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The relationships of perceived susceptibility, perceived severity, and subjective norms with COVID-19 preventive behaviors: a secondary data analysis comparing adolescents and emerging adults in South Korea

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Purpose: Based on the health belief model and theory of planned behavior, this study investigated how age group (adolescence and emerging adulthood) moderated the relative effects of perceived susceptibility, perceived severity, and subjective norms on preventive behavior against coronavirus disease 2019 (COVID-19). **Methods:** This secondary data analysis utilized data from adolescents (n=272) and emerging adults (n=239). Hierarchical multiple regression analysis was performed to test the moderating effect of age group on the relationships among variables. **Results:** Higher perceived susceptibility (β=.21, p<.001), perceived severity (β=.14, p=.002), subjective norms (friends) (β=.26, p<.001), subjective norms (parents) (β=.44, p<.001), and subjective norms (schools) (β=.28, p<.001) enhanced COVID-19 preventive behaviors. Moderated regression analysis showed that subjective norms (friends and school) impacted preventive behavior in adolescents more than in emerging adults. **Conclusion:** Given the need to increase perceived susceptibility and severity among adolescents and emerging adults, these findings provide baseline data for designing effective COVID-19 prevention interventions that consider the developmental characteristics of different age groups. Interventions by health centers at universities can strengthen COVID-19 preventive behavior among emerging adults. As adolescents are influenced by friends, their peer roles must be strengthened to enhance adherence to COVID-19 preventive guidelines.

Key words: Adolescent; Young adult; COVID-19; Health belief model; Theory of planned behavior

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INTRODUCTION

As of October 2022, there were over 624 million confirmed cases of coronavirus disease 2019 (COVID-19) [1]. This number continues to rise despite worldwide efforts to end the pandemic. COVID-19 hotspots have expanded to military bases, educational institutions, sports complexes, health facilities, and social gatherings, with young people in their teens and 20s at the center [2]. Since young people with COVID-19 infections are often asymptomatic or mildly symptomatic, there is a risk that they could spread the virus unknowingly [3]. The increase in COVID-19 cases in young people can be attributed to low adherence to COVID-19 prevention protocols, such as maintaining personal hygiene, wearing face masks, and following social distancing guidelines [4] due to their developmental characteristics. The frontal lobe, which is responsible for functions such as judgment, problem-solving, language, and emotion control, is incompletely developed in adolescents [5]. Consequently, adolescents have a lower tendency to adhere to health behavior guidelines. However, some studies have found a decline in health-promoting behaviors during the transitional period from adolescence to adulthood [6] between 18 and 29 years of age, which is also known as emerging adulthood.

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Prior research has recommended that healthcare workers investigate a population group's demographic characteristics that could be variables associated with adherence to pandemic protocols, such as age and sex, and address these accordingly. Age is the main demographic factor affecting preventive behaviors [7]. Most previous studies have consistently reported that young people are particularly vulnerable to COVID-19 outbreaks due to their high mobility, extended social relationships, and active leisure activities, and that young people are less likely to follow preventive behavior guidelines than older people and perceive less risk to themselves [7]. However, to the best of our knowledge, no study has subdivided age for a more in-depth investigation into young people, who are considered less likely to follow preventive behavior guidelines. Several studies have classified adolescents and emerging adults as "youth" with shared characteristics, but these groups have physical, cognitive, and psychosocial differences that can affect proper adherence to COVID-19 preventive guidelines. Therefore, identifying the differences in factors related to adherence to preventive behavior in adolescents and emerging adults, with the ultimate aim of designing communication and intervention strategies that are suitable for each age group, can help prevent the spread of COVID-19 in young people.

The health belief model (HBM) is a framework that helps to understand people's beliefs about health and their non-adherence to preventive guidelines [8]. The HBM provides a vital understanding of personal factors that influence people's intentions to perform health behaviors; however, it does not consider the social factors that impact the decision-making process. Therefore, to address the social factors influencing COVID-19 preventive behaviors in adolescents and emerging adults, it is necessary to consider the concept of subjective norms in the theory of planned behavior (TPB) [9]. The HBM and TPB can be integrated complementarily because they emphasize the importance of different types of beliefs in predicting COVID-19 preventive behavior. A previous study that analyzed COVID-19-related behavior by integrating the HBM and TPB succeeded in explaining 66% of the variance [10]. Therefore, it is useful to integrate the HBM and TPB when explaining factors related to COVID-19 preventive behaviors.

Of the constructs of the HBM, perceived susceptibility and perceived severity are crucial variables associated with disease preventive behaviors [8], and we hypothesized that age group could exert a moderating effect on the relationship between these variables and COVID-19 preventive behavior based on previous studies. Numerous studies have reported that adolescents had a high optimism bias and a low-risk assessment of various diseases [11]. However, some researchers have demonstrated that early adulthood was the period most affected by optimism bias [12]. The perceived risk of COVID-19 also changes in magnitude and nature according to age. Adolescents are more inclined to value potential rewards for actions [13]; hence, they are more cognizant of the severe consequences of failing to maintain social relationships than the severity of the disease and its medical consequences. By contrast, emerging adults are more concerned about the impact of COVID-19 on day-to-day functions, such as restrictions on economic activities [14]. Subjective norms, a key concept in the TPB, reflect people's perceived understanding of how their social environment—including parents, friends, and schools (teachers)—accepts, encourages, and exemplifies adherence to COVID-19 preventive behaviors. Previous studies have used the TPB to explain the factors influencing COVID-19 preventive behaviors and reported that subjective norms positively affect the performance of such behaviors [15]. Subjective norms were found to differ according to age [16], and the relationship between subjective norms and COVID-19 preventive behaviors increased with age. Therefore, age needs to be considered as a moderating variable in the relationship between subjective norms and preventive behaviors [17].

This study investigated the extent to which different age groups (adolescents and emerging adults) moderate the relative effects of perceived susceptibility, perceived severity, and subjective norms on preventive behaviors in the context of the COVID-19 pandemic. We defined adolescents as 13-17 years old, the age range generally accepted in South Korea, and emerging adults were defined as those 18-29 years old following previous studies [6]. In order to answer our research questions, we conducted a secondary data analysis using data collected in previous studies [18,19]. Secondary data analysis has the advantage of saving time, money, and other resources. A detailed exploration of existing research data also avoids repetition of research and wastage of resources [20]. This study aimed to 1) compare the status of perceived susceptibility, perceived severity, subjective norms, and COVID-19 preventive behaviors between adolescents and emerging adults; 2) explore differences in the correlations among those four factors; and 3) identify the moderating effect of age group (adolescents and emerging adults) in the effects of perceived susceptibility, perceived severity, and subjective norms on COVID-19 preventive behavior.

The theoretical framework of this study was constructed by postulating a positive relationship between health behavior and (1) perceived susceptibility and perceived severity in the HBM [8] and (2) subjective norms in the TPB [9]. We hypothesized that the magnitude of the relationship between the variables and preventive behavior would differ according to age group (i.e., between adolescents and emerging adults). Accordingly, we constructed a theoretical model to

test the moderating effect of age group on the relationships of perceived susceptibility, perceived severity, and subjective norms with COVID-19 preventive behaviors (Figure 1).

METHODS

Ethics statement: This study received an Institutional Review Board (IRB) review exemption from the IRB of Jeju National University (No. JJNU-IRB-2021-062) due to the use of secondary data with anonymity.

1. Study Design, Participants, and Procedure

This study was a secondary data analysis that collected and analyzed existing research data from adolescents [18] and emerging adults [19]. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines [21].

Data collection from adolescents was performed from August 3 to 14, 2020, at a middle school in South Korea that had displayed recruitment posters containing the study details on the school bulletin board. At the school's request, only second-year middle school students were included in the face-to-face surveys, which were performed after obtaining written consent from both adolescents and parents. Data collection from emerging adults was performed from August 28 to 29, 2020. Because in-person classes were suspended at universities because of COVID-19, participants were recruited through the recruitment website of a university in South Korea. Surveys were conducted through online questionnaires sent to university students who indicated that they understood the study aims, and the final data were downloaded. A total of 280 adolescents and 241 adults were recruited through this process. We excluded data from participants with several non-responses (eight adolescents and two adults), and 511 samples were considered for the final analysis. The number of study subjects was calculated using G*Power version 3.1. Using a power of 95% for multiple regression analysis, a significance level of .05, a medium effect size of 0.15 (moderate), and 11 independent variables (perceived susceptibility, perceived severity, subjective norms [friends], subjective norms [parents], subjective norms [schools], age group, perceived susceptibility×age group, perceived severity×age group, subjective norms [friends]×age group, subjective norms [parents]×age group, and subjective norms [schools]×age group), the minimum number of samples required would be 178. Thus, the sample size of this study was appropriate.

2. Variables and Measurements

The research variables analyzed from the primary data collection were the demographic characteristics of the participants (age and sex), perceived susceptibility, perceived severity, subjective norms, and performance of COVID-19 preventive behaviors. The measurement tools used in the primary data were developed based on previous studies, news articles, and COVID-19 preventive guidelines, and their content validity was verified by experts.

1) Demographic characteristics

To gather the demographic characteristics of participants, two question items, on age and sex, were used from the primary data.

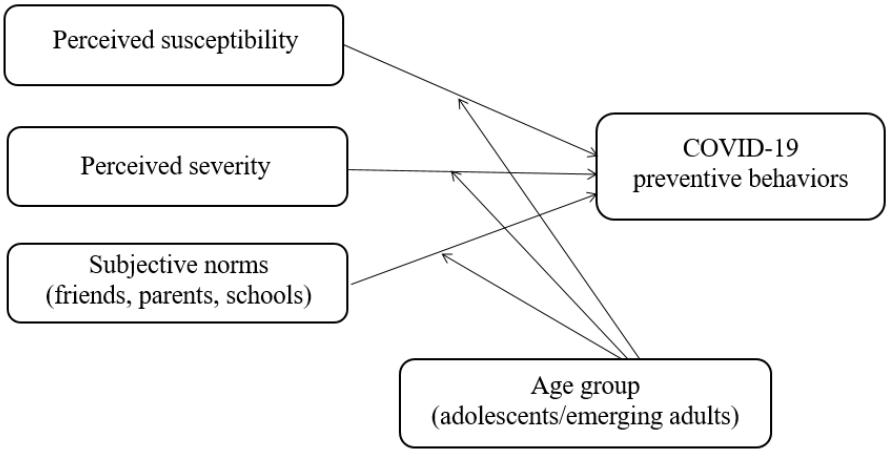

Figure 1. Theoretical framework for understanding the moderating effect of age group on the relationships of perceived susceptibility, perceived severity, and subjective norms with COVID-19 preventive behaviors.

2) Perceived susceptibility

Perceived susceptibility to COVID-19 referred to participants' belief in whether they could be infected with the virus. This study used primary data obtained using measurement tools developed in previous studies examining high school students' perceived susceptibility during an earlier infectious disease outbreak [22,23]. The participants were asked to rate how afraid they were of contracting COVID-19 and how vulnerable they believed themselves to be compared to others. Questions were answered through a 5-point Likert scale, ranging from 1 ("strongly disagree") to 5 points ("strongly agree"), with higher scores indicating higher perceived susceptibility. Cronbach's α for the primary data was .46 for adolescents [18] and .53 for emerging adults [19]. For this study, Cronbach's α was slightly low, at .49.

3) Perceived severity

The perceived severity of COVID-19 referred to participants' perception of the severity of COVID-19 infection. The study used primary data from modified measurement tools developed from questionnaires used in research on influenza epidemics [24]. The items asked about the participants' beliefs regarding whether COVID-19 could affect their studies, daily life, and family. Each item was answered on a 5-point Likert scale, ranging from 1 ("strongly disagree") to 5 points ("strongly agree"), with higher scores indicating higher perceived severity. Cronbach's α for the primary data was .78 for adolescents [18] and .57 for emerging adults [19]. For this study, it was .76, indicating acceptable internal consistency.

4) Subjective norms relating to COVID-19 preventive behavior

Subjective norms about COVID-19 preventive behavior referred to how much pressure individuals feel from their social environment when performing preventive actions. The study used primary data from measurement tools developed using Ajzen and Madden's questionnaire composition method to verify the TPB [9]. Questions on norms and participants' motivation to comply with each item were measured on a 5-point scale; the scores were calculated using the calculation method proposed by Ajzen, with higher scores indicating higher subjective norms. We defined parents, school (teachers), and friends as critical referents who can encourage individuals to adhere to COVID-19 prevention guidelines and included six question items asked to both groups: three on norms and three on motivation. Each item was answered on a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 points ("strongly agree"), with higher scores indicating higher subjective norms for COVID-19 preventive behavior. Cronbach's α for the primary data was .85 for adolescents [18] and .76 for emerging adults [19]. It was .77 for this study.

5) COVID-19 preventive behaviors

COVID-19 preventive behaviors refer to actions performed to prevent COVID-19 infection. The study used primary data from measurement tools developed from the COVID-19 prevention guidelines [4,25]. We used seven items that asked about COVID-19 preventive behaviors such as handwashing, hygiene habits, mask-wearing, and distancing. Six question items related to handwashing, hygiene habits, and mask-wearing were directly included in the analysis because both groups were asked the same questions. However, one item on distancing asked different questions; hence, the average score was calculated and used for the analysis. Each item was answered on a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 points ("strongly agree"), with higher scores indicating a higher degree of COVID-19 preventive behavior. Cronbach's α in the primary data was .86 for adolescents [18] and .52 for emerging adults [19]. Cronbach's α was .76 in this study.

3. Data Analysis

The collected data were analyzed using SPSS version 26.0 (IBM Corp.). Descriptive statistics were used to evaluate the demographic characteristics and the descriptive results of the key variables. Reliability was evaluated using Cronbach's α. Differences in key variables between groups according to general characteristics and age were analyzed using the two-sample t test. Correlation coefficients were calculated to test the correlations between variables, and Fisher's z test was used to test the significance of the correlation coefficients. Hierarchical multiple regression analysis was performed to test the moderating effect of the age group (adolescents or emerging adults) on the relationships between variables. Additionally, the significance of the moderating effect on whether the slope of the simple regression line differed significantly according to the group was tested using PROCESS macro model 1 (bootstrap sample size=5,000) with a 95% confidence interval.

RESULTS

1. Participants' Demographic Characteristics

Of the participants, 37.2% were male, 53.2% (n=272) were under the age of 18 years, and 46.8% (n=239) were older than 18 years. There was no significant difference in the performance of COVID-19 preventive behaviors by sex, but a significant difference was found according to age (Supplement 1).

2. Descriptive Statistics of Study Variables

When the average scores of the study variables were com-

pared between age groups, those of emerging adults were significantly higher than those of adolescents for COVID-19 preventive behaviors such as handwashing, mask-wearing, and distancing. Three items showed no significant difference (Supplement 2). Perceived susceptibility did not have a significant between-group difference, but perceived severity was significantly higher in emerging adults. No significant difference was found in subjective norms from parents and friends, but subjective norms from school were significantly higher in adolescents (Table 1). Skewness was less than an absolute value of 3, and kurtosis was less than an absolute value of 7, thus satisfying the criteria for normality (Table 1).

3. Differences in Correlations between Perceived Susceptibility, Perceived Severity, Subjective Norms, and COVID-19 Preventive Behaviors in Adolescents and Emerging Adults

The correlation analysis of the variables revealed significant positive correlations of COVID-19 preventive behavior with perceived susceptibility, perceived severity, and subjective norms. Specifically, higher scores for perceived susceptibility, perceived severity, and subjective norms were associated with higher preventive behavior scores. Fisher's z test for the significance of correlation coefficients between age groups revealed a significantly stronger correlation between COVID-19 preventive behaviors and subjective norms, as represented by friends and school, in adolescents than in emerging adults. Additionally, stronger correlations among the subfactors of subjective norms (parents, schools, and friends) were noted in adolescents than in emerging adults (Table 2).

4. Moderating Effect of Age Groups in the Relationships of Perceived Susceptibility, Perceived Severity, and Subjective Norms with COVID-19 Preventive Behaviors

To determine the moderating effect of age group on the relationship between variables, we conducted a hierarchical multiple regression analysis. First, we assessed the significance of the relationships between the independent variables (perceived susceptibility, perceived severity, and subjective norms) and the dependent variable. The findings confirmed that higher perceived susceptibility (β=.21), perceived severity (β=.14), subjective norms (friend) (β=.26), subjective norms (parents) (β=.44), and subjective norms (schools) (β=.28) were associated with higher levels of COVID-19 preventive behaviors. Subsequently, we assessed the significance of the moderating variable (age group) on the dependent variables. Finally, we included the moderating effect of age group, which was significant in the relationships of subjective norms (friends) and subjective norms (schools) with COVID-19 preventive behaviors (Table 3).

Using the SPSS PROCESS macro, an additional analysis was conducted on the relationships of subjective norms (friends) and subjective norms (schools) with COVID-19 preventive behaviors, in which age group was found to have a significant moderating effect. An analysis of the moderating effect of age group on the relationship between subjective norms (friends) and COVID-19 preventive behaviors revealed that in adolescents, subjective norms (friends) were positively associated with preventive behaviors, while in emerging adults, there was no significant relationship between subjective norms (friends) and preventive behaviors. For the relationship between subjective norms (schools) and preventive behaviors, adolescents showed a greater degree of behavioral change influenced by subjective norms (schools) than emerging adults (Table 4, Supplement 3).

DISCUSSION

This study is a secondary data analysis that investigated the moderating effect of two age groups, adolescents and emerging adults, on the influence of perceived susceptibility, perceived severity, and subjective norms on COVID-19 preventive behaviors. The strongest moderating effect of age group was found for relationships of subjective norms (friends) and subjective norms (schools) with COVID-19 preventive behaviors. To our knowledge, this is the first study to explore adherence to COVID-19 prevention guidelines and the correlation between relevant factors in adolescents and emerging adults.

A comparison between the average scores of each variable in the two age groups revealed that in COVID-19 preventive behaviors, apart from sanitizing surrounding items, the average score of adolescents was significantly lower in all areas. A meta-analysis on children and adolescents' adherence to COVID-19 preventive behaviors reported significantly lower adherence to COVID-19 guidelines than among adults aged 20-59 years [26]. This aligns with the present study's findings and emphasizes the need to develop interventions that promote COVID-19 preventive behaviors in adolescents. However, although emerging adults showed a significantly higher quantitative performance of actions such as "washing hands after going out" and "wearing masks when going out," there were no significant differences between the two age groups in the performance of actions such as "washing hands thoroughly for 30 seconds" and "not touching the mask while wearing it" (Supplement 2), suggesting that emerging adults also need interventions to improve the quality of these preventive behaviors.

Based on the HBM and TPB, factors related to COVID-19

Table 1. Descriptive Statistics of Perceived Susceptibility, Perceived Susceptibility, Subjective Norms, and COVID-19 Preventive Behaviors among Adolescents and Emerging Adults (*N*=511)

Variables	Categories	n	Total	Adolescents	Emerging adults	t (*p*)	Skewness	Kurtosis
			M±SD	M±SD	M±SD			
Preventive behaviors	Hand hygiene	2	4.03±0.85	3.86±0.94	4.23±0.68	-5.12 (< .001)	-0.57	1.16
	Belongings hygiene	1	3.12±1.24	3.17±1.15	3.07±1.34	0.89 (.375)		
	Mask	3	3.95±0.70	3.84±0.73	4.05±0.65	-3.34 (.001)		
	Distancing	1-2[a)]	3.66±1.00	3.53±0.89	3.80±1.10	-2.99 (.003)		
Risk perception	Perceived susceptibility	2	2.66±0.82	2.64±0.81	2.68±0.83	-0.53 (.600)	-0.29	-0.50
	Perceived severity	3	4.46±0.67	4.28±0.73	4.66±0.51	-6.82 (< .001)	-1.66	3.70
Subjective norms	Friends	2	11.73±5.70	11.81±5.88	11.64±5.50	0.34 (.732)	0.27	-0.01
	Parents	2	17.22±5.36	16.97±5.67	17.49±4.99	-1.10 (.271)		
	Schools	2	16.14±5.55	17.31±5.64	14.82±5.14	5.23 (< .001)		

[a)]Emerging adults: one item, adolescents: two items; M, mean; SD, standard deviation.

Table 2. Correlations among Perceived Susceptibility, Perceived Severity, Subjective Norms, and COVID-19 Preventive Behaviors and Intergroup Correlation Coefficient Significance Test (*N*=511)

Variables		1. Preventive behaviors	2. Perceived susceptibility	3. Perceived severity	4. Subjective norms (friends)	5. Subjective norms (parents)	6. Subjective norms (schools)
		r[a)] (*p*)	r[a)] (*p*)	r[a)] (*p*)	r[a)] (*p*)	r[a)] (*p*)	r[a)] (*p*)
Total	2	.21 (< .001)	1				
	3	.14 (.002)	.24 (< .001)	1			
	4	.26 (< .001)[b)]	.13 (.005)	.09 (.034)	1		
	5	.44 (< .001)	.13 (.003)	.21 (< .001)	.44 (< .001)[c)]	1	
	6	.28 (< .001)[b)]	.11 (.016)	.12 (.006)	.47 (< .001)[c)]	.60 (< .001)[c)]	1
Adolescents	2	.22 (< .001)	1				
	3	.09 (.151)	.25 (< .001)	1			
	4	.37 (< .001)	.16 (.008)	.10 (.095)	1		
	5	.46 (< .001)	.14 (.018)	.23 (< .001)	.54 (< .001)	1	
	6	.43 (< .001)	.15 (.014)	.21 (.001)	.59 (< .001)	.72 (< .001)	1
Emerging adults	2	.20 (.002)	1				
	3	.11 (.093)	.26 (< .001)	1			
	4	.12 (.070)	.08 (.201)	.11 (.101)	1		
	5	.40 (< .001)	.12 (.075)	.18 (.005)	.30 (< .001)	1	
	6	.17 (.009)	.07 (.267)	.19 (.003)	.34 (< .001)	.49 (< .001)	1

[a)]Correlation estimate; [b)]Fisher's z test, $p < .01$; [c)]Fisher's z test, $p < .001$.

preventive behaviors were explored, and perceived susceptibility, perceived severity, and subjective norms were found to influence COVID-19 preventive behaviors, supporting previous studies in that the integration of the two theories was useful for explaining and predicting COVID-19 preventive behaviors [10]. The moderating effect of age group was confirmed for the relationship between subjective norms (schools) and COVID-19 preventive behaviors. The correlation between subjective norms (schools) and preventive behaviors was stronger among adolescents. These results reflect the fact that, unlike adolescents, emerging adults have not been properly managed by schools during the crisis. Korean adolescents receive COVID-19 education and management from licensed school nurses and are managed by schools through regular text messages about the pandemic. However, university students have no institutions or health workers who manage their health or encourage COVID-19 preventive actions. Hence, health centers at universities should undertake managing students' health in pandemic situations and encourage health-promoting behaviors in emerging adults. Additionally, these results may reflect the characteristics of the developmental stages of emerging adults, who experience instability and fluctuations in many areas such as school and studies [6]. Unlike adolescents, emerging adults do not regularly spend time at school, and incidents such as taking a leave of absence occur frequently. Therefore, it will be necessary to supplement the

Table 3. The Moderating Effect of Age Group on the Relationships of Perceived Susceptibility, Perceived Severity, and Subjective Norms with COVID-19 Preventive Behaviors (*N*=511)

Variables	Step 1			Step 2			Step 3		
	β	t (*p*)	R^2	β	t (*p*)	R^2	β	t (*p*)	R^2
Perceived susceptibility	.21	4.82 (< .001)	.04	.21	4.80 (< .001)	.07	.32	2.40 (.017)	.08
Age group				.17	4.04 (< .001)		.30	2.06 (.040)	
Perceived susceptibility×age group							-.18	-0.91 (.363)	
Perceived severity	.14	3.17 (.002)	.02	.10	2.13 (.034)	.04.	.06	0.44 (.663)	.04
Age group				.15	3.31 (.001)		.05	0.16 (.876)	
Perceived severity×age group							.11	0.29 (.775)	
Subjective norms (friends)	.26	6.18 (< .001)	.07	.27	6.36 (< .001)	.10	.69	5.44 (< .001)	.12
Age group				.18	4.32 (< .001)		.49	5.08 (< .001)	
Subjective norms (friends)×age group							-.54	-3.53 (< .001)	
Subjective norms (parents)	.44	10.99 (< .001)	.19	.43	10.94 (< .001)	.22	.61	5.14 (< .001)	.22
Age group				.16	3.98 (< .001)		.37	2.71 (.007)	
Subjective norms (parents)×age group							-.29	-1.62 (.107)	
Subjective norms (schools)	.28	6.53 (< .001)	.08	.34	7.92 (< .001)	.14	.79	6.22 (< .001)	.16
Age group				.25	5.97 (< .001)		.71	5.57 (< .001)	
Subjective norms (schools)×age group							-.59	-3.80 (< .001)	

Table 4. The Moderating Effect of Age Group on the Relationship between Subjective Norms (Friends and School) and COVID-19 Preventive Behaviors by SPSS PROCESS Macro Analysis (*N*=511)

Variables	Effect	SE	t (*p*)	LLCI	ULCI
Subjective norms (friends) → preventive behaviors ↑ Age group					
Adolescents	.32	.04	7.16 (< .001)	.23	.41
Emerging adults	.08	.05	1.58 (.114)	-.02	.18
Subjective norms (schools) → preventive behaviors ↑ Age group					
Adolescents	.39	.05	8.57 (< .001)	.30	.48
Emerging adults	.12	.05	2.32 (.021)	.02	.23

LLCI, lower limit of the confidence interval; SE, standard error; ULCI, upper limit of the confidence interval.

management provided by schools by distributing scientific evidence from the government and academic societies in the internet space that emerging adults mainly inhabit.

The moderating effect of age group was also confirmed by the effect of subjective norms (friends) on COVID-19 preventive behaviors. The correlation between subjective norms (friends) and COVID-19 preventive behavior was significant only in adolescents. This finding supports previous studies demonstrating that peers significantly influenced the adoption of healthy behaviors in adolescence [27]. Research on adolescent health behaviors has reported that peer recommendations significantly influence the adolescent decision-making process, especially when adolescents have ambivalent attitudes toward a behavior [27]. Additionally, peer influence on adolescent health behaviors may continue impacting the trajectories of health behaviors in adulthood [28]. Therefore, schools should offer group health education on COVID-19 preventive behaviors to help adolescents acquire and exchange accurate COVID-19 information and strengthen positive peer roles in preventing the disease.

The moderating effect of age group was not confirmed in the relationship between perceived susceptibility, perceived severity, subjective norms (parents), and COVID-19 preventive behavior. However, the finding that the above variables had significant effects on COVID-19 preventive behaviors in both age groups suggests that interventions targeting these varia-

bles are important in both age groups. The average score for perceived susceptibility was 2.68 points for adults and 2.64 points for adolescents, indicating that perceived susceptibility was similar in both groups. Numerous studies have reported that the prefrontal cortex is underdeveloped during adolescence, making it difficult for teens to grasp the full repercussions of their actions and the high risk of poor health behaviors [5]. However, this study found that emerging adults had a similar level of low perceived susceptibility. This result aligns with previous studies reporting that young adults had significantly lower perceived susceptibility to COVID-19 than middle-aged and older adults [14]. Perceived severity was significantly higher among emerging adults, indicating that emerging adults had a higher awareness than adolescents of the impact of COVID-19 on their lives. Perceived severity was significantly related to the performance of preventive behaviors in both groups, but the moderating effect of the age group could not be confirmed. Therefore, although higher perceived severity leads to better preventive actions, the magnitude of the relationship between the two variables did not change significantly according to age group. As low perceived susceptibility and severity can be related to non-adherence to COVID-19 preventive measures and vaccinations [29,30], it is necessary to increase perceived susceptibility and severity in both age groups. Improving knowledge about COVID-19 may be an effective strategy to enhance perceptions of individual risk and perceived susceptibility and severity among adolescents and emerging adults. In the context of a pandemic in which information is constantly updated, a clear educational message that is accessible and useful to young people is necessary.

The relationship between subjective norms (parents) and COVID-19 preventive behavior was significant in both groups, and there was no moderating effect of age group, suggesting that it is critical for parents of both age groups to manage their children's emotional needs during the pandemic, and educate and encourage them to perform COVID-19 preventive behaviors. Adolescents strive to become independent of their parents, but complete emotional and financial independence is difficult to achieve [31]. Although emerging adults have a sense of control and independence, even they still tend to be highly dependent on their parents [6]. Thus, as the role of parents still significantly impacts adolescents' and emerging adults' compliance with COVID-19 preventive behaviors, education and support must be provided for parents to function as appropriate role models.

This study has several limitations. First, the data were collected through a cross-sectional design, which does not allow the inference of causal relationships between variables. Future longitudinal studies should explore the relationships between variables. Second, the primary data were collected through convenience sampling at a single institution for adolescents and emerging adults. The survey methods also differed; face-to-face surveys were conducted among the adolescents and online surveys among the emerging adults. Bias due to the difference in the data collection method is not expected to be large because the face-to-face surveys for adolescents were conducted in a free atmosphere without the intervention of the investigator. However, to improve the generalizability of the results, it will be necessary to retest the relationships between variables using data collected through consistent methods at multiple institutions. Finally, health behavior is a complex concept that can be influenced by many factors. Our theoretical framework can explain only a limited part of COVID-19 preventive behaviors because we considered only a few variables described by the HBM [8] and the TPB [9]. Thus, future research should include more factors and establish a model that can explain this behavior more comprehensively.

All humans share responsibility to prevent the spread of COVID-19. Numerous studies have compared COVID-19 preventive behavior by age group, from adults in their 20s and older to the elderly, but to the authors' knowledge, no studies have compared adolescents with emerging adults. This study defined predictors of COVID-19 preventive behavior based on two theories, and then confirmed the moderating effect of age group (adolescents and emerging adults) on the relationships between variables. On this basis, it may be possible to develop better intervention programs to prepare for the current and possible future pandemics. For example, evidence-based nursing education can be provided to adolescents, who are usually heavily influenced by their friends, to ensure they have accurate information. In addition, as schools have a major influence on the performance of preventive actions by adolescents, school nurses need to be supported to play a role in COVID-19 prevention education and management. Further research will be needed on the development and application of interventions to prevent COVID-19 and other infectious diseases based on the developmental stage of the target population.

CONCLUSION

Based on the HBM and TPB, this study constructed a model to test whether perceived susceptibility, perceived severity, and subjective norms are correlated with COVID-19 preventive behavior, and to determine whether age group (adolescents or emerging adults) had a moderating effect on these relationships. The results showed a moderating effect of age group on the correlation between subjective norms (friends and school) and COVID-19 preventive behavior, and the magnitude of this correlation was particularly high in adolescents. This

study contributes to the literature both theoretically and practically. Theoretically, it explored a model incorporating the moderating effect of age group on the relationships between variables based on the HBM and TPB, thus adding to the understanding of COVID-19 preventive behaviors in the existing literature. Practically, this study's results provide baseline data for designing effective COVID-19 prevention interventions matching the developmental characteristics of diverse age groups.

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Conflict of interest

No existing or potential conflict of interest relevant to this article was reported.

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Data availability

Please contact the corresponding author for data availability.

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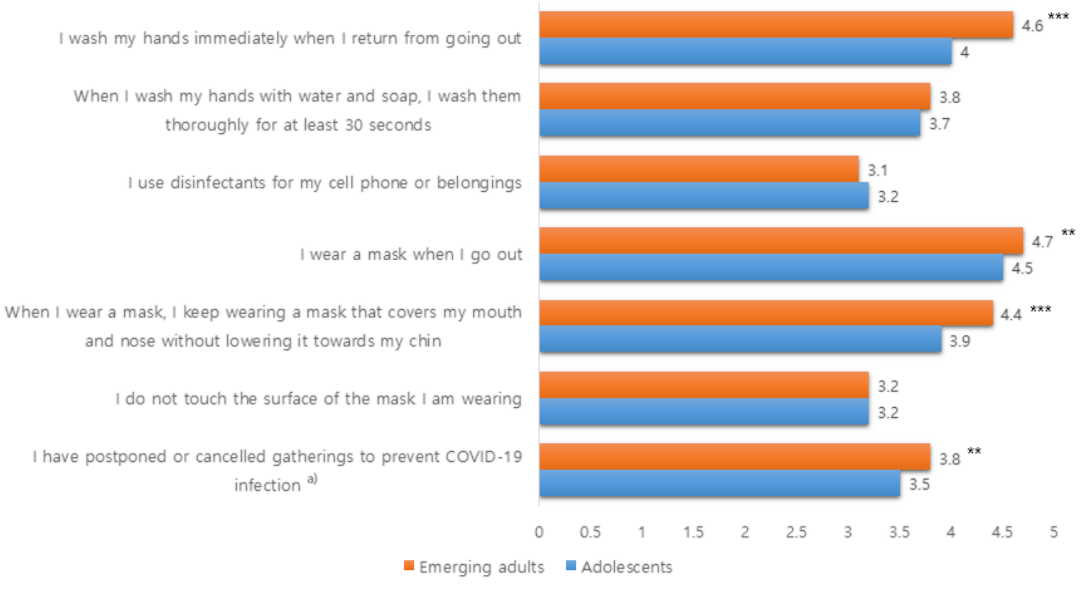
Supplement 1. Description of Participants' Demographic Characteristics and COVID-19 Preventive Behaviors (*N*=511)

Variables	Categories	n (%)	Preventive behaviors M±SD	t (*p*)
Sex	Male	190 (37.2)	26.27±4.92	-1.87 (.062)
	Female	321 (62.8)	27.05±4.34	
Age	Adolescents (13-17 years)	272 (53.2)	26.00±5.08	-4.14 (<.001)
	Emerging adults (18-29 years)	239 (46.8)	27.63±3.75	

M, mean; SD, standard deviation.

Supplement 2. Score Comparison by Item in the Preventive Behaviors Domain (*N*=511)



**p<.01; ***p<.001; [a]Emerging adults: "I have postponed or canceled gatherings to prevent COVID-19 infection," Adolescents: "I do not go to an enclosed space with no ventilation and I keep a distance of at least 1 m when meeting people."

Supplement 3. The Moderating Effect of Age Group on the Relationship Between Subjective Norms (Friends and Schools) and COVID-19 Preventive Behaviors (*N*=511)