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ADHERENCE TO PREVENTIVE BEHAVIORS AND PERCEIVED RISK OF IRANIAN MEDICAL STUDENTS IN RESPONSE TO THE COVID-19 PANDEMIC: STRUCTURAL EQUATION MODELING

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ABSTRACT

BACKGROUND. The COVID-19 pandemic resulted in a significant threat to people's lives. Detection of adherence to preventive behaviors and risks perceived by people is essential for infection control. Medical students are future healthcare providers. This study explored adherence to preventive behaviors and risk perception of the COVID-19 pandemic in Iran's medical students.
METHODS. In this cross-sectional study, Iranian medical students participated whose preventive behaviors and risk perceptions of COVID-19 were assessed by an online tool. Generalized Structural Equation Modeling (SEM) with a beta-regression family was used for mediation analysis.
RESULTS. A total of 654 medical students participated. The mean risk perception of COVID-19 on a 1 to 7 range scale was 3.53±1.7 for themselves and 3.66±1.7 for their family members. The risk perception for disease severity was 2.9±1.5. According to SEM, male sex, COVID-19 history, and living with parents were predictors of adherence directly and through the mediator pathway of risk perception ($P < 0.1$). Briefly, the male sex reduced adherence directly and through risk perception reduction. The history of COVID-19 directly reduced adherence, but through the mediation pathway of risk perception, it increased adherence. However, the total effect was in favor of adherence reduction. Living with parents directly increased adherence but reduced adherence through the mediation pathway of risk perception. However, the total effect was in favor of adherence increase.
CONCLUSION. Although conventionl statistical analaysis did not support the association of risk perception and adherence, the generalized SEM showed risk perception as a potential mediator with a small effect. The present study showed the roles of sex, COVID-19 history, and living with parents as the factors affecting risk perception and preventive behaviors on the basis of SEM results. Among the results, living with parrants was a modifiable factor to increase the adherence.

Keywords: *risk perception, COVID-19, adherence, structural equation modeling (SEM), medical student, health behavior*

INTRODUCTION

Iran's coronavirus disease of the year 2019 (COVID-19) pandemic was officially confirmed on February 18, 2020. This disease has since disrupted daily life activities and not only had severe effects on people's health but also natively affected the economic situation as well as transportation and education at the global level (1). The COVID-19 pandemic has led to the disruption of education and the total or partial closure of educational institutions (2). In many countries, medical schools have turned to online instruction in response to the need for social quarantine to reduce infection and mortality (3). In addition, in many countries, due to the need to care for an increasing number of COVID-19 patients, internships have been greatly affected by the rapid changes in hospitals, and medical students have been advised to stay at home due to the potential risk of COVID-19 infection in healthcare centers and the lack of personal Protective

Equipment (P.E.) (3, 4). However, the role of medical students in the COVID-19 pandemic has changed rapidly due to the shortage of healthcare professionals in many countries, even in developed countries. Thus, the British School of Medicine and the Association of American Medical Colleges (AAMC) have issued guidelines for the involvement of medical students in providing the best care for patients with COVID-19. They have also recommended that medical students work voluntarily, receive appropriate training, not perform any activity beyond their level of competence, and receive continuous monitoring and adequate personal protective equipment (4).

Medical students as a group of young adult population, like other healthcare providers, are the first people who come in contact with patients who are the source of infection, so they are at greater risk of disease (5). The participation of students in preventive behaviors ranges from 56.8% to 96.4% in different countries (6-10). Risk perception is the factor that may affect the willingness and motivation of people to perform preventive behaviors (11). Research has shown that risk perception significantly predicts health behaviors (12). Risk perception means evaluating the threat of disease, which determines the willingness to adopt preventive behaviors (2).

Public acceptance of preventive behaviors is essential for crisis management (13). As mentioned earlier, the effectiveness of preventative measures depends on the level of compliance of Public members (14), and the inability of individuals to voluntarily comply with the health recommendations has been considered a factor that increases the spread of COVID-19 (15). The findings of previous studies indicate that a lower risk perception is associated with performing risky behaviors or reducing preventive behaviors. Also, a high-risk perception is related to an increased tendency to perform preventive behaviors (11,16). A synthesis of evidence has shown that behavioral science played a critical role in informing public health policies during the COVID-19 pandemic. The mentioned research highlighted the importance of understanding human behavior to encourage adherence to health guidelines, such as mask-wearing and social distancing. Various studies indicated that factors like trust in authorities, social norms, and effective communication significantly influenced public compliance. The synthesis emphasizes the need for policy-makers to integrate behavioral insights to enhance public health responses, ultimately improving the effectiveness of interventions aimed at controlling the spread of the virus (17). A systematic review has shown that various interventions can effectively improve adherence to behaviors aimed at minimizing the spread of COVID-19. This review highlights the importance of tailored messages, behavioral prompts, and community engagement strategies in promoting compliance with public health guidelines. Furthermore, this review identifies gaps in the literature, and suggests that more research is needed to examine the long-term adherence and effectiveness of a variety of specific interventions among different populations (18).

In any pandemic, outbreak, or crisis, the behaviors and actions of different groups, such as healthcare providers and students, are of great importance. It is crucial, especially in the early stages of these emerging conditions, as there is currently no evidence on effectively managing and treating the disease. Ideally, it is possible to control such conditions by suitable behaviors. Regarding COVID-19, even though it is no longer classified as a public health emergency according to the World Health Organization (WHO) (19), it is crucial to examine the associated experiences for future use in similar crises, epidemics, or pandemics. The main issue is that medical students becoming healthcare providers should demonstrate appropriate responses during crises. Hence, it is necessary to examine the patterns of risk perception and behaviors and the factors that affect them to handle future crises effectively. Conducting suitable modeling would help researchers and policymakers for future crises or public health emergencies. Medical students, as representatives of the young adult population, are characterized by their relatively lower age and lower prevalence of underlying diseases, making them less susceptible to severe illness from COVID-19. However, despite their lower risk of severe illness, they can still be a significant source of disease transmission due to their social interactions and family ties. In addition, the behavior of medical students is the pattern of people's behavior in society.

Although many studies have been conducted worldwide to investigate the risk perception of COVID-19, there is still limited data on the risk perception of COVID-19 among Iranian medical students and their behaviors in such situations. Since medical students are a source of information for their families and society (20), and due to their close contact with patients and living in a crowded environment, they are at a higher risk of infection.

As a result, the present study aimed to evaluate risk perception and its related factors among medical students because knowing such information could help policymakers design appropriate interventions to deal with COVID-19 and similar conditions. The results can be generalized to other medical students whom are young adults. We attempted to utilize Structural Equation Modeling (SEM) to explore how risk perception influences adherence to preventive

behaviors. Our hypothesis suggests that perceived risk plays a mediating role in affecting preventive behaviors. The results of such modeling techniques may be reproducible for similar crises.

MATERIAL AND METHODS

Study design. This cross-sectional study was conducted from the 23rd to November 29, 2021. We used the risk perception and preventive behavior sections of the COVID-19 Population Survey of Iran (COPSIR) questionnaire by Janani et al. to develop the needed tool regarding the conditions of our population based on the relevant selected items. The validity of this questionnaire was evaluated and reported in their study protocol published in 2020 (21). Our final questionnaire consisted of demographic questions, four questions about risk perception, and 33 questions about adherence to COVID-19 precautionary measures (Appendix 1). We evaluated the reliability of our questionnaire's risk perception and adherence to preventive behaviors sections using Cronbach's alpha and Kuder-Richardson formulas, respectively. The results were 0.82 for risk perception and 0.74 for preventive behavior questions.

Data collection. Data were collected by an online survey in all educational stages (including Basic Sciences, Pathophysiology, Clerkship, and Internship). In Iran, medical education has four levels of Basic Sciences, Pathophysiology, Clerkship, and Internship, in which in Basic Sciences there is no contact with patients (also in most courses of Pathophysiology), while in Clerkship and Internship there is direct contact with patients. The inclusion criteria were being medical student, being Iranian and being the student of Iran University of Medical Sciences. The exclusion criteria were lack familiarity with Persian language and refusing to give informed consent. The identities of the students taking the survey were kept anonymous and confidential. This study was approved by the Research Ethics Committee, Vice-Chancellor of Research Affairs, Iran University of Medical Sciences (IUMS), Tehran, Iran (ethics registration number: IR.IUMS.REC.1400.469).

Variables and checklist score. Demographic items included socio-demographic variables (age, sex, education, marital status, family yearly income, and educational level). Respondents also responded on history of COVID-19 infection, vaccination status to COVID-19, marital status, history of medical problems, household type and size. By studying COPSIR report, our study assessed thirty-three preventive behaviors as a checklist format, namely proper hand washing, face mask-wearing, avoiding touching one's eyes and nose, a government recommendation based on early COVID-19 advice, and carrying hand sanitizer when they did not have accessible soap to wash hands, social distancing behavior and hygiene recommendations based on Ministry of Health and Medical Education (government recommendation), presence in public places to prevent the spread of COVID-19, consumption of some vitamins, nutrition regimes, presence in hospital wards. All questions were rated on a binary scale from 1 = yes (effective behaviors) and 0 = no (ineffective behaviors). So, the students had to specify which behaviors they would perform to prevent COVID-19 infection.

Participants were asked four questions regarding the perceived risk of COVID-19 based on perceived probability (for themselves and their families), perceived susceptibility, and perceived severity on a seven-point scale and level of anxiety in contracting COVID-19 rating score from 1 = 'Strongly disagree' to 7 = 'Strongly agree'.

Statistical analysis. The collected data was received as an Excel output file, transferred to SPSS 24 (IBM Corp., NY, U.S.), and analyzed at the significance level 0.05. Qualitative variables were reported as a frequency and percentage, and quantitative variables were described using the mean and standard deviation. Furthermore, measuring the relationship between qualitative and quantitative variables was done using a t-test and analysis of variance (ANOVA). The Pearson correlation test was used to check the relationship between risk perception and adherence score. After crude analysis, all variables with 0.2 p value or less were entered into the linear regression model.

Modeling. Stata 14 software (Stata Corp. LLC, U.S.) was used for SEM. In this regard, adherence was the outcome, and risk perception was the mediator. According to the left-skewed distribution of the adherence score, the score was adjusted to the range of 0-1, and the beta-regression family (logit link) was used (as a generalized SEM or GSEM). Covariates with a P value less than 0.1 remained in the model based on a backward Wald stepwise approach. Categorical variables were converted to binary form.

The aim of using SEM in this study was mediation analysis. In mediation analysis, a variable called "mediator" is positioned between the independent (exogenous) and outcome (endogenous) variables. The pathway that passes the mediator is called the "indirect" pathway, while the pathway linking the independent to dependent variable without passing the mediator is called the "direct" pathway. The SEM technique is widely used in health behavior studies, and its popularity is growing compared to regression and ANOVA (22). Mediation analysis commonly utilizes SEM in these studies because calculating direct, indirect, and total effects is crucial (23). The

suggested sample size for SEM studies is at least 15 cases per variable (22) achieved in the present study.

Two models were created using a Directed Acyclic Graph (DAG) by following these steps. The expert opinion of the researchers designed the primary graphs, then all the possible pathways were designed, and finally, the non-significant pathways were removed by the stepwise approach.

Model one: The mean of risk perception was considered the mediator variable as the observed variable. No latent variable was used in this model.

Model two: The four risk perception items were used as the mediators. If collinearity based on the Variance Inflation Factor (VIF) is more than two, the collinear items were considered reflective indicators of a latent variable. In addition, a logical temporal consequence was regarded for these items.

RESULTS

Demographic results. Six hundred fifty-four voluntary medical students of IUMS participated in all educational stages after removing duplicates and incomplete responses; the final inclusion participants were six hundred fifty cases. Their characteristics are shown in Table1.

Risk perception. According to our participants, the mean risk of contracting COVID-19 on a 1 to 7 range scale (1 being very unlikely and seven being very likely) was 3.49±1.9 for themselves and 3.66±1.7 for their family members. They believed that if they caught the disease, its severity on a 1 to 7 range scale (1 being very mild and 7 being very severe) would be 2.9±1.5. The students also rated their mean level of worry about contracting the disease as 3.5±1.9 in the same range scale. Overall, the mean score of their perceived risk from 1 to 7 was 3.26±1.3. The associations of the demographic variable with the mean risk perception score are shown in Table 2.

The mean risk perception score of female students was 3.45, significantly higher than the 3.1 of males (P <0.001). The difference between the mean risk perception scores of those with and without a prior history of COVID-19 infection did not reach the level of statistical significance (3.37 vs. 3.18, P = 0.07). Also, no significant difference was observed between vaccinated and unvaccinated students' mean risk perception scores.

On the other hand, students at different stages of medical education had different levels of risk perception (P = 0.003), with students at the basic science stage reporting a mean score of 3.01±1.3 versus physiopathology and internship stages with 3.47±1.4 and 3.52±1.1 respectively. Students with underlying diseases had significantly higher perceived risk scores than the others (4 vs. 3.2, P < 0.001). The risk perception of the subjects in different reported socio-economic levels was not different (P = 0.20).

Table1. Characteristics of the participating students

Demographic characteristics	Frequency / mean ±SD
Age	22±3.1
Sex	Female: 304 (46.8%) Male: 346 (53 .2%)
Marital status	Single: 624 (96%) Married: 26 (4%)
Educational stage	Basic sciences: 320 (49.2%) Pathophysiology: 186 (28.6%) Clerkship: 68 (10.5%) Internship: 76 (11.7%)
Living condition	Living with parents: 450 (69.2%) Living in the university dorm: 119 (18.3%) Living alone: 35 (5.4%) Other: 46 (7.1%)
Reported socio-economic status of the family	Poor: 31 (4.8%) Average: 485 (74.6%) Affluent: 134 (20.6%)
Underlying disease	Positive: 34 (5.2%) Negative: 616 (94.8%)
COVID-19 history	Positive: 256 (39.4%) Negative: 394 (60.6%)
COVID-19 vaccination	Positive: 633 (97.4%) Negative: 17 (2.6%)

Table 2. Mean risk perception scores of the participants according to each variable category and their crude and multivariable analysis P values.

Variables and their categories	Mean of risk perception	Crude analysis P value	Multivariable analysis P value	Partial Eta squared value
Sex:				
Female	3.45±1.3	<0.001	<0.001	0.023
Male	3.09±1.3			
Marital status:				
Single	3.25±1.3	0.218	-	-
Married	3.57±1.2			
Educational stage:				
Basic sciences	3.09±1.3			
Pathophysiology	3.47±1.4	0.003	0.028	0.014
Stager	3.17±1.1			
Internship	3.52±1.1			
Reported socio-economic status of the family:				
Poor	3.52±1.5	0.207	-	-
Average	3.28±1.3			
Affluent	3.11±1.2			
Underlying disease:				
Positive	4.00±1.3	<0.001	0.004	0.013
Negative	3.22±1.3			
Covid-19 history:				
Positive	3.37±1.3	0.073	0.144	0.003
Negative	3.18±1.3			
Covid-19 vaccination:				
No	2.88±1.1	0.333	-	-
Just the first dose	3.14±1.3			
At least two doses	3.28±1.3			
Living condition:				
With parents	3.17±1.3			
In the university dorm	3.52±1.3	0.013	0.221	0.007
Alone	3.11±1.2			
Other	3.60±1.2			
Age	r = +0.216	<0.001	<0.001	0.029

Mean risk perception scores of those students who lived with their parents were significantly lower than those living in dorms or other conditions, 3.16±1.3 vs. 3.52±1.3 and 3.6±1.2, respectively (P = 0.01). The age of the participants and mean risk perception score were significantly correlated (r = +0.22, P < 0.01). All variables with a P value of 0.2 or less (including age, sex, educational stage, reported socio-economic status, living condition, history of previous COVID-19 infection, and presence of underlying conditions) were then entered into the final general linear model. Among these, age, sex, presence of underlying conditions, and educational stage showed significant associations with mean risk perception score with partial eta squares and P values of 0.029, 0.023, 0.013, 0.014, and P < 0.001, P < 0.001, P = 0.004 and P = 0.028 respectively. The R-squared value of this model was 0.10.

Adherence. The mean score of adherence to preventive measures was 20.73±4.3. The age of the students was significantly and negatively correlated with their adherence score (r = -0.10, P = 0.01), but no correlation was observed between their risk perception and adherence scores (P = 0.15). Table 3 shows the mean adherence scores of the participants according to each variable and their crude and multivariable general linear model P values. The R-squared value of this model was 0.09.

SEM results. Model one: According to SEM, risk perception (positive effect), male sex (negative effect), history of COVID-19 (negative effect), and living with parents (positive effect) could directly predict adherence (P < 0.1). Risk perception could be a significant mediator for all the pathways (Table 4, Figure 1). Similar associations were found in total effect calculation (direct effect plus the effects through

Table 3. Mean adherence scores of the participants according to each variable category and their crude and multivariable analysis P values.

Variables and their categories	Mean adherence to preventive measures score	Crude analysis P value	Multivariable analysis P value	Partial Eta squared value
Sex:				
Female	21.49±3.8	<0.001	<0.001	0.027
Male	20.05±4.6			
Marital status:				
Single	20.77±4.3	0.21	-	-
Married	19.69±4.3			
Educational stage:				
Basic sciences	21.22±4.2			
Pathophysiology	20.35±4.1	0.03	0.377	0.005
Clerkship	20.18±5.1			
Internship	20.07±4.4			
Reported socio-economic status of the family:				
Poor	20.77±4.6	0.17	0.207	0.005
Average	20.55±4.3			
Affluent	21.34±4.2			
Underlying disease:				
Positive	20.85±4	0.86	-	-
Negative	20.71±4.3			
Covid-19 history:				
Positive	20±4.4	0.001	0.007	0.012
Negative	21.2±4.2			
Covid-19 vaccination:				
No	20.18±5.5	0.21	-	-
Just the first dose	21.54±4.3			
At least two doses	20.64±4.3			
Living condition:				
With parents	21.27±4.2			
In the university dorm	19.60±4.1	0.001	0.003	0.022
Alone	19.49±5			
Other	19.26±4.4			
Age	r = -0.10	0.010	0.504	0.001

Table 4. SEM results based on the beta-regression family at a significance level of 0.1

Model	Coefficient	Standard error	z	P>|z|	95% confidence interval (lower, upper)	
Outcome: Adherence prediction						
Risk perception	0.033	0.019	1.730	0.084	-0.004	0.071
Sex (male)	-0.177	0.050	-3.550	<0.001	-0.275	-0.079
History of COVID-19	-0.130	0.050	-2.590	0.010	-0.229	-0.032
Life with parents	0.257	0.053	4.840	<0.001	0.153	0.361
Constant	0.663	0.089	7.440	<0.001	0.488	0.837
Outcome: Risk perception prediction						
Sex (male)	-0.385	0.101	-3.810	<0.001	-0.582	-0.187
History of COVID-19	0.185	0.103	1.790	0.073	-0.017	0.387
Life with parents	-0.306	0.109	-2.800	0.005	-0.520	-0.092
Constant	3.601	0.116	31.170	<0.001	3.375	3.828
Model summary						
Logs	2.355	0.053			2.250	2.460
Variance (error of risk perception)	1.638	0.091			1.469	1.826

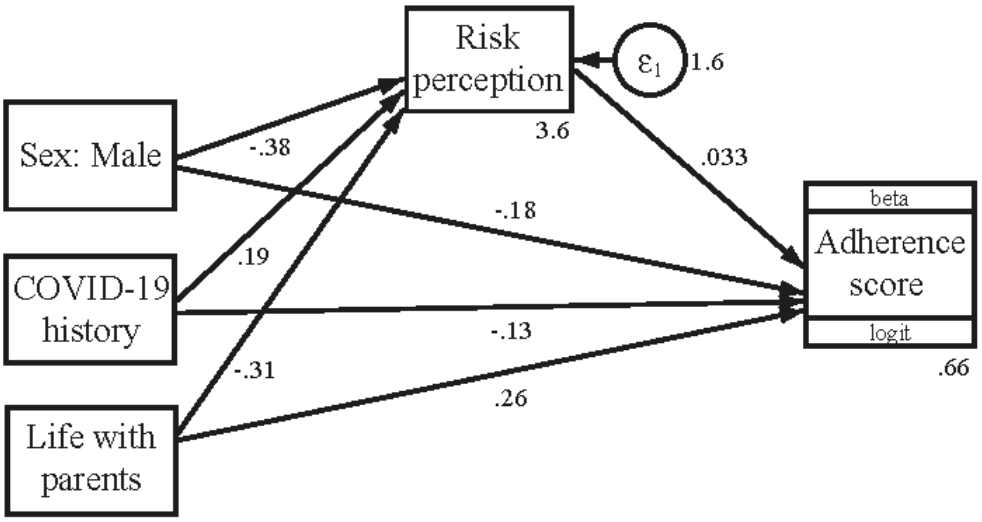

Figure 1. Mediation analysis based on the beta-regression family at a significance level of 0.1. The numbers in the down-right corner of the endogenous variables are intercepts. The numbers on the pathways are regression beta coefficients.

mediation of risk perception) (Table 5). Briefly, the male sex reduced adherence both directly and through the reduction of risk perception. The history of COVID-19 directly reduced adherence, but through the mediation pathway of risk perception, it increased adherence. However, the total effect was in favor of adherence reduction. Living with parents directly

Table 5. Comparison of direct and total effects of the SEM

Variable	direct	indirect	total
Risk perception	0.033		0.033
Sex (male)	-0.177	-0.013	-0.190
History of COVID-19	-0.130	0.006	-0.124
Life with parents	0.257	-0.010	0.247

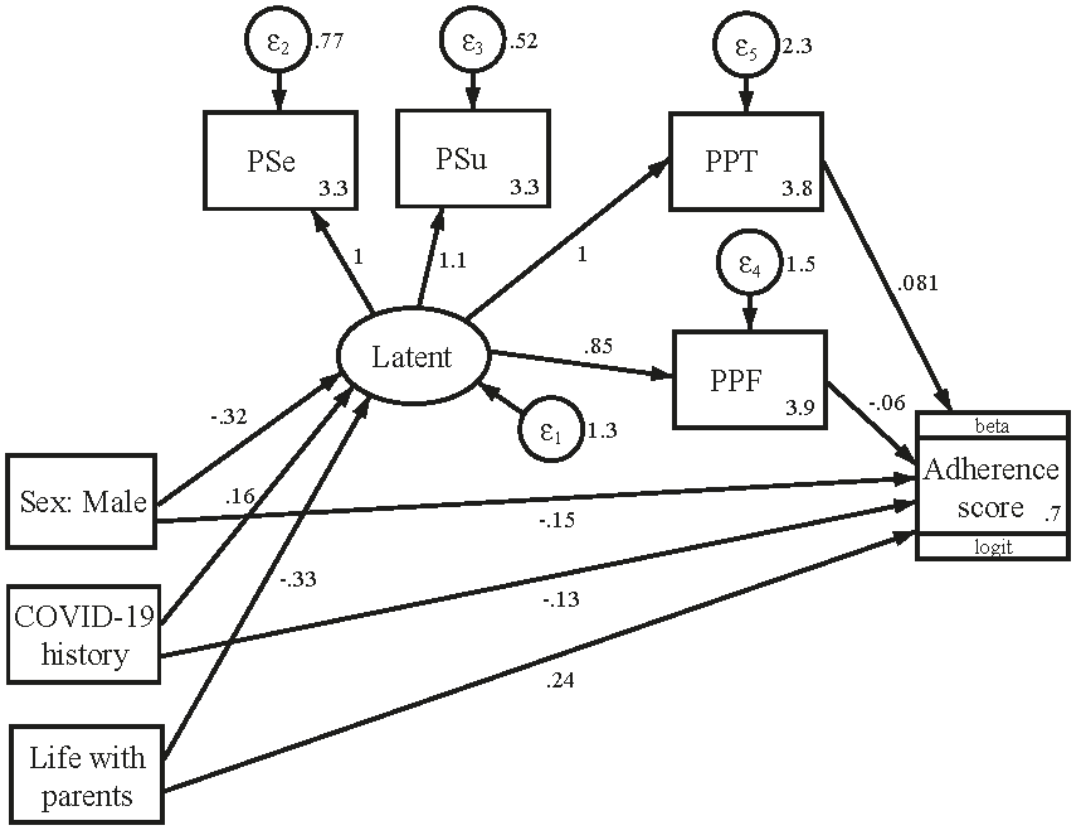

Figure 2. Mediation analysis is divided by the items of risk perception. The numbers in the down-right corner of the endogenous variables are intercepts. The numbers on the pathways are regression beta coefficients. PSe: perceived severity; PSu: perceived susceptibility; PPT: perceived probability (themselves); PPF: perceived probability (families)

Table 6. SEM results divided by the items of risk perception based on the beta-regression family at a significance level of 0.1

Model	Coefficient	Standard error	z	P>|z|	95% confidence interval (lower, upper)	
Outcome: adherence score						
Sex (male)	-0.147	0.049	-2.98	0.003	-0.244	-0.050
History of COVID-19	-0.127	0.049	-2.56	0.010	-0.224	-0.030
Life with parents	0.244	0.052	4.71	<0.001	0.143	0.346
Perceived probability (families)	-0.060	0.017	-3.51	<0.001	-0.094	-0.027
Perceived probability (themselves)	0.081	0.014	5.69	<0.001	0.053	0.109
Constant	0.704	0.085	8.25	<0.001	0.537	0.871
Outcome: Perceived severity						
Latent	1.000			Constraint		
Constant	3.288	0.116	28.32	<0.001	3.061	3.516
Outcome: Latent						
Sex (male)	-0.322	0.099	-3.27	0.001	-0.515	-0.129
History of COVID-19	0.164	0.100	1.64	0.100	-0.031	0.360
Life with parents	-0.333	0.106	-3.15	0.002	-0.541	-0.126
Outcome: Perceived susceptibility						
Latent	1.129	0.053	21.36	<0.001	1.026	1.233
Constant	3.307	0.128	25.86	<0.001	3.057	3.558
Outcome: Perceived probability (families)						
Latent	0.846	0.054	15.79	<0.001	0.741	0.951
Constant	3.949	0.106	37.27	<0.001	3.741	4.156
Outcome: Perceived probability (themselves)						
Latent	1.025	0.066	15.6	<0.001	0.896	1.154
Constant	3.838	0.129	29.71	<0.001	3.585	4.092
Model summary						
Adherence score						
Logs	2.402	0.054			2.297	2.507
Variance (error of latent)	1.319	0.116			1.110	1.567
Variance (error of perceived severity)	0.769	0.063			0.655	0.903
Variance (error of perceived susceptibility)	0.523	0.066			0.409	0.670
Variance (error of perceived probability [families])	1.509	0.094			1.335	1.705
Variance (error of perceived probability [themselves])	2.299	0.143			2.035	2.598

Latent: a latent variable behind the perceived susceptibility and perceived severity

increased adherence, but it reduced adherence through the mediation pathway of risk perception. However, the total effect was in favor of adherence increase.

Model two: The items of risk perception were also analyzed as mediators. In this regard, another SEM was conducted. In addition to the criteria for graphing and model selection strategy of the previous SEM, temporal and logical precedence of the perceived risk items were regarded. Multicollinearity was observed for perceived susceptibility (VIF = 2.39) and perceived severity (VIF = 2.13), in which the pairwise correlation between them was 0.71. Therefore, a latent variable called "Latent" was designed. This latent variable was positioned at the temporal precedence of perceived probability. Accordingly, the direct pathways were similar to model one. The indirect pathways showed similar results. Although perceived probability for the families had a negative effect on adherence, the total effect was similar to model one (in favor of the positive role of risk perception on adherence). Convergence was achieved in less than 100 iterations (Table 6, Figure 2).

DISCUSSION

The cross-sectional study was designed to investigate the adherence and perceived risk in medical students of IUMS performing preventive behaviors against COVID-19 infection. A large enough number of students have participated. SEM was conducted for the mediation role of risk perception. The main theme of this study was to reach a model from the COVID-19 era to be used for similar disasters in the post-COVID-19 era. This modeling can be generalized to other medical students in similar conditions. It is worth noting that the target population was limited to the young adults whom most of them do not have chronic diseases.

As the demographic characteristics were investigated, most subgroups had enough samples; however, lack of vaccination, marriage, and poor socio-economic status were the least frequent subgroups, respectively (< 5%). The average perceived risk of getting COVID-19 (3.53 for themselves and 3.66 for their families) was approximately in the middle of its range (1 to 7), while the average perceived risk of COVID-19 severity (2.9) showed a tendency to the lower limit of the range. It means most participants believe they will not get a severe disease. Overall, the mean score was in the middle of the field. Statistically, female students showed a significantly higher perceived risk (0.35 score more). Also, age showed a significant positive correlation with risk perception. The lack of significant difference between the groups with and without a history of COVID-19 and between the vaccinated and unvaccinated groups for perceived risk was notable. As expected, different stages of education showed different perceived risks, as it was lower in students of the basic science stage compared with other groups. As expected, students with underlying diseases reported a significantly more perceived risk (0.8 score more). Risk perception was not significantly different between the groups of socio-economic status. Risk perception significantly differed between living conditions, as it was lower among the students who lived with their parents. From the associations mentioned for risk perception, associations with age, sex, underlying disease, and educational stage remained significant in the multivariable model.

On average, the score of adherence to preventive behaviors was acceptable. In crude statistical analysis, female students and students with a negative history of COVID-19 had more adherence scores. In addition, the adherence score was significantly different between educational stages and living conditions. In multivariable statistical analysis, the female sex, having COVID-19 history, and living conditions remained statistically significant.

University students including medical and non-medical students are a group of young adult population. Akhter et al (2022) conducted an online survey of university students to investigate their perception, awareness, and adherence to COVID-19 prevention measures. They found that overall, women, Asian/Pacific Islanders, and graduate students were more likely to adhere to COVID-19 prevention guidelines, but those who tested positive for COVID-19 were less likely to do so (24). It was in line with our study that in our modeling, history of COVID-19 infection was associated with decreased adherence. A Chinese study conducted by Tam et al (2023) on college students based on health belief model (HBM). According to their SEM, they found perceived susceptibility as the positive predictor of precautionary behaviors (25). Although the literature was not enough to compare medical and non-medical students, it seems that they have similar results.

A study was conducted in China (2020) based on the use of the HBM in compliance with preventive behaviors on 616 people from the general population and through telephone calls, and the results indicated that 96.4% of the participants followed the use of masks and 42.3% followed social distancing. It believed that strategies based on social beliefs improved behaviors and compliance indicators. For perceived risk, they found no association with preventive measures (26). In the present study, we found no association between perceived risk and adherence to preventive measures in crude analysis, but our SEM showed a trend for significance in using beta regression instead of general linear regression. However, this association was not large enough, as there was no considerable difference between direct and total effects (Table 4). It seems that the direct effects are more dominant than the indirect. In another health belief modeling, Mortada and Elhessewi (2022), in Saudi Arabia, 286 participants showed significant gaps between perceived risk and personal hygiene (27). In the present mediation analysis, perceived risk was associated with adherence based on beta regression. Regarding the components of perceived risk, perceived probability was associated with adherence. Also, we had a larger population.

Karim et al.'s study (2020) showed that people who understood the dangers of COVID-19 collected sanitary and disinfectant items, while people who did not take the disease seriously or did not have a high perception of the risks of the disease carelessly and behaved negligently without any preventive behavior (28). Also, Wise et al. study (2020) showed that higher personal risk perception predicted participation in preventive behaviors such as hand washing and social distancing (29). However, the present study could not show a significant correlation between risk perception

and adherence in crude analysis (P = 0.15), but it was found in beta regression of SEM as a trend for significance (P < 0.1). Adiyoso (2021) investigated the factors affecting social distancing to reduce the spread of COVID-19 using the developed theory of planned behavior. The results showed that mental norms and perceived behavioral control were effective in the desire to practice social distancing. Also, risk perception affects attitude, mental norms, and perceived behavioral control (30).

In addition, some studies were conducted in Iran. A study was conducted in Shiraz (2020) among intern and stager medical students to perform preventive behaviors and understand the risk of COVID-19. The average performance of preventive behaviors was 94.47%, and the average risk perception score (4.08 out of 8) was reported (31). Compared with our study, their performance of preventive behaviors was better, but risk perception was similar. A study was conducted to measure the perception of the risk of COVID-19 among the general population. The results of this study showed a significant difference in the effectiveness, defense responses, and perceived threat among different demographic groups, especially in people over the age of 60 (32). Due to the importance of risk perception, an Iranian study conducted a webinar training on the risk perception of COVID-19 among emergency technicians. They found that webinar training was as practical as conventional training. Therefore, webinar training might enhance risk perception (33). A study performed in Khalkhal, Ardabil, Iran, by Rezakhani Moghaddam et al. (2022) showed that HBM constructs were predictable by e-Health literacy and some cognitive factors. Using regression modeling was the similarity of methodology, be the novelty of our study was using mediation analysis (34). In general, health literacy is a very important factor affecting preventive behaviors. Therefore, the importance of the present study is that we studied the future healthcare providers who would be the designers of health literacy contents and media (35). Psychological well-being and social support were other important factors affecting preventive behaviors (36). These factors were not investigated in our study as a limitation.

SEM was conducted in the present study since modelings are usually used to generalize theory to future similar conditions. In general, none of the indirect factors could change the direction of the total effects. Male sex reduced adherence both directly and through reduction of risk perception. It means that male students have lower risk perception and preventive behaviors. The history of COVID-19 directly reduced adherence, but through the mediation pathway of risk perception, it increased adherence. However, the total effect was in favor of adherence reduction. It seems that a history of infection (as a proxy for belief in natural immunity) results in lower preventive measures, but since they have the disease experience, they have more perceived risk. Living with parents directly increased adherence, but it reduced adherence through the mediation pathway of risk perception. However, the total effect was in favor of adherence increase. It seems that living with parents along with more pressure from the family toward observing preventive measures and the families' emotional support, may result in a lower perception of the risk. Among the investigated exogenous variables, the male sex and COVID-19 history are not modifiable, while living with parents may be modifiable. Studies are needed to investigate how living with parents increases preventive measures and what its related modifiable factors, such as familial support, are.

The most important limitation of this study was that this study was performed at a time when most participants had been vaccinated. This could be a potential source of selection bias. However, such results could be interpreted among the vaccinated population. Although the sampling time was old, the results of this study could be considered for similar crises in the future. Also, the perception of risk and the use of protective behaviors are multifactorial concepts, influenced by, e.g. age, trust in key opinion leaders in the field of health, trends in social media and so on which were not included in the study. On the other hand, the present study had some strengths, including approximately large sample size and conducting the mediation analysis modeling, which could be interpreted as modeling for health beliefs and behaviors.

CONCLUSION

Our descriptive investigations showed a moderate risk perception and adherence to preventive behaviors. Although conventionl statistical analaysis did not support the association of risk perception and adherence, the generalized SEM showed risk perception as a potential mediator. According to our modeling, the male sex was associated with decreased risk perception and decreased adherence (totally negative effect on adherence), a history of COVID-19 infection was associated with increased risk perception and decreased adherence (totally negative impact on adherence), and living with parents was associated with decreased risk perception and increased adherence (totally positive effect on adherence). Among the results, living with parents was a modifiable factor to increase the adherence. The results of such modeling methods can be used to create ideas for other infectious diseases or other epidemics and pandemic conditions.

Although the COVID-19 global emergent condition is currently terminated, health beliefs and behavioral patterns are always essential, and the COVID-19 experiences can be used for the post-COVID era. The future study should also consist of health literacy, phychological well-being, social support and so on.

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Conflicts of Interest
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Supplements
Appendix 1: the adherence and risk perception questionnaires

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