ORIGINAL ARTICLE

Structural equation modeling for explaining preventive health practices of rural adults in the new normal context of COVID-19 pandemic

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ABSTRACT

The effects of the coronavirus disease 2019 (COVID-19) are not only limited to health, they also impinge on the social life and economy of communities around the globe. Challenges faced by developing countries such as Bangladesh were multi-factorial and its rural population was highly vulnerable in this situation due to their cultural and sociodemographic context. Preventive behavioral changes were considered the best way to fight against the virus in absence of specific treatment and vaccines. This study has tried to explain preventive health practices during the COVID-19 pandemic, and aimed to explore the causal relationships of its major determinants through structural equation modeling (SEM) based on reasoned action approach (RAA). This cross-sectional study was conducted in 2020 among 810 rural Bangladeshi respondents aged 18-55 years. Around half of the respondents showed poor knowledge, motivation and practice regarding COVID-19 and its prevention. Along with socio-demographic factors, information, attitude, motivation, and intention of the people were found to be associated with the adoption of preventive health practices. The causal model of the COVID-19 prevention behaviors was assessed and justified through SEM. The model fits well with the empirical data (GFI=0.94, CFI=0.97, NFI=0.97, RMSEA=0.05, SRMR=0.04). Intention significantly influenced COVID-19 prevention behavior directly, showing the highest effect (β=0.89, $p<0.001$). Attitude (β=0.83, $p<0.001$) and motivation (β=0.15, $p<0.001$) also showed significant direct effects on intention. All the predictors together explained 79.6% of the variance for COVID-19 preventive behaviors. Adequate knowledge, a positive attitude, proper motivation, and positive intention can encourage rural adults to adopt healthy behaviors against COVID-19. The theoretical model of the study effectively explained COVID-19 preventive behaviors rationally and provided a roadmap for policy-makers to formulate strategies to combat COVID-19 and any future similar pandemic.

Key words:
COVID-19 pandemic; prevention; health practices; rural adults; structural equation modeling

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INTRODUCTION

The coronavirus disease 2019 (COVID-19) started in China and was soon declared a pandemic.[1,2] It caused high casualties across the globe causing morbidity and mortality beyond calculation. Prevention was considered the best remedy in the absence of any definitive treatment, and the world opted for lockdowns and shutdowns following China.[3-6] However, a third world country like Bangladesh could not afford a long-term lockdown because of its growing but fragile economy.[7,8] Urban centers showed a rapid spread of cases due to population density and connection with the outside world, but the rural population was also considered equally vulnerable due to their poor socio-demographic status, lack of awareness, and access to healthcare and community structures.[9,10]

COVID-19 was quick to show its devastating effect and predicting its end was found impossible.[4] Governments across the world emphasized preventive behaviors and social distancing to control the pandemic. Face masks were made mandatory in public places almost everywhere, despite widespread confusion and controversy among the mass population.[11,12] Hand washing was not a new thing for people in general, but the concept of social distancing was new to many cultures. The sudden behavioral changes were not well accepted everywhere and protests against social distancing or using face masks were even observed in the most developed countries like the United States (US).[13,14] Although there was no such protest in Bangladesh, maintaining social distancing in hugely crowded situations was quite difficult in many cases, and good quality face masks and hand soaps were often out of reach for rural people.[15-17]

Airborne transmission of COVID-19 was soon acknowledged by the World Health Organization (WHO) and people were instructed to avoid crowded, closed and unventilated areas.[18] The Government of Bangladesh adopted the relevant preventive and restrictive measures to control the situation. Screening facilities were introduced in airports and land ports along with bans on mass gatherings by the middle of March, 2020.[19] However, execution of the policies was questioned by experts and non-compliance from the public was seen on many occasions.[20] A similar situation was found even in developed countries such as the US, Italy and Spain. They suffered high casualties despite having strong healthcare systems, law enforcement bodies and an educated population.[21,22] Few studies focused on the causal relationships of preventive health practices.

Doubtless, widespread lockdowns and social distancing flattened the pandemic curve, but poor nations like Bangladesh could not afford lengthy lockdowns.[23] People would have died of hunger instead of the coronavirus. It was important for the country to educate people about the preventive measures against the highly contagious pandemic and bring them to the workplaces using full precautions. Challenges in achieving such behavioral changes are multi-factorial and need to be addressed at various levels both individual and environmental.

Rural people of Bangladesh were assumed to be highly vulnerable to the pandemic due to their ignorance of healthy practices and poor access to healthcare information.[20] In addition to socio-demographic factors like lower educational and economic status, cultural factors like regular social gatherings within close-knit communities brought their ability to adapt to alien preventive behaviors, like social distancing, into question.

Confusion and controversy should be minimized at individual as well as policy levels through proper scientific methods. A theoretical approach to explore the behavioral changes during the pandemic among the rural Bangladeshis can provide a roadmap for any policy intervention. However, there are few related studies concerning the causal relationships of preventive health practices during the COVID-19 pandemic in Bangladesh. Therefore, this study aimed to determine the structural relationship of a set of variables, and to test the model using the empirical data through the reasoned action approach (RAA) theoretical framework. The RAA model is useful for understanding individual behavior or practice in a more rational way.[24] The theory predicts the individual behaviors from attitude and social norms through intention towards the behaviors, while not ignoring the background issues.[24-26] Behavioral models regarding COVID-19 prevention using the RAA theory can be effective in formulating health promotion programs through rational decision-making among the rural adults toward adopting preventive behaviors. Only the practice of healthy lifestyles can save the individual as well as the community from the most virulent virus so far in the 21st century.

METHODS

A cross-sectional study was carried out among rural adults of Mymensingh and Munshiganj districts of the Dhaka division of Bangladesh from July to October 2020. Average percentage of use of face masks in rural areas was found around 50% in a recent national survey.[27] Considering 5% nonresponsive cases the calculated sample size in each area was around 404. As it was conducted in 2 upazilas, a total of 810 respondents were randomly taken from two areas. The sample was also adequate for conducting structural equation modeling (SEM) with 4 latent variables having 13 indicators connected by 3 causal relationships. A multi-stage sampling was done with random selection of respondents in the final stage. A division (administrative unit) was selected randomly, followed by 2 districts within the division according to the highest and lowest number of COVID-19 cases. Munshiganj district was selected for the highest case detection and Mymensingh district was selected for the lowest case detection within the selected division. After selecting two districts, one upazila from each district was randomly selected, and after that, a union was randomly selected from each upazila again for the required number of respondents.

Data collection was done by trained interviewers through face-to-face interviews using a six-part questionnaire to assess socio-demographic information, knowledge of COVID-19 and its prevention, attitude towards the pandemic, social norms, intention and COVID-19 prevention behavior. Likert scale was used except for the socio-demographic and knowledge assessing parts. Content validation and reliability of the tools were checked, and Cronbach's Alpha value of more than 0.80 was found in all cases. Mann–Whitney U and Kruskal-Wallis H tests were done to explain the relationships of individual factors with COVID-19 prevention behaviors and path relationships were explained through structural equation modeling (SEM). Attitude and motivation were shown in the 1st block as exogenous variables to find out their significance on health practices in the 3rd block through the 2nd block intention. The hypothetical model of COVID-19 prevention behaviors was examined using Maximum Likelihood Estimation (MLE) through Analysis of Moment Structures (AMOS). An ethical clearance was acquired from the Ethical Review Committee of the Bangladesh Medical Research Council (BMRC) [Reg. no: BMRC/Revenue-Grant/2019-20/753(1-31)].

RESULTS

About half of the respondents (50.7%) were between 26 and 35 years with an average age of 29.5 (±7.4) years. The majority (88.1%) of the respondents were Muslim and almost two-thirds of the respondents were men. The majority of the male respondents were involved in agricultural work or worked as day laborers, and females were mainly housewives. Poor educational status and poverty were common scenarios in rural areas. Rural adults got health information mostly from media like television, mobile phones etc. during the pandemic crisis. Field activities of health workers were limited, and healthcare service was just focused on COVID-19 management except in a few emergency cases. Less than 5% of respondents had a COVID-19 patient among their family members or relatives (Table 1).

Table 1. Distribution of background factors (n=810)

Socio-demographic characteristics	Number	Percentage
Age of respondents (years)		
≤25	264	32.6
26-35	411	50.7
≥36	135	16.7
$\bar{x}$±SD=29.5±7.4 years (min-max:18-55 years)		
Gender		
Male	542	66.9
Female	268	33.1
Religion		
Islam	714	88.1
Hindu	96	11.9
Monthly family income (Taka)		
≤10000	327	40.4
10001-15000	250	30.8
>15000	233	28.8
$\bar{x}$±SD=13,351±6,564(min-max: 5,000-80,000)		
Educational level of respondents		
Illiterate	85	10.5
Primary	303	37.4
Junior School Certificate (JSC)	272	33.6
Secondary School Certificate (SSC) and above	150	18.5
Informed by health workers		
Yes	305	37.7
No	505	62.3
History of COVID-19 infection among family members/ relatives		
Yes	35	4.3
No	775	95.7

About half the selected population possessed poor knowledge, and motivation to practice preventive behaviors. Similarly, almost half of the respondents (48.1%) provided

evidence of poor practice of COVID-19 preventive behaviors. However, only about 15% of the selected rural adults showed a poor attitude and a third of them showed poor intention (Table 2).

Table 2. Level of scores of preventive behaviors in COVID-19 control and its predictors

Variables	Level of scores			$\bar{x}$±SD	Chronbach's alpha (α)
	Poor (≤60%)	Fair (61-80%)	Good (>80%)		
Practice	48.1	29.9	22.0	10.3(3.2)	0.85
Information	55.6	25.4	19.0	8.7(4.4)	0.89
Attitude	15.6	49.6	34.8	22.8(3.1)	0.90
Motivation	52.7	29.8	17.5	21.6(3.6)	0.87
Intention	31.1	32.6	36.3	18.3(4.0)	0.88

$\bar{x}$ = Mean, SD = Standard deviation

Mymensingh district was found to have a higher mean rank of preventive behaviors than Munshiganj and demonstrated a significant regional variation (U=58,747.5, p<0.001). Similarly, significant gender variation and marital status were found through the Mann-Whitney U test. However, religion and family types did not show any significant variation on preventive health behaviors (Table 3).

Table 3. Factors of COVID-19 prevention behavior tested through Mann-Whitney U test

Predictors	Category	N	Mean Rank	Mann-Whitney U	p-value
Region	Munshiganj	404	347.9	58,747.5	<0.001
	Mymensingh	406	462.8		
Gender	Female	268	451.6	60,274.5	<0.001
	Male	542	382.7		
Family income	Unmarried	165	362.9	46,190.5	<0.01
	Married	645	416.4		
Religion	Muslim	714	402.0	31,774.5	0.24
	Hindu	96	431.5		
Family type	Single	465	393.7	74,746.5	0.09
	Joint	345	421.3		

Kruskal-Wallis H tests confirmed significant age variations in COVID-19 prevention behavior adoption [χ^2 (2) = 36.6, p<0.001]. Middle-aged adults were significantly different from others (p<0.001). Educational levels also showed a significant difference of means, χ^2 (2) = 426.1, p<0.001, with a mean rank of health practices score of 234.5 for up to primary level, 521.3 for respondents of junior schools and 637.9 for secondary schools and above. Further, post hoc tests confirmed the vulnerability of the illiterate and those with primary level education compared to those with higher educational levels. A similar trend was also found for income levels [χ^2 (2) = 252.1, p<0.001]. A mean rank health practices score of 269.4 was found for the lowest income group, 415.5 for the middle-income group and 585.8 for the highest income group. The significance of information, attitude,

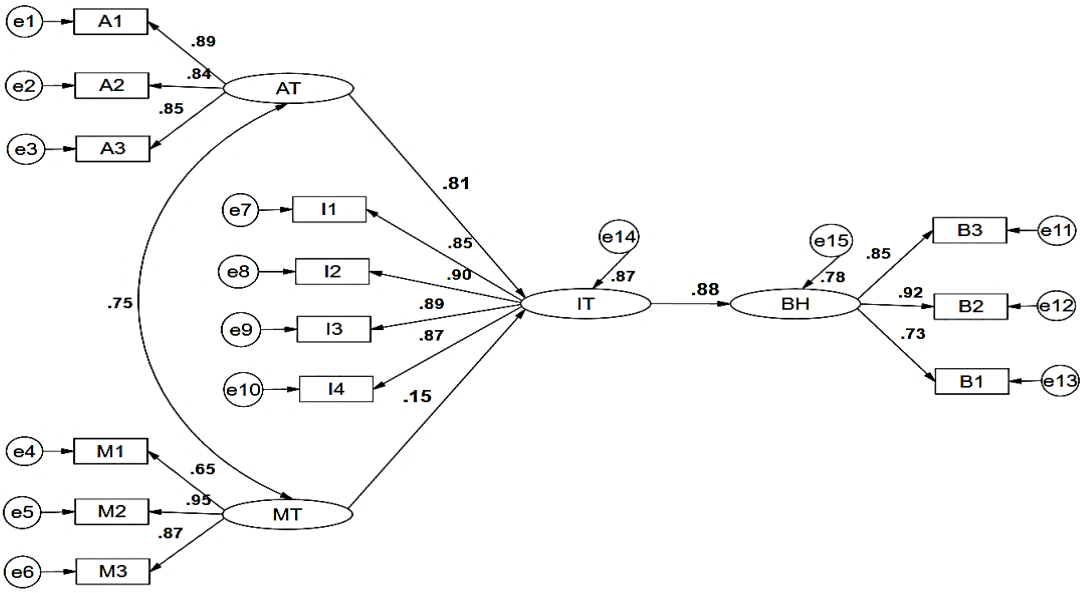
motivation, and intention was also confirmed in shaping COVID-19 prevention behavior during the pandemic crisis (p<0.001) (Table 4).

Table 4. Factors of COVID-19 prevention behavior tested through Kruskal-Wallis H test

Predictors	Category	N	Mean Rank	*df*	χ^2	p-value
Age	Up to 25 years	264	372.1	2	36.6	<0.001
	26 to 35 years	411	452.1			
	> 35 years	135	328.9			
Education	Up to primary	388	234.5	2	426.1	<0.001
	JSC	272	521.3			
	SSC and above	150	637.9			
Family income	Up to 10,000 Taka	327	269.4	2	252.1	<0.001
	10,001 to 15,000 Taka	250	415.5			
	>15000 Taka	233	585.8			
Information	Poor	450	253.5	2	469.6	<0.001
	Average	206	530.2			
	Good	154	682.9			
Attitude	Poor	126	186.7	2	371.2	<0.001
	Average	402	330.4			
	Good	282	610.3			
Motivation	Poor	427	277.3	2	291.1	<0.001
	Average	241	510.4			
	Good	142	612.9			
Intention	Poor	252	228.2	2	436.4	<0.001
	Average	264	329.8			
	Good	294	625.4			

JSC=Junior school certificate, SSC= Secondary school certificate, *df*=Degree of freedom

A causal model was explained through SEM with the latent variables to describe the relationships theoretically in a more rational way using the RAA model, following the identification of the significance of attitude, motivation, and intention on COVID-19 prevention behavior. The model was framed with 3 causal relationships among 4 latent variables with 13 indicators. Attitude and motivation were presented in the 1st block as exogenous variables to find out their significance on health practices in the 3rd block through the 2nd block of intention. Health practices in the 3rd block were the outcomes of rational decision-making for preventing the spread of the coronavirus in the rural community (Figure 1). The initial model was reasonably suitable [χ^2=546.75*, df=61,* GFI=0.90, CFI=0.95, NFI=0.94, RMSEA=0.06, SRMR=0.05] to describe the structural relationships. Attitude and motivation showed positive significant effects on COVID-19 prevention behaviors through intention in the initial model. Attitude and motivation showed significant results in the structural relationships with the intention to engage in health practices. Intention was also found to have a significant association with health behavior at the initial stage.

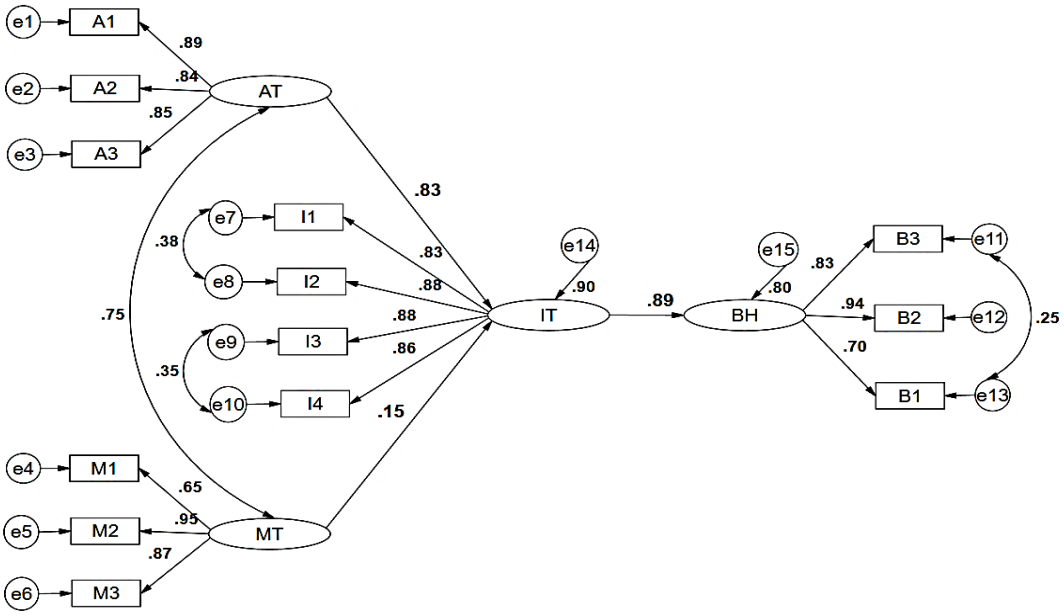


Opinion on severity (A1), opinion on prevention (A2), opinion on health rules (A3), family influence (M1), community influence (M2), organizational influence (M3), readiness on lockdown (I1), readiness on social distancing (I2), Readiness on using face mask (I3), Readiness on hand washing (I4), Social distancing (B1), face mask use and hand washing (B2), following rules of lockdown (B3). Attitude (AT), motivation (MT), intention (IT) and behavior (BH), e=error

Figure 1: Initial model of health practices regarding COVID-19 prevention

Implied parameter changes for the proposed modification indices were large enough to improve the fit of the initial model. Consequently, post hoc modifications to the initial model were undertaken without altering the basic concept of RAA. Only 3 modification indices were taken to make the model more suitable [χ^2=338.60, *df=58,* GFI=0.94, CFI=0.97, NFI=0.97, RMSEA=0.05, SRMR=0.04].

In the adjusted model, attitude showed positive significant effects on the intention (p<0.001) again, and β the structural relationships of attitude with intention was 0.83. Motivation also showed a highly significant result (β=0.15, p<0.001) with intention in the adjusted model (Figure 2, Table 5). Health behavior regarding COVID-19 prevention was significantly influenced by intention (β=0.89, p<0.001).



Opinion on severity (A1), opinion on prevention (A2), opinion on health rules (A3), family influence (M1), community influence (M2), organizational influence (M3), readiness on lockdown (I1), readiness on social distancing (I2), Readiness on using face mask (I3), Readiness on hand washing (I4), Social distancing (B1), face mask use and hand washing (B2), following rules of lockdown (B3). Attitude (AT), motivation (MT), intention (IT) and behavior (BH), e=error

Figure 2: Adjusted model of health practices regarding COVID-19 prevention

Table 5: Maximum likelihood estimates of regression weights at the adjusted model

			Estimate*	SE	CR	*p*-value
Intention	<--	Attitude	0.83	0.03	21.02	<0.001
Intention	<--	Motivation	0.15	0.02	4.25	<0.001
Behavior	<--	Intention	0.89	0.06	31.46	<0.001
Opinion on severity	<--	Attitude	0.89	---	---	---
Opinion on prevention	<--	Attitude	0.84	0.04	32.15	<0.001
Opinion on health rules	<--	Attitude	0.85	0.03	32.98	<0.001
Family influence	<--	Motivation	0.65	0.02	21.60	<0.001
Community influence	<--	Motivation	0.95	---	---	---
Organizational influence	<--	Motivation	0.87	0.02	37.80	<0.001
Readiness on lockdown	<--	Intention	0.83	0.03	31.00	<0.001
Readiness on social distancing	<--	Intention	0.88	0.03	35.13	<0.001
Readiness on using face mask	<--	Intention	0.88	---	---	---
Readiness on hand washing	<--	Intention	0.86	0.03	41.68	<0.001
Social distancing	<--	Behavior	0.70	0.01	23.52	<0.001
Face mask use and hand washing	<--	Behavior	0.94	---	---	---
Following rules of lockdown	<--	Behavior	0.83	0.01	31.74	<0.001

Estimate*=Standardized regression weight, SE=Standard error, CR=Critical ratio

All the indicators of latent variables showed their significance (p<0.001) in the adjusted model. Intention showed the highest direct positive effect on COVID-19 prevention behavior in the adjusted model, and among the two determinants of RAA, attitude showed the highest positive direct effect on the intention. Attitude and the motivation had significant indirect effect on COVID-19 preventive behaviors through intention. All the predictors together were able to correctly explain 79.6% of the variance of COVID-19 preventive behaviors in the adjusted model.

DISCUSSION

The current study tried to formulate a causal model of COVID-19 prevention behaviors with significant predictors among the rural Bangladeshi population. Along with the socio-demographic factors, other elements like information, attitude, motivation, and intention showed significance in preventive health practices. About half of the rural adults (48.1%) showed poor health practices regarding COVID-19 prevention. A similar number (55.6%) had poor knowledge of transmission, symptoms, prevention, and management of COVID-19. Socio-demographic characteristics of the respondents favorably described typical rural scenarios. Age, income, religion, family size etc. showed congruence with national findings of the Bangladesh Demographic and Health Survey, 2017-18 with some exceptions due to regional variation and sampling process.[28]

Hand washing with soap may not be a common routine practice in rural areas even after defecation.[29] The government has been promoting hand washing for at least 20 seconds since the beginning of the pandemic. The study findings described the real situation regarding the rural hand washing culture. Although people were not aware of washing hands for 20 seconds and using soap, the frequency and rate of hand washing increased after the crisis. Availability of hand washing facilities in public places is still a big concern and the situation is prevalent in many South Asian countries. More than 80% of the rural households in India were devoid of tap water and piped-water supplies, and this gets worse in the states of West Bengal and Uttar Pradesh where only 1 percent of rural households have a tap connection for piped-water supply.[30] It is a major challenge for them to manage water to wash their hands in order to fight against COVID-19. The United Nations Children's Fund (UNICEF) also elucidated the critical importance of hand washing to fight against COVID-19 where about 3 billion people still lack proper hand washing facilities with soap at home.[31]

Although the use of face masks was mandatory at the vast majority of public gatherings around the world, unfortunately a large portion of the population in Bangladesh was reluctant to wear masks.[32] This study revealed that more than two-thirds of the respondents used face masks during the pandemic crisis, but the majority of them used the masks irregularly and were not aware of the proper use and quality of face masks. A cross-sectional survey conducted by the Dhaka Tribune found 22,546 people wearing masks during the survey and 13,407 people were not wearing any kind of face covering. Rural people were more relaxed initially, believing that COVID-19 might be more infectious only in over-crowded urban areas. The survey found Munshiganj district in the bottom ten for non use of face masks.[27] Regional and age variation were also observed in the current study.

Authorities in Bangladesh shut schools in the middle of March immediately after confirming the first cases of COVID-19 and asked locals to avoid large gatherings to halt the spread of the disease. Many took the government's

declaration of sudden closure as a vacation opportunity to visit village homes, and some were not afraid to go for tourism. Lockdown was urgent then and the Bangladeshi government had no better option for saving its people.[33] This portrays the limitation of the government machinery to implement the imposed restrictive regulations, and the attitude of the urban population toward the new disease during the earlier days of the pandemic. On this note, we can assume a nightmare scenario among the rural population where education, health awareness and access to healthcare are lower. This is well reflected in the results of this study.

Many socio-demographic factors were found in significant relationships with preventive behaviors against COVID-19 among the rural Bangladeshi population. In a similar way, information, attitude, motivation, and intention were also significant in predicting the outcome. All the major determinants like attitude and motivation were significantly justified in the causal model of preventive behaviors as in other studies based on RAA.[26,34] Knowledge and attitude were found to have significant relationships with COVID-19 prevention behavior in other studies at home and abroad.[35-38] Few online surveys in Pakistan and India showed a better percentage of good knowledge among the respondents, and this might have differed only due to sample selection or study process.[39-40] The importance of background issues in promoting a positive attitude and healthy practices during the COVID-19 crisis has been described in so many studies across the world.[38,40-41]

The current study included background issues along with individual, family, and social factors predicting preventive behaviors among the rural adults during the pandemic crisis. However, multi-stage sampling from two rural areas might not be sufficient for providing representative samples and avoiding regional variations. Being a cross-sectional survey, the study inherits some limitations in describing the significance of predictors in relation to the final outcome. However, proper theoretical and methodical approaches, with valid and reliable tools, enable the study to reveal the major determinants from the RAA model in describing the preventive practices against COVID-19 in a rational manner.

CONCLUSIONS

The study provided significant information about the current status of preventive behavior against COVID-19, and its predictors among the rural adults of Bangladesh. The study portrayed reluctance towards using face masks and maintaining social distancing among the majority of the rural population, and revealed various socio-demographic determinants. The study further provides a bigger picture of individual factors and social circumstances influencing healthy practices of rural adults. Adequate knowledge, positive attitude, proper motivation, and positive intention can encourage rural adults to adopt relevant healthy behaviors against COVID-19. The findings will help to prioritize the intervention areas and promote healthy practices against COVID-19. The pandemic is not over yet and incorporating evidence-based strategies into the current national COVID-19 prevention program can enhance prevention activities in rural areas.

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