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RESEARCH ARTICLE

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The choice of Taiwanese college students to vaccinate against severe special infectious pneumonia COVID-19 based on the integrated theory of planning behavior

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ABSTRACT

Taiwan's coronavirus (COVID-19) vaccine procurement was delayed until October 2021. With the vaccine's introduction in Taiwan, the public will have an opportunity to choose vaccination. Choosing to vaccinate involves considerations regarding the trade-off between the protective power of the vaccine and its side effects, which is a planned behavior. College students have considered high-risk objects for COVID-19 outbreaks given their lifestyle, and their efficient vaccination may help reduce mutual infection between college students and the general public. This study obtained 707 valid questionnaires from Taiwan college students (20 years old and above). We investigated several factors during our college students' survey regarding vaccination. Among this integrated TPB model, "Attitude," "Subjective Norm," "Perceived Behavioral Control," and "COVID-19 Information Asymmetry" had a positive impact on vaccination "Behavioral Intention." COVID-19 information asymmetry positively and significantly affected behavioral intention through perceived behavioral control, while perceived behavioral control had a mediating effect. To promote the behavioral intention of college students to choose COVID-19 vaccination, public and private departments for epidemic prevention must aim to overcome the self-efficacy barriers of perceived behavioral control and promote the primary group influence effect of subjective norm and the self-interest factor of attitude. Governments and NGOs should also ensure prompt and accurate transmission of epidemic and vaccine information and actively investigate and prohibit misleading details from unknown sources and no scientific basis. Such a policy will generate trust, effectively increasing the vaccination rate and reducing cluster infection.

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Epidemic prevention policy; vaccination choice; theory of planned behavior; COVID-19

Introduction

College students in Taiwan are considered an important target group for COVID-19 vaccination; the divergence of information on the epidemic and vaccination risks on the Internet which increases the uncertainty of college students' perceptions of the safety and risk of vaccination. In January 2020, the first confirmed case of imported coronavirus disease (COVID-19) was found in Taiwan, and the first confirmed case in mainland China was found in January.[1] The first BNT(BioNTech) anti-epidemic vaccine, jointly developed by Pfizer in the United States and BioNTech in Germany, was officially launched in December 2020. Due to certain factors, Taiwan's vaccine procurement has been delayed, resulting in a severe shortage of vaccines on the island. Initially, the vaccine was donated by friendly countries of Taiwan, but it could not meet the vaccination needs of the people. Since October 2021, owing to donations from large companies and religious groups on the island, vaccination sources have become abundant.

Thus, unvaccinated people under the age of 50 could choose the vaccination to take among those vaccination brands. Choosing to vaccinate involves weighing the protective power of the vaccine against its side effects, which could prove fatal in the worst cases. Therefore, the behavioral intention of the public to choose vaccination conforms to the elements of planned behavioral decision-making. In various countries, college students generally live a diverse and convenient lifestyle, have free course selection, are close to community residents, and often have cross-community activities; therefore, college students are considered to as highly susceptible to COVID-19 infection and become super-spreaders. As a result, college students in those countries are listed as groups that need to be vaccinated.[2–6] In this study, we used the theory of planned behavior combined with the financial information asymmetry theory as a theoretical basis to investigate the factors that may influence the behavioral intentions of Taiwanese college students aged 20 and above in opting to vaccinate against COVID-19.

Methods

Research theory

The primary theoretical basis of this study was the theory of planned behavior (TPB). In recent years, the applied research scope of TPB has included various planned decision-making behaviors, including the consumption behavior of essential products, the user behavior of new information technology

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products, relevant research at multiple levels such as leisure and recreational behavior, social behavior, environmental behavior, and medical care behavior. In recent years, TPB has been used to investigate decision-making in vaccination behavioral researches.[7–13] TPB was proposed by Ajzen, who believed that "Behavioral Intention (BI)" is one of the best variables for predicting the rational behavior of individuals.[14] TPB was developed from the theory of multi-attribute attitude (TMA) and the theory of reasoned action (TRA). TPB can be traced back to TMA, proposed by Fishbein, positing that behavioral attitudes could determine behavioral intentions.[15] Later, Ajzen and Fishbein developed the multi-attribute attitude theory into TRA, which stated that behavioral intention was a direct factor that determines behavior, influenced by "Attitude (AT)" and "Subjective Norm (SN)."[16–19] It was not until 1985 that Ajzen's observed that rational behavior theory postulates that "whether or not an individual takes a particular action" is entirely out of voluntary control, ignoring many external factors that can affect the degree of controllability of an individual's will.

Personal behavior is usually not entirely formed by "attitude (AT)" and "subjective norm (SN)," but is subject to some external factors. Therefore, the behavioral control perception variable of "individual's ability to control the external environment" is added, which refers to the degree of ease or difficulty that an individual perceives to accomplish a specific behavior, reflecting the individual's experience and expected obstacles. When individuals perceive themselves as having more resources and opportunities; and fewer common barriers, the greater the perceived behavioral control of behavior and the extension of TRA into a new TPB model.[14]

Given the different opinions on the number of vaccines and the safety of various vaccines during the COVID-19 epidemic, asymmetric information regarding vaccines may be a possibility, resulting in uncertainty and increased risk perception regarding vaccination and affecting the willingness of college students to be vaccinated. Therefore, in addition to the TPB model, this study combined the information asymmetry theory proposed by Akerlof.[20] The theory of information asymmetry states that in general market transactions or exchanges, there is usually information asymmetry between buyers and sellers (participants), which leads to adverse selection and moral hazard. There is an apparent information asymmetry regarding COVID-19 vaccination. Due to the urgent needs of the market and the severe relaxation of audit standards by the relevant audit institutions due to the epidemic, the production process of vaccine companies is likely rushed to make profits. They may deliberately hide some unfavorable information or risks of vaccines, resulting in moral hazards. On the other hand, the vaccinating party may be adversely affected because people believe that vaccination is under the vigorous promotion of the government's epidemic prevention guidelines and the information provided by the vaccine company.

Study design

Based on the aforementioned theoretical bases, this study was designed to explore the relationship among AT, SN, PBC, and COVID-19 information asymmetry and their effects on the "behavioral intention" toward vaccination. The AT constructs influencing COVID-19 vaccination choices in this study refer to an individual's positive or negative feelings about behaviors. More specifically, it is conceptualized later by an individual's assessment of a particular behavior. Therefore, the composition of AT is often viewed as a function of an individual's salient beliefs about the outcome of the behavior. Several studies regarding COVID-19 vaccination confirmed that AT has a positive and significant impact on vaccination willingness.[2–8–27] In this study, AT was divided into three dimensions: Self-interest (SI)," "Altruism (AL)," and "Benefit Society (BS)." "SN" refers to the social pressure an individual feels about whether to take a particular action; that is, when predicting an individual's behavior, those individuals or groups (salient individuals or groups) that influence an individual's behavioral decision-making influence whether an individual performs a particular behavior. Recent research on COVID-19 vaccines confirmed that "SN" does have a positive and significant impact on vaccination willingness.[9–29] In this study, the factors affecting "Subjective Norm (SN)" were divided into "Primary Group (PG)" and "Secondary Group (SG)."

Moreover, PBC reflects an individual's experience and expected obstacles. The more resources and opportunities individuals believe they have, the fewer obstacles they anticipate, and the stronger the PBC to behavior. Previous studies confirmed that PBC had a positive and significant effect on BI of vaccination.[9–11,12–23–30] Taylor and Todd deconstructed "PBC" into the concepts of "self-efficacy (SE)" and "facilitating conditions (FC)."[31–35]

Regarding the influencing factors of "COVID-19 vaccine information asymmetry (COIA)," according to recent studies, the correctness and completeness of the disclosure of vaccine information will help increase the willingness to vaccinate.[36–40] Other reports pointed out that the opacity of epidemic and vaccine information may promote increased risk perception and fear, which are not conducive to promoting epidemic prevention policies.[9,11,41,42] Roma et al. reported the influence of government vaccine information on risk perception, self-efficacy, and willingness to vaccinate.[43] Bao et al., Limay et al., and Pennycook also pointed out that "false epidemic information" is a severe problem.[44–46] Rumors, fake news, and deliberate misinformation have been spreading on social media platforms, creating mistrust in vaccines and further jeopardizing public health.[47–51] Thus, the abovementioned design was used to inform the structure of this study, as shown in Figure 1.

Research hypothesis

The hypothesis of this study (as shown in Figure 1) was established through the collection and review of literature related to the theory above of planned behavior, the theory of information asymmetry, and vaccine selection and was verified through statistical analysis.

Researches on COVID-19 and other vaccination confirmed that AT has a positive and significant impact on vaccination intention.[23–27–29] In this study, AT was divided into three

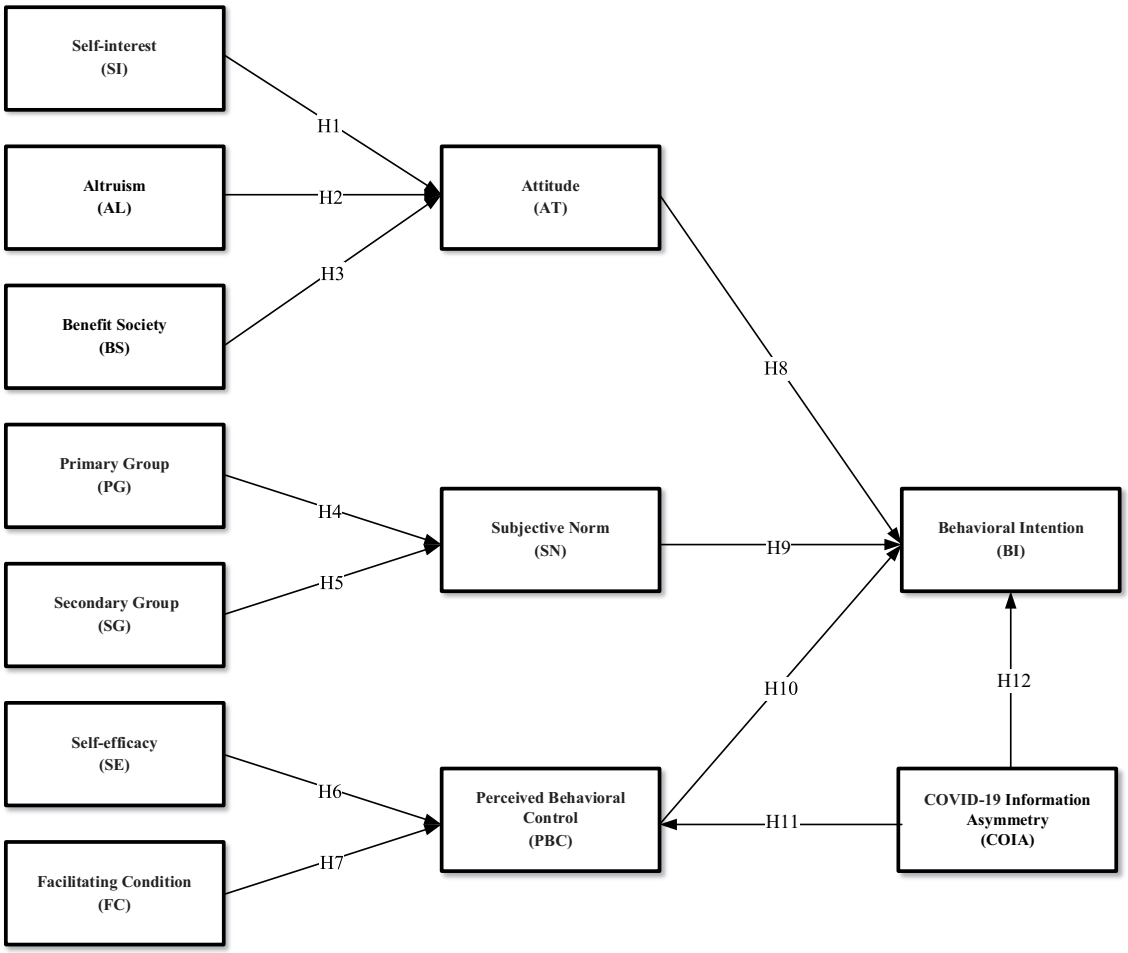

Figure 1. Schema of research structure model and hypotheses.

dimensions: Self-interest (SI)," "Altruism (AL)," and "Benefit Society (BS), thus constructing H1-H3.

H1: Taiwanese college students' "SI" in choosing the COVID-19 vaccine has a positive and significant correlation with "AT."

H2: Taiwanese college students' belief in "AL" in choosing the COVID-19 vaccine positively and significantly correlates with "AT."

H3: Taiwanese college students' belief in "BS" in choosing the COVID-19 vaccine has a positive and significant correlation with "AT."

Researches on COVID-19 and other vaccination confirmed that "SN" has a positive and significant impact on vaccination intention.[23–29] In this study, the factors affecting "Subjective Norm (SN)" were divided into "Primary Group (PG)" and "Secondary Group (SG).," thus constructing H4 and H5.

H4: College students' belief in "PG" in choosing the COVID-19 vaccine showed a positive and significant correlation with "SN."

H5: Taiwanese college students' "SG" belief in choosing the COVID-19 vaccine has a positive and significant correlation with "SN."

Researches on COVID-19 and other vaccination confirmed that PBC has a positive and significant impact on vaccination intention.[23–30] Taylor and Todd deconstructed "PBC" into the concepts of "self-efficacy (SE)" and "facilitating conditions (FC),"[31–35] thus constructing H6 and H7.

H6: Taiwanese college students' "SE" belief in choosing the COVID-19 vaccine has a positive and significant correlation with "PBC."

H7: Taiwanese college students' belief in "FC" in choosing the COVID-19 vaccine positively and significantly correlates with "PBC."

Based on past studies of integrated TPB application in vaccination, the information asymmetry of AT, SN, and PBC, as well as its impact on vaccination "behavioral intention" was confirmed,[26,27,29] thus constructing H8-H10.

H8: The "BI" of choosing the COVID-19 vaccine by Taiwanese college students is positively and significantly influenced by "AT." Stronger the "AT." stronger the "BI."

H9: Taiwan college students choose the "BI" of the COVID-19 vaccine, which is positively and significantly affected by its "SN." The stronger the "SN." the more robust the "BI."

H10: Taiwan college students' choice of the "BI" of the COVID-19 vaccine is positively and significantly influenced by its "PBC." Stronger the "PBC." the more the "BI."

Correct and complete disclosure of vaccine information can help increase the intention to vaccinate. Related reports pointed out that the opaqueness of epidemic and vaccine information may increase risk perception and fear among college students, which is not conducive to promoting epidemic prevention,[26–47–51] thereby constructing H11 and H12.

H11: "COIA," the choice of COVID-19 vaccine among Taiwanese college students, showed a positive and significant correlation with "PBC."

H12: The choice of "BI" of the COVID-19 vaccine by Taiwanese college students is positively and significantly affected by "COIA." The more complete the "COIA." the more robust the "BI."

The mediation of intention-behavior pathways is essential to inform future interventions effectively and to promote beneficial health behaviors,[26,27] thus constructing H13-H15.

H13: "PBC" has a mediating effect on the relationship between "SE" and "BI."

H14: "PBC" has a mediating effect on the relationship between "COIA" and "BI."

H15: There are significant differences in the TPB behavioral intention patterns of college students in different regions of Taiwan in choosing COVID-19 vaccination.

Research survey and statistical methods

The Ethics Committee of Antai Medical Care Cooperation Antai-Tian-Sheng memorial Hospital ethically approved this study [Reference number: 22-042-C] before distributing the questionnaire. The students aged 20 and above who consented to participate in this study completed an online questionnaire. (In Taiwan, the legal age of civil law sets the age of adulthood at 20 years old. Therefore, in the recruitment principles of clinical trial subjects of the Taiwan Joint Institutional Review Board, "people under 20 years old" are listed as "vulnerable groups," and the research data are difficult to collect. For the distribution of this research questionnaire, the college teachers in the northern, central, and southern regions who agreed to assist in sending the questionnaires were consulted first. College teachers willing to help are requested to link the online questionnaire and provide it to the third-year and fourth-year students of the colleges. At the beginning of the questionnaire, a test question was set for the first question, and it was informed that the applicant must be over 20 years old. Therefore, this study established the age of "willing students to participate in the interview" to be 20 years and older.) A total of 750 questionnaires were collected, and 707 valid questionnaires were selected. The effective recovery rate was 94.26%. This study used partial least squares (PLS) estimation for structural equation modeling data analysis. We conducted a comparison of the structural equations of the research framework. Therefore, this study used SmartPLS version 3.3.7 and SPSS 28 statistical software to perform various statistical analyses. According to the purpose and hypothesis of this study, the structural equation model was used for data analysis.

Results

Reliability and validity of the research model

This study used the PLS software for statistical analysis. PLS adopts a two-stage model, a measurement model, and a structural model, to test the relationship between the variables included in the research model and the explanatory power of the overall model. The measurement mode mainly lies in testing reliability, convergent validity, and discriminant validity. The reliability of the question item lies in the factor loading of each question item, and a higher loading means that the shared variance between the question item and the construct is higher than the error variance.[52] The screening benchmark is as follows: factor loadings higher than 0.7 are regarded as high reliability, and those less than 0.5 must be discarded. The factor loadings of the questions raised in this study were all up to the standard after testing, indicating that this research model has good reliability (Table 1). Convergent validity is used to ensure that different items measure the same construct, and it must be tested through the composite reliability of the measure and the average variance extracted (AVE).[53] Cronbach's alpha was also used to measure the reliability of the construct (Table 2). Composite reliability was calculated by dividing the "square root of the total load" by the sum of two items, "the square root of the total load" and the "sum of errors terms" $\left(\frac{(sum\ of\ standardized\ loadings)^2}{(sum\ of\ standardized\ loadings)^2 + sum\ of\ indicator\ measurement\ errer}\right)$.[46,54] The AVE value should be higher than 0.5 to show that the construct has sufficient validity. However, if the AVE is higher than 0.5, the factor loading must be higher than 0.7. Considering the fundamental aspect of the data, an AVE above 0.36 can also be considered a reluctance standard[53] (Table 2).

The purpose of discriminant validity analysis was to verify whether there was a statistical difference in the correlation between two different dimensions and if so, the items in different dimensions should not be highly correlated. Table 3 presents the cross-loading, and Table 4 presents the correlation between descriptive statistics and constructs. The mean-variance extraction method is the most commonly used method to verify discriminant validity (Table 4). The criterion for its judgment is that

Table 1. Weights and loading of measures (n = 707).

Construct	Item	Loading	Mean	VIF	STDEV	T Statistics
Self-interest (SI)	SI1	0.795	0.796	1.645	0.018	45.118
	SI2	0.758	0.757	1.592	0.025	30.207
	SI3	0.663	0.662	1.312	0.035	18.948
	SI4*	0.496*	0.494	1.243	0.049	10.023
	SI5	0.722	0.721	1.371	0.027	27.127
Altruism (AL)	AL1	0.913	0.912	1.869	0.011	80.250
	AL2	0.921	0.921	1.869	0.009	106.137
Benefit Society (BS)	BS1	0.827	0.825	1.936	0.025	33.054
	BS2	0.849	0.847	2.022	0.020	41.550
	BS3	0.806	0.807	1.329	0.022	37.129
Primary Group (PG)	PG1	0.682	0.682	1.430	0.034	20.027
	PG2	0.890	0.890	3.114	0.011	78.991
	PG3	0.890	0.890	3.272	0.011	78.960
	PG4	0.824	0.823	1.876	0.015	53.193
Secondary Group (SG)	SG1	0.765	0.763	1.965	0.020	37.647
	SG2	0.704	0.703	1.738	0.027	26.171
	SG3	0.657	0.656	1.527	0.029	22.445
	SG4	0.780	0.779	1.957	0.022	35.087
	SG5	0.824	0.824	2.934	0.017	48.105
	SG6	0.827	0.827	2.914	0.016	50.300
Self-efficacy (SE)	SE1	0.860	0.857	2.335	0.022	38.903
	SE2	0.805	0.806	1.798	0.021	39.167
	SE3	0.820	0.814	2.479	0.029	28.085
	SE4	0.808	0.805	2.323	0.029	28.360
	SE5	0.782	0.778	1.902	0.035	22.314
Facilitating Condition (FC)	FC1	0.706	0.708	1.451	0.029	24.011
	FC2	0.671	0.674	1.343	0.031	21.552
	FC3	0.819	0.817	2.192	0.022	37.169
	FC4	0.830	0.828	2.593	0.020	40.973
	FC5	0.816	0.814	2.609	0.025	33.149
Attitude (AT)	AT1	0.776	0.775	1.903	0.026	30.300
	AT2	0.836	0.835	2.297	0.015	54.859
	AT3	0.810	0.809	1.957	0.018	46.231
	AT4	0.822	0.822	2.066	0.018	46.257
	AT5	0.799	0.799	1.902	0.016	48.778
Subjective Norm (SN)	SN1	0.735	0.732	1.297	0.034	21.837
	SN2	0.852	0.852	2.273	0.018	47.506
	SN3	0.902	0.902	2.538	0.011	83.295
Perceived Behavioral Control (PBC)	PBC1	0.846	0.843	1.545	0.017	51.122
	PBC2	0.872	0.872	1.677	0.014	62.535
	PBC3	0.636	0.650	1.216	0.059	10.768
COVID-19 Information Asymmetry (COIA)	CO-IS 1	0.793	0.793	1.927	0.019	42.636
	CO-IS 2	0.773	0.772	1.965	0.024	32.502
	CO-IS 3	0.844	0.844	2.321	0.015	55.553
	CO-IS 4	0.879	0.879	2.994	0.011	82.777
	CO-IS 5	0.840	0.841	2.543	0.013	63.602
Behavioral Intention (BI)	BI1	0.915	0.914	2.960	0.010	94.315
	BI2	0.935	0.935	3.648	0.009	98.946
	BI3	0.909	0.909	2.795	0.012	74.324

Both standard deviation and t-values are for loadings, VIF < 5.
*SI 4 Loading = 0.496 is rounded to 0.5, so this disguise is not deleted.

Table 2. Results of reliabilities and AVE. (n = 707).

Measures construct	Cronbach's Alpha	rho_A	Composite Reliability	AVE
Self-interest (SI)	0.731	0.763	0.820	0.500
Altruism (AL)	0.811	0.812	0.914	0.841
Benefit Society (BS)	0.772	0.779	0.867	0.685
Primary Group (PG)	0.841	0.854	0.895	0.682
Secondary Group (SG)	0.854	0.864	0.892	0.581
Self-efficacy (SE)	0.876	0.893	0.908	0.665
Facilitating Condition (FC)	0.827	0.827	0.879	0.595
Attitude (AT)	0.868	0.868	0.904	0.654
Subjective Norm (SN)	0.774	0.779	0.871	0.693
Perceived Behavioral Control (PBC)	0.701	0.749	0.832	0.627
COVID-19 Information Asymmetry (COIA)	0.884	0.891	0.915	0.684
Behavioral Intention (BI)	0.909	0.909	0.943	0.846

AVE: Average variance extracted.

Table 3. Cross-factor loading. (n = 707).

Construct	Item	SI	AL	BS	PG	SG	SE	FC	AT	SN	PBC	COIA	BI
Self-interest (SI)	SI1	0.795	0.633	0.383	0.405	0.277	0.374	0.426	0.462	0.214	0.258	0.363	0.231
VIF = 4.736	SI2	0.758	0.417	0.341	0.300	0.217	0.292	0.291	0.355	0.145	0.182	0.262	0.217
	SI3	0.663	0.391	0.338	0.247	0.224	0.309	0.306	0.326	0.173	0.163	0.259	0.208
	SI4	0.496	0.204	0.210	0.127	0.084	0.112	0.115	0.205	0.064	0.065	0.186	0.101
	SI5	0.722	0.540	0.364	0.335	0.222	0.298	0.313	0.389	0.163	0.238	0.232	0.225
Altruism (AL)	AL1	0.634	0.913	0.444	0.441	0.300	0.383	0.415	0.446	0.240	0.277	0.366	0.275
VIF = 4.736	AL2	0.585	0.921	0.420	0.428	0.257	0.369	0.421	0.469	0.227	0.239	0.368	0.244
Benefit Society (BS)	BS1	0.339	0.361	0.827	0.310	0.326	0.251	0.255	0.296	0.195	0.163	0.260	0.163
VIF = 4.736	BS2	0.320	0.334	0.849	0.308	0.360	0.263	0.300	0.306	0.201	0.185	0.274	0.199
	BS3	0.502	0.453	0.806	0.391	0.363	0.312	0.412	0.381	0.158	0.187	0.336	0.211
Primary Group (PG)	PG1	0.407	0.465	0.329	0.682	0.353	0.330	0.367	0.364	0.309	0.204	0.307	0.215
VIF = 2.185	PG2	0.399	0.432	0.347	0.890	0.514	0.269	0.353	0.385	0.387	0.227	0.342	0.210
	PG3	0.352	0.386	0.332	0.890	0.532	0.259	0.326	0.341	0.376	0.233	0.377	0.183
	PG4	0.282	0.307	0.355	0.824	0.675	0.190	0.302	0.339	0.416	0.194	0.344	0.171
Secondary Group (SG)	SG1	0.301	0.312	0.410	0.563	0.765	0.253	0.368	0.304	0.356	0.163	0.352	0.204
VIF = 2.185	SG2	0.287	0.253	0.334	0.468	0.704	0.218	0.332	0.234	0.345	0.168	0.317	0.242
	SG3	0.320	0.372	0.319	0.511	0.657	0.276	0.379	0.338	0.263	0.206	0.368	0.237
	SG4	0.168	0.109	0.259	0.430	0.780	0.149	0.215	0.195	0.361	0.156	0.213	0.122
	SG5	0.195	0.195	0.332	0.477	0.824	0.205	0.322	0.237	0.370	0.155	0.253	0.115
	SG6	0.184	0.198	0.304	0.499	0.827	0.195	0.277	0.231	0.407	0.158	0.220	0.121
Self-efficacy (SE)	SE1	0.341	0.357	0.285	0.270	0.252	0.860	0.595	0.319	0.093	0.371	0.270	0.239
VIF = 3.012	SE2	0.315	0.285	0.317	0.251	0.245	0.805	0.508	0.303	0.131	0.382	0.249	0.225
	SE3	0.360	0.381	0.259	0.246	0.178	0.820	0.575	0.300	0.046	0.237	0.239	0.216
	SE4	0.379	0.329	0.237	0.244	0.180	0.808	0.554	0.330	0.082	0.267	0.305	0.275
	SE5	0.327	0.341	0.259	0.250	0.254	0.782	0.681	0.298	0.074	0.283	0.260	0.242
Facilitating Condition (FC)	FC1	0.362	0.317	0.344	0.261	0.322	0.541	0.706	0.337	0.160	0.279	0.313	0.267
VIF = 3.012	FC2	0.216	0.208	0.207	0.214	0.303	0.439	0.671	0.248	0.146	0.289	0.240	0.237
	FC3	0.380	0.397	0.296	0.332	0.284	0.632	0.819	0.344	0.169	0.227	0.358	0.285
	FC4	0.381	0.443	0.364	0.402	0.329	0.555	0.830	0.357	0.178	0.296	0.405	0.272
	FC5	0.363	0.389	0.318	0.342	0.315	0.572	0.816	0.348	0.159	0.285	0.392	0.241
Attitude (AT)	AT1	0.416	0.384	0.252	0.335	0.183	0.278	0.292	0.776	0.279	0.315	0.331	0.319
VIF = 1.324	AT2	0.413	0.416	0.296	0.370	0.228	0.286	0.343	0.836	0.243	0.306	0.390	0.269
	AT3	0.420	0.387	0.372	0.333	0.310	0.309	0.349	0.810	0.304	0.309	0.377	0.247
	AT4	0.436	0.413	0.336	0.342	0.286	0.342	0.373	0.822	0.284	0.254	0.390	0.308
	AT5	0.405	0.414	0.366	0.358	0.318	0.316	0.358	0.799	0.297	0.322	0.433	0.350
Subjective Norm (SN)	SN1	0.266	0.259	0.200	0.390	0.282	0.193	0.235	0.355	0.735	0.302	0.311	0.293
VIF = 1.436	SN2	0.169	0.208	0.170	0.365	0.414	0.044	0.151	0.269	0.852	0.111	0.258	0.187
	SN3	0.143	0.173	0.183	0.379	0.456	0.044	0.145	0.250	0.902	0.110	0.277	0.216
Perceived Behavioral Control (PBC)	PBC1	0.256	0.252	0.195	0.190	0.147	0.329	0.345	0.325	0.139	0.846	0.291	0.411
VIF = 1.257	PBC2	0.243	0.256	0.178	0.242	0.208	0.370	0.317	0.333	0.203	0.872	0.296	0.382
	PBC3	0.143	0.138	0.138	0.187	0.166	0.203	0.164	0.206	0.154	0.636	0.218	0.239
COVID-19 Information Asymmetry (COIA)	CO-IS1	0.347	0.321	0.260	0.355	0.304	0.299	0.342	0.430	0.308	0.301	0.793	0.357
	CO-IS2	0.276	0.266	0.301	0.311	0.292	0.159	0.271	0.344	0.306	0.219	0.773	0.326
	CO-IS3	0.312	0.329	0.309	0.350	0.299	0.266	0.364	0.365	0.233	0.266	0.844	0.369
	CO-IS4	0.345	0.369	0.308	0.361	0.313	0.306	0.416	0.418	0.293	0.300	0.879	0.410
	CO-IS5	0.301	0.356	0.297	0.339	0.312	0.287	0.424	0.406	0.267	0.316	0.840	0.422
Behavioral Intention (BI)	BI1	0.271	0.255	0.213	0.205	0.206	0.258	0.295	0.339	0.261	0.431	0.403	0.915
	BI2	0.244	0.246	0.202	0.216	0.211	0.245	0.299	0.335	0.258	0.390	0.440	0.935
	BI3	0.290	0.279	0.230	0.222	0.191	0.303	0.338	0.349	0.248	0.409	0.423	0.909

Table 4. Correlation among constructs and the square root of the AVE. (n = 707).

	SI	AL	BS	PG	SG	SE	FC	AT	SN	PBC	COIA	BI
Self-interest (SI)	0.695											
Altruism (AL)	0.664	0.917										
Benefit Society (BS)	0.480	0.470	0.827									
Primary Group(PG)	0.430	0.473	0.412	0.826								
Secondary Group (SG)	0.309	0.303	0.425	0.640	0.762							
Self-efficacy (SE)	0.418	0.410	0.337	0.310	0.277	0.816						
Facilitating Condition (FC)	0.442	0.455	0.399	0.404	0.406	0.709	0.771					
Attitude (AT)	0.517	0.499	0.403	0.431	0.329	0.380	0.425	0.809				
Subjective Norm (SN)	0.229	0.255	0.221	0.454	0.464	0.110	0.211	0.349	0.833			
Perceived Behavioral Control (PBC)	0.278	0.281	0.217	0.259	0.216	0.390	0.362	0.372	0.207	0.792		
COVID-19 Information Asymmetry (COIA)	0.383	0.400	0.356	0.415	0.367	0.324	0.445	0.476	0.338	0.342	0.827	
Behavioral Intention (BI)	0.292	0.283	0.234	0.233	0.220	0.292	0.338	0.371	0.278	0.446	0.459	0.920

S.D.: standard deviation; the shaded numbers in the diagonal row are square roots of the average variance extracted (AVE).

the square root of the AVE of the factor is higher than all the correlation coefficients (Correlation co-efficiency) with the element. Cross-loading indicates that each item in the construct has a more significant load than it shares with other items. The results of this study showed that discriminant validity in the research model was supported.

To validate the measurement model, reliability, convergent validity, and discriminant validity were assessed. This study used "rho_A," "composite reliability," and "Cronbach's alpha" to assess the internal consistency reliability.[55,56] In this study (Table 2), the "rho_A" were between 0.763 and 0.909, "composite reliabilities" were between 0.820 and 0.943, and all the

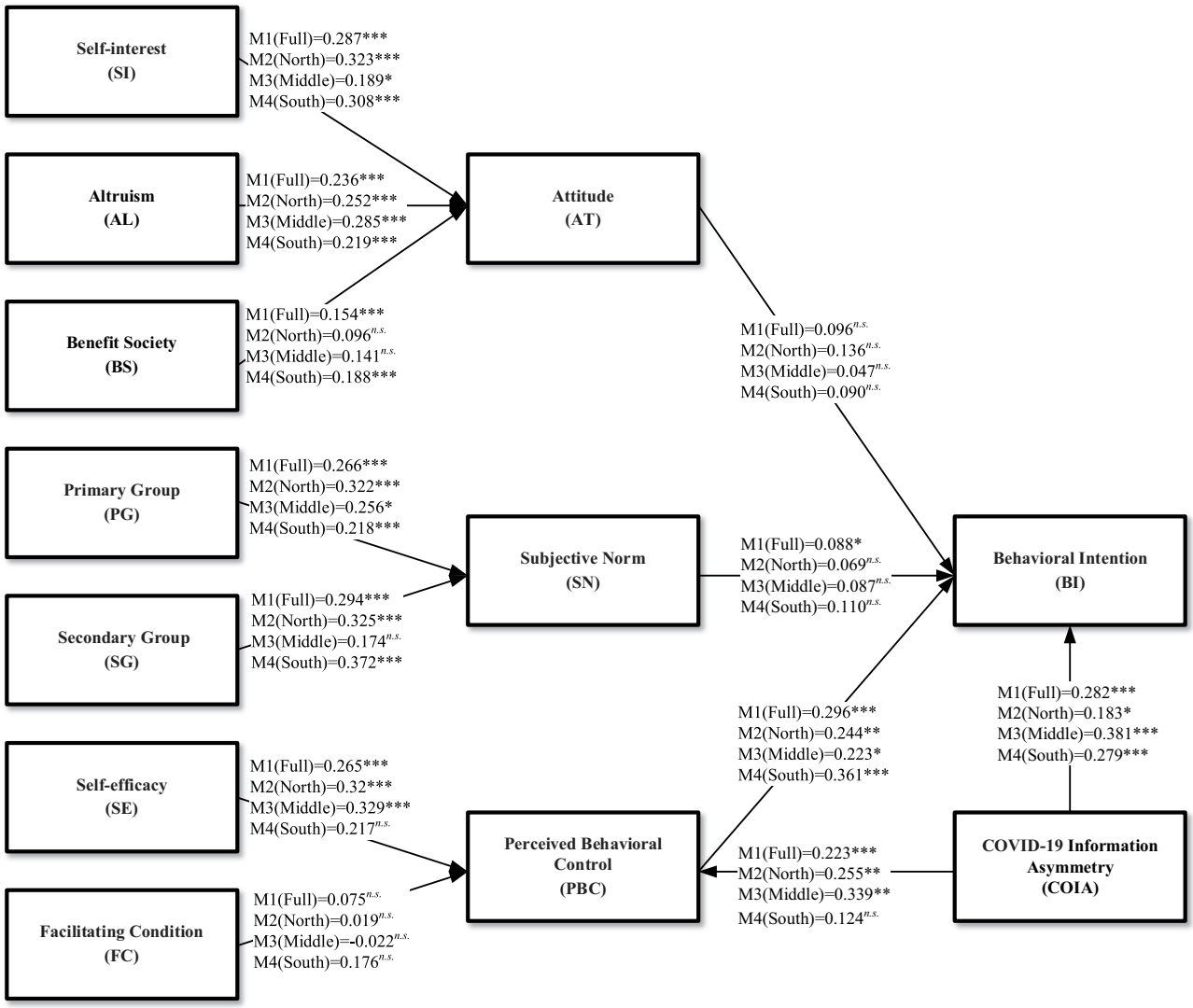

Figure 2. SEM of the research model. *p < .05 = t > 1.96; **p < .01 = t > 2.58; ***p < .001 = t > 3.29; n.s. = not significant.

Table 5. Hypothesis testing. (n = 707).

Hypotheses		β-Value	t-value	Result
H1	SI → AT	0.287***	7.053	Support
H2	AL → AT	0.236***	6.222	Support
H3	BS → AT	0.154***	3.998	Support
H4	PG → SN	0.266***	5.777	Support
H5	SG → SN	0.294***	5.982	Support
H6	SE → PBC	0.265***	3.606	Support
H7	FC → PBC	0.075 n.s.	1.177	***Non-Support***
H8	AT → BI	0.096 n.s.	1.939	***Non-Support***
H9	SN → BI	0.088*	1.983	Support
H10	PBC → BI	0.296***	6.677	Support
H11	COIA → PBC	0.223***	3.789	Support
H12	COIA → BI	0.282***	5.939	Support

*p < .05 = t > 1.96; **p < 0.01 = t > 2.58; ***p < 0.001 = t > 3.29; n.s.= not significant.

"Cronbach's alpha" values were between 0.731 and 0.909. "Convergent validity" was assessed using the AVE for each construct (Table 3). Table 1 presents the results showing that the factor loadings of all the items exceeded 0.5[57]were significant. The AVE value of each construct exceeded 0.5, which indicated that the construct explained at least 50% of the variance of its items.[58] To evaluate the discriminant validity, the Fornell – Larcker ratio of correlation was examined. As shown in Table 4, a construct's correlations with other constructs were all smaller than the square root of the construct's AVE.[52,59,60] Therefore, the results confirmed the model's discriminant validity.

Analysis of research hypothesis and validation results

We examined the structural model by a bootstrapping technique specifying 5,000 subsamples to test the hypotheses. In structural model analysis, it is important to determine the significance and association of each hypothesized path and the variance explained. The results are shown in Figure 2 and Table 5. The model explained 32.8% of the variance for AT, 25.7% of the variance for SN, 20.7% of the variance for PBC, and 32.1.0% of the variance for BI. SI had significantly positive effects on AT (H1, β = 0.287, p < .001), AL had significantly positive effects on AT (H2, β = 0.236, p < .001), and BS had significantly positive effects on AT (H3, β = 0.154, p < .001). PG had significantly positive effects on SN (H4, β = 0.266, p < .001), and SG had significantly positive effects on SN (H5, β = 0.194, p < .001). SE had significantly positive effects on PBC (H6, β = 0.265, p < .001), FC did not significantly affect PBC (H7, β = 0.075, N.S.), and COIA had significantly positive effects on PBC (H11, β = 0.223, p < .001). In addition, AT did not significantly affect BI (H8, β = 0.096, N.S.), SN had significantly positive effects on BI (H9, β = 0.088, p < .05), PBC had significantly positive effects on BI (H10, β = 0.296, p < .001), and COIA had significantly positive effects on BI (H12, β = 0.282, p < .001). Therefore, only two hypotheses were not supported. In this study, we also tested the mediating effect.

Analysis of mediation

We proposed H13 and H14, which suggest that confirmation mediates the effect of SE, COIA, and PBC on BI. To elucidate the mediating effect, we used the formal mediation test proposed by Zhao et al.[61] As shown in Table 6, first, the indirect effect of SE on BI (a*b) was significant (β = 0.078, t = 3.146). Second, the direct effect of SE on BI (c) was non-significant (β = 0.055, t = 1.227). Third, the direct and indirect effects operate in the same direction (a*b*c is positive), and the results supported H13; SE's effect on BI was fully mediated by confirmation. Therefore, complementary partial mediation was confirmed. Similarly, the indirect effect of COIA on BI (a*b) was significant (β = 0.066, t = 3.266), and the direct effect of COIA on BI (c) was significant (β = 0.282, t = 5.939). As with the analysis above, the direct and indirect effects operate in the same direction (a*b*c is positive). Therefore, the study supports H14; COIA's effect on BI was partially mediated by confirmation (see Table 6).

Analysis of CMB and SRMR

Common method biases (CMB)

Common method biases (CMB) were examined by conducting Harmon's single-factor test.[62] Twelve factors with eigenvalues >1 was extracted; The results indicate that the first factor is 22.9% explains less than 40% of the variances, and the twelfth factor's cumulative percentage is 58.5%. The first factor's percentage of variance is less than the standards compliant with Podsakoff et al.[62] These findings suggest that CMB is not the primary concern.

Standardized root mean residual (SRMR)

Finally, we provided the Standardized root mean residual (SRMR), which reflects the difference between the observed and the predicted correlation, as an absolute fit measure. With a value of 0.066 for this research model which is less than the recommended value of 0.08, fits the acceptable range for the SRMR index is between 0 and 0.08.[61] Our result has a good fit that concluded.[63–65]

Comparative analysis of SEM patterns of students in different regions

H15 explored the significant differences in the TPB behavioral intention patterns toward vaccination among college students in different regions of Taiwan. Therefore, we divided college students from the different areas of Taiwan into three groups, north, middle, and south, to compare the research structure model. Mode 1 (M1) represents Northern Taiwan (N = 212), Mode 2 (M2) represents Middle Taiwan (N = 158), and Mode 3 (M3) represents Southern Taiwan (N = 337), as shown in Figure 2 and Table 7:

H1 pathway (SI → AT)

College students studying in three different regions of Taiwan, North, Central, and South, showed a positive and significant correlation between SI and AT of vaccination.

H2 pathway (AL→AT)

College students studying in three different regions of Taiwan, North, Central, and South, showed a positive and significant correlation between AL and AT of vaccination.

Table 6. Significance of mediation effect. (n = 707).

Direct effect	Std. β	t-value	Result
SE → PBC	0.265***	3.606	Support
COIA → PBC	0.223***	3.789	Support
PBC → BI	0.296***	6.677	Support
SE → BI	**0.055** n.s.	*1.227*	***Non-Support***
COIA → BI	0.282***	5.939	Support
Indirect effects	**Std. β**	**t-value**	**Result**
SE → PBC → BI (H13)	0.078**	3.146	Support
COIA → PBC→ BI (H14)	0.066**	3.266	Support

*p < .05 = t > 1.96; **p < .01 = t > 2.58; *** p < .001 = t > 3.29; n.s. = not significant.

Table 7. Research model assumptions established by different stakeholders.

Hypotheses		All (*N*=707)	Result	Northern (M1=212)	Middle (M2=158)	Southern (M3=337)
H1	SI→AT	0.287(7.053)***	Support	0.323***	0.189*	0.308***
H2	AL→AT	0.236(6.222)***	Support	0.252***	0.285***	0.219***
H3	BS→AT	0.154(3.998)***	Support	0.096 n.s.	0.141 n.s	0.188***
H4	PG→SN	0.266(5.777)***	Support	0.322***	0.256*	0.218***
H5	SG→SN	0.294(5.982)***	Support	0.325***	0.174 n.s	0.372***
H6	SE→PBC	0.265(3.606)***	Support	0.321***	0.329***	0.217 n.s
H7	FC→PBC	0.075(1.177) n.s	Non-Support	0.019 n.s.	−0.022 n.s	0.176 n.s
H8	AT→BI	0.096(1.939)n.s	Non-Support	0.136 n.s.	0.047 n.s	0.090 n.s
H9	SN→BI	0.088(1.983)*	Support	0.069 n.s.	0.087 n.s	0.110 n.s
H10	PBC→BI	0.296(6.677)***	Support	0.244**	0.223*	0.361***
H11	COIA→PBC	0.223(3.789)***	Support	0.255**	0.339**	0.124 n.s
H12	COIA → BI	0.282(5.939)***	Support	0.183*	0.381***	0.279***

*$p < .05 = t > 1.96$; **$p < .01 = t > 2.58$; ***$p < .001 = t > 3.29$; n.s. = not significant.

H3 pathway (BS → AT)

Only Southern Taiwan (M3) showed a positive and significant correlation between BS and AT for vaccination among college students studying in three different regions of Taiwan, while the rest showed no significant correlation.

H4 pathway (PG → SN)

College students studying in three different regions of Taiwan, North, Central, and South, showed a positive and significant correlation between PG and SN for vaccination, among which Northern Taiwan (M1 = 0.322***) had the highest value, and it had a significant effect, followed by Southern Taiwan (M3 = 0.218***).

H5 pathway (SG → SN)

The relationship between SG and SN of the vaccination of college students in three different regions of Taiwan, North, Central, and South, showed a positive and significant correlation with Northern Taiwan (M1) and Southern Taiwan (M3), of which Northern Taiwan (M1 = 0.372***) had a more significant effect.

H6 pathway (SE → PBC)

The relationship between SE and PBC of vaccination of college students studying in three different regions of Taiwan, Northern Taiwan (M1) and Middle Taiwan (M2) showed a positive and significant correlation, of which Middle Taiwan (M2 = 0.329***) had a more significant effect.

H7 pathway (FC→PBC)

There was no significant correlation between FC and PBC among college students who were vaccinated in three different regions of Taiwan, North, Central, and South.

H8 pathway (AT → BI)

The BI of the college students who were vaccinated in the three different regions of Taiwan was positively affected by AT but was not significantly affected.

H9 pathway (SN → BI)

The BI of college students who were vaccinated in three different regions of Taiwan was positively affected by SN but not significantly.

H10 pathway (PBC → BI)

The BI of the vaccination of college students studying in three different regions of Taiwan is positively and significantly affected by PBC, of which Southern Taiwan (M3 = 0.361***) was the most significantly affected. The influent effect was followed by Northern Taiwan (M1 = 0.244**).

H11 pathway (COIA→PBC)

COIA of the vaccination of college students studying in three different regions in North, Central, and South Taiwan had a positive impact on PBC, but only in Northern Taiwan (M1 = 0.255**) and Middle Taiwan (M2 = 0.339**), the effects were significant.

H12 pathway (COIA → BI)

The BI of the vaccination of college students studying in three different regions of Taiwan was positively and significantly affected by COIA, among which Middle Taiwan (M2 = 0.381***) had the most significant effect, followed by Southern Taiwan (M3 = 0.279***).

Discussion

This study integrated planning behavior theory and information asymmetry theory to explore the behavioral intentions of Taiwanese college students toward vaccination more rigorously and could be achieved using TPB alone. The results of this study found that except for H7 (FC→PBC) and H8 (AT→BI) were not established, the rest of the research additions were established, indicating that the research framework of the integrated planning behavior theory adopted in this study has considerable explanatory power to verify the choice of Taiwanese college students.

The results of this study H1, H2, and H3 are all established, which means that "SI," "AL," and "B" have a significant positive impact on "AT," where "SI" is greater than "AL;" "AL" is greater than "BS." During the epidemic period, college students will give priority to "SI," followed by "AL" and "BS." This is not consistent with the previous studies.[8–13–21,22] In this study, both H4 (PG→SN) and H5 (SG→SN) were valid, which means that both PG and SG had a positive and significant impact on SN, and the effect of SG was greater than that of PG. This also shows that the vaccination information of college students was more valued by the opinions of SG (relevant

government agencies, news media, medical staff, religious groups, institutions that donate vaccines, and other social groups) than PG (family, friends, classmates, and teachers). This is inconsistent with the previous studies reporting that PG is greater than SG. Besides, H9 (SN→BI) was also established. This is consistent with the results of previous studies on COVID-19 vaccination [9–30] which confirmed that SN had a positive and significant effect on BI. Therefore, the government should promote the publicity and supervision of relevant institutions (health agencies, medical institutions, schools, and news media) to provide prompt and accurate information on epidemics and vaccines.

The Ministry of Health and Welfare of the Executive Yuan, the competent authority of Taiwan's central government, held a press conference every day at 2:00 pm since the epidemic had outburst to release the most updated epidemic information and set up the LINE APP community "@taiwancdc." The counties and cities directly under the central government also held press conferences and established the local government's LINE APP community, and communicated with the public, which was a significant boost to the success of Taiwan's epidemic control in the early stage. H7 (SE→PBC) was valid, and H8 (FC→PBC) was not accurate, highlighting the importance of SE ("Do you have enough ability to collect vaccine-related information?" "Do you have enough ability to distinguish whether the vaccine is good or bad?" "Do you have enough health to wait for vaccination?" and "Do you have enough time and transportation convenience to get vaccinated?") for PBC. H10 (PBC→BI) had a positive and significant correlation. Furthermore, through the mediation effect analysis, H13 (SE → PBC → BI) was established, confirming that PBC has a mediating function. The results of this study were the same as those of previous studies.[9–26–42] This study concluded that college students' vaccination depends on their collection of vaccine information and judgment of the quality of the vaccine, and their decision about which vaccine to choose depends on their own physiological and psychological conditions. H11 (COIA→PBC) and H8 (COIA→BI) were both valid, emphasizing that the COIA dimension did not only positively and significantly affect PBC but also positively and significantly affected BI through PBC. It was confirmed that H14 (COIA → PBC → BI) was established, PBC had an intermediary function, and COIA also significantly affected BI. It can be seen that the variables of COIA ("Correctness of COVID-19 vaccine risk information provided by relevant government departments," "Transparency of COVID-19 vaccine procurement information provided by relevant government departments," "Convenience of COVID-19 vaccination information provided by relevant government departments," "Adequacy of vaccine-related information provided by healthcare workers for COVID-19 vaccination," "Adequacy of vaccine-related information provided by COVID-19 vaccination sites") are essential in the construction of this study. The results of this study echo the findings of previous researches.[9–11–40,41-47–51]

Finally, this study examined the differences in the research patterns of college students studying in three regions in North, Central, and South Taiwan (Figure 2). There was little difference in the proportions of the significant effects of vaccination among college students in the three different regions of Taiwan, North, Central, and South. Eight hypotheses in the northern region were significantly higher than the seven in the central and southern areas. Although the severity of the epidemic in the north was higher than that in the central and southern regions, it is also possible that due to the high population density in the northern region and the small size of Taiwan, the factors that have not caused the students in the northern, central and southern regions to choose vaccines have too much influence on the differences in their behavioral intentions. Only the students in the southern region showed no significant relationship between PBC and SE, FC, and COIA, which highlights that the students in the southern region did not pay much attention to the collection and judgment of vaccine information. Southern students' COIA and PBC still had a positive and significant impact on BI.

Recommendations

According to the Taiwan Centers of Disease Control, Ministry of Health and Welfare of the Ministry of Health and Welfare,[66] 120,000 people have been vaccinated against COVID-19 in Taiwan as of May 2022, of which 55,000,000 people have been vaccinated, including 15,000,000 people vaccinated with AstraZeneca, 21000,000 people vaccinated with Moderna, and 2,800,000 people have received high-end vaccines. 16000,000 people were vaccinated. The COVID-19 vaccination population coverage rate was 87.8% for the first dose (66.5% globally), 81.70% for the second dose (60.6% globally), 0.9% for the basal booster dose, and 65.1% for the booster dose (if vaccinated with eligible booster doses). The number of people at intervals was approximately 89.0%. As of May 2022, the cumulative number of confirmed COVID-19 cases reached 1,700,000. In addition, according to the Food and Drug Administration of the Ministry of Health and Welfare (2022), the COVID-19 vaccination program was initiated in Taiwan in March 2021, and the use of vaccines for the above-mentioned four vaccines approved for import by the project ends on May 2022; the total number of COVID-19 vaccines administered nationwide was 54,000,000 doses, and a total of 19,000 vaccine adverse events were reported (9,700 serious adverse events, accounting for 49.5%), and the average number of notifications per 100,000 doses was about 36.2. The notification rate was 17.9, of which 1,488 died, which was higher than the 1,200 deaths as of May 2022. According to the above two statistics on vaccination and adverse events of vaccination, it was found that the vaccination rate in Taiwan was much higher than that of the world, which shows that the relevant government agencies in Taiwan have spared no effort in promoting vaccines and have achieved remarkable results. However, the death toll from serious adverse events of vaccination in Taiwan is greater than the death toll from infection. First, it is the biggest burden on the Taiwanese people's hearts, and the government holds press conferences every day to mainly announcing the number of confirmed cases and confirmed deaths and to explain the activity footprint of confirmed cases. Government authorities will not proactively state the status of vaccination adverse event notifications unless questions are raised by the media. This is

the information asymmetry between the COVID-19 outbreak and a vaccine. This also highlights the transparency and openness of government authorities on the new crown pneumonia epidemic as well as vaccine information will expand the correctness of indirect dissemination of information on subjective normative subgroups (SN-SG) such as mass media, medical institutions, and school institutions. It also affects college students' understanding of epidemic and vaccination information, perceived behavioral control self-efficacy (PBC-SE), and may also indirectly affect college students' attitudes toward vaccination.

We finally suggest that the relevant government departments should announce the status of the actual epidemic situation on the day at the daily press conference, and at the same time, announce the rate of serious adverse events of various vaccines administered on the same day. Thus, the general public and college students can have sufficient and symmetrical information for reference and avoid adverse selection on vaccination. Even if the vaccination rate is high, the negative news of vaccination is no longer low-key. The confirmed rate and death toll are high, which stretches the past epidemic prevention model.

Limitations

This cross-sectional study leaves us unable to understand the causal relationship between the longitudinal variables. Questionnaires were collected online and responses were collected based on self-forwarding. Longitudinal studies and randomized trials should be conducted in the future. Given that students chose to participate in the study, these findings may not generalize to students who decided not to participate. It is better to replicate the conclusions among students in different countries, similar universities, and use a representative sample of students rather than a convenient sample.

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