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Public acceptability of COVID-19 control measures in Singapore, Hong Kong, and Malaysia: A cross-sectional survey



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ABSTRACT

Background: Several countries have implemented control measures to limit SARS-CoV-2 spread, including digital contact tracing, digital monitoring of quarantined individuals, and testing of travelers. These raise ethical issues around privacy, personal freedoms, and equity. However, little is known regarding public acceptability of these measures.

Methods: In December 2020, we conducted a survey among 3635 respondents in Singapore, Hong Kong, and Malaysia to understand public perceptions on the acceptability of COVID-19 control measures.

Findings: Hong Kong respondents were much less supportive of digital contact tracing and monitoring devices than those in Malaysia and Singapore. Around three-quarters of Hong Kong respondents perceived digital contact tracing as an unreasonable restriction of individual freedom; <20% trusted that there were adequate local provisions preventing these data being used for other purposes. This was the opposite in Singapore, where nearly 3/4 of respondents agreed that there were adequate data protection rules locally. In contrast, only a minority of Hong Kong respondents viewed mandatory testing and vaccination for travelers as unreasonable infringements of privacy or freedom. Less than 2/3 of respondents in all territories were willing to be vaccinated against COVID-19, with a quarter of respondents undecided. However, support for differential travel restrictions for vaccinated and unvaccinated individuals was high in all settings.

Interpretation: Our findings highlight the importance of sociopolitical context in public perception of public health measures and emphasize the need to continually monitor public attitudes toward such measures to inform implementation and communication strategies.

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Background

Several countries have implemented control measures to limit SARS-CoV-2 spread, including digital contact tracing, digital monitoring

of quarantined individuals, and testing of travelers. The rollout of COVID-19 vaccines means that vaccine acceptance, as well as vaccination requirements for travelers as a means to ease travel-related restrictions, are likely to be important considerations for policymakers.

Singapore, Hong Kong, and Malaysia have all implemented policies in relation to digital contact tracing, monitoring of individ-

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uals during quarantine, and testing of travelers. As of December 2020, when this study was conducted, COVID-19 testing and quarantine in hotels or designated quarantine facilities was mandatory for incoming travelers in all three territories. Digital contact tracing is implemented to different extents. The official digital contact tracing apps in Hong Kong (LeaveHomeSafe) and Malaysia (MySejahtera) can be used to record visits to premises by scanning a QR code on entry, report a positive COVID-19 test, and receive notifications of potential exposure to COVID-19 cases. Although use of the app is voluntary, premises in Malaysia are required to record visits through the app. In Singapore, digital contact tracing comprises a combination of SafeEntry, which is used to record visits to premises, and TraceTogether, which uses Bluetooth technology either within a mobile phone app or standalone wearable token to record proximity to other users. Although TraceTogether is technically voluntary, its use is mandated for schoolchildren and for entry to certain venues.

These types of control measures raise ethical issues around restrictions on personal freedoms, invasion of privacy, and fairness or equity in the distribution of benefits and burdens (Gasser et al., 2020; Mello and Wang, 2020; Morley et al., 2020; WHO, 2020a; WHO, 2020b; Xafis et al., 2020). At the time of our survey, there was some evidence about public opinions on digital contact tracing and vaccination-based measures but not digital monitoring of quarantined individuals and testing requirements for travel (Abuhammad et al., 2020; Guillon and Kergall, 2020; Nehme et al., 2020; O'Callaghan et al., 2020). Various surveys have since been conducted on the acceptance of use of vaccination requirements to restrict movement in domestic and international travel contexts (Drury et al., 2021; Hu et al., 2021; Ipsos, 2021). Acceptance is likely to depend on numerous factors, including the epidemic situation, perceived effectiveness, individual burdens, trust in authorities, and mechanisms to ensure data privacy. We conducted surveys in Singapore, Hong Kong, and Malaysia to understand public perceptions on the acceptability of digital contact tracing, wearable quarantine monitoring devices, and travel-related COVID-19 testing and vaccination measures due to the paucity of information on public perceptions of their acceptability in these settings. We focused on these measures because they were novel technological responses to the pandemic which raised significant ethical issues and selected these sites because of their common heavy reliance on digital contact tracing and digital monitoring of quarantined individuals to reduce spread. At the time of survey, Singapore and Hong Kong had very low levels of transmission, at around two and 12 new COVID-19 cases daily per million population; serological studies indicate that <0.2% of the Singapore population had been infected with SARS-CoV-2 at the time (Clapham et al., 2022). Malaysia was experiencing an upsurge in transmission, but mortality was very low, with fewer than 5 COVID-19 deaths reported daily (Dong et al., 2020). There were plans for bilateral arrangements for quarantine-free interstate travel using virological testing (so-called “travel bubbles”) between Singapore and Malaysia (Tham, 2020), and Singapore and Hong Kong (ChannelNewsAsia, 2020), which would likely (and indeed have now extended) to include use of proof of vaccination. COVID-19 vaccination had yet to roll out in any country in December 2020 when we conducted the survey.

Methods

The surveys were conducted during December 2020 in all three territories. In Singapore and Hong Kong, respondents were recruited from population-representative online panels. In Malaysia, a market surveyor recruited respondents at shopping malls, community town halls, and residential halls. Respondents were adults aged 18 years or older in Hong Kong and Malaysia and 21 years or

older in Singapore, corresponding to the minimum age of consent in each setting. Details of sampling and recruitment procedures are given in the Supplementary Information.

Survey Questionnaire

We developed a series of questions to understand the general population's sentiment toward policies that had been introduced or were likely to be introduced in the three jurisdictions. Respondents were first asked about their perceptions of digital contact tracing and the use of wearable monitoring devices during quarantine, the broader implications on privacy as well as their trust in their respective governments and private companies to responsibly manage data collected via digital contact tracing. Subsequent sections included questions that prompted the respondents' general attitudes toward vaccines, willingness to get vaccinated, prioritization of vaccines across population segments as well as COVID-19 testing and vaccine policies that were relevant to international travel. The same questionnaire was used in all three territories, with modifications made to collect setting-specific sociodemographic information for comparison with census statistics.

General vaccine attitudes were measured using the Vaccine Confidence Scale (Larson et al., 2016), and respondents were also asked whether they would be willing to take a safe and effective COVID-19 vaccine when it became available. To measure public opinion on the use of monitoring devices during quarantine and digital contact tracing, respondents were asked to register their level of agreement with a series of statements using a 5-point scale. These statements pertained to perceived effectiveness and benefits of digital contact tracing, concerns about privacy and personal freedom, and trust in the governance of contact tracing data.

Additionally, we asked respondents for their opinions on travel-related COVID-19 testing and vaccination policies. To measure public perception of policies related to COVID-19 vaccination for travel, we used two different scenarios: in the first, respondents were asked to imagine that a COVID-19 vaccine had been approved for general use and is widely available, whereas in the second, respondents were asked to imagine that a COVID-19 vaccine had been approved but was in limited supply. The core questions under each scenario were the same and the two scenarios were administered to randomly selected subsets of survey respondents; this was to allow for comparison of whether vaccine availability influenced public perception of vaccination policies. For instance, we asked respondents if they thought it would be reasonable to allow travel only for vaccinated individuals or that additional restrictions be placed on unvaccinated travelers. Lastly, to measure vaccination intention, we asked respondents if they would be willing to get a COVID-19 vaccine to travel abroad. The questionnaire was field tested in the respective countries before data collection to ensure questions were easily comprehensible within the local context.

Data analysis

We assessed representativeness of survey samples by comparing the sociodemographic characteristics of the survey sample from each site with those from their national census in terms of age group, sex, ethnicity, educational level, and socioeconomic status.

For each territory, we computed response frequencies and percentages for each survey question. For sociodemographic variables with notable deviations from the census distribution, we assessed the impact on survey responses using poststratification weights to reweight sample responses in proportion to the census distribution. For each respondent, we calculated scores for vaccine confidence, support for use of monitoring devices during quarantine,

and support for digital contact tracing (Supplementary Information Tables S9–S11)

We further investigated whether willingness to be vaccinated against COVID-19 was influenced by general confidence in vaccines and the level of support for use of monitoring devices during quarantine and digital contact tracing using Spearman correlation coefficient.

All analyses were performed using R version 4.0.3 (R Core Team, 2020).

Ethics Statement

Ethical approval for this study was obtained from the Ethics Review Committee of the Saw Swee Hock School of Public Health, National University of Singapore (SSHSPH-092); Universiti Malaya Research Ethics Committee (UM.TNC2/UMREC_1129); and the Institutional Review Board of the University of Hong Kong (UW-20-095).

Results

There were 982 eligible respondents in Singapore, 1974 in Malaysia, and 679 in Hong Kong. Response rates for the Singapore and Hong Kong panels were 79.0% and 8.9%, respectively. A response rate was not available for the Malaysia convenience sample. In Singapore, the survey sample was comparable to the census population in terms of marital status and housing type, but there was an over-representation of females and those with post-secondary and tertiary education, whereas those of Malay ethnicity and people in the highest income bracket were under-represented. In the Malaysia sample, those who were aged 30–49 years, females, those of Chinese ethnicity, unmarried individuals, and those living in condominiums or single-occupancy housing were over-represented compared with the census population. In Hong Kong, the survey sample comprised proportionately more males, people with tertiary education, people in the highest income bracket, and those living in public housing (Supplementary Information Tables S1–S3).

Vaccine confidence and willingness to be vaccinated against COVID-19

In general, vaccine confidence was higher in Malaysia compared with Singapore and Hong Kong (Figure 1); 68% of respondents agreed that vaccines are safe (compared with 42% in Hong Kong and 56% in Singapore), 60% agreed that vaccines are effective (Hong Kong: 50%, Singapore: 61%), and 71% agreed that vaccines are an important health intervention for children (Hong Kong: 52%, Singapore 67%). In addition, 79% of Malaysian respondents agreed that vaccines are compatible with their religious beliefs (Table S4). This figure was higher than in both Singapore and Hong Kong, where less than two-thirds and less than half of respondents, respectively, felt that vaccines were compatible with their religious beliefs.

Across all three settings, two-thirds or fewer respondents said that they would be willing to be vaccinated against COVID-19 when an approved vaccine became available (Figure 1 and Table S4). Notably, about a quarter of respondents in all three settings were undecided about vaccination. Willingness to vaccinate was strongly associated with vaccine confidence in all three settings (Supplementary Information Tables S9–S11). Willingness to vaccinate was also higher among those displaying greater support for digital contact tracing, use of monitoring devices during quarantine, and travel-related vaccination requirements (Supplementary Information Figures S1–S3).

Concerns about invasiveness of different control measures

In general, respondents in Singapore and Malaysia demonstrated greater support for control measures compared with Hong Kong, with higher mean scores for support of digital contact tracing, use of wearable monitoring devices, and travel-related vaccination (Table 1). In Singapore, 75% of respondents believed that digital contact tracing was effective at reducing the risk of COVID-19 spread and 65% felt that the benefits of digital contact tracing outweighed the harms. In contrast, only 22% of Hong Kong respondents agreed that the benefits outweighed the risks and 35% believed such technologies to be effective at reducing risk of COVID-19 spread (Table S14).

Differences were also seen between settings in the perceived intrusiveness of different control measures. In Hong Kong, 73% of respondents perceived that digital contact tracing technologies were unreasonable restrictions of individual freedom, compared with 55% in Malaysia and 17% in Singapore (Figure 2 and Table S5). Interestingly, in Hong Kong, the mandatory use of testing and vaccination for travelers were viewed far more positively; only 32% and 14% of respondents, respectively, believed that these measures are unreasonable infringements of privacy or freedom. In Singapore, testing was considered less intrusive but vaccination was more intrusive than digital contact tracing and the use of monitoring devices. In Malaysia, intrusiveness concerns were similar for all measures, with around 50% of respondents stating that these were unreasonable intrusions.

These differing views were also reflected in differences in the level of trust in how digital contact tracing data would be used in different settings. In Hong Kong, 16% of respondents trusted that there were strict rules in place locally to prevent these data from being used for other purposes, whereas 28% trusted that there were such rules in place in other countries. This was the opposite in Singapore, where 73% of respondents agreed that there were adequate data protection rules in place locally, but 30% felt that this was the case in other countries. In Malaysia, two-thirds of respondents agreed that there were adequate data protection rules in place both locally and in other countries (Figure 3 and Table S6). Similarly, support for mandatory use of digital contact tracing during the pandemic was low in Hong Kong. Only 39% agreed that this technology could help reduce the risk they posed to others if they became infected, whereas 24% agreed that digital contact tracing was a way for them to contribute to pandemic control efforts. In contrast, more than two-thirds and three-quarters of respondents in Malaysia and Singapore, respectively, agreed with these statements.

Perceptions of vaccination policies for travelers

Support for travel-related COVID-19 vaccination was higher in Malaysia than in the other two settings; 69% of respondents in Malaysia agreed that it was reasonable to allow travel only for vaccinated individuals, that it was reasonable to require all travelers to be vaccinated, and that it was reasonable to allow all travel for vaccinated individuals but only essential travel for unvaccinated individuals. These figures were slightly lower in Singapore; whereas in Hong Kong, less than half of respondents agreed with these statements (Figure 4 and Table S7).

Perceptions of equity implications of vaccination policies were mixed. Around a half of respondents in all three settings agreed that banning unvaccinated people from traveling internationally would be unfair. The majority of respondents in all three settings also agreed that it was reasonable to place different restrictions on vaccinated and unvaccinated travelers, and around a half agreed that it was reasonable for travelers to pay for vaccination even if

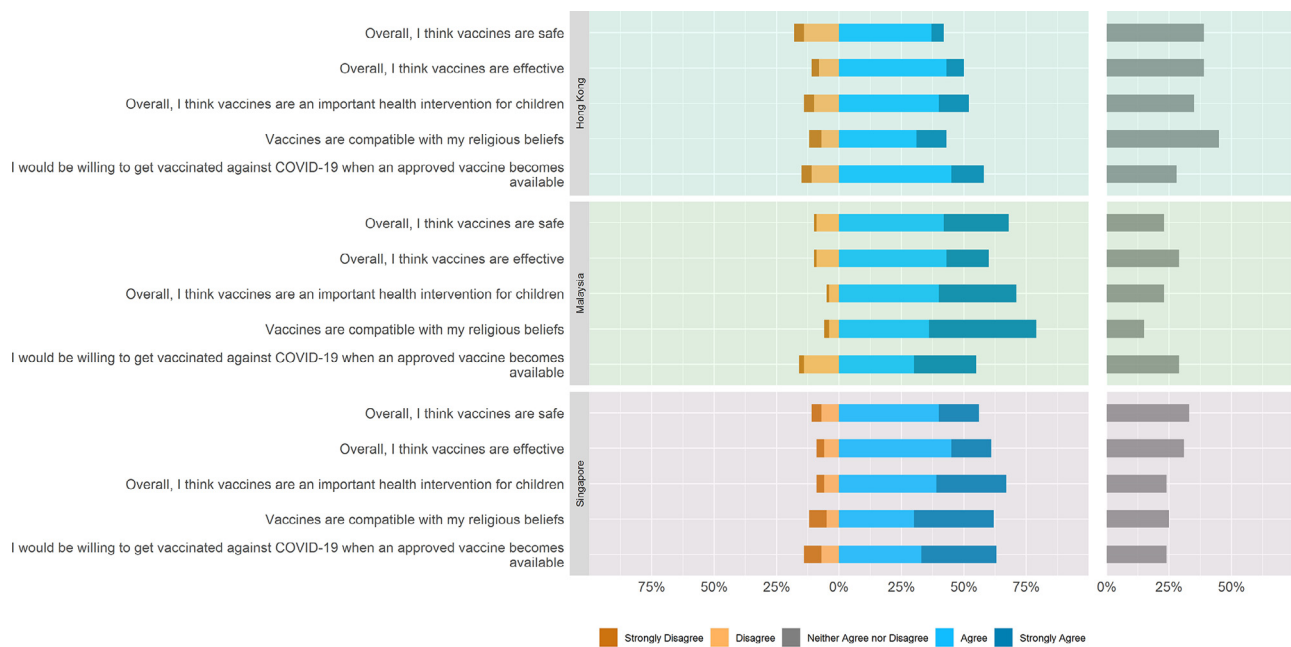


Fig. 1. Vaccine confidence and willingness to be vaccinated against COVID-19 among respondents in Hong Kong, Malaysia, and Singapore, December 2020.

Table 1

Mean scores for vaccine confidence and support for digital contact tracing, use of wearable monitoring devices and travel-related vaccination requirements by survey setting. Higher scores indicate greater confidence/support.

	Hong Kong (N=679)	Malaysia (N=1974)	Singapore (N=982)
Vaccine confidence ¹			
- Mean (SD)	3.4 (0.8)	3.8 (0.8)	3.7 (0.9)
- Median (Q1, Q3)	3.3 (3.0, 4.0)	4.0 (3.3, 4.3)	4.0 (3.0, 4.3)
- Missing values	1	0	0
Digital contact tracing ¹			
- Mean (SD)	2.8 (1.0)	3.8 (0.5)	3.9 (0.8)
- Median (Q1, Q3)	2.8 (2.0, 3.5)	3.8 (3.5, 4.2)	4.0 (3.5, 4.5)
- Missing values	12	0	1
Wearable monitoring devices ¹			
- Mean (SD)	3.2 (1.0)	3.9 (0.6)	4.2 (0.7)
- Median (Q1, Q3)	3.3 (2.3, 4.0)	4.0 (3.7, 4.3)	4.3 (4.0, 5.0)
- Missing values	4	0	0
Travel-related vaccination requirements ¹			
- Mean (SD)	3.0 (0.7)	3.8 (0.5)	3.4 (0.7)
- Median (Q1, Q3)	3.0 (2.5, 3.5)	3.8 (3.5, 4.0)	3.5 (3.0, 4.0)
- Missing values	6	0	0

¹ Details of the derivation of score variables are provided in Tables S9–S12.

it meant that some groups in the population may not be able to afford to travel (Figure 5 and Table S8).

Views on vaccination requirements for travel were not strongly influenced by whether vaccines were widely available or in limited supply, and applying weights to reflect the census distribution of demographic variables made little difference to the results.

Discussion

Like many countries and territories, Singapore, Malaysia, and Hong Kong have adopted multiple strategies to ensure safe movement in community and international travel contexts during the COVID-19 pandemic. These include COVID-19 testing, wearable quarantine monitoring devices, and digital contact tracing. The use of these control measures to ease or lift movement and travel restrictions is likely to continue in many countries, at least during the pandemic; and many, including Singapore, Malaysia, and Hong Kong, have also made vaccination certification a condition to access activities that pose a potentially high risk of transmission, such as large-scale events and indoor gatherings in settings

where masks might not be worn continuously, such as restaurants and gyms. In January 2021, the World Health Organization Emergency Committee on COVID-19 recommended that countries should not introduce policies that require proof of vaccination from incoming travelers owing to the limited global vaccine supply and uncertainty regarding whether vaccines reduce transmission risk (WHO, 2021a). In October 2021, the committee revised this recommendation and stated that proof of vaccination against COVID-19 should not be “the only pathway or condition permitting international travel given limited global access and inequitable distribution of COVID-19 vaccines” (WHO, 2021b). This change in position is justifiable by recent evidence that vaccination reduces transmission (Harris et al., 2021; Levine-Tiefenbrun et al., 2021) and also by public acceptance of the use of proof of vaccination to restrict movement (Drury et al., 2021; Hu et al., 2021; Ipsos 2021). Understanding the public’s acceptance of public health control measures at the point of introduction and over time is thus important for informing policy and communication strategies.

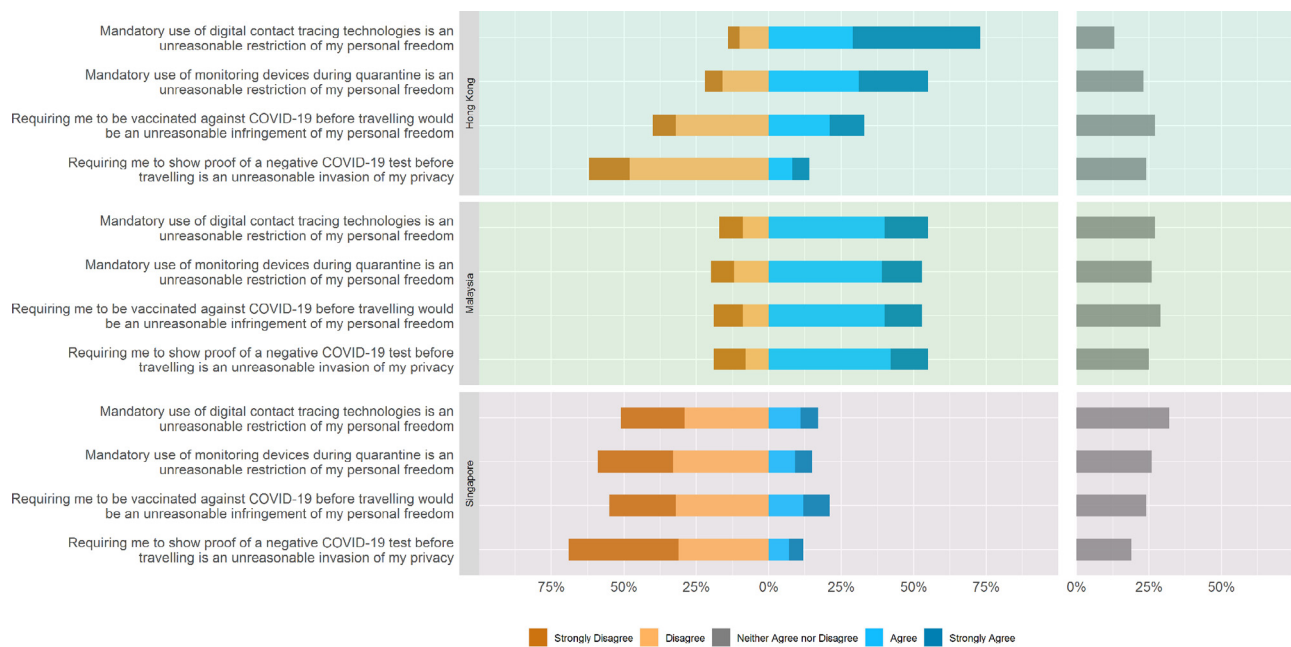


Fig. 2. Perceived intrusiveness of different control measures among respondents in Hong Kong, Malaysia, and Singapore, December 2020.



Fig. 3. Digital contact tracing: privacy, trust, and mandatory use among respondents in Hong Kong, Malaysia and Singapore, December 2020.

Justification for potentially intrusive control measures depends on a range of public health and ethical considerations such as effectiveness, necessity, proportionality, equitable distribution of benefits and burdens, and risk minimization (Allen and Selgelid, 2017; Kass, 2001). Acceptance, however, depends as much on the context as the intervention itself. Although on the face of it, both Hong Kong and Singapore have had similar success minimizing community transmission of SARS-CoV-2 with similar measures focused on travel restrictions, strict quarantining, case isolation, and testing, our study reveals stark differences in public opinion regarding the measures used to achieve this. Hong Kong residents display much lower support for surveillance and monitoring technologies such as digital contact tracing and wearable devices, lower trust in the governance of these technological measures, and greater opposition to their intrusiveness. The neighboring Singa-

pore and Malaysia, despite sharing many cultural similarities, also differ substantially in their views on the intrusiveness of control measures and implications for personal freedoms, including use of monitoring devices, digital contact tracing, and testing for travel.

The acceptability of surveillance, monitoring, and health certification measures are context sensitive, contingent on a territory's specific epidemic situation, inequalities, power structures, and legal protections. Trust in these structures and protections is a fundamental element of social capital, especially in the context of a public health emergency, and an important determinant of the citizens' compliance with public health policies. Research during the 2014–2015 Ebola epidemic in Liberia found that individuals who distrusted their government took fewer precautions against Ebola and were less compliant with control measures (Blair et al., 2017), whereas a recent study in France showed that trust in government



Fig. 4. Perceptions of COVID-19 vaccination for travel among respondents in Hong Kong, Malaysia, and Singapore, December 2020.

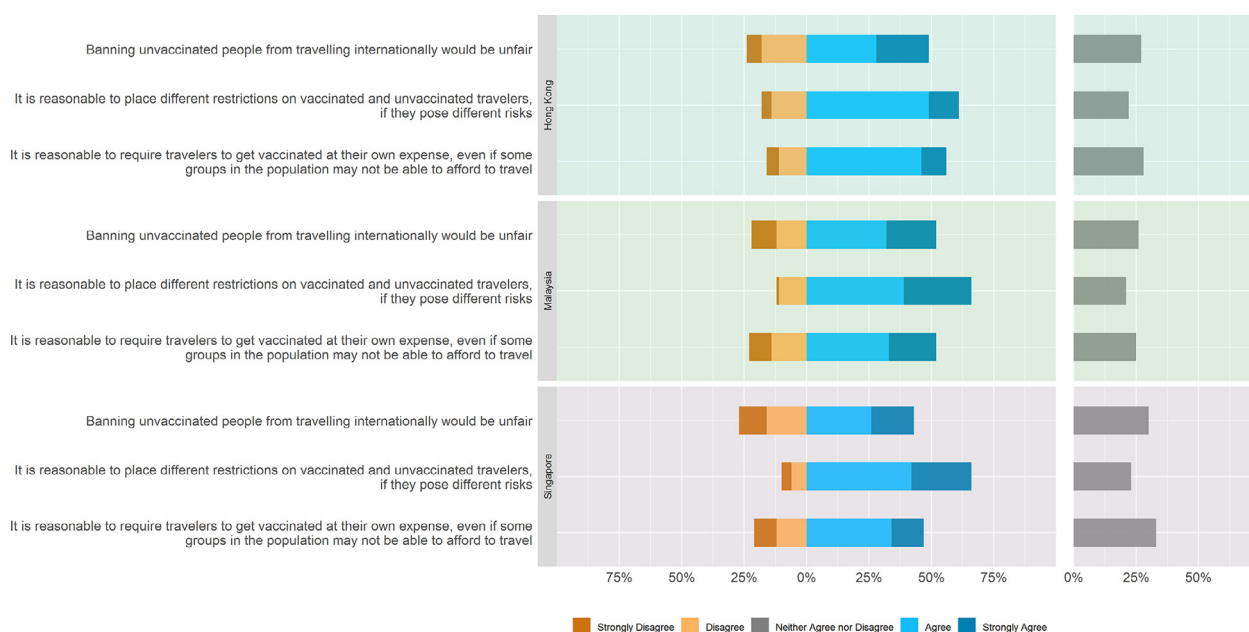


Fig. 5. Equity considerations in travel-related COVID-19 vaccination among respondents in Hong Kong, Malaysia, and Singapore, December 2020.

was highly associated with willingness to use digital contact tracing technology (Guillon and Kergall, 2020).

During the 2002–2003 Severe Acute Respiratory Syndrome (SARS) epidemic, public trust in the Singaporean government to deal with the epidemic was shown to be high (Deurenberg-Yap et al., 2005), whereas public trust in the Hong Kong government appeared to have been lower (Lee, 2009). The 2019 Edelman Trust Barometer also demonstrated higher trust in government (“do you trust the government to do what is right?”) in Singapore (67%) compared with Malaysia (60%) and Hong Kong (55%) (Edelman Trust Barometer, 2019). Our research similarly demonstrates the influence of wider political and social conditions on people’s perception of public health interventions. For example, respondents from Hong Kong viewed contact tracing technology

as less effective than respondents from Malaysia or Singapore. The effectiveness of the technology used for digital contact tracing in these three settings is unlikely to differ significantly. This difference in perceived effectiveness likely reflects a broader lack of trust in political institutions and data security in Hong Kong (Hartley and Jarvis, 2020; Wan et al., 2020); more than two-thirds of respondents in Hong Kong expressed concern about domestic measures in place to prevent use of contact tracing data for other purposes.

Our study indicates that in Singapore, Hong Kong, and Malaysia, there is a high public acceptance of COVID-19 testing to support safe international travel. Moreover, testing was considered less intrusive than the use of monitoring devices during quarantine and digital contact tracing, particularly in Hong Kong. The reasons for

this are unclear but could be related to the lower burden of testing, perceived trust in how testing data are used, and individual benefit gained from knowing one's test result.

Recent surveys have shown wide variability in the public's willingness to be vaccinated against COVID-19, raising concerns about the potential impact of vaccine hesitancy on COVID-19 vaccination programs (Fisher et al., 2020; Lazarus et al., 2020; Lin et al., 2020; Voo et al., 2021). Our survey indicates that willingness to vaccinate is modest in all three settings. Although we did not specifically ask about reasons why respondents were unwilling to be vaccinated, general confidence in vaccines was strongly related to willingness to be vaccinated against COVID-19. Importantly, a substantial fraction of the public in all three territories were undecided about whether to be vaccinated, which may indicate a need for more effective communication strategies to allay concerns among undecided individuals.

Nevertheless, support for travel-related vaccination was relatively high, with the majority of respondents in all three territories being in favor of vaccination requirements for travelers and showing willingness to be vaccinated for travel purposes. This is consistent with a recent population-based survey in Geneva, Switzerland, which showed general public support for vaccination requirements to allow foreign travel and strong support for policies that place different travel restrictions on vaccinated and unvaccinated individuals (Nehme et al., 2020). From an ethical stand point, allowing unvaccinated and vaccinated individuals to travel under different least restrictive conditions (consistent with minimizing public and individual health risks) would be equitable and respects individual freedom of movement (Lazarus et al., 2020).

Our study has some potential limitations. For logistical reasons, it was not possible to recruit Malaysian respondents through online panels as in the other two settings. Therefore, the Malaysian sample was younger than the general population, which may have affected the representativeness of opinions on control measures. In Hong Kong, the survey sample was skewed toward those with tertiary education and higher household income. However, reweighting survey responses to reflect the census distribution of demographic variables made no substantive difference to the results.

It should also be noted that public perceptions of control measures are dynamic and can change over time, particularly during an epidemic. In Singapore, our survey was conducted before the government's announcement that digital contact tracing data could legally be used for criminal investigations despite earlier public assurance that data would be used solely for contact tracing (Illmer, 2021). Subsequent to this announcement, in its efforts to maintain trust, the Singapore government passed a bill to limit criminal investigation uses of the data to specific serious offenses and set stronger penalties for data misuse than what is set out in current public sector data protection laws. In Hong Kong, the government recently announced that residents would be able to choose which vaccine to receive from those that are available to build trust in its vaccination program (Cheung, 2020). Such policy developments influence the public discourse around public health control measures and likely shape the public's opinion on the use of these measures over time. This emphasizes the need to continually monitor public perception of public health measures both during peace time and during the course of a public health emergency. This can inform policy by providing an understanding of the limits of public acceptance of control measures in different contexts, identifying areas of concern to be addressed in the design, implementation and communication of control measures, and anticipating changes in public opinion that may affect acceptance or adherence to these measures. For example, a recommended intervention to promote public trust and acceptance of digital surveillance and monitoring is to implement an ethics oversight mechanism (Mello and Wang, 2020; WHO, 2017; Ferretti et al., 2020), but

much will likely depend on how impartial, independent, and inclusive this mechanism is regarded by the public. Routine community engagement and public deliberation exercises could be useful mechanisms to better understand and respond to specific local concerns rather than relying on historical research, research findings from other settings, or on abstract normative analysis alone.

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Ethical approval

Ethical approval for this study was obtained from the Ethics Review Committee of the Saw Swee Hock School of Public Health, National University of Singapore (SSHSPH-092); Universiti Malaya Research Ethics Committee (UM.TNC2/UMREC_1129); and the Institutional Review Board of the University of Hong Kong (UW-20-095).

Author contributions

Conceptualization of study: VTC, CCT, and AB; development of study protocols: VTC, CCT, AJB, CJN, BJC, JX, PKC, SK, GJ, VK, JML, and ZMT; verification of data: NCBW, ZMT, CCT, JX, and CJN; data analysis: NCBW, ZMT, and CCT; interpretation of data: CCT, ZMT, NCBW, VTC, AB, CJN, BJC, JX, PKC, SK, and GJ; manuscript drafting: VTC, CCT, and AB; editing of manuscript: all authors.

Data sharing statement

Will individual participant data be available (including data dictionaries)?	Yes
What data in particular will be shared?	All of the individual, deidentified participant data collected during the study
What other documents will be available?	Study questionnaires
When will data be available?	Beginning 9 months after article publication for an indefinite period
With whom?	Anyone who wishes to access the data
For what types of analyses?	Any purpose
By what mechanism will the data be made available?	The data will be available in our university's data warehouse or other public data repository but without investigator support other than deposited metadata

Declaration of Competing Interest

The authors declare no conflicts of interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ijid.2022.04.021.

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