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Structural equation modeling analysis of health belief model-based determinants of COVID-19 preventive behavior of academic staff: a cross-sectional study

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Abstract

Introduction Despite COVID-19 being highly contagious and spreading to several countries, the university community has overlooked prevention measures. For more than five decades, the Health Belief Model (HBM) has been a widely used conceptual framework in health behavior. structural equation modeling(SEM) analysis is an advanced statistical method capable of rectifying failures of the basic models and showing complex relations Thus this study aimed to determine the magnitude of COVID-19 prevention behavior and identify its associated factors using HBM and SEM analysis.

Method An institutional-based cross-sectional study was conducted among academic staff of the University of Gondar in Ethiopia from April 10 to May 10/2021. Daniel Soper's sample size calculator was used to determine the sample size. Proportional allocation to each campus followed by a simple random sampling technique was employed to select study subjects. A pre-tested, structured questionnaire was used to collect the data. Structural equation modeling analysis was employed to show the relationship between health belief model constructs and their effect on preventive behavior.

Result A total of 602 academic staff participated. The magnitude of good COVID-19 preventive behavior was 24.8%. The HBM explained 55% of the variance in preventive behavior. Perceived barriers (β = -0.37, $p<0.05$), self-efficacy ($\beta=0.32$, $p<0.05$), perceived susceptibility ($\beta=0.23$, $p<0.05$), and perceived benefit ($\beta=0.16$, $p<0.05$) were the direct significant predictors of COVID 19 prevention behavior.

Conclusion only a quarter of the academic staff have good COVID-19 preventive behavior. The HBM explained a great amount of variance in preventive behavior and Perceived barriers, benefits, susceptibility, and self-efficacy significantly associated with prevention behavior. Carefully planned intervention that considers those significant perceptions should be designed and implemented to raise COVID-19 prevention behavior.

Keywords COVID-19 prevention practice, Structural equation modeling, Health belief model, Infectious disease, Ethiopia

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Introduction

The 2019 Novel Corona Virus Disease is caused by the Severe Acute Respiratory Syndrome Corona Virus 2 (SARS-CoV-2) and spread to several countries. Even if vaccines were produced and made available, still there were no reliable antiviral medications that could treat COVID-19 worldwide [1]. Globally, until 5 April 2023; COVID-19 has resulted in 762,201,169 confirmed cases and 6,889,743 deaths. America and Southeast Asia were the most affected regions of the world relatively [2].

Given the high contagiousness of COVID-19, an individual may contract the virus through contact with another known coronavirus-positive person or from any other unidentified source of infection [3–5]. WHO recommended the main strategies for preventing COVID-19 include wearing a face mask, social distancing yourself from people by at least one meter, washing your hands with soap and water, using alcohol-based hand sanitizer, covering your mouth and nose when you cough or sneeze, isolating yourself when you're feeling sick, and avoiding crowded areas and groups [6–8]. As of April 5, 2023; in Ethiopia, the pandemic causes 5,522,154 cases and 7,573 deaths [2]. Under resource-constrained nations, like Ethiopia in which only half of the populations are vaccinated the fundamental preventive techniques are the most sensible options [9, 10]. Although vaccines are the most effective strategy for disease control, their production processes are very long and require a much higher vaccination rate to reach 'herd immunity to control the pandemic [11]. Furthermore, vaccine hesitancy and ignorance of protective behaviors by those vaccinated groups is another challenge in vaccine effectiveness, that makes preventive behaviors more vital and central to controlling the pandemic [12]. However, the practice of those prevention measures is not as expected [13]. For example, studies done in government employers in Addis Ababa and educated groups of the nation in the country revealed more than two-thirds and nearly half of study participants had poor COVID-19 prevention practices respectively [14, 15]. Even the healthcare workers are not practicing as expected [16]. The national pooled COVID-19 prevention practice among the whole population and the most risk (chronic disease patients) was 51.6% and 44.02 respectively [17, 18].

As there was no published work in this group of population, from our observation; academic staff are not following the precautions during their stay in the institution and outside, which increases the risk of transmission since the academic staff is expected to be the role model for students as well as the surrounding community. Furthermore, if academic staff is not following the prevention precaution they may be an index case for students in the class and further propagation of the pandemic in the university. In the other way, they may take the infection from their students and colleagues and transmit it to their families as well as neighbors and the surrounding community [19]. Up to the level of investigators' knowledge, there is no study done on prevention behavior among university academic staff despite they are expected to be the main playmaker for COVID-19 prevention and control which increases the need to investigate the issue and intervene accordingly.

Fear appeals which are part of certain fear theories have long been used in public health preventive behavior change [20]. Those fear appeals which are fremed in the form of perceived susceptibility or risk and perceived severity were predictors of behavioral intention to perform COVID-19 prevention behaviors [21, 22]. For more than five decades, the Health Belief Model (HBM) has been a widely used conceptual framework in health behavior. HBM is an individual-level theory that is well-suited for preventive behaviors and has well-defined constructs that are easy to use and apply [23]. The model constructs such as perceived threat had a significant relation with behavioral response which increases the predictive ability of those constructs in COVID-19 preventive behavior which means the conceptual model explains the significant proportion of variance of the outcome variable [24, 25]. The study used Structural equation modeling (SEM) analysis for HBM which is capable of rectifying failures of the basic models such as regression by considering the error of measurement and showing indirect and other complex relations. Behavioral concepts such as preventive behavior, perception, motivation, attitude, self-efficacy, and extra are difficult to measure and have a complex relationship. So the study will become a reference for the behavior of academicians in the prevention and control of similar pandemics that might emerge in the future and the application of methodological approaches for other contexts. Therefore, the purpose of this study was to determine COVID-19 prevention practice and pinpoint the factors that are linked to it among the University of Gondar academic staff Gondar using HBM and SEM analysis.

The study provides important evidence inputs for designing programs to address the prevention practice gap that is observed in higher education institutions. This study fills the COVID-19-related evidence gaps that are observed since there is no study done on this study topic and helps as a baseline. In order to prepare messaging and materials for outreach and media efforts to prevent and control COVID-19, this study also provides evidence inputs.

Method

Study design, period, and setting

An institutional-based cross-sectional study was conducted from April 10 to May 10/2021 at the University of

Gondar, located in the historical town of Gondar which is part of a broad research project with another research published that has a different objective [19]. The current information was not included in the previous; because it had different aims since the current manuscript measured and tested the relation of different variables, and found and made conclusions on other aspects of the pandemic. Currently, the University of Gondar has 5 Campuses namely CMHS (College of Medicine and Health Sciences), Maraki, AsteTewodros, Atse Fasil, and Teda campus. Gondar University gives 87 undergraduate, 137 master's, and 29 Ph.D. programs for approximately 45,000 students. According to the university's human resource department's first-quarter report of 2013 E.C., Gondar University had 8,019 staff from these 2,774 academic staff.

Population and sample

All academic staff of the University of Gondar were the source population for this study. Selected academic staff from each campus of the University of Gondar who fulfilled the inclusion criteria were the sample population. Being an academic staff of the University of Gondar and being present at the university during the data collection period were the inclusion criteria. Academic Staff of the University of Gondar who are under study in some other area and currently at the University of Gondar for vacation are excluded. The current study is part of a broad research project in which there was published research that has a different research objective from the current [19].

Regarding sample size, the study employed structural equation modeling analysis, So we have used Daniel Soper's free statistic sample size calculator for SEM [26]. This calculator computed the sample size required for a study that uses SEM, given the anticipated effect size of 0.3 (medium) which is the usual effect size, the Desired statistical power level of 0.8, and 7 latent variables which are health belief model constructs and the prevention practice, 53 observed variables in the model and probability level or type 1 error rate of 0.0 5 which equals 560 [26]. Considering a 10% non-response rate, the final sample size was 616.

To select the study participants, the sample size was proportionally allocated to those 5 campuses (2,774 academic staff) based on the number of academic staff they had. Finally, using the human resource department registration of each campus as a sampling frame, a simple random sampling method was used for selecting study units from each campus using a computer-generated random number.

Study variables and measurement

In a multivariate analysis, variables are classified into four categories endogenous, exogenous, latent, and observed variables [27]. In this regard, COVID-19 prevention behavior; and health belief model constructs: perceived susceptibility, severity, benefit, barriers, and self-efficacy were latent endogenous variables, and all items or indicators that are used to measure each construct of the health belief model were observed endogenous variables. A cue to action was an exogenous latent variable. Modifying factors: including socio-demographic characteristics such as; age, sex, religion, marital status, educational status, monthly income, family size, number of rooms per family, and other modifying factors such as; COVID-19-related knowledge, field of study (profession), chronic disease status, and Likelihood of accepting COVID 19 related recommendation was observed exogenous variable in this model.

COVID-19 preventive behavior is the magnitude of the practice of COVID-19 prevention measures, and how much individuals perform the measures in day-to-day life. It was measured by 8 questions containing five five-point Likert scales (0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = always) the score lies 0–32. To determine the magnitude of preventive behavior (that is descriptive part), it is dichotomized into academic staff who scored < 24 (75%) were considered as having poor preventive behavior and above as having good preventive behavior [28],(α = 0.89).

Perceived susceptibility one's belief regarding the chance of getting COVID-19. It was measured by 6 questions containing five-point Likert scales the score lies 6–30. A higher score indicates high perceived susceptibility to COVID-19 [29], (α = 0.87).

Perceived severity one's belief regarding the serious consequences of COVID-19. It was measured by 5 questions containing five five-point Likert scales the score lies 5–25. A higher score indicates a high Perceived severity of COVID-19 [28],(α = 0.83).

Perceived benefit one's beliefs in the effectiveness of COVID-19 prevention practice in preventing the disease. It was measured by 6 questions containing five-point Likert scales the score lies 6–30. A higher score indicates a high Perceived benefit of COVID-19 prevention measures [14], (α = 0.90).

Perceived barriers one's belief about the tangible and psychological costs of practicing COVID-19 prevention. It was measured by 8 questions containing five-point Likert scales the score lies 8–40. A higher score indicates a high Perceived barrier of COVID-19 prevention measures [14], (α = 0.90).

Cues to action strategies to activate one's readiness to use COVID-19 prevention practices. It was measured by 4 questions containing five-point Likert scales the score lies 4–20. A higher score indicates having high cues to action [28], (α = 0.83).

Self-efficacy one's confidence to practice COVID-19 prevention measures. It was measured by 4 questions containing five-point Likert scales the score lies 4–20. A higher score indicates high self-efficacy in practicing COVID-19 prevention measures [28],(α = 0.86).

COVID-19 knowledge was measured by 8 items regarding prevention, transmission, signs, and symptoms of COVID-19. Each correct response was scored 1 and each incorrect response was scored 0. The score lies 0–8 and a higher score indicates high COVID-19 knowledge [28], (α = 0.89).

Data collection tool and procedures

The data were collected using a pretested structured questionnaire which was adapted from published articles, other related literature, and WHO guidelines in which the content and preparation were better explained in the published article which was part of the current research [19]. The data were collected by five first-year MPH students. Two assistant lecturers supervised the procedure of the data collection.

Data quality assurance

To keep data quality the questionnaire (English version) is translated into Amharic and back-translated to English by two different persons. Two days of training were given to the data collectors on the objective, relevance of the study, confidentiality of information, respondent's rights, informed consent, and prevention precautions that they should follow during data collection. To check content validity the questionnaire was given to three health behavior experts with assistant professors and above qualification, two medical doctors and one infectious disease professional (6 in total) checked its relevance and gave their comments. Finally, the investigator incorporated the comments and prepared the final draft of the tool for data collection. The questionnaire was pre-tested on Gondar teachers training college academic staff on 5% of the final sample. After pre-testing, amendments were made. The supervisors made frequent checks on the data collection process to ensure the completeness & consistency of the gathered information.

Statistical analysis and model assumptions

After collection, data were entered using Epi data version 4.6 statistical software and then exported to SPSS version 25 for further data management. Variable coding and transformations were done to make the data set ready for analysis. The descriptive analysis such as proportions, percentages, means, and measures of dispersion, tables, and graphs was done using SPSS version 25. Structural equation modeling analysis assessed the relationship between health belief model constructs using Stata version 14. First, we built a measurement model to test whether the observed variables reliably reflect the latent variables (i.e. prevention practice, perceived susceptibility, severity, benefits, barriers, self-efficacy, and cues to action,). This measurement part implies confirmatory factor analysis (CFA) that determines the construct validity of the tool. Thereafter, once the measurement parts of all health belief model constructs were determined, we framed the structural model with COVID-19 prevention practice as a final outcome variable. The model fitness was evaluated through several fit indices, including the chi-square to the degree of freedom ratio of 5 or less, root means-square error of approximation (RMSEA) values below 0.06, and the standardized root mean square residual (SRMR) values less than 0.08 indicating good model fit [30–32]. A *p*-value of less than 0.05 and a 95% confidence interval were used to declare statistical significance.

As the model assumption, the multivariate normality test was done and the data deviated from the multivariate normality assumption since Mardias' skewness and kurtosis test of normality is significant which indicates the data is not multivariate normal [33]. Hence, robust correction of the Satorra-Bentler estimation technique was used [34]. The large sample size was another assumption of SEM in which we have used a standard sample size calculator for SEM which gives the sample required to detect and estimate the hypothesized model structure (26). Correct model specification is also another assumption of SEM in our case we have used the HBM which is a verified behavioral model which supports the specified model supported by theory [23]. Our model is properly specified with an over-identified (positive degree of freedom (1018 in our case)) model structure. No multicollinearity is also an assumption of SEM in which in our case it is checked by making a correlation matrix of items that supports multi-collinearity is not an issue in our data since the correlation of all items in the correlation matrix is less than 0.8 [35]. Furthermore, multiple measurements (three or more items must be used to measure a construct) are assumptions of SEM in which in our case the minimum number of items per construct was four (for cues to action and self-efficacy) [27].

Table 1 The sociodemographic details of the University of Gondar's academic staff members in Ethiopia in 2021 (*n* = 602)

Variables		Frequency	Percent
Age	20–28	159	26.4
	≥ 29	443	73.6
Sex	Male	483	80.2
	Female	119	19.8
Religion	Orthodox	496	82.4
	Muslim	54	9.0
	Protestant	48	8.0
	*Other	4	0.7
Marital status	Single	245	40.7
	Married	349	58.0
	Divorced	7	1.2
	Widowed	1	0.2
Educational status	Degree	108	17.9
	Master	464	77.1
	Ph.D. and above	30	5.0
Family size	1–3	417	69.3
	4–6	169	28.1
	≥ 7	16	2.7
No. of rooms per family	1–2	390	64.8
	≥ 3	212	35.2
Income	≤ 9056	198	32.9
	9057–14,999	354	58.8
	≥ 15,000	50	8.3

*Others are Catholic and do not have

Table 2 Score of health belief model constructs of the academic staff of the University of Gondar, Ethiopia, 2021 (*n* = 602)

Variable	Minimum	Maximum	Score mean (± SD)
Perceived susceptibility	6	30	18.35(± 5.83)
Perceived severity	5	25	16.8(± 4.72)
Perceived benefit	6	30	24.17(± 5.03)
Perceived barrier	8	40	24.44(± 7.75)
Self-efficacy	4	20	13.67(± 3.86)
Cues to action	4	20	14.2(± 3.64)

Results

Socio-demographic characteristics of the study population

With a 97.7% response rate, 602 academic staff members participated in the study. The respondents' mean age with standard deviation (SD), was 32.38 (±5.83) years. Most(80.2%) of the respondents were men, and (82.4%) of them identified as members of the Orthodox religion. In terms of educational status, 77.1% of them held master's degrees, and more than half (58%) were married. The majority of respondents, or 69.3%, had a family size of one to three members. Of the research participants, about two-thirds (64.8%) had one or two rooms per family. The participants' mean monthly income was 10,789 (±2,786.37 E.birr (Table 1).

Constructs of health belief model

The study participants' mean perceived susceptibility score was 18.35 (±5.83). The mean score for the perceived severity of COVID-19 was 16.8 (±4.72). For perceived benefit, barriers, self-efficacy, and cues to action, the corresponding mean scores with (SD) were 24.17(±5.03), 24.44(±7.75), 13.67(±3.86), and 14.2(±3.64), respectively (Table 2).

Modifying factors of the health belief model

Most 570(94.7%) of the participants had no chronic disease. More than one-third (38.7%) of the study population were from health-related fields. Regarding the probability of adopting recommendations related to COVID-19, 35% of the study population were very likely to do so. In terms of knowledge about COVID-19, the respondents' median score was 8, with an interquartile range (IQR) ranging from 8 to 7.

The magnitude of COVID-19 preventive behavior

The study revealed that 148(24.6%) 95% confidence interval (CI) (21.3 –28.3%) of the respondents had good COVID-19 preventive behavior.

The mean score of preventive behavior was 18.34 and SD of 6.79 with a minimum of 0 to a maximum of 32.

Factors associated with COVID-19 preventive behavior based on SEM analysis

Two steps were taken in the structural equation model analysis process. Seven-factor CFA was used in the first step to evaluate the measurement model. Second, to confirm relationships between exogenous and endogenous variables, the model with the seven-factor and modifying variables was performed.

Measurement part of SEM

The Kaiser-Meyer-Olkin (KMO) sample adequacy test was performed right away, and the result was 0.924, indicating that the sample was sufficient to move forward with factor analysis. Likewise, the correlation matrix among the items was not an identity matrix, according to Bartlett's test of sphericity, since it was significant with $p = 0.000$ [36]. The seven-factor CFA was then used to complete the measurement model. Then the standardized factor loading of all items in the respective construct of the HBM was >0.5, with a *p*-value of less than 0.05 (Fig. 1).

The direct effect of health belief model constructs on preventive behavior

According to the structural part of SEM concerning direct relationship a unit increase in SD of perceived susceptibility, benefit, and self-efficacy results in 0.23, 0.16, and 0.32 SD increase in preventive behavior respectively.

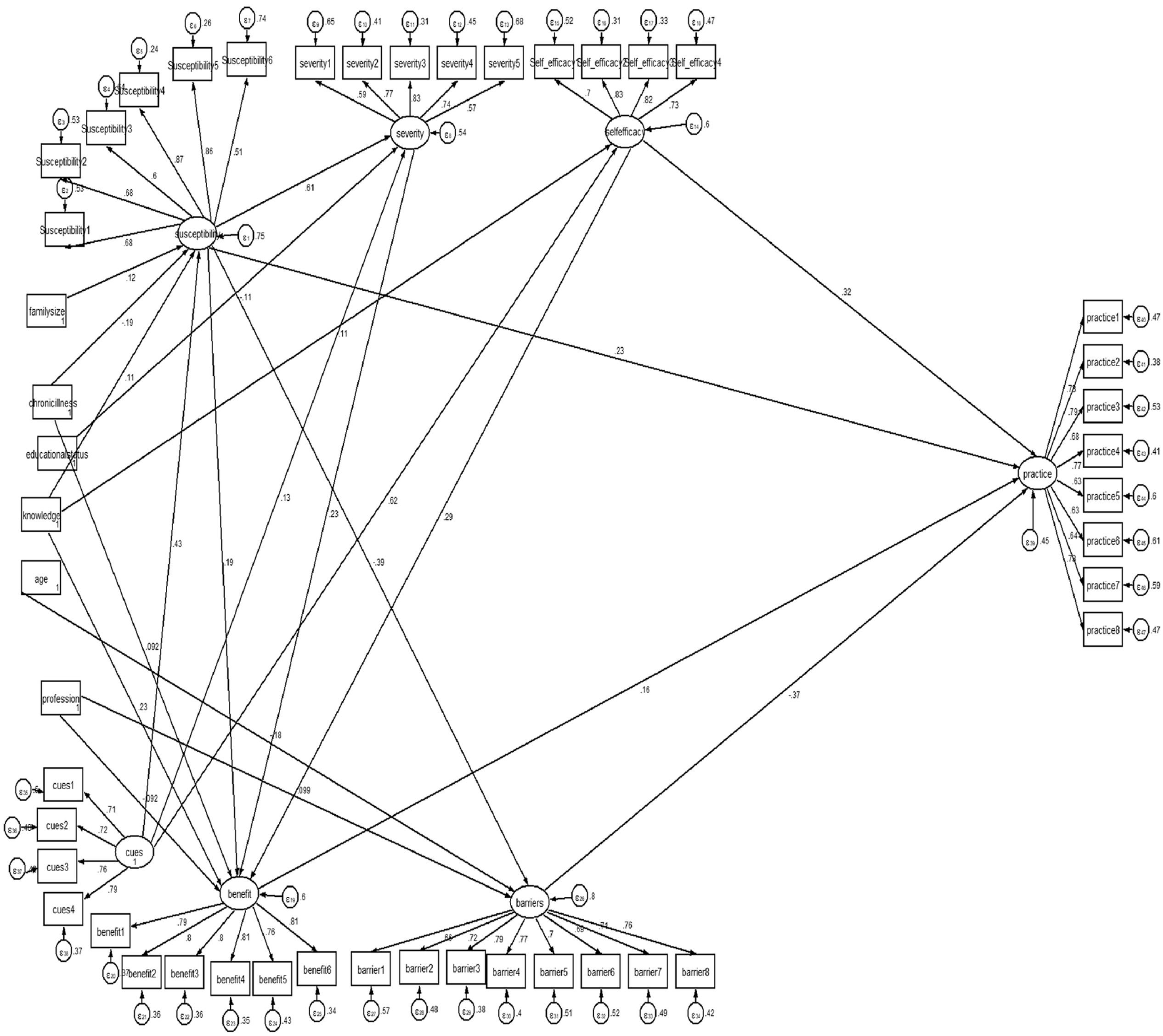

Fig. 1 Structural equations modeling with standardized coefficients for pidictors of COVID-19 preventive behavior among academic staff of the University of Gondar, Ethiopia, 2021 using the health belief model

Conversely, unit increases in the SD of the perceived barrier result in a 0.37 SD decrease in preventive behavior. However, perceived severity (β=0.07, $p=0.236$) and cues to action (β = -0.03, $p=0.527$) did not have a direct statistically significant association with preventive behavior. Those predictors explained 55% of the variance in preventive behavior (Table 3).

Indirect effects of HBM constructs on preventive behavior

Conceptually constructs of HBM are interrelated; so they indirectly affect COVID-19 preventive behavior by becoming one a mediator for the other. Perceived susceptibility has an indirect effect (β=0.20, $p<0.05$) on preventive behavior through a positive effect on perceived severity, and benefit, and a negative effect on perceived barrier making the total effect (sum of direct and indirect effect) of (β=0.43, $p<0.05$) and making it an overall strong predictor of practice. Similarly, self-efficacy has an indirect effect (β=0.05, $p<0.05$) on preventive behavior through perceived benefit making a total effect of (β=0.37, $p<0.05$). Even if perceived severity has no direct statistically significant effect on preventive behavior it exerts its indirect effect (β=0.04, $p<0.05$) through perceived benefit which is equal to its total effect. Similarly, cues to action exert a strong indirect effect on preventive behavior (β=0.41, $p<0.05$) through perceived susceptibility, severity, and self-efficacy which is equal to its total effect. Furthermore, perceived benefits and barriers in addition to their direct effect serve as a mediator for other HBM constructs (Table 4).

Table 3 Standardized regression weights of direct predictors of COVID-19 preventive behavior of academic staff of the University of Gondar, Ethiopia, 2021 (*n*=602)

Variable		B	95% Conf. Interval of β		*P*-value	Variance explained
			LB	UB		
preventive behavior <--	susceptibility	0.23	0.14	0.32	0.000	55%
	self-efficacy	0.32	0.24	0.39	0.000	
	Benefit	0.16	0.08	0.23	0.000	
	Barrier	−0.37	−0.44	−0.30	0.000	
	severity	0.07	−0.04	0.18	0.236	
	cues	−0.03	−0.12	0.06	0.527	

Table 4 Standardized indirect and the total effect of HBM constructs on preventive behavior of academic staff of the University of Gondar, Ethiopia, 2021

Variable		Indirect effect β	Total effect β	*P*-value
preventive behavior <--	PBA, PBE, PSE<--susceptibility	0.20	0.43	0.000
	PBE<--self-efficacy	0.05	0.37	0.000
	benefit		0.16	0.000
	barrier		−0.37	0.000
	PBE<--severity	0.04	0.04	0.000
	SE, PSE, PSU<--cues	0.41	0.41	0.000

Where PSE=perceived severity, PBE=perceived benefit, PBA=perceived barrier, SE=self-efficacy, PSU=perceived susceptibility, CA=cues to action,

The final model explained a significant portion of the variation in COVID-19 preventative behavior since it explained 55% of the variance of the final outcome variable. The model also showed good model fit indices (Satorra-Bentler chi-square to the degree of freedom ratio of 2724/1018=2.68, Satorra-Bentler RMSEA 0.053 and SRMR 0.074) [30–32] (Fig. 1).

Discussion

As the COVID-19 pandemic is a highly contagious disease preventive behaviors are more vital and central to controlling the pandemic in resource-limited settings like Ethiopia. However, the practice of those prevention measures is not as expected. HBM is an individual-level theory that is well-suited for preventive behaviors and SEM analysis is an advanced statistical method that is capable of rectifying failures of the basic models and showing complex relations. This study attempted to investigate the magnitude of COVID-19 preventive behavior and the factors associated with it using HBM and SEM analysis. It also covers the relationship between HBM constructs and the HBM's predicting ability in COVID-19 preventive behavior.

In the current study, the magnitude of good COVID-19 preventive behavior was 24.8% with 95%CI (21.3 −28.3%). This was similar to a study conducted on residents of Ethiopia on an online base assessment (22.6%) [37]. However, it was lower than a study conducted among government Employees in Addis Ababa [14], among health care workers in Bale zone [38], in Debretabor town [39], with two studies in Uganda [40, 41], and with the study conducted in Henan, China [42]. This discrepancy might be due to the difference in the study population or study period. Since the previous studies were conducted on health professionals (Bale zone and Debretabor town) and at the beginning of the COVID-19 pandemic everybody had given attention to prevention measures which is why good prevention practice is higher in those studies [43]. This figure implies strong efforts should be made to increase the prevention practice; since they are expected to have better preventive behavior than the general population and serve as role models.

In this study, HBM provided good model fit statistics and explained 55% of the variance in COVID-19 preventive behavior. This is in line with a study done in Egypt [44] and Ardabil Iran [45] where the model explained about 58.4% and 54.7% of the variance of practice respectively. However, it is higher as compared to studies conducted in Iran [46], Sudan [47], and Malaysia [48] where 29.3%, 43%, and 29.3% of the variance practice were explained by the model respectively. The difference from those two former studies (Iran and Sudan) may be due to the drawback of analysis in which their analysis was done by linear regression that doesn't account for measurement error which results in biased coefficients and lowered predicting ability. For the study conducted in Malaysia, the discrepancy may be due to the study considering only the latent constructs, unlike the current study where the modifying factors are included in the analysis which increases its predictive ability [49]. This finding hints that HBM has enough predictive ability of COVID-19 preventive behavior and can be used for designing preventive interventions by considering the predictors in accordance with their significance in practical settings [24, 50].

In the current study, we found that perceived barriers, self-efficacy, perceived susceptibility, and perceived benefit were directly and significantly associated with respondents' COVID-19 preventive behavior in which perceived barrier was the strongest direct negative predictor. This finding is supportive of what is expected from the health belief model that was appreciated from a critical review of the evidence for the model's performance in which Perceived barriers were the most powerful single predictor across all studies and behaviors [50]. The current finding is also consistent with a study conducted in Iran [51], Belgium [52], China [53], and Addis Ababa [14] in which perceived barrier was a negative predictor of practice. This finding implies the need to focus on minimizing these barriers such as increasing access to water, soup, and sanitizers, correcting biased perceptions on mask and sanitizer use, providing a reminder of prevention measures, and education focusing on universal practice.

Self-efficacy was the second strong positive direct predictor of preventive behavior. This finding was complemented with the study done in Northern Iran [51], Belgium [52], China [53], India [54], Sudan [47], Debrebrhan [28], and Addis Ababa [14]. This implies strategies focused on increasing self-efficacy are vital in increasing preventive behavior.

Regarding perceived susceptibility, this study found that a rise in participants' perceived susceptibility results in increased preventive behavior directly as well as indirectly by increasing perceived benefit and self-efficacy and decreasing perceived barriers which make perceived susceptibility an overall strong positive predictor of preventive behavior. This finding complements the studies done in India [55], Ghana [56], Egypt [44], and Debrebrhan [28]. On the other hand, the finding is against a study done in Addis Ababa [14] in which perceived susceptibility was not significantly associated with preventive behavior. This difference may be due to study population variation in updated information access regarding disease susceptibility since the current study participants had access to day-to-day updated evidence of susceptibility to the disease [57]. This finding suggests messages targeted at susceptibility such as work-related, health-related, and other general vulnerabilities will increase preventive behavior.

This study also found that perceived benefit is a direct significant predictor of preventive behavior. This finding is similar to the study conducted in Belgium [52], China [53], and India [54], two studies in Iran [46, 58], Sudan [47], Egypt [44], and Addis Ababa [14], and Debrebrhan [28]. This result implies intervention focused on the effectiveness and importance of each prevention measure is valuable to increase the level of preventive behavior.

Even if, cues to action and perceived severity exert an indirect effect on preventive behavior by increasing perception of threat, self-efficacy, and perceived benefit (for perceived severity) however, they were not direct significant predictors of preventive behavior. This finding is similar to meta-analyses of studies that used the HBM, those studies showed that perceived severity was least often significantly associated with intention and behavior [59]. The finding is also complemented by the study conducted in Egypt [44] and Debrebrhan [28]. However, this finding is contrary to a study done in India [54] in which perceived severity and cues to action were significantly associated with preventive behavior. This discrepancy may be due to the attention diversion of the participants, hence during the study period of this study, there was political instability in Ethiopia that may affect the perception of severity since the condition takes their attention to the instability. On the other way, possible cues to action especially the media were focusing on political issues rather than the COVID-19 pandemic [60]. This result implies possible cues to action (information from media, health professionals, and written material) are better if they focus on disease susceptibility, severity, and self-efficacy to increase practice rather than directly focusing on practice.

Strengths and limitations of the study

Strength of the study

The present study had several strengths. First, it stands on global issue. Secondly, it incorporates SEM as an analysis model for HBM which is capable of rectifying failures of the basic models such as regression by considering the error of measurement and showing indirect and other complex relations. Behavioral concepts such as preventive behavior, perception, motivation, attitude, self-efficacy, and extra are difficult to measure and have a complex relationship with other variables which increases the need to employ SEM analysis in behavioral research [31].

Limitations of the study

Notwithstanding its strength, this study has some limitations. First, the study is limited to a single university's academic staff which makes it difficult to infer the findings to other universities. Secondly, there was limited research done by HBM with structural equation modeling as an analysis model on the COVID-19 pandemic. This makes our discussion short and lacks detailed comparison. Self-administered way of data collection and the cross-sectional nature of the study were other limitations of our study.

Conclusion

Only a quarter of academic staff have good COVID-19 preventive behavior, which calls for focused and carefully planned intervention to improve preventive behavior. The HBM explained a great amount of variance of COVID-19 preventive behavior with a good model fit, and key HBM variables; perceived barrier, self-efficacy, perceived susceptibility, and benefit were significantly associated with the preventive behavior as proposed by the theoretical underpinning of the model. Therefore, the HBM should be considered in designing interventions by incorporating those significant model constructs to improve COVID-19 preventive behavior so as to control the pandemic.

Abbreviations

CFA	Confirmatory Factor Analysis
HBM	Health Belief Model
IQR	Interquartile Range
KMO	Kaiser Meyer Olkin
RMSEA	Root Mean Square Error of Approximation
SARS	Severe Acute Respiratory Syndrome
SD	Standard Deviation
SEM	Structural Equation Modeling
SRMR	Standardized Root Mean Square Residual
WHO	World Health Organization

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Author contributions

AZ: Conceptualizations of the study, Methodology, validation, and, Statistical analysis coordinate data collection. AN and MW performed supervision, validation, Writing, review & editing. The authors read and approved the manuscript.

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Data availability

All relevant data are within the manuscript and its Supporting Information files.

Declarations

Ethical approval and consent to participate

Ethical approval was obtained from the IRB (institutional review board) of the University of Gondar with letter reference no. of IPH/1414/2013. Following an explanation of the purpose of the study, written informed consent was obtained from participants. Also, affirmation was made that they are free to withdraw their consent and discontinue participation without any form of prejudice. To preserve the confidentiality the data is not exposed to any third party except investigators

Consent for publication

Not applicable

Competing interests

The authors declare no competing interests.

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References

1. World health organization. Technical guidance-coronavirus disease (COVID-19). Geneva, Switzerland: WHO; 2020.
2. World health organization. World health organization COVID 19 dashboard 2023. https://covid19.who.int/
3. Tenforde MW, Rose EB, Lindsell CJ, Shapiro NI, Files DC, Gibbs KW, et al. Characteristics of adult outpatients and inpatients with COVID-19–11 academic medical centers, United States, March–May 2020. Morb Mortal Wkly Rep. 2020;69(26):841.
4. Al-Qahtani AA. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): emergence, history, basic and clinical aspects. Saudi J Biol Sci. 2020.
5. Acter T, Uddin N, Das J, Akhter A, Choudhury TR, Kim S. Evolution of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) as coronavirus disease 2019 (COVID-19) pandemic: a global health emergency. Sci Total Environ. 2020:138996.
6. World Health Organization. Infection prevention and control guidance for long-term care facilities in the context of COVID-19: interim guidance, 21 March 2020. World Health Organization; 2020.
7. Control CfD. Prevention. Centers for Disease Control and Prevention Coronavirus disease 2019 (COVID-19) 2020. 2020.
8. Abdullahi Z, Aliyu M, Umar B, Lawal M, Auwal B, Kumar A et al. Sanitizer and cleaning for COVID-19: principles, guidelines and prospective. 2020. https://www.researchgate.net/profile/Mayadhar-Barik-3/publication/343548580_A_TEXT_BOOK_OF_THE_SARS-CoV-2_SANITIZER_AND_CLEANING_FOR_COVID-19_PRINCIPLES_GUIDELINES_AND_PROSPECTIVE_A_TEXT_BOOK_OF_THE_SARS-CoV-2/links/5f3120ab458515b729121210/A-TEXT-BOOK-OF-THE-SARS-CoV-2-SANITIZER-AND-CLEANING-FOR-COVID-19-PRINCIPLES-GUIDELINES-AND-PROSPECTIVE-A-TEXT-BOOK-OF-THE-SARS-CoV-2.pdf
9. Ali I, Alharbi OM. COVID-19: disease, management, treatment, and social impact. Sci Total Environ. 2020;728:138861.
10. Mose A, Wasie A, Shitu S, Haile K, Timerga A, Melis T, et al. Determinants of COVID-19 vaccine acceptance in Ethiopia: a systematic review and meta-analysis. PLoS ONE. 2022;17(6):e0269273.
11. Thomas SJ, Moreira ED Jr, Kitchin N, Absalon J, Gurtman A, Lockhart S, et al. Safety and efficacy of the BNT162b2 mRNA Covid-19 vaccine through 6 months. N Engl J Med. 2021;385(19):1761–73.
12. Coustasse A, Kimble C, Maxik K. COVID-19 and vaccine hesitancy: a challenge the United States must overcome. J Ambul Care Manag. 2021;44(1):71–5.
13. Akim A-m, Ayivodji F. Interaction effect of lockdown with economic and fiscal measures against COVID-19 on social-distancing compliance: evidence from Africa. Available at SSRN 3621693. 2020.
14. Tadesse T, Alemu T, Amogne G, Endazenaw G, Mamo E. Predictors of Coronavirus disease 2019 (COVID-19) prevention practices using health belief model among employees in Addis Ababa, Ethiopia, 2020. Infect Drug Resist. 2020;13:3751.
15. Dagne H, Alemu KA, Dagnew B, Taddesse D, Alemayehu AM, Andualem Z et al. Prevention practice and associated factors of Coronavirus disease 2019 (COVID-19) outbreak among educated Ethiopians: An online based cross-sectional survey 2020. https://assets.researchsquare.com/files/rs-34504/v1/32960af8-1384-4c36-ab1d-84402512e8ea.pdf?c=1631842806
16. Kassie BA, Adane A, Abebe Kassahun E, Ayele AS, Kassahun Belew A, Poor. COVID-19 preventive practice among healthcare workers in Northwest Ethiopia, 2020. Advances in Public Health. 2020;2020.
17. Tegegne MD, Melkam M, Adane T, Getawa S. COVID-19 preventive practice and associated factors in Ethiopia: a systematic review and meta-analysis. Public health in practice. (Oxf England). 2022;4:100329. PubMed PMID: 36267492. Pubmed Central PMCID: PMC9568273. Epub 2022/10/22. eng.
18. Zewdie A, Mose A, Sahle T, Kasahun AW, Melaku E, Zemene MA. COVID 19 prevention practice of patients with known chronic illness in Ethiopia: a systemic review and meta-analysis. J Multimorbidity Comorbidity. 2023;13:26335565231176166. PubMed PMID: 37197196. Pubmed Central PMCID: PMC10184217. Epub 2023/05/18. eng.
19. Zewdie A, Nigusie A, Wolde M, Mazengia EM, Belaineh A, Habtie A et al. Determinants of COVID-19 related perception among University of Gondar Academic Staff, Gondar, Ethiopia, 2021: a structural equation modeling approach. Adv Public Health. 2022.
20. Leventhal H. Fear appeals and persuasion: the differentiation of a motivational construct. Am J Public Health. 1971;61(6):1208–24.
21. Roberto AJ, Zhou X, Lu AH. The effects of perceived threat and efficacy on college students' social distancing behavior during the COVID-19 pandemic. J Health Communication. 2021;26(4):264–71.

22. Park T, Ju I, Ohs JE, Hinsley A. Optimistic bias and preventive behavioral engagement in the context of COVID-19. Res Social Administrative Pharm. 2021;17(1):1859–66.
23. Glanz K, Rimer BK, Viswanath K. Health behavior. Theory, research, and practice. 2015;5.
24. Cohen J. A power primer. Psychol Bull. 1992;112(1):155.
25. Pourhaji F, Tehrani H, Talebi M, Peyman N. Perceived threat and stress responses in the face of Covid-19 based on health belief model. J Health Lit. 2022;7(1):17–25.
26. Soper DS. A-priori sample size calculator for structural equation models [Software]. Recuperado de http://www.danielsoper.com/statcalc. 2017.
27. Civelek ME. Essentials of structural equation modeling. Essentials of Structural Equation Modeling (2018). 2018.
28. Shewasinad Yehualashet S, Asefa KK, Mekonnen AG, Gemeda BN, Shiferaw WS, Aynalem YA, et al. Predictors of adherence to COVID-19 prevention measure among communities in North Shoa Zone, Ethiopia based on health belief model: a cross-sectional study. PLoS ONE. 2021;16(1):e0246006.
29. Costa MF. Health belief model for coronavirus infection risk determinants. Rev Saude Publica. 2020;54:47.
30. Lt H, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct Equation Modeling: Multidisciplinary J. 1999;6(1):1–55.
31. Teo T. Handbook of quantitative methods for educational research. Springer Science & Business Media; 2014.
32. West SG, Taylor AB, Wu W. Model fit and model selection in structural equation modeling. Handb Struct Equation Model. 2012;1:209–31.
33. Oppong FB, Agbedra SY. Assessing univariate and multivariate normality. A guide for non-statisticians. Math Theory Model. 2016;6(2):26–33.
34. Walker DA, Smith TJ. Computing robust, bootstrap-adjusted fit indices for use with nonnormal data. Meas Evaluation Couns Dev. 2017;50(1–2):131–7.
35. Shrestha N. Detecting multicollinearity in regression analysis. Am J Appl Math Stat. 2020;8(2):39–42.
36. Anastasiadou SD. Reliability and validity testing of a new scale for measuring attitudes toward learning statistics with technology. Acta Didactica Napocensia. 2011;4(1):1–10.
37. Bekele D, Tolossa T, Tsegaye R, Teshome W. The knowledge and practice towards COVID-19 pandemic prevention among residents of Ethiopia. An online cross-sectional study. PLoS ONE. 2021;16(1):e0234585–e. PubMed PMID: 33507906. eng.
38. Zenbaba D, Sahiledengle B, Bogale D. Practices of healthcare workers regarding infection prevention in Bale Zone Hospitals, Southeast Ethiopia. Advances in Public Health. 2020;2020.
39. Birihane BM, Bayih WA, Alemu AY, Belay DM. Perceived barriers and preventive measures of COVID-19 among Healthcare providers in Debretabor, North Central Ethiopia, 2020. Risk Manage Healthc Policy. 2020;13:2699.
40. Ssebuufu R, Sikakulya FK, Mambo SB, Wasingya L, Nganza SK, Ibrahim B, et al. Knowledge, attitude, and self-reported practice toward measures for prevention of the spread of covid-19 among ugandans: a nationwide online cross-sectional survey. Front Public Health. 2020;8:890.
41. Ssebuufu R, Sikakulya F, Binezero SM, Wasingya L, Nganza SK, Ibrahim B et al. Awareness, knowledge, attitude and practice towards measures for prevention of the spread of COVID-19 in the ugandans: a nationwide online cross-sectional survey. Medrxiv. 2020.
42. Zhang M, Zhou M, Tang F, Wang Y, Nie H, Zhang L, et al. Knowledge, attitude, and practice regarding COVID-19 among healthcare workers in Henan, China. J Hosp Infect. 2020;105(2):183–7.
43. Azene AG, Workie MS, Aragaw AM. Knowledge, attitude, and prevention practice towards Covid-19 in Ethiopia: systematic review and meta-analysis. Curr Therapeutic Res. 2021:100633.
44. Barakat AM, Kasemy ZA. Preventive health behaviours during coronavirus disease 2019 pandemic based on health belief model among Egyptians. Middle East Curr Psychiatry. 2020;27(1):1–9.
45. Kamran A, Isazadehfar K, Pirzadeh A, Azgomi RND, Heydari H. Risk perception and adherence to preventive behaviors by the public amid COVID-19 pandemic; a community-based study applying the health belief model 2020. https://assets.researchsquare.com/files/rs-30183/v1/ed4ed43d-43c9-4454-8c9e-b25c3e60d9e8.pdf?c=1631861499
46. Mirzaei A, Kazembeigi F, Kakaei H, Jalilian M, Mazloomi S, Nourmoradi H. Application of health belief model to predict COVID-19-preventive behaviors among a sample of Iranian adult population. J Educ Health Promotion. 2021;10(1):69.
47. Mehanna AA, Elhadi YAM, Lucero-Prisno DE. Factors influencing intention to adhere to precautionary behavior in times of COVID-19 pandemic in Sudan: an application of the health belief model. medRxiv. 2020.
48. Al-Tahitah AN, Al-Sharafi MA, Abdulrab M, How. COVID-19 pandemic is accelerating the transformation of higher education institutes: a health belief model view. Emerging Technologies During the Era of COVID-19 Pandemic. 2021;348:333.
49. Schumacker RE, Lomax RG. A beginner's guide to structural equation modeling. psychology; 2004.
50. Glanz K, Rimer BK, Viswanath K. Health behavior and health education: theory, research, and practice. Wiley; 2008.
51. Shahnazi H, Ahmadi-Livani M, Pahlavanzadeh B, Rajabi A, Hamrah MS, Charkazi A. Assessing preventive health behaviors from COVID-19 based on the health belief model (HBM) among people in Golestan province: a cross-sectional study in Northern Iran 2020. https://assets.researchsquare.com/files/rs-24871/v1/41c29fe3-b0af-4430-99ab-751b27a82dff.pdf?c=1631833482
52. Walrave M, Waeterloos C, Ponnet K. Adoption of a contact tracing app for containing COVID-19: a health belief model approach. JMIR Public Health Surveillance. 2020;6(3):e20572.
53. Tong KK, Chen JH, Yu EWy, Wu AM. Adherence to COVID-19 precautionary measures: applying the health belief model and generalised social beliefs to a probability community sample. Appl Psychology: Health Well-Being. 2020;12(4):1205–23.
54. Jose R, Narendran M, Bindu A, Beevi N, Manju L, Benny P. Public perception and preparedness for the pandemic COVID 19: a health belief model approach. Clin Epidemiol Global Health. 2021;9:41–6.
55. Singh CB. Perceptual threat, social distancing and well-being of people, during COVID 19 pandemic. Int J Hum Potentials Manage. 2020;2(2):35–50.
56. Amankwah-Poku M. COVID-19-related health behaviour changes among ghanaians: applying the health belief model. Health Sci Investigations (HSI) J. 2020;1(2):135–8.
57. Turgut YE, Aslan A, Denizalp NV. Academicians' awareness, attitude, and use of open access during the COVID-19 pandemic. J Librariansh Inform Sci. 2021:09610006211016509.
58. Fathian-Dastgerdi Z, Tavakoli B, Jaleh M. Factors associated with preventive behaviors of COVID-19 among adolescents: applying the health belief model. Res Social Administrative Pharm. 2021.
59. Jones CJ, Smith H, Llewellyn C. Evaluating the effectiveness of health belief model interventions in improving adherence: a systematic review. Health Psychol Rev. 2014;8(3):253–69.
60. Kejela T. Probable factors contributing to the fast spread of the novel Coronavirus (COVID-19) in Ethiopia. J Infect Dis Epidemiol. 2020;6:169.

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