 6.7)	5	3.8 (1.6 to 8.6)
Never married	69	14.2 (11.3 to 17.7)	43	32.6 (24.9 to 41.3)
Economic activity in past 7 days				
Worked outside own household	177	36.3 (32.2 to 40.7)	73	55.3 (46.8 to 63.4)
Did not work outside own household	310	63.7 (59.3 to 67.8)	59	44.7 (36.6 to 53.1)
Mode of recruitment				
Former residents	93	19.1 (16.8 to 21.7)	73	55.3 (45.7 to 64.5)
Current residents	84	17.3 (16.0 to 18.5)	--	--
Referred siblings	310	63.7 (60.7 to 66.6)	59	44.7 (35.5 to 54.3)

Notes: [1] One rural respondent refused to answer the question about marital status. HH = Household.

Only one respondent reported not having heard about COVID-19 (0.2%). The most common sources of COVID-related information were the radio and conversations with friends (Figure 1). In urban areas, respondents reported relying more extensively on the

television (62.6% vs. 18.1% in rural areas), WhatsApp groups (37.4% vs. 15.6%), social media (26.0% vs. 10.1%), newspapers (14.5% vs. 5.1%), and the internet (14.5% vs. 4.9%). In rural areas, respondents reported obtaining COVID-related information more frequently from relatives (36.3% vs. 27.5% in urban areas) and health facilities (35.7% vs. 24.4%).

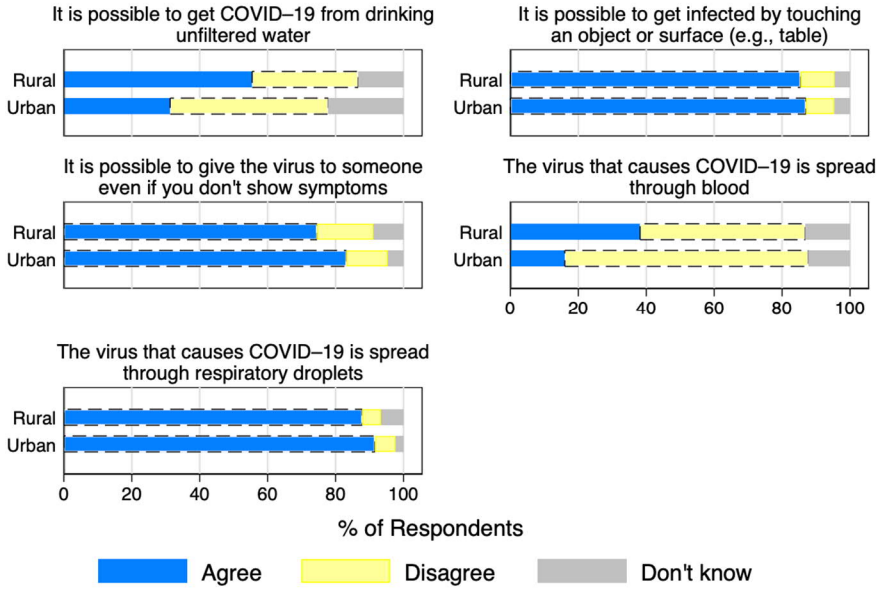
Figure 1: Reported sources of information about COVID-19, by place of residence (n = 618)



Notes: NGO = Nongovernmental organizations; "Msgs from MNO" refers to informational messages sent by mobile network operators via text messages; "MOH Hotline" refers to the toll-free numbers set up by the Ministry of Health to provide COVID-related information. Respondents were asked to list all sources of information through which they had heard about COVID-19. They were not prompted about each source of information.

Most participants knew that SARS-CoV-2 is spread through respiratory droplets (Figure 2), can be spread without showing symptoms, and can be spread by touching an infected surface. However, almost half of the participants also thought that SARS-CoV-2 is waterborne, and one-third believed it is blood borne. The prevalence of these misconceptions was higher among rural than urban participants.

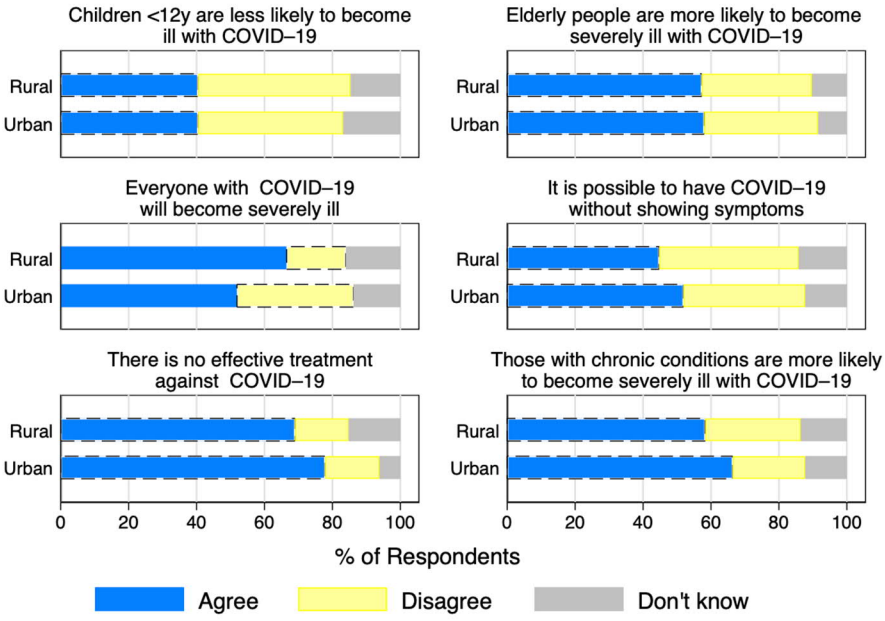
Figure 2: Knowledge of disease transmission patterns, by place of residence (n = 618)



Notes: Correct answers are highlighted by dotted lines in the graphs above. One rural participant refused to answer the question about the spread of SARS-CoV-2 via droplets.

Knowledge of the course of the disease was limited (Figure 3). Two-thirds of respondents believed that everyone with COVID-19 will become severely ill. Large proportions did not know that the risk of becoming severely ill varies by age; for example, one-third of respondents disagreed that elderly people are at a higher risk of severe disease.

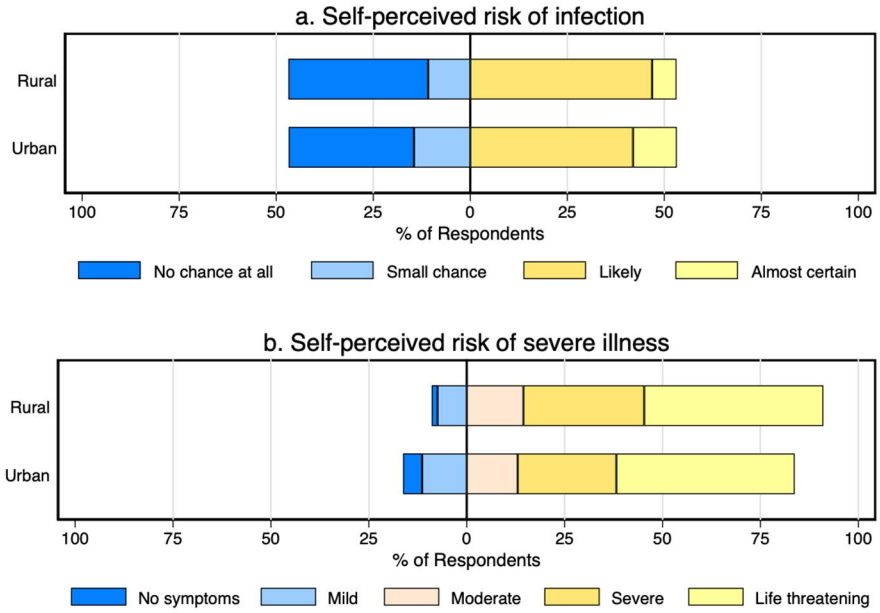
Figure 3: Knowledge of disease patterns, by place of residence (n = 618)



Notes: The correct answer is highlighted by dotted lines in the graphs above. Cronbach's Alpha for the six questions in Figure 3 was 0.75.

Shown in Figure 4, Panel a, 44% of respondents perceived themselves at no risk or low risk of infection. Few respondents expected to experience "no symptoms" if they became infected (2.1%). Overall, close to three out of four respondents expected "severe" or "life threatening" symptoms (Figure 4, Panel b). Respondents in urban areas expected slightly less severe disease if they became infected than respondents in rural areas. For example, 15.2% of urban respondents expected "no symptoms" or "mild symptoms" vs. 8.6% among rural respondents.

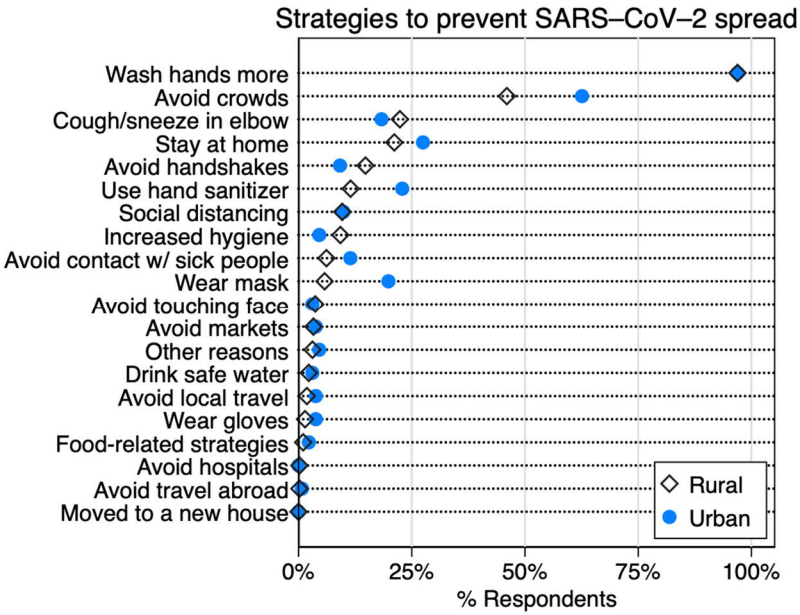
Figure 4: Risk perceptions, by place of residence (n = 612)



Notes: A total of 33 respondents reported not knowing their self-perceived risk of infection and are not included in Panel a.; 23 respondents reported not knowing their self-perceived risk of severe illness, and 2 respondents refused to answer this question and are thus not included in Panel b. For each category of severity appearing in Panel b, we provided respondents with a description of associated limitations as Atchison, Bowman, et al. (2020) did. For example, we explained that "severe" symptoms would require hospitalization.

Seven respondents reported not having adopted any behavior to prevent the spread of SARS-CoV-2 (1.1%). Among others, more than 95% reported washing their hands more frequently (Figure 5), approximately 50% reported avoiding crowds, and 22.5% reported staying at home. The use of face masks was more prevalent among urban (19.9%) than rural residents (5.8%). Urban residents also reported using hand sanitizer more frequently than rural residents (22.9% vs. 11.5%).

Figure 5: Adoption of preventive strategies, by place of residence (n = 612)



Notes: Percentages are calculated among respondents having adopted at least one prevention strategy. Respondents were asked to list all the behaviors they had used over the past month to prevent the spread of the coronavirus. They were not prompted about each behavior. Multiple responses were allowed. After each prevention strategy reported by the respondent, interviewers were instructed to probe by asking "Was there anything else that you did?"

4. Discussion

Despite multiple sources of information, respondents in this sample of Malawian adults had imperfect knowledge about the course of COVID-19 a few weeks after the first case of COVID-19 was recorded in the country. Even in urban areas, only one in eight respondents perceived a high risk of infection, whereas in studies in Nairobi slums, this proportion was as high as one in three (Austrian et al. 2020). Study respondents seemed to overestimate the risk of severe illness from COVID-19: the large majority of respondents expected to experience symptoms requiring hospitalization if they became infected with SARS-CoV-2, even though a recent model (Cabore et al. 2020) indicated that only 2% of infections projected to occur in Malawi would require hospitalization. For comparison, in the United Kingdom in March 2020, only one in five survey

respondents reported that they would expect COVID-19 to be severe or life-threatening (Atchison et al. 2020), even though the UK population might be more vulnerable to adverse disease outcomes due to its older age structure (Dowd et al. 2020).

In the first few weeks of the COVID-19 pandemic in Malawi, virtually everybody reported washing hands more often, but fewer respondents reported implementing other strategies including social distancing or wearing face masks. This limited adoption of preventive behaviors might be related to how individuals assessed the health threat from the pandemic. Low perceived levels of infection risks have been associated with lack of behavioral changes for diseases such as influenza (Reintjes et al. 2016) or HIV (Prata et al. 2006). Similarly, misperceptions about the likely impact of a disease on health and survival might preclude the adoption of safer behaviors (Delavande and Kohler 2016).

Our study has several limitations. First, it is based on a sample of individuals who could be reached by mobile phone. Only three out of four potential participants had a phone number where they could be contacted, and among those about 80% participated in the COVID-19 study. We did not employ post-stratification techniques to adjust study estimates (Greenleaf et al. 2020). If the COVID-related knowledge and/or behaviors of nonparticipants differ from those of participants, our results might be biased. Second, only 45% of the sample was randomly selected (current and former KHDSS residents). Other respondents were referred to this study by their (randomly selected) siblings. Third, our sample included only a limited number of respondents in population groups at increased risk of adverse COVID-19 outcomes. Future studies related to the pandemic in Malawi should ensure the representation of individuals in older age groups or who present specific risk factors (Dowd et al. 2020; Nepomuceno et al. 2020). Finally, our analyses are based on self-reported data, which might be affected by social desirability biases (Kelly et al. 2013). For example, respondents might overreport the number of preventive behaviors they have adopted. Some mobile interviews might also occur at times when the respondent is not in a place that ensures privacy. This might affect some of their answers.

Despite these limitations, our study indicates that additional information campaigns are needed to address knowledge gaps and misperceptions about the health risks posed by COVID-19. Whereas prior studies of attitudes and behaviors related to the COVID-19 pandemic in low- and middle-income countries have focused on urban or humanitarian settings (Austrian et al. 2020; Lopez-Pena et al. 2020), several knowledge gaps are larger, and the adoption of preventive behaviors is slower, in rural areas. Information campaigns and behavioral change communication about COVID-19 need to be tailored to these different contexts. Messages diffused using social media or WhatsApp groups might be effective in urban settings but are unlikely to reach a significant percentage of rural residents. Instead, information campaigns that mobilize social networks of friends and relatives might play a key role in diffusing essential information about the pandemic into rural areas.

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References

Africa CDC (2020a). Africa CDC – COVID-19 daily updates [electronic resource]. https://africacdc.org/covid-19/.

Africa CDC (2020b). Community use of face masks [electronic resource]. https://africacdc.org/download/community-use-of-face-masks/.

Amoah, A., Brumfield, S., Crampin, A.C., Dube, A.N., Helleringer, S., McLean, E., and Reniers, G. (2020). Collecting data on HIV-related mortality during household surveys: a randomized validation study in Malawi. *medRxiv*. doi:10.1101/2020.06.01.20118810.

Anglewicz, P. and Kohler, H.-P. (2009). Overestimating HIV infection: The construction and accuracy of subjective probabilities of HIV infection in rural Malawi. *Demographic Research* 20(6): 65–96. doi:10.4054/DemRes.2009.20.6.

Atchison, C., Bowman, L., Eaton, JW., Imai, N., Redd, R., Pristera, P., Vrinten, C., and Ward, H. (2020). Report 10: Public response to UK government recommendations on COVID-19: Population survey, 17–18 March 2020. London: Imperial College London. doi:10.25561/77581.

Atchison, C., Bowman, L., Vrinten, C., Redd, R., Pristera, P., Eaton, J.W., and Ward, H. (2020). Perceptions and behavioural responses of the general public during the COVID-19 pandemic: A cross-sectional survey of UK adults. (Public and Global Health). doi:10.1101/2020.04.01.20050039.

Austrian, K., Pinchoff, J., Tidwell, J.B., White, C., Abuya, T., Kangwana, B., Ochako, R., Wanyungu, J., Muluve, E., Mbushi, F., Mwanga, D., Nzioki, M., and Ngo, T.D. (2020). *COVID-19 related knowledge, attitudes, practices and needs of households in informal settlements in Nairobi, Kenya*. Rochester: Social Science Research Network. doi:10.2139/ssrn.3576785.

Baulch, B., Botha, R., and Pauw, K. (2020). *Short-term impacts of COVID-19 on the Malawian economy: Initial results*. International Food Policy Research Institute (IFPRI). doi:10.2499/p15738coll2.133788.

Cabore, J.W., Karamagi, H.C., Kipruto, H., Asamani, J.A., Droti, B., Seydi, A.B.W., Titi-Ofei, R., Impouma, B., Yao, M., Yoti, Z., Zawaira, F., Tumusiime, P., Talisuna, A., Kasolo, F.C., and Moeti, M.R. (2020). The potential effects of widespread community transmission of SARS-CoV-2 infection in the World Health Organization African Region: A predictive model. *British Medical Journal Global Health* 5(5): e002647. doi:10.1136/bmjgh-2020-002647.

Chibwana, M.G., Jere, K.C., Kamng'ona, R., Mandolo, J., Katunga-Phiri, V., Tembo, D., Mitole, N., Musasa, S., Sichone, S., Lakudzala, A., Sibale, L., Matambo, P., Kadwala, I., Byrne, R.L., Mbewe, A., Henrion, M.Y.R., Morton, B., Phiri, C., Mallewa, J., Mwandumba, H.C., Adams, E.R., Gordon, S.B., and Jambo, K.C. (2020). High SARS-CoV-2 seroprevalence in health care workers but relatively low numbers of deaths in urban Malawi. *Wellcome Open Research* 5: 199. doi:10.12688/wellcomeopenres.16188.1.

Chikoti, L., Vundru, W.D., Fuje, H.N., Ilukor, J., Kanyanda, S., Kanyuka, M., Kilic, T., Tiope, M., Moylan, H., Mvula, B., Mwale, I., Mwalwanda, T., and Yoshida, N. (2020). *Monitoring COVID-19 Impacts on Households in Malawi: Findings from the First Round of the High-Frequency Phone Survey*. Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/591551597706342578/Findings-from-the-First-Round-of-the-High-Frequency-Phone-Survey.

Corsi, D.J., Neuman, M., Finlay, J.E., and Subramanian, S.V. (2012). Demographic and health surveys: A profile. *International Journal of Epidemiology* 41(6): 1602–1613. doi:10.1093/ije/dys184.

Crampin, A.C., Dube, A., Mboma, S., Price, A., Chihana, M., Jahn, A., Baschieri, A., Molesworth, A., Mwaiyeghele, E., Branson, K., Floyd, S., McGrath, N., Fine, P.E.M., French, N., Glynn, J.R., and Zaba, B. (2012). Profile: The Karonga health and demographic surveillance system. *International Journal of Epidemiology* 41(3): 676–685. doi:10.1093/ije/dys088.

Delavande, A. and Kohler, H.-P. (2016). HIV/AIDS-related expectations and risky sexual behaviour in Malawi. *The Review of Economic Studies* 83(1): 118–164. doi:10.1093/restud/rdv028.

Dowd, J.B., Andriano, L., Brazel, D.M., Rotondi, V., Block, P., Ding, X., Liu, Y., and Mills, M.C. (2020). Demographic science aids in understanding the spread and fatality rates of COVID-19. *Proceedings of the National Academy of Sciences* 117(18): 9696–9698. doi:10.1073/pnas.2004911117.

Government of Malawi (2017). *Malawi Growth Development Strategy (MGDS III) – 2017–2022*. https://www.afidep.org/publication/malawi-growth-development-strategy-mgds-iii-2017-2022/.

Greenleaf, A.R., Gadiaga, A., Guiella, G., Turke, S., Battle, N., Ahmed, S., and Moreau, C. (2020). Comparability of modern contraceptive use estimates between a face-to-face survey and a cellphone survey among women in Burkina Faso. *PLoS One* 15(5): e0231819. doi:10.1371/journal.pone.0231819.

Kanyuka, M., Ndawala, J., Mleme, T., Chisesa, L., Makwemba, M., Amouzou, A., Borghi, J., Daire, J., Ferrabee, R., Hazel, E., Heidkamp, R., Hill, K., Álvarez, M.M., Mgalula, L., Munthali, S., Nambiar, B., Nsona, H., Park, L., Walker, N., Daelmans, B., Bryce, J., and Colbourn, T. (2016). Malawi and Millennium Development Goal 4: A countdown to 2015 country case study. *The Lancet Global Health* 4(3): e201–e214. doi:10.1016/S2214-109X(15)00294-6.

Kelly, C.A., Soler-Hampejsek, E., Mensch, B.S., and Hewett, P.C. (2013). Social desirability bias in sexual behavior reporting: Evidence from an interview mode experiment in rural Malawi. *International Perspectives on Sexual and Reproductive Health* 39(1): 14–21. doi:10.1363/3901413.

Lopez-Pena, P., Davis, C.A., Mobarak, A.M., and Raihan, S. (2020). Prevalence of COVID-19 symptoms, risk factors, and health behaviors in host and refugee communities in Cox's Bazar: A representative panel study. *Bulletin of the World Health Organization* (E-pub). doi:10.2471/BLT.20.265173.

Ministry of Health and Population (2020). COVID-19 – MOHP MALAWI [electronic resource]. https://covid19.health.gov.mw/.

National Planning Commission (2020). Medium and long-term impacts of a moderate lockdown (social restrictions) in response to the COVID-19 pandemic in Malawi: A rapid cost-benefit analysis. https://www.afidep.org/publication/medium-and-long-term-impacts-of-a-moderate-lockdown-social-restrictions-in-response-to-the-covid-19-pandemic-in-malawi-a-rapid-cost-benefit-analysis/.

National Statistical Office (2019). *2018 Malawi Population and Housing Census*. Zomba, Malawi. http://www.nsomalawi.mw/index.php%3Foption%3Dcom_content%26view%3Darticle%26id%3D226:2018-malawi-population-and-housing-census%26catid%E2%80%89%3D%E2%80%898:reports%26Itemid%E2%80%89%3D%E2%80%896.

Nepomuceno, M.R., Acosta, E., Alburez-Gutierrez, D., Aburto, J.M., Gagnon, A., and Turra, C.M. (2020). Besides population age structure, health and other demographic factors can contribute to understanding the COVID-19 burden. *Proceedings of the National Academy of Sciences* 117(25): 13881–13883. doi:10.1073/pnas.2008760117.

Prata, N., Morris, L., Mazive, E., Vahidnia, F., and Stehr, M. (2006). Relationship between HIV risk perception and condom use: Evidence from a population-based survey in Mozambique. *International Family Planning Perspectives* 32(4): 192–200. doi:10.1363/3219206.

Reintjes, R., Das, E., Klemm, C., Richardus, J.H., Keßler, V., and Ahmad, A. (2016). 'Pandemic public health paradox': Time series analysis of the 2009/10 influenza A / H1N1 epidemiology, media attention, risk perception and public reactions in 5 European countries. *PLoS One* 11(3): e0151258. doi:10.1371/journal.pone.0151258.

Roberton, T., Carter, E.D., Chou, V.B., Stegmuller, A., Jackson, B.D., Tam, Y., Sawadogo-Lewis, T., and Walker, N. (2020). *Early estimates of the indirect effects of the coronavirus pandemic on maternal and child mortality in low- and middle-income countries*. Rochester: Social Science Research Network. doi:10.2139/ssrn.3576549.

Rosenstock, I.M., Strecher, V.J., and Becker, M.H. (1988). Social learning theory and the health belief model. *Health Education Quarterly* 15(2): 175–183. doi:10.1177/109019818801500203.

Smith, K.P. and Watkins, S.C. (2005). Perceptions of risk and strategies for prevention: responses to HIV/AIDS in rural Malawi. *Social Science and Medicine* 60(3): 649–660. doi:10.1016/j.socscimed.2004.06.009.

UN-DESA (2020). *UN/DESA Policy Brief #81: Impact of COVID-19 on SDG Progress: A Statistical Perspective.* New York: UN-DESA, Department of Economic and Social Affairs. https://www.un.org/development/desa/dpad/publication/un-desa-policy-brief-81-impact-of-covid-19-on-sdg-progress-a-statistical-perspective/.

United Nations (2019). *World Population Prospects Volume 1*. New York: United Nations.

Weiss, D.J., Bertozzi-Villa, A., Rumisha, S.F., Amratia, P., Arambepola, R., Battle, K.E., Cameron, E., Chestnutt, E., Gibson, H.S., Harris, J., Keddie, S., Millar, J.J., Rozier, J., Symons, T.L., Vargas-Ruiz, C., Hay, S.I., Smith, D.L., Alonso, P.L., Noor, A.M., Bhatt, S., and Gething, P.W. (2020). Indirect effects of the COVID-19 pandemic on malaria intervention coverage, morbidity, and mortality in Africa: A geospatial modelling analysis. *The Lancet Infectious Diseases* 21(1): 59–69. doi:10.1016/S1473-3099(20)30700-3.

WHO (2020). Strategic preparedness and response plan for the novel coronavirus [electronic resource]. https://www.who.int/publications-detail-redirect/strategic-preparedness-and-response-plan-for-the-new-coronavirus.

World Bank (2020). LSMS launches high-frequency phone surveys on COVID-19 | Living Standards Measurement Study (LSMS) [electronic resource]. http://surveys.worldbank.org/covid-19.

Appendix: Description of the study sample

We selected respondents of the COVID-19 study presented in this paper among lists of participants previously enrolled in KHDSS studies conducted before the COVID-19 pandemic (between December 2019 and March 2020). The focus of these pre-COVID-19 studies was on improving survey methods to measure adult mortality and its risk factors in settings with limited death registration. During pre-COVID-19 studies, phone numbers were collected to allow the recruitment and/or follow-up of specific groups of participants. We detail below the procedures used to obtain phone numbers for each of the groups. Then, we describe differences in socioeconomic characteristics between those who participated in the COVID-19 study and those who did not.

Selection process

Former KHDSS residents: 514 former KHDSS residents were randomly sampled from KHDSS lists. Recruitment procedures entailed asking an informant in their last known KHDSS household to provide a contact number where the former resident could be reached so that an in-person interview could be scheduled at their new place of residence. Due to budget constraints, in-person interviews could be arranged only if the former KHDSS resident had moved to specific parts of the country (i.e., large cities or districts neighboring Karonga district, such as Rumphi or Chitipa). Study investigators thus did not seek the phone numbers of 188 former residents because (a) they resided outside of Malawi at the time of the study (n = 52), (b) they were reported to be deceased (n = 13), (c) no informant was available to provide their mobile number (n = 32), (d) they resided in areas of Malawi where they could not be visited in-person (n = 55), or (e) other reasons (n = 36). Study investigators thus inquired about the mobile numbers of 326 former residents who could be visited for an in-person interview, and contact mobile numbers were obtained for 221 former residents (67.8%). During the COVID-19 study, we attempted to contact all the former KHDSS residents for whom a contact number was available, and 166 completed the phone interview (75.1% participation).

Current KHDSS residents: 193 current KHDSS residents were sampled from KHDSS lists during the pre-COVID-19 studies. These residents were visited in person by study teams. However, 38 KHDSS residents could not be recruited due primarily to temporary absence from the KHDSS area. Study investigators also did not inquire about the phone numbers of 32 current KHDSS residents due to a programming error. Among the remaining 123 KHDSS residents, 105 provided a contact number (85.4%), and among those 84 completed a phone interview during the COVID-19 study (80.0% participation).

Referred siblings: Current KHDSS residents were asked to list all their maternal siblings to report basic information about them (e.g., vital status, age, sex, and education) and to refer them to the study for potential enrollment. Among the siblings that they reported, 197 were deceased, 68 resided abroad, and 67 were aged younger than 18 years old and were thus ineligible for the study. In total, 587 siblings were eligible for referral to the study. After referral attempts, phone numbers were obtained for 453 siblings (75.5%). Among those referred siblings, 370 completed a phone interview during the COVID-19 study (81.7% participation).

Selectivity of the study sample

The pre-COVID-19 studies inquired about the phone numbers of 1,036 individuals. Among those, there were 428 men and 608 women. Women were overrepresented for several reasons. On the one hand, survey data on adult mortality are primarily collected from female respondents in Malawi and in other African countries (e.g., in Demographic and Health Surveys). Since they were focused on improving survey methods for mortality data collection, pre-COVID-19 studies thus oversampled women. On the other hand, selected women were also less likely to be absent from the study area at the time of recruitment visits for pre-COVID-19 studies. Finally, women were overrepresented among referred siblings due to lower rates of international migration and adult mortality. They were also less likely to have migrated to areas of Malawi where in-person interviews could not be arranged for recruitment.

We classified participation outcomes into three categories: (a) individuals for whom a contact number was not provided during pre-COVID-19 studies, (b) individuals for whom a contact number was provided but who did not complete the COVID-19 interview, and (c) individuals who were interviewed in the COVID-19 study. In Figure A-1, we describe differences in participation by age, sex, and educational levels in each of the study groups (i.e., former residents, current residents, and referred siblings).

We found limited gender differences in participation outcomes across all three study groups. However, there were large educational differentials in all study groups. Respondents with higher educational levels were more likely to have a contact number and to have participated in the COVID-19 interview. There were also differences in participation associated with age in all study groups. In particular, respondents in the younger age group (younger than 25 years old) were less likely to have a contact number and to participate in the interview.

Figure A-1: Participation outcomes in the COVID-19 study

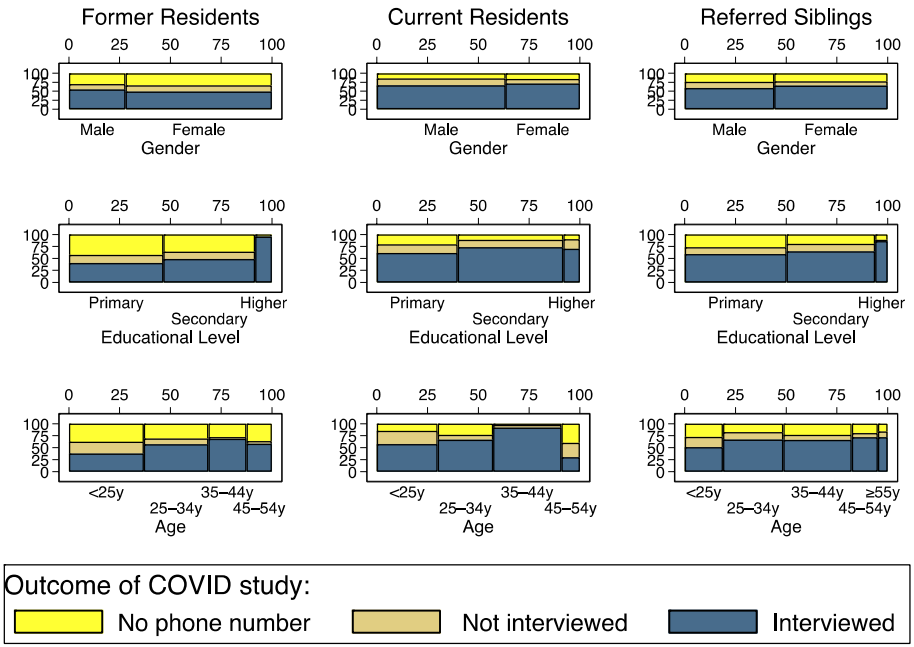

Figure A-2: Geographic distribution of respondents not residing in Karonga district, by place of residence