

Article

Factors Affecting Pandemic Biosecurity Behaviors of International Travelers: Moderating Roles of Gender, Age, and Travel Frequency

Myung Ja Kim ^{1,*}, C. Michael Hall ^{2,3,4,5,*}  and Mark Bonn ^{6,*}¹ The College of Hotel & Tourism Management, Kyung Hee University, Seoul 02447, Korea² Department of Management, Marketing and Entrepreneurship, University of Canterbury, Christchurch 8140, New Zealand³ Geography Research Unit, University of Oulu, 90014 Oulu, Finland⁴ Ekonomihögskolan, Linnéuniversitet Universitetskajen, Landgången 6, 39182 Kalmar, Sweden⁵ Department of Service Management and Service Studies, Lund University, Campus Helsingborg, 25108 Helsingborg, Sweden⁶ Dedman School of Hospitality & Tourism Management, Florida State University, Tallahassee, FL 32306-2541, USA

* Correspondence: silver@khu.ac.kr (M.J.K.); michael.hall@canterbury.ac.nz (C.M.H.); mbonn@dedman.fsu.edu (M.B.); Tel.: +82-10-9035-2696 (M.J.K.); +1-850-567-1826 (M.B.); Fax: +82-2-961-0549 (M.J.K.); +1-850-644-5565 (M.B.)

Abstract: Research undertaken during the COVID-19 pandemic has identified a number of significant factors that affect international travelers' biosecurity behavior. Tourists' age and gender as well as travel frequency have been found to have significant impacts on consumers' non-pharmaceutical intervention practices. However, despite the importance of age, gender, and travel frequency, such studies have overlooked international tourists' values, attitudes, interventions, and behaviors relevant to biosecurity during a pandemic. In order to bridge this gap, the purposes of this study are to build and test a conceptually comprehensive framework on the relationships between values, attitudes, interventions, and behaviors, along with the moderating effects of age, gender, and travel frequency. To meet the study objectives, a digital survey was administered during 1–5 September 2020, which generated $n = 386$ total useable responses. Data were analyzed using the partial least squares approach. The results revealed that tourists' values have the greatest effect on their attitudes toward COVID-19 biosecurity for travel, which in turn positively influences interventions and behaviors. Interventions also have a significant impact on travelers' COVID-19 biosecurity behavior. This study expands the theoretical understanding of biosecurity and pandemic behavior. The findings of this research also provide significant insights to the literature as well as stakeholders, such as governments, health organizations, international health and tourism agencies, and destinations, with respect to managing international travel biosecurity measures.

Keywords: values; attitudes; interventions; biosecurity behaviors; gender; age; international travel frequency; COVID-19; United States



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1. Introduction

Since the report of a novel coronavirus (COVID-19) in December 2019, in Wuhan, People's Republic of China, and the subsequent imposition of non-pharmaceutical interventions (NPIs) and biosecurity measures to reduce contagion, international tourism passenger flows have been unprecedentedly affected, resulting in significant damage to the tourism industry [1–3]. Behavioral interventions to ensure that travelers follow appropriate biosecurity and health measures to protect populations from transmissible infectious agents have long been recognized as vital measures in ensuring that international travel does not act as a vector for the introduction of infectious diseases or alien fauna and flora between

countries [4–8]. Developing more effective global surveillance tools and mechanisms (e.g., biosecurity behaviors) to better communicate and coordinate between countries can facilitate more rapid and effective responses to infectious disease outbreaks [9]. However, ensuring that tourists follow biosecurity measures also requires the development of effective health marketing and communication strategies that are grounded in an understanding of tourist behavior [10]. Such information is also going to be extremely important as international travel recommences and new campaigns are developed to encourage international tourists to follow appropriate destination health protocols, which include NPIs as well as vaccination requirements [11,12].

Tourism-related biosecurity behaviors have been shown to be influenced by perceived values with respect to sustainability practices and attitudes toward sustainability [13]. Experiences of previous pandemics show that tourist NPIs can have a significant impact on the behavioral intentions of consumers to travel internationally [14]. In seeking to segment the international travel market to intervene more effectively in modifying health-related behaviors, age and gender have been found to be significant in travel-related incidence of infectious diseases (e.g., *Chlamydia trachomatis*) [15] as well as biosecurity behaviors [16].

In terms of different traveler characteristics, gender, age, and travel frequency have been found to be positively related to the risk of greater exposure to infectious diseases [17–19] and different levels of risk perception [20,21]. During COVID-19, demographic characteristics (e.g., age, gender) played key roles in influencing immunity levels and predicting mortality, while there are substantial gender-based differences for COVID-19-related psychosocial factors and adoption of preventive behaviors [22,23]. The frequency of travel and outdoor recreation participation also has significant effects on predicting traveling behavior [24,25]. Interestingly, international travel frequencies may also help predict biosecurity tourists' values, attitudes, and behaviors during the COVID-19 pandemic [26].

Despite the significance of biosecurity behaviors as a public and travel health measure, comprehensive studies of the factors affecting tourists' biosecurity behaviors are limited [5]. In order to fill this gap, the purposes of this study are to build and test a theoretically conceptualized research model on COVID-19 biosecurity for international travelers from the United States (US), including values, attitudes, interventions, and behaviors, together with three moderators representing gender, age, and travel frequency. To achieve these research goals, seven hypotheses are proposed, raising and verifying two research questions. First, do international tourists' values, attitudes, and interventions affect biosecurity behaviors during the COVID-19 pandemic? Second, do international travelers' gender, age, and travel frequency moderate the four relationships between values, attitudes, interventions, and biosecurity behaviors during the pandemic? In order to verify the research model, research questions, and hypotheses, we conducted a digital survey during the first year of COVID-19 with international travelers from the United States having substantial overseas travel experience. Accordingly, this study contributes to a better understanding of the variables that influence international travelers' biosecurity behaviors, providing theoretical and practical implications to stakeholders and/or future research.

2. Literature Review

2.1. Theoretical Framework

Biosecurity measures aim to prevent or slow the mobility of people and/or vectors in order to reduce the rate of contagion [5]. Tourism has thus become a focal point of biosecurity interventions undertaken by government and others during pandemics [27,28]. For example, long-distance commercial aircraft, ships, trains, buses, and automobiles may all be controlled and monitored in coordination with public health authorities in order to limit the spread of COVID-19 [29]. Although the implementation of biosecurity restrictions led to a reduction in international tourism globally because of the pandemic, considerations of biosecurity measures are also an element of tourism industry recovery and rebuilding plans because of the role they can play in restoring customer confidence and risk perceptions [30]. For example, the use of NPI biosecurity measures has been shown to be related to psycho-

logical and financial resilience [31] as well as the experience of COVID-19, wearing masks, and entering quarantine [32]. Studies have also found that the value–attitude–behavior model and the moderating role of tourist’s personalities are significant for COVID-19 biosecurity [33]. Researchers identified that tourist values, attitudes, personal norm, social norm, and tourist biosecurity behaviors are different depending on international travel frequency, while frequency has also been found to influence U.S. tourists’ biosecurity behaviors [26]. However, despite the potential importance of values, attitudes, interventions, behaviors, tourist characteristics (e.g., gender and age), and travel frequency on international travel following a pandemic, comprehensive integrated research on how these factors influence international travel consumers’ COVID-19 biosecurity behaviors is limited. Thus, this study aims to identify the relationships between the values, attitudes, interventions, and behaviors, along with the moderators of gender, age, and travel frequency in the context of COVID-19 biosecurity for international tourism.

2.2. Hypothesis Development

Attitudes towards COVID-19 health measures, including vaccination, can be derived from ascertaining people’s values, which, in turn, are found to affect COVID-19-related decision-making behavior among United States adults [34]. In the context of sustainable tourism behaviors, consumers’ perceived values have a great effect on their attitudes toward on sustainable consumption behavior [35]. United States travel consumers’ values on biosecurity during the COVID-19 pandemic are also identified as highly influencing attitudes towards biosecurity [33]. Grounded in the literature review above, this study proposes the following hypothesis:

Hypothesis 1 (H1). *Values on COVID-19 biosecurity for travel positively influence attitudes toward COVID-19 biosecurity for travel.*

Public attitudes regarding various NPIs influence their adoption during COVID-19 [36]. Strong attitudes have been found to be a good predictor of the adoption of four personal NPIs (handwashing, proper coughing habits, social distancing, and mask wearing) [37]. Attitudes regarding COVID-19 and the government/health system appear likely to influence compliance with preventive measures such as self-reporting, physical distancing, the use of face masks, and the acceptability of vaccines [38]. Drawing on this literature, this study posits the following hypothesis:

Hypothesis 2 (H2). *Attitudes toward COVID-19 biosecurity for travel positively influence COVID-19 interventions for travel.*

Individual attitudes toward COVID-19-related public health measures are closely related to compliance behavior with respect to such public health rules [39]. From a tourism sustainability perspective, consumers’ attitudes have a significant impact on their behavior in relation to environmentally friendly consumption [35]. During the COVID-19 pandemic, international travel consumers’ attitudes positively lead to their biosecurity behavior on COVID-19 [33]. Based on the literature review above, this study suggests the following hypothesis:

Hypothesis 3 (H3). *Attitudes toward COVID-19 biosecurity for travel positively influence COVID-19 biosecurity behaviors for travel.*

In the context of the 2009 H1N1 influenza pandemic, international travel consumers’ NPIs were found to have a significant influence on their behavioral intention [14]. During the COVID-19 pandemic, travelers’ NPIs significantly affected behavioral intention [40]. Furthermore, destination requirements for international travel consumers to adopt NPIs have a strong effect on their biosecurity behavior for travel during the COVID-19 pandemic [31]. In line with this literature, this study proposes the following hypothesis:

Hypothesis 4 (H4). *COVID-19 interventions for travel positively influence COVID-19 biosecurity behaviors for travel.*

Gender and age groups often display different infectious disease profiles in high incidence destinations [15]. For instance, in a cross-national study across eight countries, women were found to be more likely to perceive COVID-19 as a very serious health problem, to agree with restraining public policy measures, and to comply with them [39]. In terms of the COVID-19 pandemic, significant gender-based differences for both psychosocial factors and the adoption of preventive behaviors have been found [22]. Different age-related influences on individuals' reactions to the pandemic and vacation preferences also provide practical insights for stakeholders interested in revising their segmentation and targeting strategies once the pandemic subsides [41]. In light of this literature, this study assumes the two following hypotheses:

Hypothesis 5 (H5). *Gender significantly moderates the relationships between values, attitudes, interventions, and behaviors in the context of COVID-19 biosecurity for tourism.*

Hypothesis 6 (H6). *Age significantly moderates the relationships between values, attitudes, interventions, and behaviors in the context of COVID-19 biosecurity for tourism.*

In terms of travel frequency, significant effects have been found of the frequency of travel on mobility-resource ownership decisions [25]. Travel frequency has a strong influence on the spread of infectious diseases (e.g., COVID-19), and there are close relationships between frequency and basic reproduction numbers and global dynamics [19]. As well as contributing to the spread of novel diseases, travel frequency also has a great impact on the persistence of infectious diseases, such as mosquito-borne diseases [18]. Interestingly, travel frequency may also be related to other travel behavior. For example, travel frequency can predict consumer behavior of leisurely walking, travel time, and/or activities in the context of outdoor recreation participation [24]. Importantly, there is a suggestion that biosecurity behaviors may be related to international travel frequency [26]. Therefore, this study proposes the following hypothesis:

Hypothesis 7 (H7). *Travel frequency significantly moderates the relationships between values, attitudes, interventions, and behaviors in the context of COVID-19 biosecurity for tourism.*

Figure 1 displays the hypothesized relationships among values, attitudes, interventions, and behaviors, along with the three moderators of gender, age, and travel frequency.

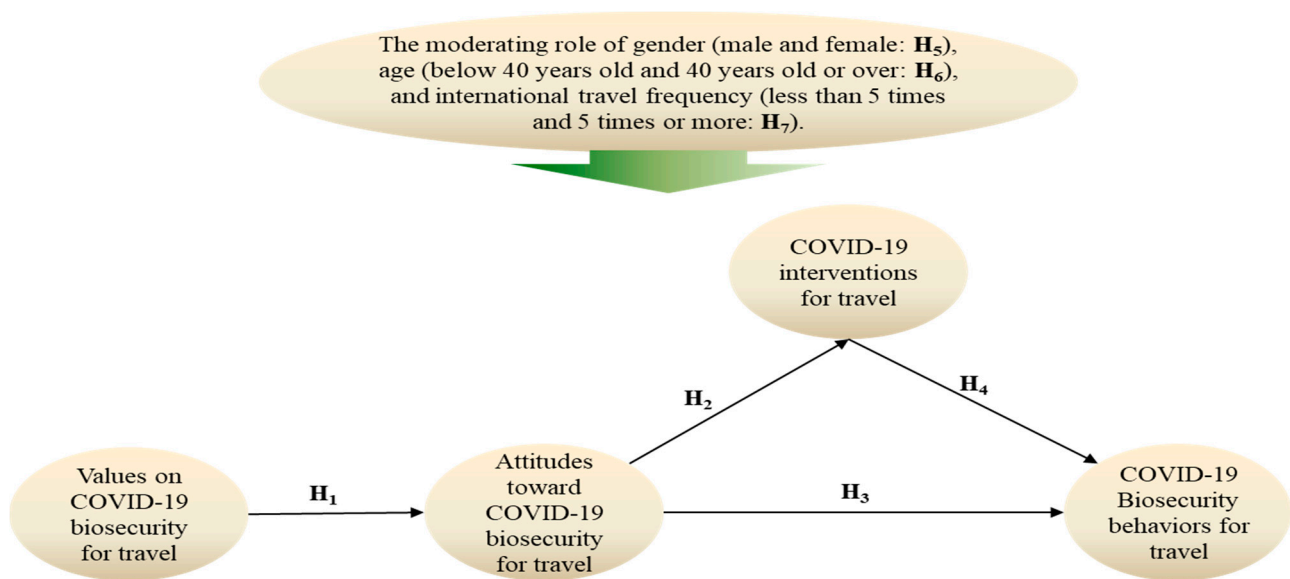


Figure 1. Proposed research model.

3. Methods

3.1. Measurement

This study has applied prior validated multi-measurement questions, which were reworded to fit the study context [42]. The measurements consist of 18 items that measure four constructs, including the following: values on COVID-19, attitudes toward COVID-19 biosecurity, COVID-19 interventions of travel, and COVID-19 biosecurity behaviors for travel. Six items addressing values on COVID-19 biosecurity for travel were generated from previous studies (e.g., “Participating in human biosecurity is an ethically right action when traveling during the pandemic”) [26]. Three items relevant to attitudes toward biosecurity for travel were based on existing literature (e.g., “Participating in human biosecurity is an ethically right action when traveling during the pandemic”) [7]. Three items regarding COVID-19 interventions for travel were adapted from past research (e.g., “Participating in human biosecurity is an ethically right action when traveling during the pandemic”) [13]. COVID-19 biosecurity behaviors for travel were assessed using six questions formed from Hall (e.g., “When traveling during the pandemic, I keep away from those who have the symptoms of COVID-19”) [4,5].

3.2. Content Validity and Pre-Test

In order to evaluate content validity, three scholars who are experts in health and travel relationships assessed the question items. In light of advice gained on the application of NPIs during pandemics [43], four questions related to COVID-19 biosecurity behaviors for travel were added to better capture the concept accordingly (e.g., “I refrain from touching my eyes, nose, and mouth when traveling during the pandemic”). A pre-test was subsequently conducted on 40 U.S. residents who had previously traveled overseas within the past five years. Two questions about guaranteeing the quality of survey data and time spent for answering all items were added based upon the pre-test (Appendix A).

3.3. Data Collection

Large panel digital surveys are frequently applied in research because of their capacity to obtain responses rapidly and in a cost-effective manner [31,44]. For collecting valid data, this study utilized the online survey firm Qualtrics, which possesses one of the world’s largest panels, as well as following and adhering to rigorous online survey procedures [45]. Based on data from the U.S. National Travel and Tourism Office [46], respondents were drawn from a Qualtrics panel using a quota sampling technique according to age (18 and

over) and gender of outbound tourists. In order to ensure commitment to the provision of considered and honest answers as well as overseas trip experience, respondents were selected via two screening questions. Scaled questions were rotated to avoid response bias. The online survey was administered on 1–5 September 2020. Inappropriate responses were excluded from the dataset by analyzing p–p plots and correlations regarding time spent on answering all the questions, as respondents who took less than the appropriate time were found to insignificantly correlate with responses from respondents that completed the survey with the established timeframe. After deleting respondents who finished the questionnaire in less than three minutes, 411 qualified responses were obtained for the analysis. In addition, 25 respondents who indicated they had no plans for international travel when COVID-19 ends were eliminated from the data set. Thus, a total of 386 useable responses were analyzed.

3.4. Data Analysis

This study utilized partial least squares (PLS)-structural equation modelling (SEM) with multi-group analysis [47]. With formative second-order constructs, PLS-SEM is useful in estimating first-order constructs concurrently [48]. PLS-SEM is also better than typical SEM (e.g., covariance based) for non-normal data, small samples, and/or complicated models with MGA [49]. The data in this research have a non-normal distribution with over 1.000 as absolute values of the items for skewness and/or kurtosis, as shown in Table 1. For these reasons, this study utilized SmartPLS 3.2.2 to validate the measurement and structural models [47]. To verify the moderating effect of low and high big five personality groups, the researchers also used MGA according to PLS-SEM algorithms [50,51].

Table 1. Confirmatory factor analysis (CFA) and descriptive statistics.

Constructs	Items	Factor Loading	Mean	Standard Deviation	Kurtosis	Skewness	VIF **
Values on COVID-19 biosecurity for travel	Item 1	0.804	5.513	1.642	0.587	−1.127	2.262
	Item 2	0.813	5.440	1.634	0.782	−1.170	2.767
	Item 3	0.796	5.438	1.599	0.538	−1.058	2.454
	Item 4	0.856	5.598	1.587	1.274	−1.347	3.390
	Item 5	0.865	5.588	1.553	1.188	−1.270	3.138
	Item 6	0.844	5.539	1.597	1.078	−1.275	3.008
Attitudes toward COVID-19 biosecurity for travel	Item 1	0.924	5.666	1.486	1.121	−1.251	3.380
	Item 2	0.931	5.661	1.474	1.170	−1.253	3.043
	Item 3	0.918	5.671	1.439	1.527	−1.322	3.380
COVID-19 interventions for travel	Item 1	0.877	5.927	1.339	2.303	−1.544	1.982
	Item 2	0.868	5.863	1.407	1.746	−1.454	2.043
	Item 3	0.872	6.000	1.327	2.565	−1.642	1.982
COVID-19 Biosecurity behaviors for travel	Item 1	0.834	6.016	1.410	2.261	−1.646	2.562
	Item 2	0.812	5.775	1.423	1.299	−1.315	2.463
	Item 3 *	-	-	-	-	-	-
	Item 4 *	-	-	-	-	-	-
	Item 5	0.831	5.979	1.313	2.948	−1.691	2.676
	Item 6	0.825	6.031	1.303	2.755	−1.693	2.534
	Item 7	0.756	5.712	1.481	1.423	−1.345	2.038
	Item 8	0.778	5.956	1.302	2.059	−1.474	2.112
	Item 9	0.830	6.104	1.283	3.236	−1.796	2.475
	Item 10	0.771	5.813	1.378	1.546	−1.356	2.349

Note: * Items are deleted after CFA. ** Variance inflation factor of multicollinearity. Items in italics have a non-normal distribution.

4. Results

Three moderators were assessed by demographic and general questions (i.e., gender, age, and international travel frequency in the past five years) (Appendix A). In order to test the moderating effects, gender (male and female: H5), age (below 40 years old and 40 years old or over: H6), and international travel frequency in the past five years (less than five times and five times or more: H7) were divided into two groups. Sample profiles of demographics and general questions are provided in Table 2.

Table 2. Demographic characteristic and general information of the entire group.

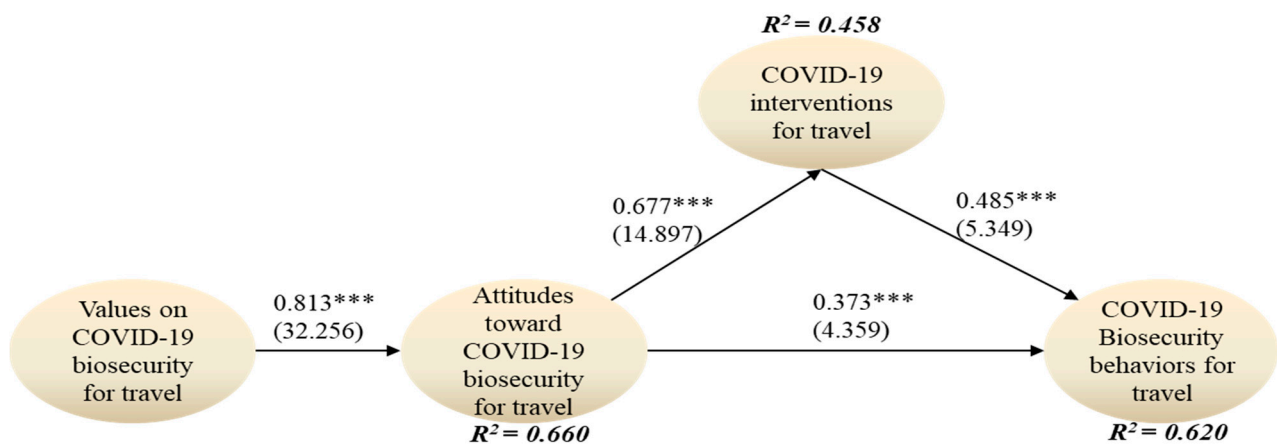
Characteristics	<i>n</i> (386)	% (100)	Characteristics	<i>n</i> (386)	% (100)
Gender			Monthly household income		
Male	187	48.4	Less than US \$2000 to 3999	121	31.2
Female	196	50.8	US \$4000 to 7999	135	35.0
Other	3	0.8	US \$8000 or more	130	33.8
Age			Overseas travel frequency in the past 5 years		
Between 18 and 39 years old	203	52.6	Less than 5 times	193	50.0
40 years old and over	183	47.4	5 times and over	193	50.0
Educational level			Had COVID-19		
Less than or high school diploma	41	10.6	Yes	40	10.4
2-year college	77	20.0	No	346	89.6
University	134	34.7	Know someone who have/had COVID-19		
Graduate school or higher	134	34.7	Yes	212	54.9
Marital status			No	174	45.1
Single	129	33.4	Cancel a trip than wear masks		
Married	240	62.2	Yes	140	36.3
Divorce, widow/er, living together	17	4.4	No	246	63.0
Occupation			Cancel a trip than enter quarantine		
Professional (e.g., attorney, engineer)	117	30.4	Yes	242	62.7
Business owner/self-employed	45	11.7	No	144	37.3
Service worker	44	11.4	Residential area		
Office/administrative/clerical worker	46	11.9	Northeast	132	34.1
Civil servant (government)	10	2.6	South	135	34.8
Home maker	11	2.8	Midwest	55	14.3
Student	25	6.5	West	60	15.8
Retiree	46	11.9	Alaska	2	0.5
Unemployed	16	4.1	Hawaii	2	0.5
Other (e.g., flight attendant, CEO)	26	6.7			

The results of the measurement and structural model assessments fitted all the required criteria well [30] (Tables 1 and 3). As the data had non-normal distributions by both skewness as well as kurtosis, this study utilized PLS-SEM to assess the seven hypotheses, applying bootstraps of 5000 re-sampling techniques. H1, H2, H3, and H4 were highly supported (Figure 2). Specifically, values have the greatest effect on attitudes with respect to COVID-19 biosecurity during traveling in this study's research model. Interestingly, attitudes have more impact on interventions than behaviors relevant to biosecurity. Behaviors are also influenced more by interventions than attitudes, showing the important mediating role of interventions.

Table 3. Reliability and discriminant validity.

Construct	Correlation of the Constructs			
	1	2	3	4
1. Values on COVID-19 biosecurity for travel				
2. Attitudes toward COVID-19 biosecurity for travel	0.889			
3. COVID-19 interventions for travel	0.709	0.770		
4. COVID-19 biosecurity behaviors for travel	0.751	0.761	0.828	
Cronbach's alpha ≥ 0.7	0.910	0.915	0.842	0.922
Rho_A (reliability coefficient) ≥ 0.7	0.912	0.915	0.844	0.926
Composite reliability ≥ 0.7	0.930	0.946	0.905	0.936
AVE ≥ 0.5	0.689	0.854	0.760	0.648
Effect size (Q^2) > 0		0.557	0.345	0.390

Standardised root mean residual (SRMR): 0.064 < 0.08



*** $p < 0.001$. Figures in parentheses are t-values.
 R^2 denotes explained variance as prediction power.

Figure 2. Results of path analysis.

With regard to the moderating effects, H6 and H7 were fully supported, but H5 was partially supported (Table 4). For example, the relationship between attitudes and behaviors has greater effects in males than in females, while the relationship between interventions and behaviors has a stronger impact upon females. In addition, the relationships between values and attitudes, attitudes and interventions, and interventions and behaviors have larger influences upon those 40 years or older, while the relationship between attitudes and behaviors has a larger influence for those less than 40 years old. More frequent international travelers have greater effects on the four relationships between values, attitudes, interventions, and behaviors than their counterparts.

Table 4. Comparison of the path coefficients between four moderators.

Moderator	H	Path	Group A	Group B	t-Value (A-B)	p-Value (A-B)	Hypothesis Test
Gender: Men (A); Women (B)	H5a	Values on COVID-19 biosecurity for travel → Attitudes toward COVID-19 biosecurity for travel	0.813 ***	0.816 ***	−0.890	>0.05	Partially supported
	H5b	Attitudes toward COVID-19 biosecurity for travel → COVID-19 interventions for travel	0.679 ***	0.678 ***	0.245	>0.05	
	H5c	Attitudes toward COVID-19 biosecurity for travel → COVID-19 Biosecurity behaviors for travel	0.496 ***	0.269 ***	19.865	<0.001	
	H5d	COVID-19 interventions for travel → COVID-19 biosecurity behaviors for travel	0.307 *	0.639 ***	−27.748	<0.001	
Age: Below 40 years old (A); 40 years old and over (B)	H6a	Values on COVID-19 biosecurity for travel → Attitudes toward COVID-19 biosecurity for travel	0.809 ***	0.818 ***	−2.480	<0.05	Fully supported
	H6b	Attitudes toward COVID-19 biosecurity for travel → COVID-19 interventions for travel	0.615 ***	0.752 ***	−21.081	<0.001	
	H6c	Attitudes toward COVID-19 biosecurity for travel → COVID-19 biosecurity behaviors for travel	0.388 **	0.328 **	5.364	<0.001	
	H6d	COVID-19 interventions for travel → COVID-19 biosecurity behaviors for travel	0.477 ***	0.519 ***	−3.389	<0.001	
Overseas travel frequency: 5 times and more (A); Less than 5 times in the past 5 years (B)	H7a	Values on COVID-19 biosecurity for travel → Attitudes toward COVID-19 biosecurity for travel	0.837 ***	0.792 ***	13.118	<0.001	Fully supported
	H7b	Attitudes toward COVID-19 biosecurity for travel → COVID-19 interventions for travel	0.697 ***	0.662 ***	5.183	<0.001	
	H7c	Attitudes toward COVID-19 biosecurity for travel → COVID-19 Biosecurity behaviors for travel	0.385 ***	0.341 *	4.197	<0.001	
	H7d	COVID-19 interventions for travel → COVID-19 biosecurity behaviors for travel	0.521 ***	0.485 ***	3.234	<0.01	

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

5. Discussion and Conclusions

5.1. Discussion

The results revealed that values with respect to the importance of biosecurity have the strongest impact on attitudes in terms of COVID-19-related biosecurity, implying that international tourists with high biosecurity values are more likely to have positive attitudes toward pandemic biosecurity behavior. This reinforces the basic, yet significant understanding that the pre-existing beliefs of overseas travelers towards prevention practices are very important with respect to perceptions of health safety measures, extending the findings of prior studies on the impact of values on attitudes [33,34]. Unexpectedly, interventions have a substantial mediating effect between attitudes and behaviors, showing that the nature of the NPIs is critical for tourist behavior. Attitudes toward pandemic biosecurity for travel greatly influence pandemic interventions for travel, revealing that people who travel internationally have positive attitudes on biosecurity and tend to accept pandemic-related interventions for travel, expanding previous findings on attitudes and NPIs [36–38]. In addition, attitudes substantially lead to pandemic biosecurity behaviors for tourism, broadening past research on attitudes and behaviors during a pandemic [33,39]. Importantly, pandemic interventions for tourism positively influence the biosecurity actions for tourism, broadening the existing literature on the topic [14,19,40].

Regarding the gender moderator, the relationships between attitudes and behaviors, as well as interventions and behaviors, show the differences between males and females. The results infer that men with positive attitudes towards COVID-19 biosecurity for travel are more likely to practice appropriate biosecurity behaviors, while women with strong interventions of the COVID-19 pandemic for travel are more likely to follow biosecurity measures, which is partially consistent with the existing literature [15,22,39]. With regard to the two age groups, representing travelers below 40 years old and those 40 years old or over, it was found that older travel consumers tend to follow biosecurity rules more than younger travelers, although attitudes and behaviors remain important influences for younger travelers. These results are somewhat similar to previous research [22,41]. Significantly, for the determination of targeted interventions in terms of travel frequency, more frequent international travelers are more likely to follow recommended biosecurity behaviors than infrequent travelers. These findings show some similarity to prior travel frequency studies [18,19,24–26].

5.2. Theoretical Implications

This study provides several theoretical contributions in terms of international travel behaviors and infectious disease control in responding to COVID-19, which are particularly relevant given the pandemic's potential longer-term effects with respect to travel practices and consumer attitudes toward tourism [52]. First, this study found that values, attitudes, and interventions are key factors that lead to travel consumers' adoption of recommended biosecurity behaviors. The finding of this study provides new knowledge to researchers and public health educators. Second, this research sheds specific light on international travel-related pandemic interventions, revealing the important mediating role of NPIs between attitudes and behaviors. These results, therefore, offer significant insights into the linkage of attitudes, interventions, and behaviors for future studies on tourism and COVID-19 as well as tourism and infectious disease in general [5].

With respect to the moderating role of gender, men are more likely to have positive relationships between values and attitudes, and attitudes and interventions. In contrast, women are more likely to have positive relationships between attitudes and behaviors, and interventions and behavior. With respect to the moderating effect of age, older tourists tend to have stronger relationships between values and attitudes, attitudes and interventions, and interventions and behaviors, whereas younger tourists tend to have stronger relationship between attitudes and behaviors. These findings provide novel insights. Interestingly, with respect to the moderating role of tourism frequency, the research model supported that international tourists who travel more frequently have stronger relationships.

5.3. Practical Implications

The findings of this work offer several practical implications for those responsible for international travelers following biosecurity measures. First, the high impact of values on attitudes in this study suggests that governments and tourism destinations should focus on promoting biosecurity values to potential overseas tourists in order to improve their attitudes toward pandemic biosecurity behaviors at destinations and when using transport. The mediating role of interventions between attitudes and behaviors also suggests that international and national health agencies and destination management organizations should emphasize the significance of NPIs to increase the willingness to adopt appropriate biosecurity behaviors when traveling while COVID-19 remains active. This could partly be done by online and mobile education campaigns as well as through social media networks and relevant print services to communicate to international tourists before and during travel to a destination [53]. The greater impact of interventions on behaviors than that of attitudes on behaviors suggests that policy makers and marketers should create strategies utilizing NPIs when they want overseas travelers to take biosecurity actions relevant to disease control.

The significant moderating effects of gender, age, and travel frequency provide clear insights for the better targeting and design of marketing and communication strategies when they wish to target international travel consumers to improve biosecurity behavior. For example, when targeting men, governments and health organizations can focus on the relationships between attitudes and behaviors as well as interventions and behaviors. This can be done by market segmentation strategies via different digital campaign contents for men or women separately. The different findings with respect to older and younger tourists suggest that marketing messages can be developed and targeted by age. That is, when targeting older people, stakeholders could emphasize the values and interventions, while when targeting younger people, attitudes and behaviors would be highlighted. That could be implemented by advertising through different types of social media channels depending on age categories. The relationship between frequency of travel and biosecurity behaviors also provides clear opportunities for effective communication via frequent flier programs as well as the potential role for social norm-based travel behavioral interventions. Owing to the strength of relationships from all hypotheses in the high frequency travel group compared with the low frequency travel group, frequency of travel clearly becomes a valuable tool for the development of marketing plans regarding tourism-related pandemic biosecurity actions.

5.4. Limitations and Future Research Directions

Although this work contributes to both theory and practice, there are several limits to the study to consider for future research opportunities. As this study was conducted on U.S. international tourists during the COVID-19 pandemic, the results need to be treated cautiously with respect to other countries, cultures, and time periods. Because demographic factors have significant impacts on COVID-19 biosecurity practices, future research on income, education, marital status, and/or place of residence are recommended. These findings might also provide interesting insights for improved segmentation measures in the development of behavioral interventions to restrict infectious disease risk and the receptiveness of biosecurity measures to voluntary adoption during international travel.

Older travel consumers (60 years and older) can have substantially different behaviors from those of other age categories regarding pandemic biosecurity for tourism. Consequently, future studies may need focus on multiple age segments of travelers to identify similarities and differences among those segments. Furthermore, future research should attempt to compare United States-based international travelers with those international travel consumers residing in different geographical regions to compare differences and similarities. Finally, the development of COVID-19 vaccine passports for the resumption of tourism is underway [54], although NPIs will potentially still be required at some destinations and especially during periods of future outbreaks. Accordingly, new research addressing

the implications of vaccination for international tourism, both as a single variable and in conjunction with NPIs, would be valuable and timely.

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Appendix A. Questionnaire on Biosecurity and Tourism

XXX university and a team of international researchers are conducting a study regarding biosecurity and tourism during the COVID-19 pandemic. Your sincere response will contribute to a better understanding of consumer behavior related to biosecurity, the introduction of exotic fauna and flora, disease control, and sustainability. Your response is completely anonymous and will be used only for academic purposes.

We would greatly appreciate your time and cooperation in completing this questionnaire.

Thank you very much!

Researchers:

Names of the researchers and university are eliminated for anonymity. The layout of this questionnaire is only for MS word file which is quite different from the online survey screen.

1–5 September 2020.

We care about the quality of our survey data and hope to receive the most accurate measures of your opinions, so it is important to us that you thoughtfully provide your best answer to each question in the survey.

Do you commit to providing your thoughtful and honest answers to the questions in this survey?

1. I will provide my best answers: Go to the next question.
2. I will not provide my best answers: End the survey.
3. I can't promise either way: End the survey.

Screen question (SQ)

SQ1. Have you ever traveled internationally?

- ① Yes If you checked "yes," please answer the following GQ1 question.

- ② No: Close the survey (We thank you for your time spent taking this survey. Your response has been recorded.).

General question (GQ)

GQ1. Do you plan to travel internationally if the pandemic ends?

① Yes ② No

GQ2. How many times have you traveled internationally in the past 5 years?
_____ times.

GQ3. Did/do you have COVID-19?

① Yes ② No

GQ4. Do you know someone who have/had COVID-19?

① Yes ② No

GQ5. Would you rather cancel a trip than wear masks?

① Yes ② No

GQ6. Would you rather cancel a trip than enter quarantine?

① Yes ② No

Note 1: Biosecurity is the protection of the economic, environmental, and/or human health in a country, region, or location from the introduction, emergence, establishment, and spread of harmful organisms (pests and diseases). In this study, **biosecurity** refers to measures that are taken to stop the spread or introduction of organisms potentially harmful to human, animal, and plant life. The main aim of biosecurity is to protect human health, agriculture, forestry, fishing, and the environment through the prevention, control, and management of biological risk factors, such as the introduction of plant or animal pests, or a disease (e.g., COVID-19).

Note 2: In this study, **travel, traveling, tourism, and tourists** mean *international* travel, traveling, tourism, and tourists.

Construct question (CQ)

CQ1. Please carefully read each item and check the score that you think best fits [select one for each] (1: strongly disagree; 2: disagree; 3: somewhat disagree; 4: neither agree nor disagree; 5: somewhat agree; 6: agree; 7: strongly agree).

CQ1. Values on COVID-19 Biosecurity for Travel	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
1-8 1. Participating in human biosecurity is an ethically right action when traveling during the pandemic.	1	2	3	4	5	6	7
2. Practicing animal biosecurity is a moral duty when traveling during the pandemic.	1	2	3	4	5	6	7
3. Supporting plant biosecurity is a virtuous behavior when traveling during the pandemic.	1	2	3	4	5	6	7
4. Wearing a mask helps biosecurity when traveling during the pandemic.	1	2	3	4	5	6	7
5. Social or physical distancing contributes to biosecurity when traveling during the pandemic.	1	2	3	4	5	6	7
6. Quarantine assists biosecurity when traveling during the pandemic.	1	2	3	4	5	6	7

CQ1. Values on COVID-19 Biosecurity for Travel	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
1-8 1. Participating in travel-related biosecurity is a positive behavior during the pandemic.	1	2	3	4	5	6	7
2. Participating in travel-related biosecurity is a beneficial behavior during the pandemic.	1	2	3	4	5	6	7
3. Participating in travel-related biosecurity is an essential behavior during the pandemic.	1	2	3	4	5	6	7

CQ1. Values on COVID-19 Biosecurity for Travel	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
1-8 1. I will carefully check information about COVID-19 related protection before traveling now.	1	2	3	4	5	6	7
2. I will read and check precautions about preventing the spread of COVID-19 before I travel now.	1	2	3	4	5	6	7
3. I will thoroughly follow recommended COVID-19 hygiene management practices when I travel now.	1	2	3	4	5	6	7

CQ1. Values on COVID-19 Biosecurity for Travel	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
1-8 1. When traveling during the pandemic, I keep away from those who have the symptoms of COVID-19.	1	2	3	4	5	6	7
2. While traveling during the pandemic, I keep away from meeting people I don't know.	1	2	3	4	5	6	7
3. While traveling during the pandemic, I keep away from meeting people even if I know them.	1	2	3	4	5	6	7
4. I only meet close friends and family when travelling during the pandemic	1	2	3	4	5	6	7
5. When traveling during the pandemic, I carefully keep an eye on my health condition.	1	2	3	4	5	6	7
6. I frequently wash my hands when traveling during the pandemic.	1	2	3	4	5	6	7
7. I refrain from touching my eyes, nose, and mouth when traveling during the pandemic.	1	2	3	4	5	6	7
8. When traveling during the pandemic I cover my mouth and nose with a tissue when I sneeze.	1	2	3	4	5	6	7
9. I wear a face mask when traveling during the pandemic.	1	2	3	4	5	6	7
10. I try and avoid public areas when travelling during the pandemic.	1	2	3	4	5	6	7

Demographic characteristics (DQ)

DQ1. What is your gender?

① Male ② Female ③ Other

DQ2. What is your age?

- ① Under 20 years old
- ② Between 20 and 29 years old
- ③ Between 30 and 39 years old
- ④ Between 40 and 49 years old
- ⑤ Between 50 and 59 years old
- ⑥ 60 years old and over

DQ3. What is the highest level of education you have completed?

- ① High school diploma or lower
- ② 2-year college attending or degree
- ③ 4-year university attending or degree
- ④ Graduate school attending or degree

DQ4. What is your marital status?

① Single ② Married ③ Other (specify) _____

DQ5. What is your monthly household income?

① Less than US \$2000 ② US \$2000–3999 ③ US \$4000–5999 ④ US \$6000–7999 ⑤ US \$8000 or more

DQ6. What is your occupation?

- ① Professional (e.g., attorney, engineer, architect)
- ② Entrepreneur/Self-employed
- ③ Service employee
- ④ Office/Administrative/Clerical
- ⑤ Civil Servant (Government)
- ⑥ Home maker
- ⑦ Student
- ⑧ Retiree
- ⑨ Unemployment
- ⑩ Other (specify) _____

DQ7. In what state do you normally reside?

We thank you for your time spent taking this survey.

Your response time has been recorded!

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