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TROPICAL, TRAVEL AND EMERGING INFECTIONS (LH CHEN AND F NORMAN, SECTION EDITORS)

Airport COVID-19 Testing of Travelers: An Island Destination Perspective

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Abstract

Purpose of Review To highlight recent literature on airport COVID-19 testing studies among travelers at international borders and to identify factors that may contribute to bias.

Recent Findings Literature search shows vastly different study designs and goals for airport COVID-19 screening programs, with positivity rates ranging from 0.1 to 100%. Goals included detecting the maximum cases with enforced isolation, determining an accurate positivity rate among travelers, investigating alternative diagnostics, and evaluating pre-travel programs. Participation rates are in the low (27–40%) to high ranges (72–100%).

Summary The implementation strategy differs depending on the primary goal. If the goal is to ban new cases or perform active surveillance of new variants, then it is reasonable to consider mandatory airport testing, or voluntary testing with genome sequencing and isolation. If the goal is to determine an accurate positivity rate among travelers or effectiveness of pre-travel programs, then it is reasonable to consider an anonymous, voluntary testing program (without associated isolation) to minimize self-selection bias or distortion of travelers.

Keywords SARS-CoV2 · Screening · International · Border · Surveillance · Quarantine · Isolation

Introduction

Island nations were once very remote, but globalization and modern advances, such as aircraft, cargo ships, and cruise boats, have revolutionized the movement of people, animals, and trade around the world. This situation has facilitated the stage for a rapid global pandemic, such as the COVID-19 pandemic [1], in which the World Health Organization (WHO) has estimated 7 million reported deaths as of February 2023 [2], while a Nature study estimated 14.8 million deaths in 2020–2021 alone [3].

Island nations such as the Pacific Island countries and territories reported high morbidity and mortality with the pandemic due to inadequate medical capacity, surveillance systems, vaccine delivery, and healthcare workforce [4]. Early in the pandemic, Hawaii upheld an emergency mandate of a required 14-day quarantine for all arriving travelers, to "flatten" the epidemic curve and allow time for the state to mobilize its medical capacity and identify facilities for isolation and quarantine. Historically, Hawaii suffered immensely from imported diseases, since the arrival of the Captain Cook in 1778, with cycles of epidemics from cholera, influenza, tuberculosis, smallpox, and leprosy

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[5•]; scholars estimated that the native Hawaiian population decreased from 700,000 to 40,000 in the span between 1778 and 1990 due to imported infections [6]. It was no surprise that Hawaiians called for and supported this travel quarantine mandate to slow down the COVID-19 spread into its community.

As travel restrictions lessened worldwide, countries have been strategizing how to conduct active surveillance of COVID-19 cases and novel variants and to minimize cross-border transmission. The WHO presented a brief report on the topic of diagnostic testing in the setting of international travel [7••]. Active surveillance with testing at international borders requires risk-cost–benefit assessment and considerations of epidemiological situations, healthcare capacities, isolation protocols, specific diagnostics, and available resources to cover test costs. The WHO calls for emerging information to better evaluate this critical topic. Since then, a number of airport COVID-19 testing studies have been published, and there lacks a review of these studies: study goals, designs, positivity rates, whether airport COVID-19 testing is recommended or not, and factors that may contribute bias to case detection or reported positivity rates.

Bias and distortion may be closely associated or even inherent to the implementation design of the airport study and affect findings. For example, one study goal may be to maximize case detection; therefore, investigators may implement mandatory departure and/or arrival testing at airports. However, this may greatly alter or distort the type of traveler who chooses to travel during this study. Many may choose not to travel due to a fear that a positive result will lead to isolation for oneself and quarantine for co-travelers. Those who may opt out of traveling will likely be those with higher COVID-19 risk, such as individuals with symptoms, recent exposure, no vaccinations, or higher-risk behaviors. The smaller number of passengers who continue to travel will likely have a comparatively low infection rate; therefore, there is negative skew, and this would not accurately reflect the broader group of travelers.

Another goal may be to capture an accurate positivity rate of the overall traveler's group. A study may have voluntary airport testing with enforced isolation for positive test results. This study design may lead to self-selection bias since passengers will consider how inconvenient a positive test result may be. Passengers who may perceive themselves as having a lower COVID-19 risk may be more willing to enroll in this voluntary testing, which would lead to a negative bias of the positivity rate. One way to minimize self-selection bias is to aim to achieve a participation rate (i.e., % of those solicited who decide to enroll) that is greater than 65–70% [8]. If one changes the study design to allow for anonymous, voluntary airport testing (without associate isolation), then this may lessen the self-selection bias. An interesting positive bias towards participation may be present among a small subset of passengers, such as those who are elderly or immunocompromised, who are more interested in taking the available and convenient COVID-19 test at the airport due to their desire for early diagnosis and treatment. Table 1 discusses factors that may affect travelers and contribute to bias towards participation and positivity rates.

We review and summarize airport COVID-19 studies with a focus on their goals, designs, positivity rates, associated biases, and recommendations. We also suggest strategies for future airport COVID-19 studies given the continued SARS-CoV-2 circulation globally and novel variants that are emerging globally and entering isolated populations.

Methods

Between January 1, 2020, and February 10, 2023, the authors searched PubMed and Google Scholar databases using search terms relevant to COVID-19 (e.g., "COVID-19," "SARS-CoV-2") combined with search terms relevant to testing (i.e., "diagnostics," "rapid test," "PCR," "screening," "surveillance"), airports (i.e., "airport," "travel," "international," "borders"), and importation of cases (i.e., "imported," "incoming," "migration"). The search was restricted to publications in English. Evidence from recent public health studies, systematic reviews, meta-analyses, and opinion articles was prioritized. The gray literature was consulted for relevant online reports from reputable domestic and international agencies involved in news, travel, and health organizations.

Results

The literature search identified 26 publications about COVID-19 testing at airports, including ten studies involving primary research of airport COVID-19 testing (details summarized in Table 2). The goals of the studies varied widely, and studies often had more than one primary goal; the five categories of goals are as follows: (A) determine a representative positivity rate of incoming travelers (6 studies); (B) detect positive cases (5 studies); (C) investigate an alternative test as a feasible option to the gold-standard test, i.e., rapid antigen test or salivary specimen (5 studies); (D) evaluate the effectiveness of a pre-travel program (2 studies); and (E) determine the most effective location for a screening center (1 study) [9••, 10••, 11••, 12–18]. Note that the study from Japan had two phases of its airport study where each phase is shown in its own columns.

Six of the ten studies provided an overall study participation rate. Of these, two had mandatory airport testing at either departure or arrival for all passengers; therefore, there was an implied 100% participation rate. Two studies had high

Table 1 Factors contributing to bias in COVID-19 case detection for airport testing programs

Timeline	Factors	Possible Effects	
		Participation	Positivity rate
Pre-travel	Previous immunity (i.e., prior vaccination or infection)	Positive bias since travelers may be confident of their lower chances of having COVID-19	Negative bias since lower chances of having COVID-19
	Mandatory PCR test < 72 h prior to departure	Positive bias since travelers may be confident of their lower chances of having COVID-19	Negative bias since lower chances of having COVID-19 and may alter the type of traveler (less risky behavior)
	Knowledge of mandatory post-arrival testing or mandatory quarantine for all travelers		Negative bias since this will significantly alter travel plans or distort the type of traveler who will choose to travel (less risky behavior)
During Travel	Announcement of arrival test		May lower COVID-19 risk for passengers
	Mitigation (masking, distancing, ventilation)		May lower COVID-19 risk for passengers
Post-arrival	Mandatory post-arrival testing	No self-selection bias at this point since every traveler is required to be tested	
	Voluntary test with no enforced quarantine (i.e., anonymous testing)	Positive bias since there is no enforced quarantine	Negative bias if those with less risky behaviors participate since they are confident of their lower chances of having COVID-19 Positive bias towards positivity rate if those who are at higher risk (i.e., symptomatic, recent exposure) are eager to participate
	Voluntary test with enforced quarantine	Negative bias since travelers do not want to alter their plans and quarantine for positive test results	Negative bias since those who are more confident of their lower chances of COVID-19 will participate

Factors contributing to bias in detecting COVID-19 cases and positivity rates for airport testing programs

Table 2 Summary chart of 10 primary research studies on airport COVID-19 testing

	Study ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8a**[a]	**8b**[a]	**9**	**10**
	Location(s)	USA	Canada	USA, Italy	Hong Kong	Hainan, China	Malaysia	Italy	Japan	Japan	Italy	South Korea
Background study details	Airport	Kahului Airport	Toronto Pearson International Airport	Atlanta or New York City to Rome or Milan	Hong Kong International Airport	Sanya Airport	Kuala Lumpur International Airport	Fiumicino or Ciampino Airports, Civitavecchia Ship Port	Narita or Haneda International Airports	Peri-Airport Quarantine Facility	Mario De Bernardi Military Airport	Incheon International Airport
	Primary goal (s)	1. Determine positivity rate 2. Evaluate pre-travel program	1. Determine positivity rate 2. Detect cases	1. Determine positivity rate 2. Evaluate pre-travel program	1. Test symp. travelers and HCWs to reduce burden at hospital	1. Validate rapid test against gold standard 2. Detect cases	1. Validate saliva vs. NP + OP 2. Determine positivity rate	1. Validate rapid test against gold standard 2. Determine cases & rate	1. Detect cases	1. Validate rapid test against gold standard	1. Validate rapid test against gold standard	1. Determine most effective location for screening centers
	Goal(s)[b]	*A, D*	*A, B*	*A, D*	*A, B*	*C, B*	*C, A*	*C, A, B*	*B*	*C*	*C*	*E*
	Types of passengers	Visitors only	All passengers	All passengers	Stable symp returning travelers; HCW	Passengers from high-risk areas	All passengers	All passengers	All passengers	Positive, asymp travelers in quarantine	Military and civilian personnel	All passengers
	Symp vs Asymp	Asymp	Asymp	Asymp	Symp	–	Asymp	–	Both	Asymp	Both	–
	Dates	November 20–30, 2020	September 3–October 31, 2020	December 19, 2020–May 19, 2021	March 20–April 19, 2020	April 8–May 11, 2020	September 1–30, 2020	August 17–October 15, 2020	July 27–August 1, 2020	July 27–August 8, 2020	November 2020–April 2021	Until March 30, 2020
	Testing type	PCR	PCR	Rapid Antigen, then Molecular	Rapid Molecular	PCR, Antibody, Xpert Assay	PCR	Rapid Antigen FIA, Molecular	PCR or LAMP	PCR, LAMP, or Antigen	AFIAS, PCR	–
	Sample type	NP	Oral-nasal	–	NP	NP	Saliva, or NP + OP	NP	NP	NP, nasal, saliva	NP	–
	Collection day	Day 0	Day 0, 7, 14	Day 0	Day 0	Day 0	Day 0	Day 0	Day 0	Days 1–7	Day 0	Day 0
	Collection by	Staff	Self	–	Staff	–	Self (Saliva) Staff (NP + OP)	Staff	–	Self and Staff	–	Staff

Table 2 (continued)

	Study ID	1	2	3	4	5	6	7	8a[a]	8b[a]	9	10
	Location(s)	USA	Canada	USA, Italy	Hong Kong	Hainan, China	Malaysia	Italy	Japan	Japan	Italy	South Korea
Study design affecting bias	Participation rate	Reported	Reported	Implied	Reported	Implied	Reported	Unreported	Unreported	Implied	Unreported	Unreported
	Participation rate (%)	72.0%	40.0%	100.0%	27.2%	100.0%	88.5%	–	–	100.0%	–	–
	Mandatory vs. voluntary	Voluntary	Voluntary	Mandatory	–	Mandatory	–	Voluntary	–	Mandatory	–	–
	Anonymous vs. not anonymous	Anonymous	Not anonymous	Not anonymous	Not anonymous	Not anonymous	–	–	–	Not anonymous	–	–
	Consequence vs. no consequence	No consequence	Consequence	Consequence	Consequence	Consequence	–	–	Consequence	Consequence	–	–
	Arrival vs. Departure	Departure	Arrival	Departure	Arrival	Arrival	Arrival	Arrival	Arrival	Arrival	Arrival	Arrival
	Randomized vs. non-randomized	Non-Randomized	Randomized	Randomized	Non-randomized	Randomized	Randomized	–	–	Non-randomized	–	–
	Informed status	Not Informed	Informed Beforehand	Informed Beforehand	–	–	–	–	–	–	–	–
	Authors discuss selection bias	Yes	Yes	Yes	No	No	No	No	No	No	No	No
	Recommend airport COVID-19 testing	Yes	Yes	No	Yes	Yes	–	Yes	Yes	Yes	–	Yes
Cases	Positive cases (#)	2	248	5	88	2	6	1176	51	27	–	–
	Total people tested[b]	281	16,361	9853	1210	–	352	73,643	7689	27	1183	–
	Positivity rate (%)	0.7%	1.5%	0.1%	7.3%	–	1.2% (0.4–2.9)	1.6%	0.7%	100.0%	–	–

participation rates of 72% and 89% with goals to reporting positivity rates, which were 0.7% and 1.2% respectively. Two studies had low participation rates, 27% and 40%, and both studies had primary goals of reporting the number of positive cases (248 and 88) and positivity rates (1.5% and 7.3%). Seven of the ten studies reported a positivity rate for their study population, in the order of Table 2: 0.7%, 1.5%, 0.1%, 7.3%, 1.2%, 1.6%, 0.7%, and 100.0%. One study reported only the number of positive cases (2 cases) but did not report the total number of study participants. One study did not report the number of positive cases but only the total number of study participants (1183); this study collected multiple specimens from participants and reported only the number of overall positive collected specimens rather than cases. One study did not report the number of positive cases nor the positivity rate.

Two of the studies involved testing at the departure airport, while eight studies involved testing at the arrival airport. Smaller studies tested an estimated range of 20–350 passengers, while larger studies tested an estimated range of 1000–70,000 passengers. The types of passengers varied among the studies: all passengers, only visitors, military personnel, passengers departing from high-risk areas, healthcare workers, or returning travelers who were symptomatic but stable. Half of the studies tested only asymptomatic passengers, while the other half tested either symptomatic or both (symptomatic and asymptomatic). The testing modalities included polymerase chain reaction (PCR), rapid antigen such as fluorescent immunoassay (FIA) or automated fluorescent immunoassay system (AFIAS), molecular testing, antibody testing, or loop-mediated isothermal amplification (LAMP). Seven of the studies used nasopharyngeal (NP) samples, while three studies included oral, nasal, oropharyngeal, and salivary specimens. All ten studies had testing on collection day 0; however, one difference for study 1 was that their collection occurred at the end of a visitor's trip. Two studies added testing on successive days (days 1–7, or days 7 and 14). Six of the studies involved testing performed by study staff, while three studies involved self-testing. Three of the studies occurred in March–May 2020, four studies occurred in July–October 2020, and the three studies occurred in November 2020–May 2021. One airport study also included testing a ship port for border control. The countries involved in primary research of airport COVID-19 screening studies included the USA, Canada, Italy, Hong Kong, China, Malaysia, Italy, Japan, and South Korea.

One study had anonymous testing (with no enforced isolation), while five studies were not anonymous and carried consequence of isolation for positive results. Two studies included informing travelers about the airport testing ahead of time, while one study did not inform travelers ahead of time. The other seven studies did not report whether they informed travelers beforehand or not. Only three of the

Table 2 (continued)

Summary of 10 studies on airport COVID-19 testing [9••, 10••, 11••, 12–18]: study details, study design components that affect bias, and overall COVID-19 cases and positivity rates

symp symptomatic, asymp asymptomatic, *HCWs* health-care workers, *NP* nasopharyngeal, *OP* oropharyngeal

[a]The study in Japan had 2 phases of airport testing

[b]Primary study goals A–E are (A) determine a representative positivity rate of incoming travelers (6 studies), (B) detect positive cases (5 studies), (C) investigate an alternative test as a feasible option to the gold-standard test, i.e., rapid antigen test or salivary specimen (5 studies), (D) evaluate the effectiveness of a pre-travel program (2 studies), and (E) determine the most effective location for screening center (1 study) [9••, 10••, 11••, 12–18]

studies discuss selection bias or distortion, while the other seven did not address it. Seven studies recommended airport COVID-19 screening, while one study did not recommend it.

Three Airport COVID-19 Studies that Discuss Selection Bias

USA and Italy Airport Study

Tande et al. partnered with Delta Airlines and Mayo Clinic to run a pilot program for mandatory testing at the departure airport to evaluate the effectiveness of the pre-travel program (required testing 72 h before departure) [9••]. Of the 9853 passengers tested at the departure airport, five were positive, leading to a 0.04% positivity rate, which the authors pointed out was significantly lower than the average 1.1% community infection at that time. Positive cases were moved to designated hotels until the results of confirmatory tests became available. The authors concluded that the pre-travel testing program was effective. Since the pilot program resulted in such a low yield, they did not recommend mandatory airport testing (either at departure or arrival) in addition to the pre-travel testing. The authors discussed that one major limitation was that the prior knowledge of the additional mandatory airport testing (and consequence of isolation if tested positive) may have been a major deterrent to travelers. There may have been self-selection where travelers who perceived themselves as lower COVID-19 risks or have lower risk behaviors may have decided to still travel while others may have opted not to travel. Also, travelers may have behaved more cautiously since there would be airport testing. These may have led to a negative bias for the positivity rate.

Toronto Airport Study

Goel et al. conducted a Toronto Airport study with voluntary testing on arriving international passengers, who were solicited on the flight via announcement and by posted signs in the arrival areas [10••]. They reported that 248 of the 16,361 enrolled passengers tested positive, resulting in a positivity rate of 1.5% (CI 1.3–1.7%). Their best estimate of the participation rate approached 40%. The authors discuss probable self-selection bias that was both positive and negative, so the overall direction of bias is unclear. Passengers with higher risk behaviors may have avoided the voluntary testing. However, at the time, PCR testing was not widely available; many passengers may have tried to take advantage of the free testing. Selection bias likely affected the overall positivity rate, and given the low participation rate (40%), it is misleading to apply their positivity rate to all incoming travelers. Two-thirds of positive cases occurred on day 0 at the airport compared to days 7 and 14; therefore, the authors recommended airport screening on day 0 to detect the most positive cases at the border.

Hawaii Airport Study

A pilot study partnered with the Hawaii Department of Health, Maui District, to evaluate the pre-travel program (required testing 72 h before departure) [11••]. Miller previously estimated a positivity rate of 0.65 cases per 1000 travelers arriving to Hawaii [19] and concluded that the pre-travel program was very effective at points of entry. Despite the large sample of nearly 22,000 post-arrival tests, concerns about bias arose regarding the low participation rate (< 10%) attributed to its online solicitation strategy and enforced isolation for positive results, as well as self-deselection biases and distortion [20•]. Based on a traveler survey, the Maui investigators determined that on-arrival testing faced barriers including the consequences of positive results (i.e., isolation for self and quarantine for co-travelers) and impact on travel plans. Thus, the Maui study enrolled visitors (with negative pre-travel COVID-19 tests) who stayed in Hawaii for ≤ 14 days, at the airport as they were leaving Maui, and positive results were only available to subjects (anonymous to health officials). The study had a high participation rate (72%) and among 281 passengers tested, there were two positive cases, leading to a positivity rate of up to 7 cases per 1000 travelers. One case from Wisconsin stayed in Maui for 1 day before testing while another from California had stayed in Maui for 7 days before testing. The latter case might have been infected in Maui; however, COVID-19 case rate had been 14-fold higher in California than Hawaii at the time, hence a higher likelihood of exposure in California. With the reduced selection bias, authors estimated that up to 20–30 infected travelers were arriving daily to Maui in November and December 2020, which surpassed the Maui District Health Office's projected ability to accommodate 10 infected visitors daily. The investigators concluded that the pre-travel program was suboptimal and recommended airport testing to provide active surveillance of imported cases and new variants, and to continually monitor the effectiveness of pre-travel programs.

Discussion

Our review found wide variation in the study designs and goals of airport COVID-19 testing of travelers, with positivity rates ranging from 0.1 to 100%. Although the WHO discussed the use of airport testing for active surveillance of incoming cases and variants in travelers [7••], this review reveals airport testing is being utilized for very different purposes, ranging from validating alternative diagnostics,

to evaluating pre-travel programs or determining an effective location for a public screening center.

One major point is when the goal is to determine a true positivity rate and to extrapolate it to greater group of incoming travelers, it is essential to evaluate for the validity of the rate and for any biases that may affect the participation or positivity rate. Low participation rates should raise concern about self-selection bias, and study design may possibly lead to distortions or biases to the positivity rate. Mandatory airport testing may distort the type of passengers that decide to travel, and voluntary airport testing with enforced isolation will likely cause less participation and negative bias to positivity rates due to the inconvenience of positive test results. Voluntary and anonymous testing (without consequence) may be the optimal setting for improving participation and removing of the major deterrent of isolation for positive results.

It is also important to consider what group was being investigated in the study (i.e., visitors only, returning visitors, travelers with a required pre-travel testing program), and conclusions can be made for this specific group. One would need to be cautious about extrapolating to the greater group of travelers because it could be misleading. Public health policies are often adjusted (tightened or loosened) to emerging data, so it is important that reports of positivity rates for incoming travelers are as specific and accurate as possible. Two studies in this review reported positivity rates (0.7%, 0.1%) with high participation rates (72%, 100%) in specific travel groups (visitors in the pre-travel program, all travelers in the pre-travel program) [9••, 11••]; therefore, these positivity rates are less likely fraught with bias and can be applied confidently to their specific study populations.

There are two studies that reported positive cases (248 cases, 88 cases), positivity rates (1.5%, 7.3%), and low participation rates (40%, 27%) [10••, 12]; therefore, it is important to recognize that these positivity rates may likely be biased due to the low percentage of the solicited passengers who decided to participate. However, they met their goals of active surveillance of case detection: proactively identifying new cases among travelers at international borders, placing them in isolation before they could enter public places and protecting their communities.

If the goal is to stop all new cases and variants from entering a country, then mandatory of all travelers is a good strategy. For example, at the time of this writing, Pakistan established mandatory testing on all arriving passengers at the airport due to close surveillance of BF.7 variant of SARS-CoV-2 virus which was causing devastating outbreaks in neighboring India and China [21]. Two of the studies evaluated the effectiveness of pre-travel programs by determining positivity rates and cases during specific locations and periods of time. Another interesting approach that was reported outside the range of the literature search is demonstrated by CDC's Traveler-based Genomic Surveillance program that sought to collect nasal swabs from volunteering international air travelers at the airport during a period with mandatory pre-travel testing compared to a later period with voluntary pre-travel testing [22]. When investigators compared the two different time periods with pooled sampling and multivariate models, the results revealed that the samples collected during the mandatory pre-travel testing (March 20-June 11, 2022) were 52% less likely to be positive than the period with voluntary pre-travel testing (June 12-September 3, 2022); this data may guide use of pre-travel testing in reducing traveler transmission for future outbreaks.

Interestingly, one half of the total studies primarily investigated the validity of alternative diagnostic testing (i.e., sensitivity, specificity, predictive values) against the gold standard which was typically PCR testing with nasopharyngeal sampling. Some studies tested different sampling methods that were less invasive such as salivary, nasal, or oropharyngeal samples. Some studies tested different modalities such as FIA, AFIAS, or LAMP. A few of these studies did not report the number of positive cases or the positivity rate, which demonstrates that their focuses were on other data points. They chose to investigate their alternative diagnostic testing at the airports; however, these studies could also be performed in different settings such as a clinic or community center. In the broader literature search, there were multiple articles expanding the discussion of alternative rapid tests at points of entry including olfactory testing, sniffing dogs, rapid antigen testing, and less invasive collection methods [23–26, 27••, 28] to make testing more convenient and effective at the international borders.

The South Korean study investigated different types of locations for public COVID-19 screening and determined that the international airport was the most effective location and had the benefit of detecting new incoming cases and isolating them before entering their community. The study did not report their actual data on cases or positivity rates, but instead focused on the multiple models, population densities, and the ground traffic volume [18].

The limitations in this review include the omission of numerous study details in Table 2, including positive cases, total number tested, and study design details (i.e., mandatory vs voluntary, anonymous vs. not, consequences vs. without consequences), but this is likely due to the variety of study aims; however, future studies could be more comprehensive about the details despite their study aims. For the studies that investigated the positivity rates, there may be other factors that influence bias, such as country of origin, age, gender, race, socio-economic status, comorbidities, traveling solo versus (vs.) in a group, length of intended stay, and visitor vs. returning resident. For example, a visitor may be less likely to participate in a voluntary arrival testing since it would ruin their vacation plans, while a returning resident

may be more willing to participate since it is not as inconvenient to isolate in the comfort of one's own home with the help from family and friends. Another example is age, where elderly travelers may be more interested in voluntary testing due to the high comorbidity and mortality of COVID-19 in their age group. If there is a disproportionately higher number of returning travelers or elderly travelers in the sample group compared to the overall traveler group, this discrepancy could be corrected for by a weighted sample calculation to determine a more representative positivity rate.

Considerations for Future Airport COVID-19 Screening

In summary, the goals of airport COVID-19 testing varied greatly and affected their implementation strategies. If the goal is to ban new variants of COVID-19 or additional cases from arriving travelers, then a mandatory testing of all incoming travelers with isolation/quarantine will reduce both the number of arriving travelers and their infection rates. If the goal is active surveillance to detect COVID-19 variants, then it is reasonable to implement voluntary testing PLUS positive-sample genome sequencing along with isolation/quarantine. If the goal is active surveillance to determine the most representative COVID-19 positivity rate of incoming travelers, then the best strategy is a voluntary testing without associated consequences to maximize participation and minimize bias in the types of travelers tested. If the goal is to validate an alternative diagnostic test, then additional details, such as how the passengers were solicited, number of positive cases, or total of passengers tested, should be collected to analyze for bias and the clinical profiles of travelers who are solicited.

In addition to these considerations, future airport studies can consider stratified analyses since results may vary depending on factors such as country of origin, visitors versus returning residents, history of prior infection, vaccination/booster status, or demographic data such as age or gender. The collection of this type of data should be considered, but ideally only after minimizing selection bias. Additionally, future studies can consider short, periodic screening periods, such as testing 1000 travelers every 3 months, to monitor incoming cases and fast-emerging variants.

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well-organized departure COVID-19 airport study and an important discussion on possible biases.

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