Perception of COVID-19 rapid antigen testing approach prior to flight schedule among air travelers: a questionnaire-based study

Mohammed Shahid and Ronni Mol Joji
Microbiology, Immunology and Infectious Diseases, College of Medicine and Medical Science, Arabian Gulf University, Manama, Bahrain
Archana Prabu Kumar
Medical Education, College of Medicine and Medical Science, Arabian Gulf University, Manama, Bahrain
Amer Almarabheh
Family and Community Medicine, College of Medicine and Medical Science, Arabian Gulf University, Manama, Bahrain
Kranthi Kosaraju
Dr Sulaiman Al Habib Medical Group, Riyadh, Saudi Arabia
Ali Almahmeed
Microbiology, Immunology and Infectious Diseases, College of Medicine and Medical Science, Arabian Gulf University, Manama, Bahrain, and
Abdel Halim Salem Deifalla
Anatomy, College of Medicine and Medical Science, Arabian Gulf University, Manama, Bahrain

Received 6 June 2022
Revised 14 September 2022
17 November 2022
28 December 2022
18 January 2023
Accepted 5 March 2023

Abstract

Purpose – The COVID-19 pandemic had a huge impact on people's lives, air travel and tourism. The authors explored travelers' perceptions of COVID rapid antigen tests before boarding aircraft, willingness to fly and the precautionary actions for safe air travel.

Design/methodology/approach – All the participants were asked to complete the survey while reflecting on their experiences of air travel during this COVID-19 pandemic. The questionnaire consisted of demographic

The authors would like to thank all the air travelers who volunteered to participate in the study. The authors thank Mr. Tomy Kaitharath for the technical support provided during the study. The authors are also grateful to the University REC for approving this study.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Declaration of interests: The authors report there are no competing interests to declare.

Arab Gulf Journal of Scientific Research
Emerald Publishing Limited
e-ISSN: 2536-0051
p-ISSN: 1985-9899
DOI 10.1108/AGJSR-06-2022-0076

information of the participants and air travel preferences during pandemic. The survey was conducted through Google Form in both English and Arabic language. The link was shared through emails and WhatsApp.
Findings – In this survey, majority had willingness to fly during pandemic. 45.2% preferred to undergo rapid test before boarding, while 41.9% refused owing to no added benefit (23.8%) and nasal discomfort (9.3%) among others. The best indicators to resume safe air travel were COVID-19 vaccination (80.4%), wearing face mask during flying hours (70.8%) and maintain social distancing with aircraft seating (49.6%).
Research limitations/implications – The findings of the current survey could help the organizations and the biosecurity authorities to act and support accordingly and thus reduce passenger anxiety about resuming the flights, thereby increasing willingness to fly and preparing oneself and the aviation industry for future pandemics.
Originality/value – The findings of the current survey could help the organizations and the biosecurity authorities to act and support accordingly and thus reduce passenger anxiety about resuming the flights, thereby increasing willingness to fly, and preparing oneself and the aviation industry for future pandemics.

Keywords Airport, Air travelers, COVID-19 rapid antigen testing, Perception
Paper type Research paper

Introduction

The COVID-19 pandemic has significantly altered people's lives and reduced global travel (Kiang *et al.*, 2021). The rapid development of novel diagnostic tests and potent vaccines was a massive relief (Kevadiya *et al.*, 2021). According to the United States Transportation Security Administration, global airline travel reduced by more than 80% during the pandemic period. This reduction was due to a variety of factors including a personal preference to avoid the risk of infection, governmental and company policies on travel restrictions or quarantine, cancellation of events requiring travel, etc. (Choi *et al.*, 2020).

The issue of travelers' safety and protection has emerged due to the globalization of modern tourism. There are numerous risks and dangers to be aware of while traveling and visiting a destination. Diverse dangers impede tourist flows, impact the way tourists perceive a place, and inevitably change travelers' intentions to travel while altering a destination's natural and manmade attractiveness. This is supported by the COVID-19 viral epidemic and its catastrophic effects (Nepal, 2020).

Aviation authorities and officials agree that restoring travelers' confidence regarding their safety is an urgent task that must be accomplished before the aviation industry can move on to a new phase in air travel that is totally different from what travelers are acquainted with (Shepardson, Reese, & Ellis, 2020). Since COVID-19 had a global impact on tourism, it is critical to understand what variables influence biosecurity behavior. Few conceptually oriented studies on COVID-19 biosecurity travel behavior have been published in the literature (Kim, Bonn, & Hall, 2022). A study by Kim, Bonn, and Hall (2021), Kim, Hall, and Bonn (2021) noticed that prosocial behavior and perception have a strong impact on intervention, which influences resilience and biosecurity behavior (Kim, Bonn, & Hall, 2021; Kim, Hall, & Bonn, 2021). Another study from South Korea explored the impact of COVID-19 on international tourists' self-protection motivations as well as the involvement of the media in this course. According to the findings, the respondents' assessments of the pandemic's severity and self-efficacy as a coping mechanism have the biggest influence on self-protection motivations (Qiao, Ruan, & Pabel, 2021). A study by Kim, Bonn, and Hall (2021), Kim, Hall, and Bonn (2021) observed that the frequency of travel has a substantial impact on biosecurity behavior. They concluded that the frequency of overseas travel has a variety of effects on biosecurity values, attitudes, personal norms, social norms, and behaviors. Low-frequency travelers experience the most significant biosecurity behaviors, thereby implying that those who travel less frequently are more likely to practice conscientious COVID-19 biosecurity behavior (Kim, Bonn, & Hall, 2021; Kim, Hall, & Bonn, 2021). Considering the travelers' biosecurity, when airlines resumed operations, all the recommended protective measures were undertaken to ensure travelers' safety (Shahid, 2021; Shepardson *et al.*, 2020).

In a variety of travel situations, including pandemics, socio-demographic factors are frequently examined. Younger participants and women were found by Kim and Kang (2021) to be influential and more aware of the dangers around them. According to Graham, Kremarik, and Kruse (2020),

older patients are happy to travel as long as safety precautions are taken. According to Peluso and Pichierri (2020), age and health status have an impact on the vacation's intended purpose. There are studies in the literature on perceived benefits, barriers and willingness to travel, which suggest that perceived benefits and barriers influence attitude but not willingness to travel (Chaulagain, Pizam, & Wang, 2020; Huang, Dai, & Xu, 2020). A study on cancer patients by Ban and Kim (2020) found that the constructs significantly influence decisions. Even prior travel history, travel risk, and travel readiness are significant factors for traveling during pandemics (Neuburger & Egger, 2021). Rittichainuwat and Chakraborty (2009) compared first-time and repeat travelers' perceptions of the risks associated with travel during the Severe Acute Respiratory Syndrome (SARS) and the Swine flu outbreak. They discovered that the first-time travelers avoided these situations because they believed they would be more susceptible to health risks.

Considering the health risks, most airlines implemented the requirement for a negative COVID-19 Real Time - Polymerase Chain Reaction (RT-PCR) test within 24–72 hours of flying. Some countries required travelers to undergo COVID-19 testing upon arrival (with an added test after a few days) and quarantine for 7–10days (Shahid, 2021). Concerns regarding the possibility of travelers carrying the disease to travel destinations even after prior negative tests are legitimate. There is still the possibility that a passenger who is COVID-19 test negative around 72 hours will become infected before boarding a flight. Such a person may start shedding the virus and thereby transmit it to the fellow passengers and the destination community (Shahid, 2021). An approximated 30–40% of infected people are asymptomatic and hugely ignorant of their illness, and this population contributes significantly to new cases and transmissions. The improved accessibility of rapid testing provides an opportunity to identify early or asymptomatic cases among travelers (Kiang *et al.*, 2021).

The effectiveness of rapid antigen testing has been established through numerous studies and simulation models (Kiang *et al.*, 2021). A research study by Qahtani *et al.* (2021) noticed that even though antigen testing has low sensitivity, it is extremely efficient in ruling out infectious passengers. Furthermore, antigen tests can identify COVID-19 variants. Therefore, this approach may be appealing for use at airports and reducing the spread of the virus through travel (Qahtani *et al.*, 2021). However, the best approach to pre-travel testing is yet to be determined and no real-world results have been reported (Kiang *et al.*, 2021). Since multiple options for rapid testing are available, deciding which one to employ for travel purposes may become increasingly difficult. As a result, the International Civil Aviation Organization (ICAO) published performance-based testing standards (>95 % sensitivity and specificity) that are consistent with the ICAO risk-centered attitude to COVID-19 mitigation (Chen and Steffen, 2021). Rapid antigen testing before boarding can make air travel safer. This approach can provide an extra filter for detecting early infectious and asymptomatic patients among travelers and thus help to curb the spread of COVID-19 across borders. Considering the travelers' biosecurity, pre-boarding testing with rapid antigen may convince the air travelers that they are unlikely to spread the virus during flight hours, but practical factors must also be taken into account (Chen and Steffen, 2021).

The importance of commercial air travel during the geographic spread of COVID-19, the effectiveness of quarantines and travel restrictions, the risk of transmission within flights and the role of preventive measures, the value of pre and post-flight testing, and the ongoing danger posed by novel, highly transmissible variants were among the recurring themes that emerged in the literature (Khatib, McGuinness, & Wilder-Smith, 2021). Kiang *et al.* (2021) developed a study on microsimulation of SARS-CoV-2 transmission in a cohort of 100,000 US domestic airline travelers. They claimed that a rapid antigen test performed the day before departure reduced the number of infectious days to 5,674 (4126−9081), a decrease of 32% from the base condition, and discovered 560 (86%) actively infectious travelers. Another study by Tande *et al.* (2021) performed COVID-19 rapid antigen tests on 9,853 travelers who had a negative PCR test for SARS-CoV-2 completed within 72 hours of departure. Five (0.05%) passengers with active infection were discovered using rapid antigen tests and the infection was proven using rapid molecular tests. As per Hindustan

Times, UAE authorities, requested India - UAE Air India Express travelers to reach airport 5-6 hours prior to boarding the flight and rapid PCR test was made mandatory for all passengers not more than four hours before the flight (Ghosh, 2021). Hence, we sought to analyze air travelers' perception of the COVID rapid antigen testing approach prior to flight schedule.

Question and hypothesis

Are air travelers willing to undergo COVID-19 rapid antigen test (within 5 hours of boarding the flight) in addition to RT PCR within 72 hours of boarding?

Our hypothesis is that air travelers are willing to undergo COVID-19 rapid antigen test (within 5 hours of boarding the flight) in addition to RT PCR within 72 hours of boarding.

We also intended to explore the willingness of travelers to fly during COVID-19 pandemic, the precautions undertaken to prevent contracting the infection during air travel, and the perceived indicators to resume safe air travel. The findings of the current study might help the organizations, the biosecurity authorities, and the air travelers to act and support accordingly during pandemics.

Materials and methods

The study was approved by the Research and Ethics Committee, CMMS, Arabian Gulf University (E06-PI-10-21). The participants included air travelers. They were asked to complete the survey while reflecting on their experiences of air travel during the COVID-19 pandemic. The survey consisted of questions adapted from Rice *et al.* (2020), which was available under creative commons license (Rice *et al.*, 2020) and International Air Transport Association (2020). The questionnaire comprised two parts: Part A on demographic information and Part B on air travel preferences during the pandemic. The survey was conducted through a Google form in both English and Arabic languages. The link was shared through email and WhatsApp.

Data collection

Data was gathered over a period of 2 months (December 2021 to January 2022) from air travelers. Participation in the survey was completely voluntary and responses were anonymous.

Data analysis

Data from the survey was loaded into MS Excel, coded, and analyzed using SPSS version 28. Descriptive analysis was applied to calculate frequencies and proportions and graphically for the qualitative variables. Additionally, means and standard deviations were calculated for the quantitative variables. Independent sample T-test and analysis of variance (ANOVA) were used to compare the mean ages of participants according to the willingness to undergo testing. The chi-square test was used to investigate the level of association among categorical variables. A p-value of less than 0.05 was considered as statistically significant.

Results

Demographic profile

The number of survey respondents were 241 including 60.2% males (n = 145) and 39.8% females (n = 96). The highest degree held by most respondents was a doctoral degree (n = 91, 37.8%), followed by master's degrees (n = 70, 29%), and bachelor's degrees (n = 66, 27.4%). Most of the respondents were between the ages of 30 and 40 years. The highest proportion of respondents were from Bahrain (n = 87, 36.6%), followed by India (n = 67, 28.2%) and Kingdom of Saudi Arabia (n = 27, 11.3%) (Table 1). In terms of air travel predictors, most of the travelers (n = 114, 47.3%) were somewhat worried during travel (Table 2).

Variable	*n*	%
Sex		
Male	*145*	*60.2*
Female	96	39.8
Total	241	100
Level of education		
High school	14	5.8
Bachelor	66	27.4
Master	70	29.0
Doctoral (PhD)	*91*	*37.8*
Total	241	100
Age group (years)	Mean ± S.D (42.63 ± 12.35)	
<30	32	13.4
30–40	*77*	*32.4*
41–50	70	29.4
<50	59	24.8
Total	238	100
Country of Residence		
Bahrain	*87*	*36.6*
India	*67*	*28.2*
Saudi	*27*	*11.3*
Oman	7	2.9
USA	6	2.9
UK	6	2.9
Singapore	4	1.7
Egypt	3	1.3
United Arab Emirates	3	1.3
Canada	3	1.3
New Zealand	3	1.3
Qatar	2	0.8
Philippines	2	0.8
Others	13	6.7

Source(s): "Author's work"

Table 1. Demographic profiles of respondents ($n = 241$)

Willingness to fly during COVID-19 pandemic

The willingness to fly scale was adapted from Rice *et al.* (2020). Seven items were scored on a Likert scale, and they were ranging from strongly disagree to strongly agree. Only 10.4% of respondents firmly believed that they would be comfortable traveling during the epidemic, while 13.7% were afraid of flying (Figure 1).

Preventive measures undertaken during travel

The study also explored the different preventive steps taken by travelers to avoid COVID-19. Most travelers opted to use a mask (97.9%), while some used disinfectants (74.7%) (Figure 2).

Preferences to undergo the COVID-19 rapid antigen test

In terms of their preferences regarding undergoing the COVID-19 rapid antigen test within five hours of boarding the flight, in addition to RT PCR within 72 hours of boarding, roughly 45.2% ($n = 109$) were willing to perform the test, whereas about 41.9% ($n = 101$) refused to do so (p-value = 0.462). The primary reason cited for the refusal was that there was no benefit (23.8%, $n = 36$) in performing this test. 36.1% ($n = 87$) participants preferred to undergo

Variable	*n*	%
Vaccination status		
Yes	*229*	*95*
No	12	5
Total	241	
Recovery from COVID-19		
Yes	50	20.7
No	191	79.3
Total	241	
Travel		
Single	44	18.3
With family	88	36.5
Both	*109*	*45.2*
Total	241	
Worried during air travel		
Very worried	38	15.8
Somewhat worried	*114*	*47.3*
Not very worried	74	30.7
Not at all worried	15	6.2
Total	241	

Table 2.
Air travel predictors

Source(s): "Author's work"

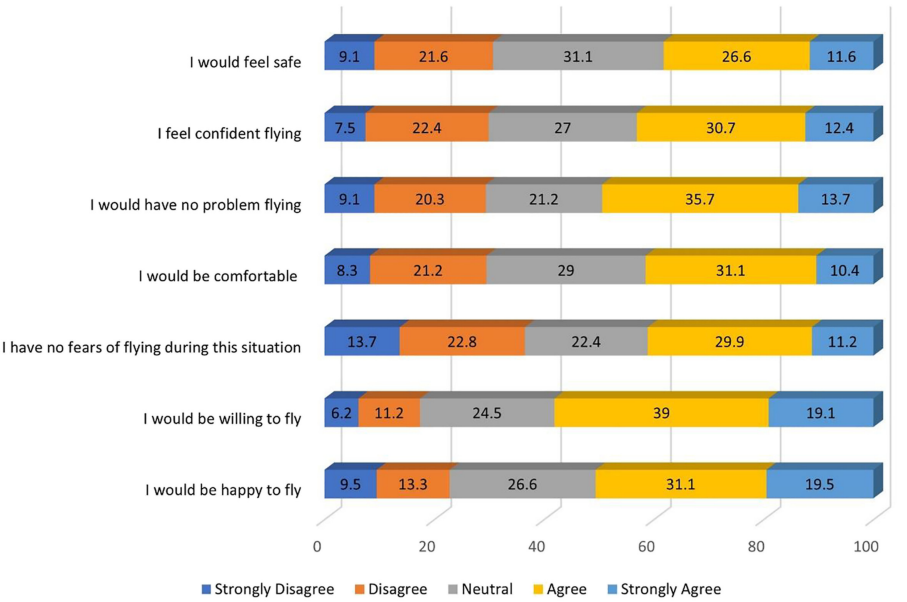
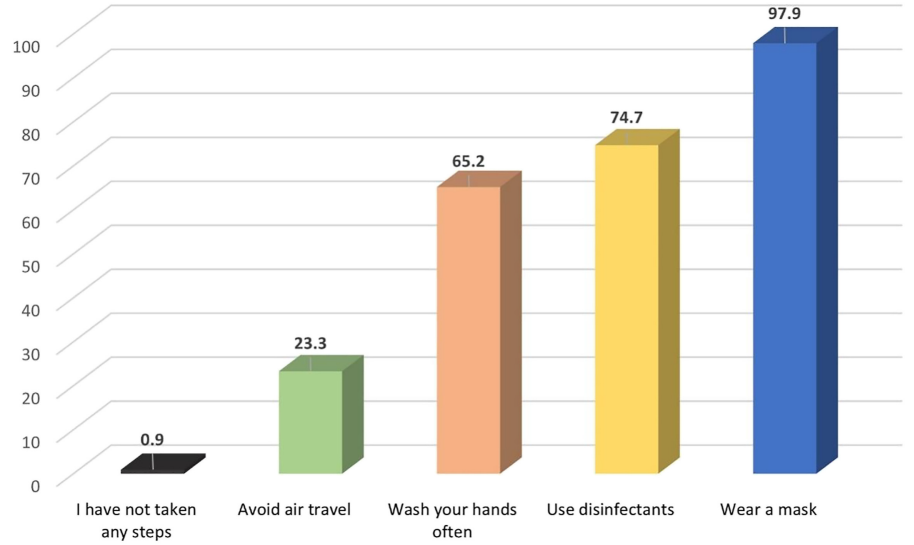


Figure 1.
Willingness to fly during COVID-19 pandemic

Source(s): Author's work

testing at the airport, while the majority (39.4%, $n = 95$) preferred to do it elsewhere including labs/hospitals/home (p-value = 0.452) (Table 3).



Source(s): Author's work

Figure 2. Precautions practice to prevent contracting COVID-19 during air travel

Statement	n	%
Willing to undergo COVID-19 rapid antigen test within 5 hours of boarding the flight in addition to RT PCR within 72 hours of boarding		
Yes	*109*	*45.2*
No	101	41.9
Not sure	31	12.9
Total	241	
Reason for refusal of COVID-19 rapid antigen test		
Expensive	8	5.3
Time consuming	13	8.6
Discomfort in the nose due to repeated testing	14	9.3
Anxiety/Stress	5	3.3
End result is doubtful	14	9.3
No extra benefit	*36*	*23.8*
Flight cancellation	8	5.3
PCR is accurate	12	7.9
Others	38	27.2
Preferred place to perform the COVID-19 rapid antigen test		
Airport	87	36.1
Somewhere else	*95*	*39.4*
Both	59	24.5
Total	241	

Source(s): "Author's work"

Table 3. Preference for COVID-19 rapid antigen test

Correlations between willingness to undergo COVID-19 rapid antigen test and participants' characteristics

The results of the Chi-square test (Table 4) showed a statistical significance for association between the participants who were willing to undergo COVID-19 rapid antigen test (within 5

Table 4. Association between willing to undergo COVID-19 rapid antigen test and socio-demographic characteristics

Sociodemographic characteristics	Classification	Willing to undergo COVID-19 rapid antigen test before boarding		Chi-square value	*p*-value
		Yes n (%)	No n (%)		
Gender	Male	63 (62.4)	63 (57.8)	0.458	0.499
	Female	38 (37.6)	46 (42.2)		
	Total	101 (100)	109 (100)		
Level of Education	High school	2 (2)	10 (9.2)	21.015	*<0.001*
	Bachelor	17 (16.8)	41 (37.6)		
	Master	38 (37.6)	20 (18.3)		
	Doctoral (Ph.D.)	44 (43.6)	38 (34.9)		
	Total	101 (100)	109 (100)		
Age groups (years)	<30	6 (6)	19 (17.6)	8.477	*0.037*
	30–40	39 (39)	31 (28.7)		
	41–50	28 (28)	35 (32.4)		
	>50	27 (27)	23 (21.3)		
	Total	100 (100)	108 (100)		

Source(s): "Author's work"

hours of boarding the flight) and their educational levels ($\chi^2 = 21.015$, df = 3, $p < 0.001$). Regarding the age of the participants, the results of the chi-square test indicated that there is a statistical significance for association between the age groups and willingness to undergo COVID-19 rapid antigen test ($\chi^2 = 8.477$, df = 3, $p < 0.037$).

The results (Table 5) also showed that the mean ages of participants who were willing to undergo COVID-19 rapid antigen test in addition to RT PCR within 72 hours of boarding was 44.09, which is greater than the mean ages of the other participants whose were not willing and were not sure if they were willing to get tested (that is, 41.70 and 41.13, respectively). The results of the analysis of variance (ANOVA) indicated that there are no statistically significant differences between the mean ages of the participants and their willingness to get tested ($F = 1.225$, $p = 0.296$).

Willingness to arrive at the airport to undergo a COVID-19 rapid antigen test. With regard to the willingness to arrive at the airport five hours before boarding the aircraft to undergo a COVID-19 rapid antigen test, 64.7% ($n = 156$) refused (were not willing to arrive at the airport early). The main reason for the refusal was that they preferred not to unnecessarily stay at the airport ($n = 90$, 58.8%). Thirty participants (20.9%) were willing to arrive early at the airport to undergo the PCR test. Furthermore, 49.8% of participants ($n = 120$) preferred to undergo a self-test using rapid antigen test while 26.6% ($n = 64$) refused to do so. This was because of lack of training ($n = 24$, 27.6%), fear of doing it incorrectly ($n = 16$, 18.4%), and the concern that individuals could falsify test results ($n = 18$, 20.7%) (Table 6). Regarding their preference of mandatory COVID-19 rapid antigen tests for all travelers, 37.8% strongly disagreed, while 21.1% agreed (Figure 3).

The results (Table 5) also showed that the mean age of the participants who were willing to reach the airport 5 hours prior to flight departure to undergo COVID-19 rapid antigen test was 40.66, while the mean age of participants who were not willing to reach the airport was 43.69. The results of the independent sample T-test indicated that there are no statistically significant differences in mean ages and the willingness to reach the airport ($T = 1.811$, $p = 0.071$).

Correlations between participants' characteristics and the preferred place and self-test using COVID-19 rapid antigen test

In terms of the preferred place to undergo the COVID-19 rapid antigen test, the results of the chi-squared test (Table 7) showed that there is no statistically significant association between the preferred place to perform the test and socio-demographic characteristics (gender, educational level, and age group) ($P > 0.05$). The results also indicated that there is no

Variables	Mean ± SD	95% C.I Lower	95% C.I Upper	Statistics	*p*-value
Willingness to undergo testing					
Yes ($n = 100$)	44.09 ± 10.97	41.91	46.2	1.225	0.296 [a]
No ($n = 108$)	41.70 ± 12.94	39.23	44.1		
Not sure ($n = 30$)	41.13 ± 14.30	35.79	46.4		
Willingness to reach the airport 5 hours to undergo testing					
Yes ($n = 83$)	40.66 ± 13.79	−6.32	0.266	1.811	0.071 [b]
No ($n = 155$)	43.69 ± 11.42				

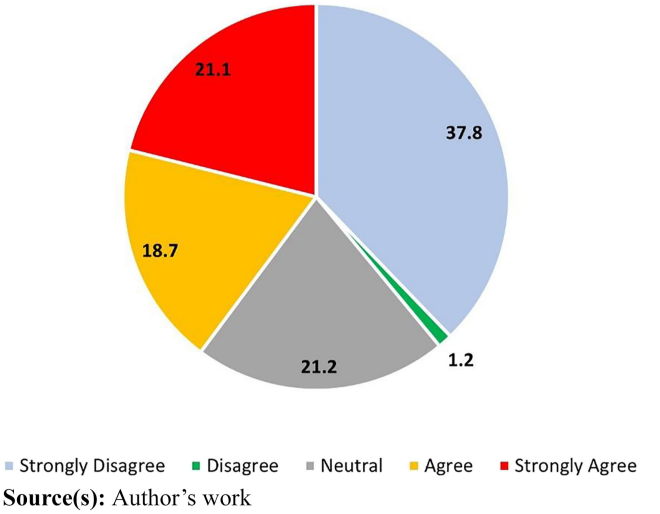
Note(s): a: One-way ANOVA, b: Independent sample *t* test, C.I: Confidence Interval, SD: Standard Deviation
Source(s): "Author's work"

Table 5. The results of the mean differences for the age of participants and their willingness to undergo testing

Statement	n	%
Willingness to reach the airport 5 hours prior to flight departure to undergo COVID-19 rapid antigen test at the airport		
Yes	85	35.3
No	*156*	*64.7*
Total	241	
If no, specify the reason		
Anxiety and stress	1	0.7
Fear of disqualifying/not boarding the aircraft. . .	16	10.5
Long duration of stay in airport	*90*	*58.8*
Practical constraints	11	7.2
If mandatory, fear of missing the flight	2	1.3
Prefer to do PCR and bring the result instead of waiting this long	*32*	*20.9*
Comfortable in our known clinic	1	0.7
Total	153	
Do you think it is feasible to perform a self-test using COVID-19 rapid antigen test?		
Yes	*120*	*49.8*
No	*64*	*26.6*
Not sure	57	23.7
Total	241	
If no, specify the reason		
Anxiety of performing on oneself	11	12.6
Lack of training	*24*	*27.6*
Fear of doing it incorrectly	*16*	*18.4*
Fake reports will be presented	*18*	*20.7*
Test result is not accurate (false positive or false negative may occur)	4	4.6
Others	14	16.1
Total	87	100

Source(s): "Author's work"

Table 6. Perception of air travelers on place and mode of testing



Source(s): Author's work

Figure 3.
Preferences of mandatory COVID-19 rapid antigen tests among travelers

Sociodemographic characteristics	The preferred place Somewhere else (labs/hospitals/ Airport	home)	Both	*p*-value	Feasible to perform a self-test Yes	No	*p*-value
Gender							
Male	48 (55.2)	61 (64.2)	36 (61)	0.456	73 (60.8)	40 (62.5)	0.825
Female	39 (44.8)	34 (35.8)	23 (39)		47 (39.2)	24 (37.5)	
Level of Education							
High school	4 (4.6)	6 (6.3)	4 (6.8)	0.868	4 (6.3)	4 (3.3)	0.692
Bachelor	21 (24.1)	29 (30.5)	16 (27.1)		15 (23.4)	30 (25)	
Master	29 (33.3)	23 (24.2)	18 (30.5)		22 (34.4)	36 (30)	
Doctoral (Ph.D.)	33 (37.9)	37 (38.9)	21 (35.6)		23 (35.9)	50 (41.7)	
Age group (years)							
<30	9 (10.6)	16 (17)	7 (11.9)	0.589	9 (14.3)	11 (9.2)	0.133
30–40	29 (34.1)	28 (29.8)	20 (33.9)		22 (34.9)	39 (32.8)	
41–50	30 (35.3)	24 (25.5)	16 (27.1)		22 (34.9)	32 (26.9)	
>50	17 (20)	26 (27.7)	16 (27.1)		10 (15.9)	37 (31.1)	

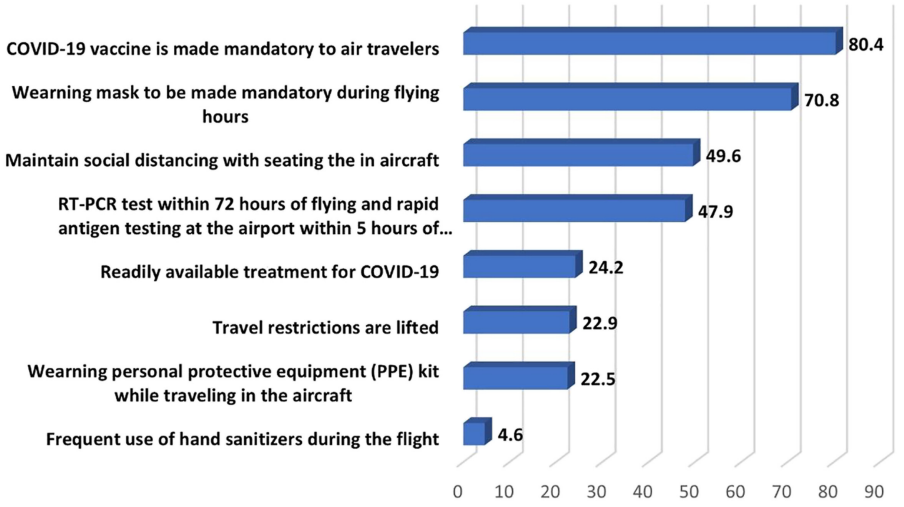
Source(s): "Author's work"

Table 7.
Association between preferred place and self-test, and socio-demographic characteristics

association between the feasibility of performing a self-test using the COVID-19 rapid antigen test and socio-demographic characteristics for participants (gender, educational level, and age group) ($P > 0.05$).

Indicators for resuming safe air travel

On enquiring about the best indicators for resuming air travel, 80.4% of participants identified COVID-19 immunization, while 70.5% identified mandatory wearing of masks during flight hours (Figure 4).



Source(s): Author's work

Figure 4.
Best indicators for resuming air travel again

Discussion

The COVID-19 pandemic impacted people's daily activities and hindered global travel, particularly in the form of bans against international travel. When the flights resumed, all necessary preventive procedures were strictly implemented by air carriers along with the requirement for a negative RT-PCR for COVID-19 within 1–3 days before boarding the flight (Shahid, 2021).

The development of RT-PCR and rapid diagnostics brought some reprieve from the pandemic and played a massive role in the resumption of normal activities including air travel (Shahid, 2021). The availability of RT-PCR and rapid diagnostics would facilitate the detection of early infectious and asymptomatic patients among travelers that reduced the risk for in-flight transmission of the disease. The challenge, thereafter, was to develop testing strategies that would be effective at reducing the risk of SARS-CoV-2 exposures and transmissions aboard commercial planes while ameliorating traveler anxiety. Accordingly, this study aimed to explore travelers' perceptions of COVID-19 rapid tests before boarding the flight, their willingness to fly, and the precautionary actions that can be taken for safe air travel. Most of our study participants were males. The majority were from Bahrain, followed by India, and the Kingdom of Saudi Arabia. Most of the respondents (95%) were also vaccinated.

In our survey, willingness to fly during the pandemic was higher than an unwillingness to fly. This agreeableness to fly may be influenced by the fact that governments allowed the resumption of air travel only after a certain measure of control had been achieved for the disease. Still, understanding the factors that influence unwillingness to fly among travelers and how their confidence can be boosted remains important. Potential passengers were understandably concerned regarding the threat posed by COVID-19. Concern about COVID-19 transmission on public transit is legitimate, even though it can impede rational judgment-make up and induce an emotional reaction (Plutchik, 2001). Even though COVID-19 can be transferred between air travelers, humans frequently make judgments based on risks that they imagine, which have not yet manifested or are not fully understood (Kahneman and Tversky, 2013).

Although personality attributes are not the focus of this study, such attributes may influence people's decisions and willingness to fly. Individuals that show a high agreeableness score are generally kind, courteous, thoughtful, helpful, and reliable, but they are not always conformists. People who fit into this category may be afraid of harming others, such as family and friends, if they fly (Rahafar, Castellana, Randler, & Antúnez, 2017). Since fear and perceived threat are often linked, those who are afraid of flying with COVID-19 are less likely to fly. Passengers may also consider the expenses and benefits of traveling and determine that staying at home is the more reasonable option (Lamb, Winter, Rice, Ruskin, & Vaughn, 2020).

This study also looked at the various precautionary measures undertaken by the travelers to avoid COVID-19. Most of them opted to wear a face mask and use disinfectants. Face masks can help to protect against a variety of respiratory illnesses transmitted by droplets, such as the coronavirus (Humphreys, 2020). The use of disinfectants is also an important measure to prevent the spread of COVID-19. Within the framework of sound infection control, no single preventive activity can be 100% successful at disease prevention (Humphreys, 2020).

Our study showed that there are no statistically significant differences between the mean ages of the participants and their willingness to get tested ($p = 0.296$), which was similar to Song *et al.* (2022). The majority of the participants (44.09 ± 10.97) were willing to undergo COVID-19 rapid antigen testing within 5 hours of boarding the flight, while 41.9% (41.70 ± 12.94) preferred not to do so. The most common reason for refusal was that it carried no added advantage, followed by discomfort in the nose due to repeated testing, and doubtful end results. Some respondents were worried about last-minute flight cancellations, while others preferred PCR tests. These findings support the evidence in the research literature. A similar response was observed in a study conducted by Qahtani *et al.* (2021) wherein a lateral flow device for screening COVID-19 was used in an airport. The researchers noted that around 35 passengers refused to undergo the test due to the fear of being denied boarding if the test was positive (28.6%), followed by the probability of receiving a false-positive result (17.1%), anxiety of nasopharyngeal swabs (17.1%), and opting for PCR testing (17.1%) (Qahtani *et al.*, 2021).

Only 21.1% of respondents agreed that COVID-19 rapid antigen tests should be made mandatory for all travelers, while 37.8% strongly disagreed. However, several studies have shown the benefit of performing a rapid test before boarding an aircraft to filter out positive cases even if the 72-h PCR test was negative (Brooks, 2020; Pitrelli, 2021). From December 2020 to May 2021, Tande *et al.* (2021) conducted COVID-19 rapid antigen tests on 9,853 travelers who had a negative PCR test for SARS-CoV-2 completed within 72 hours of departure. Five (0.05%) passengers with active infection were discovered using rapid antigen tests and the infection was proven using rapid molecular tests. This amounts to a case detection rate of 1 per 1,970 tourists during the high prevalence of active infection in the United States (Tande *et al.*, 2021). A simulation study by Kiang *et al.* (2021) also found that performing a rapid antigen test on the date of travel lowered the infected days to 5,674, which is a 32% decline compared to the baseline (Kiang *et al.*, 2021). Illustrating the significance of rapid antigen testing, following the research by OXERA and Edge Health, the International Air Transport Association (IATA) in 2021 also urged nations to accept rapid antigen tests to meet COVID-19 testing standards. According to the OXERA-Edge Health report commissioned by IATA, antigen tests are effective and the test results are broadly comparable to PCR tests with regard to detecting infected travelers. These tests also involve a short processing time and are cost-effective (Review, 2021). Qahtani *et al.* (2021) demonstrated that COVID-19 screening using rapid tests is feasible in passengers departing on same-day flights. Multiple strategies for asymptomatic test-and-travel are likely to be advantageous, but they will not consistently stop transmission or outbreaks, according to research by Kiang *et al.* (2021). However, each has disadvantages that should be considered.

According to Hindustan Times, all the passengers traveling to UAE by Air India Express were asked to reach the airport 5-6 hours before departure. According to UAE regulations, the Rapid PCR tests must be completed no later than four hours before take-off. The UAE authorities had stated that these paid tests must be performed at source airports (Ghosh, 2021). As per our survey regarding the willingness to arrive at the airport 5 hours prior to boarding to undergo a rapid antigen test, most participants (43.69 ± 13.79) refused this action citing an unnecessary longer stay at the airport and a preference for PCR tests. The study also showed no statistically significant differences in mean ages and the willingness to the reach airport ($P = 0.071$).

The preferred location for the rapid antigen test when examined showed that majority of the respondents preferred to undergo the test at home, hospitals, or in labs. The preference for undergoing the test in places other than the airport could be as per the individual's convenience as well as the fact that places like home and private labs provide more comfortable, stress-free environments. Performing the test in such places would not interfere with their regular schedules while eliminating needless travel to and stay at the airport. In terms of self-testing, 49.8% of the respondents preferred to undergo a self- COVID-19 rapid antigen test, whereas 26.6% ($n = 64$) preferred otherwise. The reasons proffered for refusal were lack of training and the possibility of fraudulent reports being provided at the airport.

Self-testing with rapid antigen tests for COVID-19 could permit extensive testing in the population, thereby enhancing its control (Larremore *et al.*, 2021). A recent study conducted in Germany found that a layperson can be educated to effectively administer a rapid self-test. A total of 146 people with symptoms participated in the trial with 40 of them testing positive for SARS-CoV-2 using a qRT-PCR test. All the subjects then used nasal swabs to conduct additional self-tests. Also, 91.4% of those who tested positive were able to confirm their results with a rapid self-test. Almost everyone who tested negative was able to double-check their results using a self-test. The findings from this study demonstrate the value of self-testing (Lindner *et al.*, 2021). Another study by Stohr *et al.* (2021) explored how well self-testing with rapid antigen detection tests (RDT) performed in the community for people with suspected COVID-19. They discovered that the sensitivity of the younger participants was higher, which might be related to younger individuals' improved self-test performance (Stohr *et al.*, 2021). A study by Polechová *et al.* (2022) also proved that rapid antigen testing at least twice a week could become a valuable weapon in the fight against the COVID-19 pandemic (Polechová *et al.*, 2022). Recently, even at the airports (New Zealand), vaccinated and eligible travelers entering the country are provided with a pack of rapid antigen tests with instructions. The travelers take their test as instructed on Day 0/1 and Day 5/6 from the arrival date and report the test result (New Zealand Government, 2022).

With regard to the best indicators to resume safe air travel, the majority of the respondents opted for mandatory COVID-19 vaccinations for all travelers, followed by wearing masks throughout flying hours, and maintaining social distancing with seating in the aircraft. Since the absence of such indicators may prevent individuals from flying, airlines must devise a broad approach to take care of their travelers as well as justify the efficiency of these measures (Lamb *et al.*, 2020). Mandatory wearing of face masks for travelers and aircrew that comply with CDC rules may be an obvious option. Implementing mandatory vaccination as a pre-requisite for air travel will of course safeguard the air travelers (Centers for Disease Control and Prevention, 2022). Disinfection and deep washing of surfaces with a quaternary ammonium compound as well as ultraviolet radiation may aid to inactivate SARS-CoV-2. In addition to vaccination and disinfection, aircrafts will need to sustain social distancing to reduce the viral spread. The likelihood of direct spread to passengers not seated near a symptomatic passenger has already been shown to be low in one investigation of respiratory infections transferred by droplets (Hertzberg *et al.*, 2018). Other interventions such as increased rate of air exchanges and enhanced clearing, social distancing during deplaning,

and the exclusion of symptomatic individuals contribute to increased safety (Tande *et al.*, 2021). These actions, as well as constant communications regarding the practical steps made to reduce the risk of flying, may be essential in the near future to assure passenger safety. It is important that customers understand that airlines are concerned about their safety (Lamb *et al.*, 2020).

Following are the limitations of the study: a) The sample size is small; hence, the results cannot be generalized for the global population. b) Furthermore, the gender, educational level, etc of the study participants are not equally distributed. c) This is a questionnaire-based study. It would have been better if it was conducted as a mixed-method study with additional qualitative data. d) All the responses are self-reported. Therefore, there is a possibility of self-reporting bias.

Research implications

This study allowed comprehending the traveler's frame of mind for air travel during COVID-19 pandemic and their perceptions of safety strategies that can be shadowed during air travel. The results of this study can assist airlines as well as national and international organizations including health officials and governments to plan accordingly in the phase of a new pandemic. This study also paves way for future research that can include mixed-methodology and other factors like effectiveness of airline and national and international policies followed during COVID-19 pandemic and can serve as empirical support to help the airlines and governments develop effective forthcoming pandemic control strategies.

Conclusions

The COVID-19 pandemic has caused great harm to tourism and hospitality industry. The current study reveals the considerations that are important for travelers as air carriers resume global travel. According to the survey, only 45.2% of travelers were willing to consent to COVID-19 rapid antigen tests. Since there was no significant difference (p-value: 0.296) among the preferences of air travelers to undergo COVID-19 rapid antigen test, we are not able to accept our hypothesis. The majority of travelers (64.7%) were hesitant to arrive at the airport five hours prior to departure. In addition, there was no statistically significant differences (p-value: 0.071) in mean ages and the willingness to reach the airport to undergo COVID-19 rapid antigen test. However, our study shows that policies requiring mandatory vaccinations, use of masks, and sanitization of the aircraft could help reduce passenger anxiety and increase their willingness to fly. It may be beneficial if airlines and other government organizations educate the travelers regarding the measures taken to ensure their safety.

References

Ban, H. J., & Kim, H. S. (2020). Applying the modified health belief model (HBM) to Korean medical tourism. *International Journal of Environmental Research and Public Health*, *17*(10), 3646. doi: 10.3390/ijerph17103646.

Brooks, K. J. (2020). What travelers should know about COVID-19 testing before boarding a plane, Available from: https://www.cbsnews.com/news/covid-testing-boarding-airplane/ (accessed 18 June 2022).

Centers for Disease Control and Prevention (2022). Requirement for proof of COVID-19 vaccination for air passengers, 31/01/2022, Available from: https://www.cdc.gov/coronavirus/2019-ncov/travelers/proof-of-vaccination.html (accessed 15 June 2022).

Chaulagain, S., Pizam, A., & Wang, Y. (2020). An integrated behavioral model for medical tourism: An American perspective. *Journal of Travel Research*, Early Access No. Mar 2020, 1–18.

Chen, L. H., & Steffen, R. (2021). SARS-CoV-2 testing to assure safety in air travel. *Journal of Travel Medicine*, *28*(2). doi: 10.1093/jtm/taaa241, taaa241.

Choi, E. M., Chu, D. K., Cheng, P. K., Tsang, D. N., Peiris, M., Bausch, D. G., . . . Watson-Jones, D. (2020). In-flight transmission of SARS-CoV-2. *Emerging Infectious Diseases*, *26*(11), 2713.

Ghosh, P. (2021). India-UAE flights: Why passengers have to reach airport 5-6 hours before departure. *Hindustan Times*, Available from: https://www.hindustantimes.com/india-news/indiauae-flights-why-passengers-have-to-reach-airport-5-6-hours-before-departure-101628679671334.html (accessed 16 December 2022).

Graham, A., Kremarik, F., & Kruse, W. (2020). Attitudes of ageing passengers to air travel since the coronavirus pandemic. *Journal of Air Transport Management*, *87*, 101865. doi: 10.1016/j.jairtraman.2020.101865.

Hertzberg, V. S., Weiss, H., Elon, L., Si, W., Norris, S. L., & Team, F. R. (2018). Behaviors, movements, and transmission of droplet-mediated respiratory diseases during transcontinental airline flights. *Proceedings of the National Academy of Sciences*, *115*(14), 3623–3627.

Huang, X., Dai, S., & Xu, H. (2020). Predicting tourists' health risk preventative behaviour andtravelling satisfaction in Tibet: Combining the theory of planned behaviour and health beliefmodel. *Tourism Management Perspectives*, *33*.

Humphreys, J. (2020). The importance of wearing masks in curtailing the COVID-19 pandemic. *Journal of Family Medicine and Primary Care*, *9*(6), 2606–2607. doi: 10.4103/jfmpc.jfmpc_578_20.

International Air Transport Association. (2020). *Passenger Market Analysis*. International Air Transport Association, Montreal, Canada. Available from: https://www.iata.org/en/iata-repository/publications/economic-reports/airlines——dec-2019/

Kahneman, D., & Tversky, A. (2013). Prospect theory: An analysis of decision under risk. In *Handbook of the fundamentals of financial decision making: Part I* (pp. 99–127). Singapore: World Scientific.

Kevadiya, B. D., Machhi, J., Herskovitz, J., Oleynikov, M. D., Blomberg, W. R., Bajwa, N., . . . Gendelman, H. E. (2021). Diagnostics for SARS-CoV-2 infections. *Nature Materials*, *20*(5), 593–605. doi: 10.1038/s41563-020-00906-z.

Khatib, A. N., McGuinness, S., & Wilder-Smith, A. (2021). COVID-19 transmission and the safety of air travel during the pandemic: A scoping review. *Current Opinion in Infectious Diseases*, *34*(5), 415–4229.

Kiang, M. V., Chin, E. T., Huynh, B. Q., Chapman, L. A. C., Rodríguez-Barraquer, I., Greenhouse, B., . . . Lo, N. C. (2021). Routine asymptomatic testing strategies for airline travel during the COVID-19 pandemic: A simulation study. *The Lancet Infectious Diseases*, *21*(7), 929–938. doi: 10.1016/S1473-3099(21)00134-1.

Kim, M. J., Bonn, M., & Hall, C. M. (2021). Traveler biosecurity behavior during the COVID-19 pandemic: Effects of intervention, resilience, and sustainable development goals. *Journal of Travel Research*, *0*(0), 00472875211034582. doi: 10.1177/00472875211034582.

Kim, M. J., Hall, C. M., & Bonn, M. (2021). Does international travel frequency affect COVID-19 biosecurity behavior in the United States? *International Journal of Environmental Research and Public Health*, *18*(8). doi: 10.3390/ijerph18084111.

Kim, M. J., Bonn, M., & Hall, C. M. (2022). What influences COVID-19 biosecurity behaviour for tourism? *Current Issues in Tourism*, *25*(1), 21–27. doi: 10.1080/13683500.2021.1883558.

Kim, Y. J., & Kang, S. W. (2021). Perceived crowding and risk perception according to leisure activity type during COVID-19 using spatial proximity. *International Journal of Environmental Research and Public Health*, *18*(2), 457. doi:10.3390/ijerph18020457.

Lamb, T. L., Winter, S. R., Rice, S., Ruskin, K. J., & Vaughn, A. (2020). Factors that predict passengers willingness to fly during and after the COVID-19 pandemic. *Journal of Air Transport Management*, *89*, 101897. doi: 10.1016/j.jairtraman.2020.101897.

Larremore, D. B., Wilder, B., Lester, E., Shehata, S., Burke, J. M., Hay, J. A., … Parker, R. (2021). Test sensitivity is secondary to frequency and turnaround time for COVID-19 screening. *Science Advances*, *7*(1). doi: 10.1126/sciadv.abd5393.

Lindner, A. K., Nikolai, O., Rohardt, C., Kausch, F., Wintel, M., & Gertler, M. (2021). Head-to-head comparison of SARS-CoV-2 antigen-detecting rapid test with self-collected nasal swab *versus* professional-collected nasopharyngeal swab. *European Respiratory Journal*, *57*(4), 2003961. doi: 10.1183/13993003.03961-2020..

Nepal, S. K. (2020). Travel and tourism after COVID-19 – business as usual or opportunity to reset? *Tourism Geographies*, 1470–1340.

Neuburger, L., & Egger, R. (2021). Travel risk perception and travel behaviour during the COVID-19 pandemic 2020: A case study of the DACH region. *Current Issues in Tourism*, *24*(7), 1003–1016.

New Zealand Government (2022). Testing requirements after arriving in New Zealand. Available from: https://covid19.govt.nz/international-travel/travel-to-new-zealand-by-air/testing-requirements-after-arriving-in-new-zealand/ (accessed 6 July 2022).

Peluso, A. M and Pichierri, M (2020). Effects of socio-demographics, sense of control, and uncertainty avoidability on post-COVID-19 vacation intention. *Current Issues in Tourism*, *24*, 1–13. doi: 10.1080/13683500.2020.1849050.

Pitrelli, M. B. (2021). Nearly 10,000 passengers tested negative before flying — here's how many infections slipped through. Available from: https://cnb.cx/39aT90R (accessed 17 April 2022).

Plutchik, R. (2001). The nature of emotions: Human emotions have deep evolutionary roots, a fact that may explain their complexity and provide tools for clinical practice. *American Scientist*, *89*(4), 344–350.

Polechová, J., Johnson, K. D., Payne, P., Crozier, A., Beiglböck, M., Plevka, P., & Schernhammer, E. (2022). SARS-CoV-2 rapid antigen tests provide benefits for epidemic control – observations from Austrian schools. *Journal of Clinical Epidemiology*, *145*, 14–19. doi: 10.1016/j.jclinepi.2022.01.002.

Qahtani, M. A., Yang, C. W. T., Lazosky, L., Li, X., D'Cruz, J., Romney, M. G., & Sin, D. D. (2021). SARS-CoV-2 rapid antigen testing for departing passengers at Vancouver International Airport. *Journal of Travel Medicine*, *28*(7). doi: 10.1093/jtm/taab085.

Qiao, G., Ruan, W. J., & Pabel, A. (2021). Understanding tourists' protection motivations when faced with overseas travel after COVID-19: The case of South Koreans travelling to China. *Current Issues in Tourism*, *25*(10), 1–19. doi:10.1080/13683500.2021.1928011.

Rahafar, A., Castellana, I., Randler, C., & Antúnez, J. M. (2017). Conscientiousness but not agreeableness mediates females' tendency toward being a morning person. *Scandinavian Journal of Psychology*, *58*(3), 249–253. doi: 10.1111/sjop.12362.

Review, I. A. (2021). IATA urges governments to accept rapid antigen tests to fulfil testing requirements. Available from: https://www.internationalairportreview.com/news/155328/iata-rapid-antigen-tests-testing-requirements/ (accessed 25 July 2022).

Rice, S., Winter, S. R., Capps, J., Trombley, J., Robbins, J., Milner, M., & Lamb, T. L. (2020). Creation of two valid scales: Willingness to fly in an aircraft and willingness to pilot an aircraft. *International Journal of Aviation, Aeronautics, and Aerospace*, *7*(1), 5.

Rittichainuwat, B. N., & Chakraborty, G. (2009). Perceived travel risks regarding terrorism and disease: The case of Thailand. *Tourism Management*, *30*(3), 410–418. doi: 10.1016/j.tourman.2008.08.0018.

Shahid, M. (2021). Can a '3-tier screening' strategy be adopted during COVID-19 pandemic for safer air travel and to help curb its spread across borders? *The Open Covid Journal*, *1*, 62-64. doi: 10.2174/2666958702101010062.

Shepardson, D., Reese, C., & Ellis, A. (2020). American airlines, delta, united to require facial coverings on US flights. *New York Times*. Available from: https://www.reuters.com/article/us-health-coronavirus-usa-airlines-idUSKBN22C3QZ (accessed 2 July 2022).

Song, S., Zang, S., Gong, L., Xu, C., Lin, L., Francis, M.R., & Hou, Z. (2022). Willingness and uptake of the COVID-19 testing and vaccination in urban China during the low-risk period: A cross-sectional study. *BMC Public Health*, *22*(1), 556. doi: 10.1186/s12889-022-12969-5.

Stohr, J. J. J. M., Zwart, V. F., Goderski, G., Meijer, A., Nagel-Imming, C. R. S., Kluytmans-van den Bergh, M. F. Q., ... Kluytmans, J. A. J. W. (2021). Self-testing for the detection of SARS-CoV-2 infection with rapid antigen tests for people with suspected COVID-19 in the community. *Clinical Microbiology and Infection: The Official Publication of the European Society of Clinical Microbiology and Infectious Diseases*, *S1198-1743X*(1121), 00434-00431. doi: 10.1016/j.cmi.2021.07.039.

Tande, A. J., Binnicker, M. J., Ting, H. H., Del Rio, C., Jalil, L., Brawner, M., . . . Berbari, E. F. (2021). SARS-CoV-2 testing before international airline travel. December 2020 to May 2021. *Mayo Clinic Proceedings*, *96*(11), 2856–2860. doi: 10.1016/j.mayocp.2021.08.019.

Corresponding author
Mohammed Shahid can be contacted at: Mohammeds@agu.edu.bh