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Socio-ecological Factors Associated with Preventive Behavior against COVID-19 in Ethiopia

A Cross-sectional Survey

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Abstract

Understanding factors influencing the adoption of preventive behaviors is crucial in pandemic prevention and control. This study employs the social-ecological model to examine the determinants of preventive actions against COVID-19 in Addis Ababa, Ethiopia. Data from a household survey were analyzed using a linear regression model. The findings indicate a moderate level of preventive behavior adoption among residents. Interpersonal behavior, community norms, and organizational-level factors are identified as significant predictors, while personal and demographic factors have little influence. These results highlight the need for context-specific health interventions, addressing social and structural aspects, to effectively combat COVID-19 in Addis Ababa and similar low- and middle-income settings.

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Keywords

COVID-19 – preventive actions – socio-ecological model – health intervention – Ethiopia – low- and middle-income setting

1 Introduction*

Preventing and controlling diseases such as COVID-19 requires regular implementation of preventive measures which has much to do with people's knowledge and behavior. People's knowledge and behavior are complex phenomena influenced by several individual, interpersonal and social factors. The World Health Organization recommended good hygiene, avoiding large gatherings, and wearing facemask to avoid the risk of contracting COVID-19 (WHO, 2022). Several countries around the world have endorsed the recommendation and implemented COVID-19 prevention protocols. Overall, evidence from credible health organizations and research institutions recommend a combination of public health interventions working well in various parts of the world resulting in the stabilization of case numbers. On the other hand, poor hand hygiene practices, overcrowding and close physical contacts like handshaking contributed to the fast spread of the virus within a very short period (WHO, 2020). Therefore, enhancing the implementation of preventive measures in combinations and targeting the high-risk group of people will have a significant contribution to end the spread of COVID-19 and other similar diseases. Later in the pandemic, vaccination has become an integral part of the COVID-19 prevention strategy (Naidoo et. al. 2023). However, this has come with its own set of challenges, that are beyond the scope of this study.

WHO reports accurately informing people about COVID-19, its mode of transmission and preventive measures such as hand washing with soap or use of hand sanitizers, maintaining physical distancing in public gatherings, ventilating closed areas, proper use of facemasks and when possible, staying at home helped to slow down the transmission of COVID-19 (Defar et al. 2021). Contrary, other studies from various settings argued that knowledge or understanding alone seldom impacted positive outcomes unless synchronized with structural interventions to facilitate meaningful behavioral changes in adopting preventive practices. A recent KAP study in Ethiopia (Bekele et al. 2021) for

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instance reported majority of the participants knew the ways to protect themselves from the novel coronavirus (COVID-19), but there was a great concern on translating this prevention knowledge to practices. This shows that there is a stark gap between having knowledge about COVID-19 and implementing preventive practices to tackle the spread of COVID-19. Similarly, KAP study in Nigeria reported incongruence between better knowledge of participants and their level of compliance to the preventive practices (Reuben et al. 2021). The same study reported low adherence attributed to the presence of urban slums, dense population, inadequate access to potable water, fragile healthcare system, sharing of sanitation facilities with a high degree of social mixing among the inhabitants.

Lessons learnt from the public health emergencies in Ebola and HIV outbreaks in the past acknowledge the effectiveness of social and behavioral interventions in slowing down transmissions and enhancing preventive measures at individual and community levels. Similarly, evidence suggests public health approaches to addressing COVID-19 are heavily dependent on social and behavioral change strategies to halt transmissions (Eaton and Kalichman, 2020). The social and economic impact of COVID-19 pandemic could remain a huge public health challenge, especially for developing countries in sub-Saharan Africa where such preventive strategies are tackled by contextual factors such as low public literacy, poor economy and infrastructures, shortage of trained human resources, misconceptions and congested residential settings and high proclivity to social life (Ogbolosingha and Singh, 2020). The relevance of identifying factors that account for adoption of preventive health goes beyond COVID-19. It is essential to learn how people respond to similar pandemics with the aim of enhancing the readiness of the health and social systems to withstand disease outbreaks.

Ethiopia was one of the top 20 African countries reported with large number of infected cases on along with Egypt, Tunisia, Morocco and South Africa (Obande et al. 2021). In Ethiopia, the first COVID-19 case was reported on March 13, 2020. By the end of the data collection period in May 2022 the total number of positive cases and death toll reported by Ethiopian Public Health Institute (EPHI) spiked to 471,145 and 7,512 respectively showing a gradual surge in spread of the virus (Ethiopian Public Health Institute, 2022). The first case in Ethiopia was reported from the capital, Addis Ababa and swiftly expanded across the city making the capital to remain the epicenter.

Emerging reports on the current preventive responses in Ethiopia appear to show that public adherence practices are far from expected and motivations for taking preventive measures is largely deteriorating. For instance, a longitudinal study in selected towns in Ethiopia including Addis Ababa highlighted

most of the respondents believed that COVID-19 still exists, but a considerable proportion perceived they are no longer at risk of contracting the disease and practicing of COVID-19 preventive measures has therefore declined significantly in the last rounds in August 2021 (Harris et al. 2020). According to the qualitative findings of the same study, perceived low prevalence of COVID-19 and low perceived susceptibility to the disease seem to have contributed to a decline in the practice of preventive measures (Harris et al. 2020). Despite these individual level factors, little is known about interpersonal, community and structural factors that affects adoption of healthy behavior. Although the threat of COVID-19 has been reduced and adoption of preventive health against the disease teaches important lessons for public health interventions.

Adopting healthy behavior can help prevent diseases, decrease morbidities, improve the quality of life, and decrease healthcare costs (Mo & Winnie, 2010). Inculcating healthy lifestyle, developing and strengthening strategies that target controlling diseases like COVID-19 require a substantial and long-term commitment of human and material resources. Such strategies would be successful if informed by theories and research which provide them with tools to understand the nature of the problem. Several health behavior theories have been employed to investigate factors that associate with preventive health, such as the Theory of Planned Behavior (Ajzen, 1991), the Transtheoretical Model (Prochaska, DiClemente & Norcross, 1992), the Health Belief Model (Rosenstock, 1966) and the social-ecological model (Bronfenbrenner, 1994). However, the social ecological model, developed in the 1979 to investigate multiple levels of factors related to preventive health, remains to be one of the most widely employed model (Belsky, 1980; Fitzgerald & Spaccarotella, 2009). The model assumes that human health behavior is a product of a reciprocal interaction between an active, evolving human organisms and its immediate environment (Bronfenbrenner, 1994).

There has been a growing interest public health and social science fields to use the socio-ecological model to explain adoption of healthy behavior. Washing hands effectively with sanitizers or soap more frequently, wearing face mask and social distancing in public places, is pivotal for reducing the transmission of COVID-19 and other similar diseases (Zhang, et al 2022; Paner-Brick, 2014; Golden and Earp 2012; Golden et al. 2015; Betsch et al. 2020). However, there have been great disparities in the adoption of these health-protective behaviors. As COVID-19 is predicted by multiple levels of factors, from individual and organizational levels to community and national levels, the socioecological perspective is informative for developing and implementing comprehensive interventions to cultivate preventive behavior and mitigate disparities in

adoption of positive practices among people during COVID-19 pandemic (West et al. 2020). Informed by the social-ecological model, this study assessed which individual, interpersonal, community level, organizational and policy level factors are associated with adoption of preventive action towards COVID-19 among the residents of Addis Ababa, Ethiopia.

1.1 *The Socio-ecological Model*

This study uses the socio-ecological model to analyze multilevel factors that influence health behavior. Initially developed by Bronfenbrenner (1977) and later adopted widely by health researchers worldwide, the Socio-Ecological Model examines health outcomes by considering the interaction between individuals and their broader social, cultural, economic, and environmental contexts. This model recognizes that health is influenced by factors at multiple levels, including individual characteristics, interpersonal relationships, community settings, societal norms, and public policies (USDHHS 2018). The model offers the advantage that it allows for the analysis of multi-level factors, which encompass individual, interpersonal, community, and societal layers. Unlike other models, such as the often-used Health Belief Model, the socio-ecological model does not restrict its focus to individual beliefs, perceptions, and behaviors. Instead, it acknowledges the complex interplay between personal and environmental factors. This holistic approach is particularly useful for analyzing COVID-19 preventive actions, as it recognizes the influence of social norms, community resources, public policies, and even global health trends, alongside individual knowledge, and attitudes. The model has been usefully applied to analyze various aspects of the COVID-19 pandemic, including vaccine uptake and changes in work condition, (Naidoo et. al. 2023, Pawluk et. al. 2023, Lun et. al. 2022).

2 Methods and Materials

2.1 *Study Setting*

The study was conducted in Addis Ababa, Ethiopia in May 2022. Having 4 million residents, Addis Ababa is the largest city in Ethiopia. The city is home to one fourth of the country's urban population and had a population density of 5,165 people per square kilometer (Word Population Review, 2020). There is a very high demand for housing and transportation in the city and most of the residents live and work in crowded and substandard places (World Bank, 2019) Due to this, residents of the city were at high risk of contracting COVID-19.

2.2 *Study Design and Sampling*

We conducted a cross-sectional survey with household representatives in Addis Ababa, Ethiopia from March to April 2022. Household representatives above the age of 18 were eligible to participate in the study. Eight trained data collectors conducted face-to-face interviews with selected residents and recorded responses using tablets. Cochran's (1977) sampling formula was used to select 381 households from 39,115 households in the city. In order to select the samples, lists of households were obtained from all districts of the city. Then, a continuous sampling frame consisting of names of household heads, sub cities and districts was prepared. Finally, stratified sampling design was used to select sample households from the sampling frame. This ensures proportionate representation of households from different sub cities and districts in the overall sample. A total of 353 respondents completed the survey.

2.3 *Instrument and Measures*

The team developed a questionnaire guided by the social-ecological model to assess the impact of individual interpersonal, community and organizational factors on adoption of preventive actions against COVID-19.

2.3.1 Dependent Variable

Preventive Behavior: The dependent variable for this study was individuals' adherence to COVID-19 preventive practices, which was assessed using seven items. Items included Following the 2-meter physical distance rule, wearing a face mask when going out, washing hands or using hand sanitizer regularly, covering the mouth and nose when coughing or sneezing, avoiding touching the face (eyes, nose, mouth), avoiding meetings or gatherings of more than 5 people, avoiding shaking hands with people.

Each item was measured on a 5-point scale, ranging from "not at all" (0 point) to "always" (4 points). The dependent variable was constructed by taking the sum of the five items, with higher scores indicating greater adherence to COVID-19 preventive practices. Cronbach's alpha (α) was 0.848.

2.3.2 Independent Variables

2.3.2.1 *Individual Level*

Fear of COVID-19: the fear of COVID-19 was measured using four items measured on a 7-point scale (1 to 7). The items include if an illness is going around, I will get it, I have a history of susceptibility to infectious disease, in general I am very susceptible to colds, flu and other infectious diseases, and I am more likely than the people around me to catch an infectious disease. We used the total of the four items (Cronbach's alpha = 0.813).

Knowledge of COVID-19: The correct knowledge of COVID-19 was computed as a sum total of correct answers for 10 items on the causes, incubation period, major symptoms, way of preventing covid infection, and major ways of transmission.

2.3.2.2 *Inter-personal/Community*

The behavior of people around us influences our adoption of COVID-19 preventive actions. Observing others taking these actions can reinforce their importance and make us more likely to follow suit. Conversely, seeing others disregarding preventive measures can discourage us from taking them seriously. The study uses two variables to measure interpersonal/community level factors.

Community behavior: these variable measures community level adherence to COVID-19 preventive actions. It was measured using the seven items: people around me follow the 2 meter physical distance rule, people around me wear face mask when they go out, people around me wash hands regularly or use hand sanitizer regularly, people around me cover mouth and nose when coughing/sneezing, people around me avoid touching face (eyes, nose, mouth), people around me avoid meetings or gatherings of more than 5 people, people around me avoid shaking hands with people. Each item was measured on a 4-point scale, ranging from "no one" (0) to "all of them" (4). The variable was constructed by taking the sum of all variables (Cronbach's alpha = 0.806).

Community norm: this variable measures participants' beliefs about what is acceptable behavior in their social circle with regards to taking COVID-19 prevention. It was measured using the following four items: people around me will be supportive if I wear a mask when staying with them, people around me will be supportive if I wash my hands frequently or use hand sanitizer, people around me will be disappointed if I insist on maintaining physical distance, people around me will be supportive if I refuse to shake hands. Each item was measured on a 4-point scale, ranging from "no one" (0) to "all of them" (4). The variable was constructed by taking the sum of all variables (Cronbach's alpha = 0.820).

2.3.2.3 *Organization/policy*

Organizational efforts: The study used series of items that measure actions that were taken by respondents' school/workplace. These reflect regulations that are implemented by organizations to promote COVID-19 prevention. These regulations are an important part of the broader policy level in the social ecological model, which recognize that organizational and policy factors can have a significant impact on health behaviors and outcomes. Items included

workplace/school are implementing social distancing, providing a ventilated environment, staggering attendance, encouraging hand washing by providing water and soap facility/hand sanitizers, providing masks, and organizing awareness raising sessions.

2.3.3 Control Variables

Control Variables include sex, age group (18–29, 30–49, 50+); and level of education (No Formal Education, Elementary School, High School, and College or Higher).

2.3.4 Data Analysis

The survey data were analyzed using Stata version 13.0 software. The study team checked for out-of-range values and other errors, cleaned the data and performed descriptive statistics. To examine the relationships between the socio-ecological factors and COVID-19 preventive behaviors, a variety of statistical techniques were employed in this study.

Firstly, a Pearson correlation matrix was utilized to assess the inter-item correlation among the independent factors. The correlation coefficients between the variables range from −0.116 to 0.476, with none of them exceeding the threshold of 0.7, indicating that there is no strong linear relationship between any pair of variables. Overall, the correlation matrix suggests that the independent variables are not highly correlated with each other, and thus multicollinearity is not a major concern in the regression analysis.

TABLE 1 Correlation matrix for independent variables

Variables	(1)	(2)	(3)	(4)	(5)
(1) Fear of COVID-19	1.000				
(2) Knowledge of COVID-19	−0.116	1.000			
	(0.029)				
(3) Community behavior	0.209	0.142	1.000		
	(0.000)	(0.008)			
(4) Community norms	0.300	0.023	0.476	1.000	
	(0.000)	(0.664)	(0.000)		
(5) Organizational efforts	0.193	0.078	0.414	0.339	1.000
	(0.000)	(0.144)	(0.000)	(0.000)	

A multiple linear regression analysis was employed to explore the association between social-ecological predictors and COVID-19 preventive behaviors. To this end, a liner regression model was developed with different levels of factors. Specifically, the individual-level factors of fear of COVID-19, and knowledge of COVID-19 were fitted in the first model, followed by the addition of interpersonal-level factors, including community behavior and community norms, in the second model. In the third model, the broader factor of organizational efforts was included. Finally, the socio-demographic variables of sex age, and educational level were included in the fourth model.

We haven't included vaccination status as an independent variable. This decision was informed by our understanding of vaccination as a distinct form of preventive behavior in the context of COVID-19. Using vaccination status to predict other preventive behaviors might not yield accurate or meaningful insights. Unlike more universally advocated preventive measures such as hand washing, social distancing, and mask-wearing, vaccination encompasses a set of complexities and influencing factors that are not necessarily shared with these other behaviors. Furthermore, vaccination is influenced by a range of unique variables, such as misinformation about vaccine safety and efficacy, accessibility issues, and public trust in healthcare systems. These factors can significantly impact an individual's decision to get vaccinated, and they operate differently from the factors influencing adherence to other preventive

TABLE 2 Demographic characteristics of the respondents (N = 353)

Socio-demography	**%**
Sex	
Male	44.48
Female	55.52
Age	
18–29	24.08
30–49	55.82
50+	22.10
Education	
No formal education	10.48
Elementary school	33.99
High school	31.44
College or higher	24.09

behaviors. Therefore, including vaccination as a predictor for other preventive actions could confound our analysis due to these distinct underlying dynamics. Additionally, we also chose not to construct our dependent variable, 'preventive behavior', to include vaccination status. The rationale behind this decision is that, historically, vaccination was not part of the initially heavily advocated preventive actions against COVID-19. The primary focus was on non-pharmaceutical interventions like hand hygiene, mask usage, and physical distancing. It was only later in the pandemic that vaccination emerged as a key preventive strategy, and it has since been influenced by an entirely different set of variables compared to the earlier preventive measures.

2.3.5 Ethical Considerations

Addis Ababa University granted permission to conduct research in Addis Ababa, Ethiopia. The study had minimal physical and psychological impact on participants. Participation in the study was voluntarily. Data collectors read information sheet for participants prior to interviews. Respondents were informed that they may withdraw at any moment, skip any question without a consequence. Confidentiality and anonymity were maintained during the data collection, analysis and report. Personal data are not mentioned in this report. Written informed consent was obtained from all participants.

3 Results

A total of 353 respondents involved in the survey, of whom 55.5% were females and 55.8% were between 30 and 49 years of age category. About 10% had no formal education, while one in three (33.99) had completed elementary school during the time of the survey. The mean total score for adopting preventive behavior was 11.74 (SD = 7) and scores ranged from 0 to 20 (higher scores indicate more adherence to preventive actions). Table 3 shows that the mean score for fear of COVID-19 was found to be 10.76 (SD = 6.91). The survey further disclosed that the average score for community norms was 4.24 (SD = 3.3); the range of scores vary between 0 and 16 while the mean score for organization efforts was found to be 1.2 (SD = 1.77).

Table 4 presents the results of a multiple linear regression analysis examining the association between social-ecological predictors and COVID-19 preventive behaviors. The analysis used a hierarchical model, with different levels of factors including individual, interpersonal/community, organizational/policy, and socio-demographic factors.

TABLE 3 Mean of dependent and independent variables

Variables	Mean
Preventive behavior	11.74 (7.00)
Fear of COVID-19	10.76 (6.91)
Knowledge of COVID-19	4.58 (1.51)
Community behavior	6.75 (4.17)
Community norms	4.24 (3.37)
Organizational efforts	1.20 (1.77)

TABLE 4 Social-ecological factors predicting Adoption of COVID-19 preventive behaviors

Variables	Model 1	Model 2	Model 3	Model 4
Socio-demography				
Sex (ref: female)				
Male	−1.002	−0.855	−0.550	−0.521
	(0.751)	(0.743)	(0.590)	(0.582)
Age (ref: 18–29)				
30–49	1.393	1.094	0.151	0.347
	(0.918)	(0.912)	(0.730)	(0.723)
50+	2.292**	2.418**	0.720	0.955
	(1.125)	(1.120)	(0.898)	(0.889)
Education (ref: no formal educ.)				
Elementary	2.148	2.189*	0.911	0.675
	(1.310)	(1.294)	(1.040)	(1.029)
Highschool	−0.195	−0.591	−0.828	−0.920
	(1.341)	(1.340)	(1.076)	(1.062)
College or higher	3.438**	2.675*	0.313	−0.245
	(1.405)	(1.408)	(1.134)	(1.132)
Individual level				
Fear of COVID-19		0.0885*	−0.0701	−0.0827*
		(0.0535)	(0.0444)	(0.0440)
Knowledge of COVID-19		0.787***	0.334	0.326
		(0.255)	(0.205)	(0.202)

TABLE 4 Social-ecological factors predicting Adoption of COVID-19 (*cont.*)

Variables	Model 1	Model 2	Model 3	Model 4
Inter-personal/community				
Community behavior			0.876***	0.801***
			(0.0813)	(0.0836)
Community norms			0.381***	0.336***
			(0.101)	(0.101)
Organization/policy				
Organizational efforts				0.588***
				(0.184)
R-squared	0.054	0.084	0.426	0.443

Note: Standard errors in parentheses; $N = 353$. *** p < 0.01, ** p < 0.05, * p < 0.1.

In Model 1, the sociodemographic variables sex, age, and education were included. The results show that being 50+ (compared to 18–29) is positively associated with COVID-19 preventive behaviors with a coefficient of 2.292 (p < 0.05). Similarly, having a college or higher education (compared to no formal education) associated positively associated with preventive behavior, with a coefficient of 3.438 (p < 0.05).

In Model 2, the individual-level factors of fear of COVID-19 and knowledge of COVID-19 were included. The results show that Knowledge of COVID-19 is positively associated with preventive behaviors, with a value of 0.787 (p < 0.01), indicating that higher levels of knowledge are strongly associated with more preventive behaviors. Fear of COVID-19 is also found to have a moderate positive association with preventive behaviors, with a value of 0.885 (p < 0.1). With the inclusion of the individual level variables, the magnitudes of coefficients for sex, age, and education change only slightly.

In Model 3, interpersonal-level factors were added, including community behavior and community norms. The results show that community behavior and community norms are strongly associated with COVID-19 preventive behaviors. Community behavior has a coefficient of 0.876 (p < 0.01), indicating that communities that engage in more preventive behaviors are associated with more preventive behaviors among individuals. Community norms have a coefficient of 0.381 (p < 0.01), indicating that communities with stronger norms around preventive behaviors are associated with more preventive behaviors among individuals. With the addition of the interpersonal/community variables in model three, the coefficient for Fear of COVID-19 becomes no longer

significant and Knowledge of COVID-19's significance is reduced, indicating that the effect of individual-level factors on the dependent variable might not be as straightforward as it seemed in simpler models.

In Model 4, organizational/policy-level factors were added, specifically organizational efforts. The results show that organizational efforts are positively associated with COVID-19 preventive behaviors, with a coefficient of 0.588 ($p < 0.001$), indicating that organizations that make more efforts to promote preventive behaviors are associated with more preventive behaviors among individuals.

Finally, the R-squared value increased from 0.054 in Model 1 to 0.443 in Model 4, indicating that the addition of each level of factors improved the model's ability to explain the variation in COVID-19 preventive behaviors.

4 Discussion and Conclusion

The findings of this report have shown that interpersonal behavior, community norms and organizational level factors are predictors of adoption of preventive actions against COVID-19 bringing the argument of the social-ecological model to the fore (Bronfebrenner, 1994). Although individual level factors such as fear of contracting COVID-19 and knowledge are found to be important factors when considered alone, in successive models, they appear to be weaker predictors of adopting preventive behavior.

Our study revealed that individual demographic variables were not statistically significantly associated with preventive behavior. It appears that adoption of preventive actions against COVID-19 were evenly distributed across different age and sex groups. Our study contradicts with prior research indicating age and gender were correlated with adoption of preventive actions (Alsan et al. 2020; Tang et al. 2021). Furthermore, we found no evidence that educational status affects adoption of preventive measures. During the early days of COVID-19, adoption of preventive actions was associated with formal education in Ethiopia (Engdawork et al. 2022) as individuals with higher education are capable of translating and adopting to information provided by peers, the media, and health education campaign (UNAIDS, 2006). This could have changed following mass health promotion activities that have targeted more vulnerable population, such as women and people with no formal education in developing countries.

The study disclosed that knowledge about COVID-19 and fear of COVID-19 positively and significantly influence preventive behavior adoption. As compared to fear, we found knowledge to be a stronger predictor of preventive

action at individual level. This result confirms prior studies that found accurate understanding to be relevant in adopting preventive mechanism against pandemics (Siegrist et al. 2021; Engdawork, 2020; Ahmed et al. 2020; Chen and Chen, 2020; Chenge and Ng, 2006). The study reiterates that knowledge about health risk could still be a motivational factor related to individuals' protective behavior. Thus, we underline the importance of health education to reduce the risk of contracting COVID-19 and potentially similar future pandemics. Health messages should be disseminated from credible sources at household, school and workplaces to encourage adoption of prevention actions against COVID-19. However, as individuals' opportunities to have complete health information and knowledge may decrease as the pandemics wanes, continues efforts should be made to provide updated and contextually feasible behavior change messages.

The other level of the social-ecological model includes interpersonal influences within one's immediate environment, such as their community and social networks, that affect individuals' decision to take preventive actions (CDC, 2020b). Individuals' preventive behavior can be shaped through social learning. If people around individuals wear facemasks and adhere to personal hygiene practices, individuals are likely to confirm to these behaviors. Moreover, the social support received from close people helps individuals to practice and maintain preventive actions. These factors are found to be more compelling than individuals' knowledge. This very fact could remind us to consider preventive action as not an individual but social phenomenon. Recognizing the importance of interpersonal factors in influencing people's preventive behavior, social scientists have recommended the adoption of a community-based sociocultural network approach to combat COVID-19 (Hannigan et al. 2020). Community-level strategies for promoting proactive engagement in health-protective behaviors and building reciprocal support for those experiencing difficulties during COVID-19 are a precious opportunity for strengthening social capital and enhancing solidarity in the face of adversity.

The study marked the role of schools and organization in shaping individuals' adoption of preventive mechanisms. Reported attempts by these organizations, among others, to provide health education, water and soap, and facemasks have been found to exert considerable influence on adoption and adherence to preventive actions. Organizations may impose sanctions to minimize risky behaviors among their employees and students. As individuals spend most of their time with organizations they belong to, there is a high possibility that common practices at their school or workplaces enter their collective consciousness and enforce personal health behavior. The organization's effort to

implement COVID-19 prevention protocols could emanate from broader policy level. The use of regulatory policies can effect dramatic changes on health of the population by helping to reduce barriers, creating enabling environment and setting standards to protect the health of individuals (McLeory et al., 1988). We found organization-level factors are more important in explaining adoption of health behavior as compared to individuals level factors. Indeed organizational-level workplace interventions are reported to bring about sustainable changes on the health of individuals as opposed to individual health intervention (Montano et al. 2014).

The study has indicated that applying socioecological model could be important to identify barriers and motivating factors in public health interventions. Various research and practical interventions have documented positive outcomes applying interventions within the socioecological frameworks (Bogardus et al. 2019). Through the lens of the framework, preventive practices during COVID-19 are influenced by societal structure, community norms, and individual characteristics (Zhang et al. 2022). Our study provides evidence on how adoption of preventive actions is shaped by these multiple factors in a low and middle income setting thereby showing the relevance of the socio-ecological constructs when conceptualizing interventions to promote preventive COVID-19 measures.

It has become evident, in this and prior studies, that external factors can exert a powerful influence on people's' ability to adopt healthy behavior. COVID-19 is intertwined with interpersonal, community and organization factors and individuals' actions against the disease that may not always be directly measured and addressed at individual level. Our study indicated how community norms and behaviors can have a profound impact on individuals' adoption of preventive action. Measuring adoption of preventive actions at individual level could give a wrong impression that intervening at the level of individuals goes a long way in enhancing adoption of healthy habits. Health interventions should consider altering social factors on top of improving individuals' health knowledge. This could lead to contextualized, comprehensive and innovative health interventions during pandemics.

The study had some strengths. We employed the socio-ecological model constructs to assess people's adoption of preventive actions. In addition, the study had a very high participation rate and respondents were randomly selected. As a result, the study has external validity. There were also some limitations to the data. It was not possible to rule out social desirability bias of participants' reports. As the survey was highly dependent on reported behaviour and actions of organizations, the result may not always indicate the actual behaviour. Assessing adoption of preventive actions and implementation of

preventive actions at organizations using both quantitative and qualitative methods i.e., observation, may help identify ways to improve people's health behaviour in times of pandemics.

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Appendix

Questionnaire items used to construct Indexes:

Preventive Behavior

Items measured on a 5-point scale, ranging from "not at all" (0 point) to "always" (4 points)

- I follow the 2-meter physical distance rule
- I wear face mask when I go out
- I wash my hands regularly or I use hand sanitizer regularly
- When I cough/sneeze, I cover my mouth and nose
- I avoid touching my face (eyes, nose, mouth)

- I avoid meetings or gatherings of more than 5 people
- I avoid shaking hands with people

Fear of COVID-19

Items measured on a 7-point scale of agreement (1 to 7)
- If an illness is going around, I will get it
- I have a history of susceptibility to infectious disease
- In general, I am very susceptible to colds, flu and other infectious diseases
- I am more likely than the people around me to catch an infectious disease

Knowledge of COVID-19

Items measured on providing correct answer (incorrect = 0, correct = 1)
- Causes of COVID-19
- Incubation period of COVID-19
- Symptom—Dry cough
- Symptom—Shortness of Breath
- Symptom—Fatigue
- Symptom—Loss of test or smell
- Washing hands with water and soap can eliminate the disease cause
- The disease can be transmitted directly through cough
- The disease can be transmitted directly through contact with infected surfaces
- COVID-19 can be transmitted directly through contact with infected individuals (handshaking/hugging, kissing)

Community Behavior

Items measured on a 4-point scale, ranging from “no one” (0) to “all of them” (4)
- People around me follow the 2-meter physical distance rule
- People around me wear face mask when they go out
- People around me wash hands regularly or use hand sanitizer regularly
- People around me cover mouth and nose when coughing/sneezing
- People around me avoid touching face (eyes, nose, mouth)
- People around me avoid meetings or gatherings of more than 5 people
- People around me avoid shaking hands with people

Community Norm

Items measured on a 4-point scale, ranging from “no one” (0) to “all of them” (4)
- People around me will be supportive if I wear a mask when staying with them

- People around me will be supportive if I wash my hands frequently or use hand sanitizer
- People around me will be disappointed if I insist on maintaining physical distance
- People around me will be supportive if I refuse to shake hands

Organization/Policy

Items measured as binary (No = 0, Yes = 1)

- Workplace/school are implementing social distancing
- My workplace/ school are working/learning in a ventilated environment
- My workplace/school are staggering attendance
- My workplace/school are encouraging hand washing by providing water and soap facility/hand sanitizers
- My workplace/school are providing masks
- My workplace/school are organizing awareness raising sessions