Effectiveness of border closures/ travel restrictions, screening and/ or quarantine to control the international spread of COVID-19

an update to a Cochrane rapid review

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Land Acknowledgement(s)

The University of Manitoba campuses are located on original lands of Anishinaabeg, Cree, Oji-Cree, Dakota, and Dene peoples, and on the homeland of the Métis Nation. We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

SPOR Evidence Alliance operates from the St. Michael's Hospital, Unity Health Toronto which is located on the traditional land of the Huron-Wendat, the Seneca, and the Mississaugas of the Credit. Today, this meeting place is still the home to many Indigenous people from across Turtle Island.

COVID-END is housed within McMaster University which is located on the traditional territories of the Mississauga and Haudenosaunee nations, and within the lands protected by the "Dish With One Spoon" wampum, an agreement to peaceably share and care for the resources around the Great Lakes**.**

We are grateful to have the opportunity to work on these lands.

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General Disclaimer

This report was prepared by Knowledge Synthesis Team, George & Fay Yee Centre for Healthcare Innovation on behalf of the SPOR Evidence Alliance and COVID-END. It was developed through the analysis, interpretation, and synthesis of scientific research and/ or health technology assessments published in peer-reviewed journals, institutional websites, and other distribution channels. It also incorporates selected information provided by experts and patient/ citizen partners with lived experience on the subject matter. This document may not fully reflect all the scientific evidence available at the time this report was prepared. Other relevant scientific findings may have been reported since completion of this synthesis report. The opinions, results, and conclusions are those of the team that prepared the living evidence synthesis, and independent of the Government of Canada, CIHR and the Public Health Agency of Canada. No endorsement by the Government of Canada, CIHR or Public Health Agency of Canada is intended or should be inferred.

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EXECUTIVE SUMMARY

Background: *The COVID-19 pandemic has proven difficult to manage for many reasons. This includes the inter-connected nature of the world today, and the free movement of individuals from country to country and region to region, with the potential of importing or exporting new variants. As such, one of the potential ways to limit spread is by restricting travel across international borders. The objective of this rapid review was to identify, critically-appraise and summarize evidence on international border entry restrictions/ closures, screening, and/ or quarantine to control the international spread of COVID-19.*

Methods*: This review is based on the Cochrane review: "International travel-related control measures to contain the COVID-19 pandemic" and followed a similar methodology. In brief, we searched for observational (including ecological) studies in general health and COVID-19-specific bibliographic databases. The primary outcome categories were (i) cases avoided, (ii) cases detected, and (iii) a shift in epidemic development. Secondary outcomes were infectious disease transmission, healthcare utilization, resource requirements, adverse effects, and user acceptability. Quality assessment of observational studies was conducted using a modified version of the Newcastle-Ottawa Scale; risk of bias of screening studies was conducted using the QUADAS-2 tool. Certainty of evidence was assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group methodology.*

Results: *Further to the 13 observational studies identified by the Cochrane review, we identified 80 new studies that met the inclusion criteria (93 studies in total). Peer-reviewed publications that were previously only available as pre-prints were also updated. Most included studies were retrospective observational studies and generally were of moderate to high quality.*

Border closures, comprehensive screening (especially with polymerase chain reaction (PCR) testing), and quarantine all carried potential benefits and harms (e.g., financial burden, anxiety, depression). While the most restrictive interventions showed the greatest potential benefit (e.g., limiting spread, delaying introduction of new variants, identifying most cases prior to entry into the community), no method was rigorously proven to be effective past a few weeks of implementation, and most were evaluated retrospectively in a short period of time (e.g., weeks to months). As such, while most studies reported some benefit to these interventions, others showed no benefit, mixed effects, or conflicting findings. Also, risk assessment and balancing the benefits and harms of interventions were regularly echoed in the study reports.

The added studies did not change the main conclusions of the Cochrane review ("some travel-related control measures during the COVID-19 pandemic may have a positive impact on infectious disease outcomes") nor the quality of the evidence (very low to low certainty). However, the additional studies added to the evidence base for most outcomes.

Conclusions: *Low to very low certainty evidence supports the balanced use of international border entry restrictions/ closures, screening, quarantine or a combination of these measures to limit the spread of COVID-19 through air travel, especially during early stages of the outbreak, during epidemic waves, and for delaying (but not eliminating) introduction of new variants past the countries' borders.*

There was not enough evidence to determine the effectiveness of each intervention separately as they were often co-introduced simultaneously during implementation. It is important to acknowledge the uncertainty due to the large variation in effect sizes, often conflicting results, level of community spread at the time the interventions were implemented, the duration and length of quarantine, vaccine uptake by the community and vaccination status of travelers. Also, generalizability of the results may be problematic as not all countries/ regions of the world were represented by these studies and health systems and available resources across countries/ regions vary. Even for countries reporting evidence, it is only a snapshot in time, and may not be applicable today due to the changing nature of the pandemic and the respective responses to the pandemic. Due to the aforementioned challenges, the evidence should be viewed as continuously evolving. Lastly, it is important to balance the potential benefits of these measures with the potential harms and negative consequences on both the individual and societal levels.

Future high-quality research is required to determine the best timing of the introduction of interventions, the comparative effectiveness of interventions, and the removal of these interventions. Studies evaluating the diagnostic accuracy of screening tools against a reference standard in this setting is required.

Key Messages

- **General notes**
    - Most studies did not clearly report on the exact ports of entry evaluated in the studies. As such, evidence from airports, international land and river crossings and seaports were often presented together. Further, even in studies that reported only one type of port of entry (e.g., airports only), this was often not limited to one airport and heterogeneity between practices at different ports within the same country cannot be ruled out. This is a general limitation to the evidence base.
- **International border closures/ travel restrictions**
    - Cases avoided due to measure: Most studies reported that stricter, and earlier implemented, border closures (e.g., total border closure through any port of entry)/ travel restrictions (e.g., travel bans for travelers from high-risk regions) were more effective than looser, or later implemented measures.
    - Shift in epidemic development: Studies showed that while border restrictions did not prevent the eventual introduction of SARS-CoV-2 variants and the associated rise in cases, it did provide a few weeks delay before the epidemic peak was reached. It was felt that this delay was important to allow governments and health systems time to prepare to respond to local transmission.
    - Cases detected due to the measure: Studies showed that stricter border control was associated with identifying more cases at the border and delaying the introduction of new SARS-CoV-2 variants.
    - Secondary outcomes: While studies reported the benefits of decreasing transmission, they also reported financial and psychological harms to individuals and their families who were denied entry. This included refugees in some parts of the world, who lost regular access to asylum offices or asylum in foreign countries. The latter may also have violated local and international laws and treaties.
- **Screening at borders**
    - Cases avoided due to measure: Only a few studies reported on this outcome, and the results were conflicting, possibly due to the type of screening conducted and the simultaneous use of other measures (e.g., quarantine). As such, it is difficult to draw firm conclusions regarding screening at borders. In general, while screening at the border was reported to be beneficial in identifying imported cases (preventing positive individuals from immediately entering or prompting quarantine), it did not prevent the eventual spread within the community/ secondary cases within the country. It should be noted that studies did not usually report on pre-boarding testing from the countries of origin and so this may have been affected the certainty of the evidence.

- Shift in epidemic development: Only a few studies reported on this outcome. There was no clear correlation between the screening at borders and shift in epidemic development; other factors (e.g., dominant circulating variant, vaccine status of travelers) may be better correlated.
- Cases detected due to the measure: Most studies on screening at borders reported this outcome with mixed results. Most studies reported that more invasive screening (e.g., PCR) was more effective than less invasive modalities (e.g., syndromic screening), and differed according to the dominant circulating variant. It should be noted that some countries required pre-boarding screening or testing within a certain period of time (e.g., 72 hours before arrival). This may have confounded the results, as individuals who screened positive may not have been allowed to travel.
- Secondary outcomes: There was a general agreement among studies that reported on resource requirements that screening requires an extensive amount of resources, both in personnel time and cost. As such, screening all travelers irrespective of disease history, citizenship, purpose of travel, quotas, testing requirements, vaccine requirements, availability of monitored quarantine facilities, cost-sharing, along with other factors, may not be feasible. For other secondary outcomes, it was not clear if screening had a direct impact on infectious disease outcomes or healthcare utilization.

- **Quarantine**
  - Cases avoided due to measure: Only a few studies reported on this outcome, and the results were conflicting. While quarantine is intended to eliminate interaction with non-infected individuals to reduce risk of transmission, from the evidence reported in the included studies, it was not clear what the true value of quarantine above and beyond other measures (e.g., border closure/ travel restrictions and/ or screening). Additionally, it was not clear if longer quarantine was better (e.g., leave after 1st negative test vs. remain for 14 days) although in theory, as viral loads change over time (e.g., distribution is skewed to the left), a “risk management” approach may have been introduced to reduce the length of quarantine.
  - Shift in epidemic development: Only a few studies reported on this outcome, but they did report that quarantine was beneficial in delaying the peak of illness. Since cases may have been asymptomatic, the effect on this outcome is generally difficult to evaluate.
  - Cases detected due to the measure: Most studies on screening at borders also reported on this outcome with mixed results. The results were similar to screening at borders as quarantine was often coupled with screening (i.e., all quarantined individuals are screened – often multiple times).
  - Secondary outcomes: In addition to the limitations on the rights of free movement, adverse effects of quarantine on individuals (e.g., insomnia, quarantine system failures) and associated resource requirements were noted as important considerations. Additionally, the benefits of quarantining on reducing community transmission were not clear and seeding within the

community from infected travelers still occurred. New variants were still introduced into countries implementing quarantine. As such, quarantine alone is not expected to lead to zero imported cases. It should be noted that some travelers were exempt from travel restrictions (e.g., essential workers), while it was not clear in most studies if quarantine was mandatory, how it was enforced, and the consequences of refusal of the intervention. This is a limitation of the implementation of the intervention and the reporting of the studies.

Interpretation of the Evidence by Patient Partners (Maya Stern and Juanita Garcia)

1. This is a very comprehensive review providing a vast amount of information, making it difficult to interpret the results in isolation and come to a concrete conclusion. Considering the number of variables that can impact the results of each study and the overall research question the consistency of results gathered is not strong enough. There is not a single piece of evidence that can provide an answer to this research question, leaving it unjustified to implement or not a certain measure.

2. Even though the review gathered a substantial number of studies, the current/ newer mandates which often involve vaccination questions were not represented as the research is not yet available. This creates a research gap and raises the question as to whether the vaccine measures would impact the effectiveness of travel restrictions and change the outcomes observed in the review. It is recommended to revisit this question when that research becomes available.

3. Based on the research studies obtained, there is almost no evidence gathered that encompasses the psychological effects of the travel measures on the individual level. Similarly, there is no research on how traumatic it can be for an individual to comply with all the different measures. For example, a person not being able to travel to be with their brother dealing with a terminal illness or the strictness of the quarantine hotels and not being able to access certain needs.

4. We believe that this review and the scientific evidence gathered is representative of people's real-life experiences. The mixed results observed in the evidence is the same one heard by anecdotal experiences of people traveling during the pandemic. For example, not everyone is having the same experience and for some people the travel measures have served to prevent the spread of COVID-19 but for others it has not.

5. The globalized nature of our world makes it impossible to implement strict travel restrictions to prevent the spread of the virus. However, it is worth acknowledging that travel measures are effective in slowing the speed of the spread, thus helping institutions prepare to lessen the impact of the virus.

Introduction

In humans, coronaviruses may cause respiratory infections ranging from the common cold to severe disease. The 2003 Severe Acute Respiratory Syndrome (SARS), the 2012 Middle Eastern Respiratory Syndrome (MERS), and the 2019 Coronavirus Disease (COVID-19) are all notable diseases caused by novel coronaviruses.

COVID-19 has proven to be more difficult to manage, compared to previous epidemics, for many reasons, including its high infectivity rate. To combat the transmission of SARS-CoV-2, governments and public health organizations and officials have implemented policies to decrease the spread of the virus, including international border closures/ travel restrictions, screening and/ or quarantine of incoming travelers. A recent Cochrane review[1] showed that there was low to very low certainty evidence for most international border restrictions and that the theorized effects (mainly from modelling studies) may be substantially different from the reality on the ground. As such, further research is required prior to making firm conclusions on the effectiveness of these interventions.

The objective of this rapid review was to identify, critically-appraise and summarize evidence on international border closures/ travel restrictions, screening and/ or quarantine to control the spread of SARS-CoV-2 transmission between countries and regions.

Methods

This review is based on the Cochrane review: "International travel-related control measures to contain the COVID-19 pandemic".[1] We conducted this review according to guidelines detailed in the Methodological Expectations of Cochrane Intervention Reviews (MECIR), and reported according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines.[2] The Cochrane review protocol is available in the Cochrane Library (https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD013717.pub2/appendices#CD013717-sec-0121). The research question was 'What is the effectiveness of international border closures/ travel restrictions, screening, quarantine or a combination of these interventions on the spread of SARS-CoV-2?'

Population, interventions, comparators, outcomes, study designs (PICOS)

The population of interest for this review was human international travelers (any age) crossing/ attempting to cross national borders (all countries). Studies focusing on inter-country travel (e.g., across province borders) were excluded. The interventions of interest were:

- Travel restrictions reducing or stopping international cross-border travel via ports of entry (e.g. air, land, sea)
- Screening at borders (e.g., syndromic screening, rapid testing, polymerase chain reaction – PCR)
- Quarantine of travelers
- Combination of the above (e.g., Quarantine and screening at borders)

It should be noted that the vaccination status of travelers was not included as an intervention in this review as it was not one of the interventions in the Cochrane review.

The comparators were no border measures, less restrictive border measures, no border measures or other border measures.

The primary outcome categories for this review were (i) Cases avoided due to the measure, (ii) Shift in epidemic development due to the intervention, and (iii) Cases detected due to the measure. The secondary outcomes were (i) any other infectious disease transmission outcome (e.g., number of severe cases in the community), (ii) healthcare utilization (e.g., number of cases requiring treatment in the intensive care unit (ICU), time until ICU capacity is reached), (iii) resource requirements for implementing the intervention (e.g., costs associated with intervention, additional personnel, number of tests required), (iv) any adverse effects (e.g., health, economic and social outcomes), and (v) user acceptability (e.g., passenger confidence).

We included any relevant non-randomized or observational studies that were used to assess the impact of interventions. The non-randomized studies could be single arm or with a control group, including but not limited to prospective or retrospective cohort studies, case-controlled studies, cross-sectional studies, interrupted time series, or ecological studies (cross-sectional, time-trend, or descriptive). We excluded case reports/ series, opinion papers, editorials, study protocols and trial registries.

Search strategy for identification of studies

The Cochrane review[1] search was adapted by excluding terms not related to COVID-19 (e.g., MERS, H1N1, SARS01) and an updated search conducted from Nov 2020 to Apr 2022, restricting to observational studies using a modified version of the observational study filter developed by the Scottish Intercollegiate Guidelines Network (https://www.sign.ac.uk/ what-we-do/ methodology/ search-filters/), and English language publications. The search was conducted in general health and COVID-19-specific bibliographic databases [Medline (Ovid), Embase (Ovid), Cochrane COVID (https://COVID-19.cochrane.org/), and the WHO COVID-19 Global literature on coronavirus disease (https://search.bvsalud.org/ global-literature-on-novel-coronavirus-2019-ncov). Each database was searched using an individualized search strategy (Appendix 1). Additionally, we conducted a grey literature search (e.g., MedRxiv, SSRN) for identification of pre-prints. Finally, the reference lists of relevant narrative and systematic reviews and included studies were hand-searched for relevant citations. We performed reference management in EndNote™ (version X9, Thomson Reuters, Carlsbad, CA, USA).

Study selection

We developed, standardized, and piloted-tested screening forms. For title/ abstract screening, all unique citations were reviewed by one reviewer to determine if a citation met the inclusion criteria. Full texts of all included citations were reviewed independently, and in duplicate, by two reviewers. All conflicts were resolved through discussion, consensus or by a third reviewer, as required. We recorded

the number of ineligible citations at the title/ abstract screening stage, and both the number and reason for ineligibility at the full-text articles.

Data abstraction and management

Following pilot testing, one reviewer extracted and summarized the findings from included study reports and a second reviewer reviewed the summaries for accuracy and completeness. Discrepancies between the two reviewers were resolved by discussion and consensus. Data management was performed using Microsoft Excel™ 2010 (Excel version 14, Microsoft Corp., Redmond, WA, USA).

Assessment of methodological quality and potential risk of bias

Non-randomized comparative studies were assessed using the Newcastle-Ottawa Scale (NOS). NOS uses a 'star' system with eight items, categorized into three domains: the selection of the study groups, the comparability of the groups, and the ascertainment of outcome of interest for cohort studies (http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp). Since the included studies were not expected to be true cohort studies, some of the items could not be assessed. It should also be noted that the Cochrane review used the ROBINS-I tool. We decided to use NOS instead due to time constraints (e.g., urgency of the work) as the ROBINS-I tool is time-consuming for the team to set up, pilot-test, and be trained on.[3]

Similar to the Cochrane review, for diagnostic accuracy studies, we used the QUADAS-2 tool which was designed to assess risk of bias in diagnostic studies.[4] QUADAS-2 is categorized in four domains: patient selection, index test, reference standard, and flow and timing (https://www.bristol.ac.uk/population-health-sciences/projects/quadas/quadas-2/).

Data summary

All data are summarized descriptively and in tabular format. Similar to the Cochrane review, we present specific characteristics of all included studies in a tabular form. The analysis of the extracted data is descriptive as data did not allow for any meta-analytic techniques to be used, except for the diagnostic accuracy of screening tests. As such, we are presenting counts and percentages, where possible, and descriptive summaries of the results per outcome. Further, we have summarized the results in summary tables including GRADE summary of findings tables.

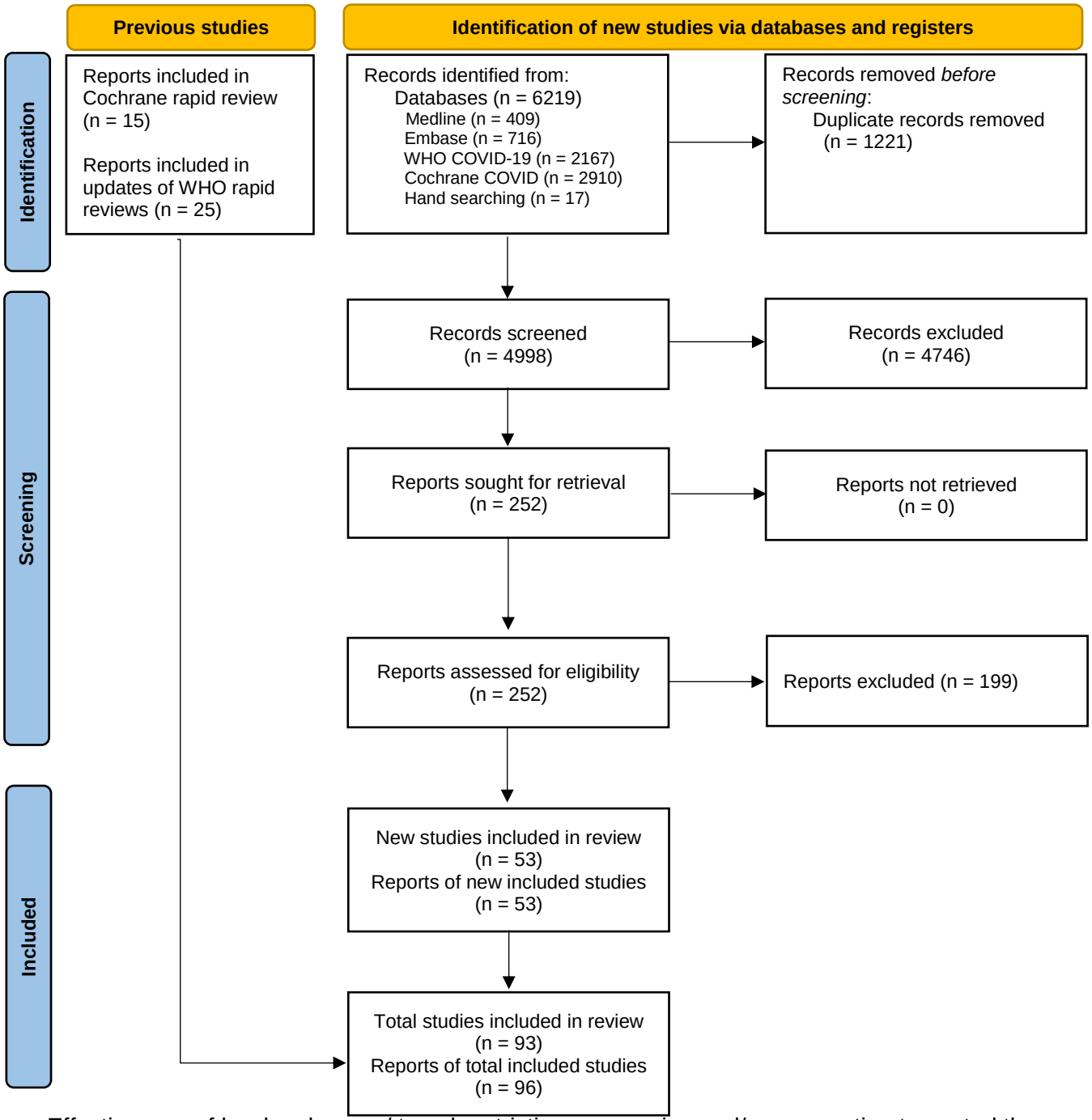
In addition to the main analysis, where data are available, we have provided a summary of evidence related to:

1. Countries similar to Canada with regards to COVID-19-related restrictions. As this is an arbitrary dichotomy with potential historical, geographic, and political bias, the country list was finalized only after consultation with decision-makers, knowledge users and content experts.
2. Voluntary vs mandatory requirements of travelers (e.g., quarantine).

Results

From 6218 retrieved citations, we included 53 study reports that met our inclusion criteria. In addition, we included another 15 study reports that were included by the Cochrane review and additional 25 study reports that were included in a previous study conducted by WHO. Therefore, in total, we included 96 study reports representing 93 studies (3 study reports were companion publications) (**Figure 1**).

Figure 1. PRISMA 2022 Flow Diagram.



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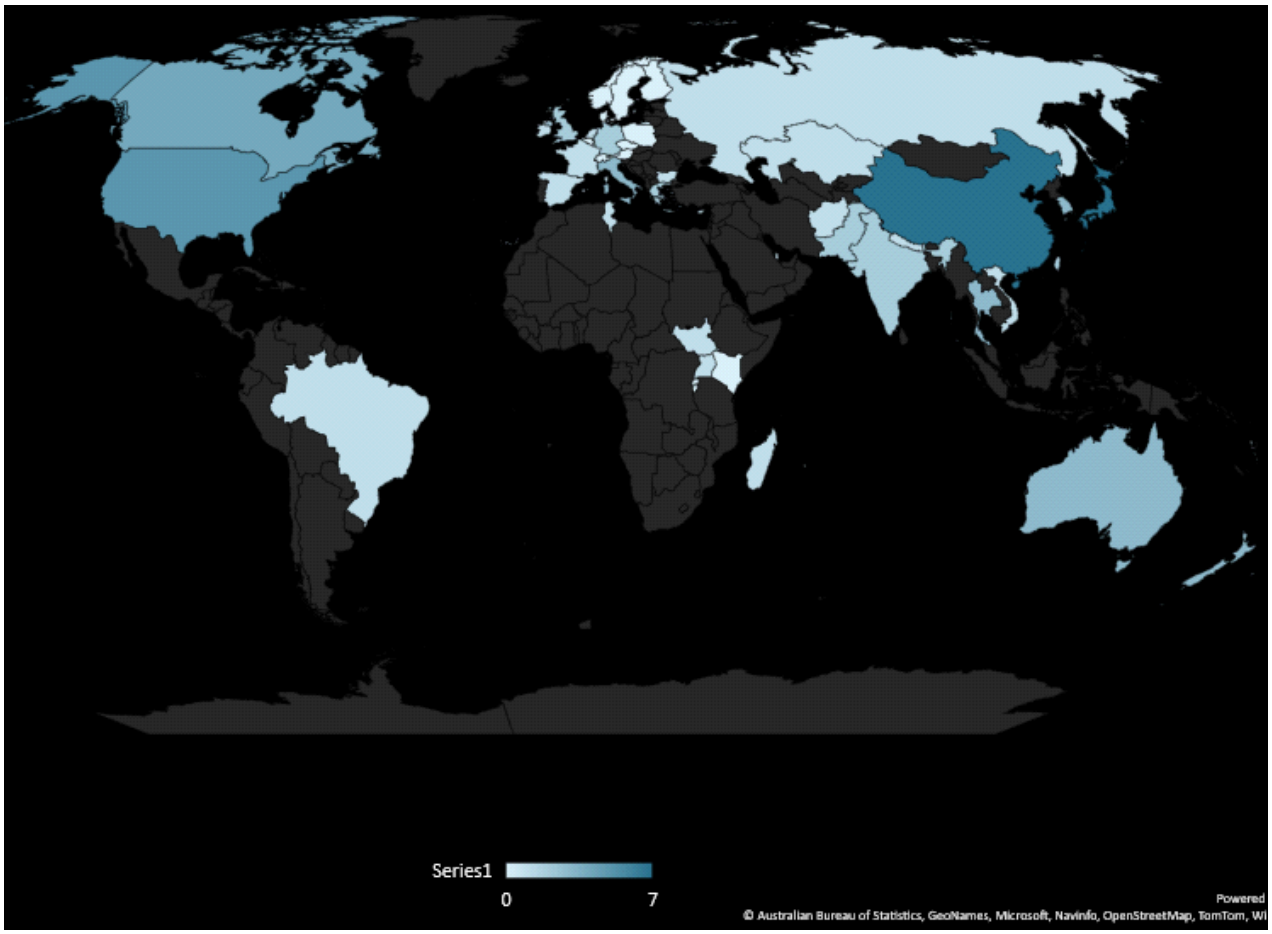
The studies were conducted mostly in North American, Europe, Australia, and Asia (**Figure 2**). **Thirty-seven studies were conducted in Canada and related countries:** Australia[5-7] (n = 3), Bulgaria[8] (n = 1), Canada[9-12] (n = 4), Cyprus[13] (n = 1), France[14] (n = 1), Germany[15-17] (n = 3), Greece[18,19] (n = 2), Ireland[20] (n = 1), Italy[21-23] (n = 3), Japan[24-30] (n = 7), Netherlands[31] (n = 1), New Zealand[6,32,33] (n = 3), Spain[34] (n = 1), UK[33,35] (n = 2), USA[18,23,36,37] (n = 4).

Figure 2. Distribution of countries implementing the interventions.



With regards to risk of bias (screening studies) and study quality (observational studies), most studies were not adequately designed as a diagnostic test accuracy study or a cohort, cross-sectional or case-control studies. As such, we had to adapt the QUADAS-2 and Newcastle-Ottawa Scales accordingly, with several domains noted as not being applicable (**Tables 1 – 2**).

The evidence for border closures/ travel restrictions, screening and/ or quarantine are presented in **Tables 3 – 5**, respectively. The exact definitions of the interventions used, length of interventions implemented, exceptions to the rules (e.g., repatriation of citizens) allowed, pre-boarding screening, and dominant circulating variants were rarely reported in detail. Due to time constraints and feasibility,

we did not attempt to identify this information from other sources. When reported, these varied markedly from study to study. As such, only general inferences about the effectiveness of these interventions can be assumed.

Additionally, border closures/ travel restrictions, comprehensive screening (especially with PCR), and quarantine all carried potential benefits and harms. While the most restrictive interventions showed the greatest potential benefit (e.g., limiting spread, delaying introduction of new variants, identifying most cases prior to entry into the community), no method was rigorously proven to be effective past a few weeks of implementation, and most were evaluated retrospectively in a short period (e.g., weeks to months) of the pandemic. As such, while most studies reported some benefit to these interventions, others showed no benefit/ mixed effects/ conflicting findings. Also, risk assessment and balancing benefits and harms of interventions were regularly echoed in the study reports.

The added studies did not change the main conclusions of the Cochrane review ("some travel-related control measures during the COVID-19 pandemic may have a positive impact on infectious disease outcomes") nor the quality of the evidence (very low to low certainty). However, it did add to the evidence base for most outcomes.

The evidence limited to Canada and related countries is presented in **Tables 6 – 8**. The evidence for most outcomes comprised only one study or was not reported by any of the included studies. Where evidence was available, it was generally not different from the global evidence assessment.

Most studies reported that, or implied, that the restrictions were mandatory. Only three studies[9,10,21] implemented voluntary interventions, two of which were Canadian [9,10]; they reported on screening[9,10] and quarantine[10,12] interventions and, on number or proportion of cases seeded by imported cases, proportion of cases detected and healthcare utilization. Lunney 2021[10] reported that quarantine did not appear to fully protect against transmission to contacts. Also, travelers who received a negative first result, and were allowed to leave quarantine, did not cause a greater number of secondary infections (n=8) than those who remained in quarantine for 14 days. All three reported that the interventions were of benefit to detect cases at the border. Lunney 2021[10] reported that among participants with positive tests, only 2.0% were hospitalized for COVID-19, and none required critical care or died.

Overall completeness and applicability of evidence

This review's goal was to update the evidence base of observational and ecological studies regarding border closures/ travel restrictions, screening and/ or quarantine. Other study designs (e.g., modelling studies) were excluded and may provide valuable information regarding the effectiveness of these interventions. Additionally, we did not review the effectiveness of vaccine requirements alone, or in addition to the aforementioned interventions.

Strengths in the review methods

This review has many strengths, including searching several bibliographic databases and hand-searching previous relevant reviews. Additionally, we incorporated interpretations of the evidence from content experts and decision makers.

Weaknesses and potential biases in the review methods

As most aspects of the study selection, data extraction, quality/ risk of bias assessments were conducted by a single reviewer, errors of omission or interpretation may have been inadvertently introduced. Additionally, we only included evidence from English-language sources, and this may have introduced language bias.

Implications of this rapid review

For current practice

The evidence from this rapid review demonstrates that early interventions may be effective in slowing down the introduction of the pathogen through ports of entry. Even so, it is important to take into account prior to implementation, the many confounding factors as well as the adverse individual and societal effects of these interventions.

For future research

Future high-quality research is required to determine the best timing of the introduction of interventions, the comparative effectiveness of interventions and the removal of these interventions. Well-designed diagnostic accuracy tests are required to determine the diagnostic accuracy and most cost-effective approach to screening travelers.

Conclusion

Low to very low certainty evidence supports the balanced use of international border entry restrictions/ closures, screening, and/ or quarantine to limit the spread of COVID-19, and for delaying (but not eliminating) introduction of new variants past the countries' borders. It is important to acknowledge the uncertainty due to the large variation in effect sizes, often conflicting results, level of community spread at the time the interventions were implemented, the duration and length of quarantine, vaccine uptake by the community and vaccination status of travelers. Also, generalizability of the results may be problematic as not all countries/ regions of the world were represented by these studies and health systems and available resources across countries/ regions vary. Even for countries reporting evidence, it is only a snapshot in time, and may not be applicable today due to the changing nature of the pandemic and the responses to it. Due to the aforementioned challenges, the evidence should be

viewed as continuously evolving. Lastly, it is important to balance the potential benefits of these measures with the potential harms and negative consequences on both an individual and societal level.

Future high-quality research is required to determine the best timing of the introduction of interventions, the comparative effectiveness of interventions and the removal of these interventions. Studies evaluating the diagnostic accuracy of screening tools against a reference standard in this setting is required.

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Table 1. Newcastle-Ottawa Scale Assessments.

Reference	Selection 1	Selection 2	Selection 3	Selection 4	Comparability 1	Outcome 1	Outcome 2	Outcome 3	Total score
Aggarwal 2022	1	1	1	0	N/A	1	1	1	6/7
Atsawawaranunt 2021	0	N/A	1	1	N/A	1	1	1	5/6
Aubry 2021	1	N/A	1	1	N/A	1	1	1	6/6
Badshah 2020	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1/1
Bae 2020	1	N/A	1	0	N/A	1	1	1	5/6
Benslimane 2021	0	N/A	N/A	N/A	N/A	1	N/A	0	1/3
Cao-Lormeau 2021	1	N/A	1	1	N/A	1	1	1	6/6
Chan 2020	1	N/A	0	0	N/A	1	N/A	1	3/5
Chen 2021	0	N/A	1	0	0	1	1	1	4/7
Cherif 2021	0	N/A	N/A	N/A	1	N/A	N/A	0	1/3
Chilla 2022	1	N/A	N/A	N/A	0	1	N/A	1	3/4
Colavita 2021	1	N/A	1	0	N/A	1	N/A	1	4/5

Reference	Selection 1	Selection 2	Selection 3	Selection 4	Comparability 1	Outcome 1	Outcome 2	Outcome 3	Total score
Douglas 2021	1	N/A	N/A	N/A	N/A	1	N/A	1	3/3
EASO 2020	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fernandes 2020	0	N/A	1	N/A	N/A	1	N/A	1	3/4
Fotheringham 2021	1	N/A	1	0	N/A	1	1	1	5/6
Fox-Lewis 2022	0	N/A	1	1	N/A	1	1	1	5/6
Gao 2021	1	N/A	N/A	N/A	N/A	1	N/A	1	3/3
Gehre 2021	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0/0
Gordon 2021	1	N/A	N/A	N/A	N/A	N/A	N/A	1	2/2
Grout 2021	1	N/A	1	N/A	0	N/A	N/A	N/A	2/3
Gwee 2021	1	0	1	1	0	1	1	1	6/8
Han 2022	1	N/A	N/A	N/A	N/A	1	N/A	1	3/3
Huy 2022	1	N/A	0	0	1	1	N/A	1	4/6
Kong 2021	1	0	1	0	N/A	1	1	1	5/7

Reference	Selection 1	Selection 2	Selection 3	Selection 4	Comparability 1	Outcome 1	Outcome 2	Outcome 3	Total score
Kostaki 2021	1	N/A	N/A	N/A	N/A	1	N/A	1	3/3
Laha 2021	0	N/A	N/A	N/A	N/A	1	N/A	1	2/3
Layer 2022	1	N/A	0	1	N/A	1	1	1	5/6
Lokuge 2022	1	N/A	N/A	N/A	N/A	1	N/A	1	3/3
Matsvay 2021	1	N/A	N/A	N/A	N/A	1	N/A	1	3/3
McDermid 2021	0	N/A	N/A	N/A	1	N/A	N/A	1	2/3
McDermid 2022	0	N/A	N/A	N/A	1	N/A	N/A	1	2/3
Melillo 2020	1	N/A	0	0	N/A	N/A	N/A	1	2/4
Middleton 2021	1	N/A	N/A	N/A	0	N/A	N/A	0	1/3
Murall 2021	1	1	N/A	N/A	N/A	1	N/A	N/A	3/3
Myers 2020	1	N/A	1	0	N/A	1	1	1	5/6
Norizuki 2021	1	N/A	1	1	N/A	1	1	1	6/6

Reference	Selection 1	Selection 2	Selection 3	Selection 4	Comparability 1	Outcome 1	Outcome 2	Outcome 3	Total score
Nsawotebba 2021	1	N/A	1	0	N/A	1	N/A	1	4/5
O'Donnell 2021	1	N/A	1	0	N/A	1	1	1	5/6
Ohlsen 2021	1	N/A	1	0	N/A	1	1	1	5/6
Papadopoulos 2020	1	N/A	N/A	N/A	1	1	N/A	1	4/4
Piryani 2020	1	N/A	N/A	N/A	N/A	N/A	N/A	1	2/2
Potdar 2020	1	N/A	N/A	N/A	N/A	1	N/A	1	3/3
Potdar 2021	1	N/A	N/A	N/A	N/A	1	N/A	1	3/3
Prapaso 2021	1	N/A	N/A	N/A	1	N/A	N/A	1	3/3
Randremanana 2021	1	N/A	1	0	N/A	1	N/A	1	4/5
Regehr 2021	1	N/A	1	0	1	1	1	0	5/7
Savini 2021	1	N/A	0	0	N/A	1	N/A	1	3/5
Shragai 2021	1	N/A	1	1	N/A	1	1	1	6/6

Reference	Selection 1	Selection 2	Selection 3	Selection 4	Comparability 1	Outcome 1	Outcome 2	Outcome 3	Total score
Song 2021	1	N/A	1	0	1	1	N/A	1	5/6
Stokes 2020	1	N/A	N/A	N/A	1	1	N/A	1	4/4
Tande 2021	1	N/A	1	1	N/A	1	1	1	6/6
Tegally 2021	0	N/A	N/A	1	N/A	1	1	1	4/5
Tokumasu 2021	1	N/A	N/A	0	N/A	1	N/A	1	3/4
Tsuboi 2020	1	1	0	0	1	1	1	1	6/8
Tsuboi 2021	1	1	1	1	N/A	1	1	1	7/8
Walker 2021	1	N/A	1	0	0	1	1	1	5/7
White 2022	1	N/A	1	1	N/A	1	1	1	6/6
Williams 2021	1	N/A	1	1	N/A	1	1	1	6/6
Yang 2022	0	N/A	0	N/A	1	N/A	N/A	1	2/4
Yordanova 2021	1	N/A	1	N/A	N/A	1	1	N/A	4/4
Zeng 2020	1	N/A	N/A	N/A	0	1	N/A	1	3/4

Reference	Selection 1	Selection 2	Selection 3	Selection 4	Comparability 1	Outcome 1	Outcome 2	Outcome 3	Total score
Zhang 2021	1	N/A	1	0	N/A	1	1	1	5/6
Zhu 2021	1	N/A	0	0	N/A	1	1	1	4/6

Table 2. QUADAS-2 Assessments.

Study	Risk of bias				Applicability		
	Participant selection	Index test	Reference standard	Flow & timing	Participant selection	Index test	Reference standard
Abdulrahman 2021	Low	Unclear	Low	Low	Low	Low	Low
Al-Qahtani 2021	Low	Unclear	Unclear	Unclear	Low	Unclear	Low
Al-Tawfiq 2020	High	Low	Low	Low	Unclear	Unclear	Low
Arima 2020	Unclear	Low	Low	Unclear	High	High	Low
Chen 2020	Low	Unclear	Low	Unclear	High	Low	Low
Goel 2021	Unclear	Unclear	Low	Unclear	Unclear	Low	Low
Hallowell 2020	Low	Low	Low	Low	Low	Low	Low
Hoehl 2020	Low	Low	Unclear	Unclear	High	High	Low
Imran 2021	Low	Low	Low	Unclear	Unclear	Low	Low
Joob 2020	Low	Low	Low	Unclear	Low	Low	Low
Kim 2020	Low	Low	Unclear	Low	High	Unclear	Low
Lagier 2020	High	Unclear	Low	Unclear	High	Low	Low
Lio 2020	Unclear	Low	Low	Low	High	Unclear	Low
Liu 2020	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Lunney 2021	Low	Low	Low	Low	Low	Low	Low
Luo 2021	Low	Low	Low	Low	Low	Low	Low

Lytras 2020	Low	Unclear	High	Unclear	High	High	Low
Molero-Salinas 2021	Low	Low	Low	Low	Low	Low	Low
Mouchtouri 2020	Low	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Ng 2020	High	Low	High	Unclear	High	High	Low
Pham 2021	Unclear	Unclear	Unclear	Unclear	Low	Unclear	Low
Ren 2021	Low	Unclear	Unclear	Unclear	Low	Unclear	Low
Shaikh Abdul Karim 2020	Low	Low	Unclear	Unclear	High	High	Low
Tapo 2021	Low	Low	Unclear	Low	Low	Low	Low
Taryam 2020	Low	Low	Low	Unclear	Low	Low	Low
Wong 2020	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Low
Yen 2020	Low	Low	Low	Low	Low	Low	Low
Yokota 2021a	Low	Low	Low	Low	Low	Low	Low
Yokota 2021b	Low	Low	Low	Unclear	Low	Low	Low

Table 3. GRADE Summary of Findings – Border closures/ travel restrictions for reducing or stopping cross-border travel

Disease: COVID-19 Interventions: implementing border closures/ travel restrictions for reducing or stopping cross-border travel; maintaining the measure; early implementation of the measure; implementing a highly stringent measure Comparators: no measure; relaxation of the measure; late implementation of the measure; implementing a less stringent measure

Outcome	Number of studies	Summary of findings	Certainty of evidence
Outcome category: 1. Cases avoided due to measure			
Number or proportion of cases in the community	1 Observational study[38] Brazil (Jan 2020)	This study reported that asymptomatic cases, and symptomatic cases that did not fit the description (at the time) of COVID, were allowed port access. That led to an epidemic outbreak that was traced back to the infected crew members.	**Low** ⨁⨁◯◯

Outcome	Number of studies	Summary of findings	Certainty of evidence
Number or proportion of cases in the community	7 Ecological studies[39-45] 4 – 130 countries per study (Dates varied by country)	Of these seven studies, most (n = 5) reported a negative association between strict (early) border closures/ travel restrictions on cases per capita (e.g., 1.48% reduction) and deaths with countries that used looser or later implementation of restrictions (e.g., Sweden, United States, Spain, Italy) reporting growth in per capita COVID cases (e.g., 15% increase) and COVID deaths per 100,000 (e.g., 63 vs. 0.03). Of the remaining two studies, one reported that the potential benefit of border closures/ travel restrictions (especially land crossings) was inconsistent across epidemic waves and country pairs. The second study reported no consistent trend in the rate of change of local cases and that no discernable correlation was observed between imported and local cases following the implementation of border closures/ travel restrictions.	**Very low** ⊕◯◯◯ Inconsistency
Number or proportion of imported or exported cases	2 Observational studies [18,46] Thailand (Apr 2020), Greece (NR)	These studies reported that stricter border closures/ travel restrictions (e.g., bans international travelers from high-risk regions) led to decreased rates of imported cases; proportion decreased by ~30% in one study and that a month after all international flights were suspended, no further imported cases were registered in the second study. These positive effects were also noted as effective only for a short duration before cases were imported from lower-risk regions.	**Low** ⊕⊕◯◯
Number or proportion of imported or exported cases	1 Ecological study[41] 5 Asian Pacific Countries (Dates varied by country)	This study reported that imported cases fell by 1.08–1.43 following border closures/ travel restrictions on departures from China. However, this benefit only lasted a few weeks as imported cases were imported from lower-risk regions.	**Low** ⊕⊕◯◯

Outcome	Number of studies	Summary of findings	Certainty of evidence
Number or proportion of deaths	1 Ecological study[47] 165 countries (Jan – Jul 2020)	This study reported that enactment of any international travel controls delayed the time in which cumulative incidence rates or deaths peaked. However, enactment of the strongest control was not associated with a reduced time to peak death or cumulative incidence of 5 cases/ 100,000 persons.	**Low** ⨁⨁◯◯
Risk of importation or exportation	1 Ecological study[48] 23 regions (Feb 2020)	This study reported that widespread international air-travel bans imposed against China by early February 2020 coincided with a significant reduction in geographic viral spread. In North America, the efficacy of this travel ban was temporary, possibly due to the lack of both containment measures against other infected regions and domestic mitigation measures.	**Low** ⨁⨁◯◯
Outcome category: 2. Shift in epidemic development			
Effective reproduction number (Rt)	1 Observational study[49] Qatar (Mar - Aug 2020)	This study reported that the Rt was >1 at the beginning of the pandemic, but <1 during the summer and till the end of 2020. By March 2021 it had rebounded to 1.5 due to the introduction of the Alpha and Beta lineages.	**Low** ⨁⨁◯◯
Number or proportion of cases at peak	1 Observational study[49] Qatar (Mar - Aug 2020)	This study reported that despite banning entry of foreign nationals (beginning March 17, 2020), Qatar witnessed a large outbreak, with the highest confirmed cases of 2,355 per day reported on May 30, 2020. As such, the ban did not prevent the eventual rise in cases within 2 weeks of implementing the border closures/ travel restrictions.	**Low** ⨁⨁◯◯

Outcome	Number of studies	Summary of findings	Certainty of evidence
Epidemic curve peak	1 Ecological study[47] 165 countries (Jan – Jul 2020)	This study reported that early implementation of international travel controls led to a mean delay of 5 weeks in the first epidemic peak of cases. Although border closures/ travel restrictions did not prevent the virus from entering most countries, delaying its introduction bought valuable time for local health systems and governments to prepare to respond to local transmission	**Low** ⨁⨁◯◯
Outcome category: 3. Cases detected due to the measure			
Number or proportion of cases detected	8 Observational studies[31,32,35,46,50-53] UK (Mar 2020), Hong Kong (Jan – Mar 2020), New Zealand (Aug 2020 – Feb 2021), The Netherlands (NR), Malta (NR), Nepal (Jan – Mar 2020), Thailand (Apr 2020), China (Feb – Mar 2020)	Of these 8 studies, most (n = 7) reported benefits of border closures/ travel restrictions with up to 90% of registered cases being stopped at the border. The remaining study reported no decrease in imported cases even when border closures/ travel restrictions were implemented.	**Very low** ⨁◯◯◯ Inconsistency

Outcome	Number of studies	Summary of findings	Certainty of evidence
Number or proportion of cases detected	1 Ecological study[47] 165 countries (Jan – Jul 2020)	This study reported that countries that implemented their strictest international travel controls before detecting any COVID-19 cases reported their first case a median of 57 days (95% CI 14–70 days) later than countries that imposed their strongest controls after the first case was reported (p = 0.04). The average time to detection of the first case occurred 1.22 (95% CI 1.06–1.41) times later in countries that implemented any restrictions than in countries that implemented no border closures/ travel restrictions. This time ratio was extended to 1.31 (95% CI 1.02–1.68) if countries implemented their strongest border closures/ travel restrictions. Such associations still held when adjusting for time-varying nonpharmaceutical interventions.	**Low** ⨁⨁◯◯
Outcome category: 4. Secondary outcomes			
Infectious disease transmission outcomes	3 Observational studies[15,49,54] Qatar (Mar - Aug 2020), Germany (Jan 2020), Russia (Mar - Aug 2020)	These studies reported benefits of border closures/ travel restrictions with one reporting that when border closures/ travel restrictions were reduced, the prevalence of imported variants increased, and succeeded in eliminating all other local lineages. The second study reported several new mutations had emerged post-travel-ban and were on the rise in specific countries. The third study reported that Russia imported variants at least 82 times, resulting in 457 Russian transmission lineages and that two Russian exports to New Zealand resulted in 33 cases (including two staff members at the isolation facility).	**Low** ⨁⨁◯◯

Outcome	Number of studies	Summary of findings	Certainty of evidence
Adverse effects	2 Observational study[55,56] Western Pacific (Oceania) (Jun – Sep 2021), Western Pacific (Oceania) (Jul – Sep 2021)	These studies reported harms of border closures/ travel restrictions with one study reporting that overall, 64.2% of individuals surveyed reported financial distress while stranded abroad, 64.4% reported moderate/ severe depression, 41.7% reported anxiety, and 58.1% reported stress. The second study suggested a significant financial burden on those impacted by border closures/ travel restrictions, with respondents' average expenditure incurred $7,285USD and 71.2% reporting financial stress. Additional financial distress was found in family members of those stranded abroad as well.	**Low** ⨁⨁◯◯
Adverse effects	1 Ecological study[57] 26 EU states + 4 Schengen-Associated Countries (Mar – Jul 2020)	This study reported that since 2020 asylum applications have drastically decreased, partly due to border closures. They also concluded that these measures may have violated the right to asylum protected by EU law.	**Low** ⨁⨁◯◯
User acceptability	1 Observational study[13] Cyprus (NA)	This study reported that most (>90% of individuals surveyed) believe that strict border closures/ travel restrictions are a necessary measure for reducing rates of new cases.	**Low** ⨁⨁◯◯

Table 4. GRADE Summary of Findings – Screening at borders

Disease: COVID-19 **Interventions:** implementing entry and/ or exit symptom/ exposure-based screening; implementing entry and/ or exit test-based screening; implementing a highly stringent screening measure **Comparators:** no measure; implementing an alternative measure; implementing a less stringent screening measure

Outcome	Number of studies	Summary of findings	Certainty of evidence
Outcome category: 1. Cases avoided due to measure			
Number or proportion of imported or exported cases	2 Observational studies[18,58] Greece (NR), India (Nov/ Dec 2021)	These studies reported that routine testing was beneficial in identifying imported cases. In one study, the proportion of imported strains decreased the most with targeted public health measures including entry testing (8.8% from 41%). In the second study, 55.9% of overseas travelers tested positive for omicron. Had no testing been in place, these travelers would have been allowed entry and potentially led to community spread.	**Low** ⨁⨁◯◯
Number or proportion of cases seeded by imported cases	2 Observational studies[10,58] Canada (Nov 2020), India (Nov/ Dec 2021)	These studies reported that routine testing did not prevent seeding of cases. One Canadian study reported that on average, one contact was identified for each infected participant, with 22 cases of secondary transmission, irrespective of first test result (positive leading to quarantine – negative leading to no refusal of entry). The second study reported that 44% of contacts of overseas travelers tested positive for omicron.	**Low** ⨁⨁◯◯

Outcome	Number of studies	Summary of findings	Certainty of evidence
Proportion of secondary cases	1 Observational study[20] Ireland (Dec 2020)	The study reported that 7% of flight close contacts (41% had COVID) were PCR positive within 2 weeks. The positivity rate was higher in longer flights (>5-hr duration).	**Low** ⨁⨁◯◯
Outcome category: 2. Shift in epidemic development			
Effective reproduction number (Rt)	1 Observational study[49] Qatar (Mar - Aug 2020)	This study reported that the Rt was associated with the dominant circulating variant; being <1 until the introduction of Alpha and Beta lineages in Dec 2020 when it rose to 1.5 by Mar 2021.	**Low** ⨁⨁◯◯
Number or proportion of cases at peak	1 Observational study[49] Qatar (Mar - Aug 2020)	This study reported that despite banning entry of foreign nationals (beginning March 17, 2020), Qatar witnessed a large outbreak, with the highest confirmed cases of 2,355 per day reported on May 30, 2020.	**Low** ⨁⨁◯◯
Epidemic curve peak	1 Observational study[28] Japan (Feb 2020)	This study reported that the epidemic curve shows infections were occurring amongst Australians before ship-based quarantine and screening commenced. The illness peaked around 3–5 days after quarantine started which supports previous findings that the movement restrictions placed on 5 February reduced the risk of infection among those passengers who had no known close contact with an infected individual.	**Low** ⨁⨁◯◯
Outcome category: 3. Cases detected due to the measure			

Outcome	Number of studies	Summary of findings	Certainty of evidence
Number or proportion of cases detected	59 Observational studies[5,7-10,14,16,17,19-26,28,29,32-37,50,52,53,59-90] Afghanistan, Australia, Brunei, Bulgaria, Canada, China, Dubai, France, French Polynesia, Germany, Greece, Hong Kong, India, Ireland, Italy, Japan, Kingdom of Bahrain, Korea, Madagascar, Malaysia, Mauritius, Nepal, New Zealand, Pakistan, Saudi Arabia, Singapore, South Korea, South Sudan, Spain, Taiwan, Thailand, Uganda, UK, USA, Vanuatu, Vietnam	Across studies, the proportion of cases detected by screening ranged from 0 to 100%. This differed markedly based on the screening modality (e.g., symptoms, thermal, etc.). In general, the more invasive screening procedures (e.g., PCR testing) had a higher sensitivity than less invasive procedures (e.g., syndromic screening).	**Very low** ⨁◯◯◯ Inconsistency

Outcome	Number of studies	Summary of findings	Certainty of evidence
Number or proportion of cases detected	2 Ecological studies[91,92] 5 African Countries (May 2020), 26 countries (Jan 2020)	These studies reported that using mobile labs, between 3 and 6% of positive PCR results can be expected and that 14.8% (95% CI 11.0–19.5) of imported COVID-19 cases can be detected through entry screening and related activities in countries which implemented entry screening.	
Positive predictive value (PPV)	3 Observational studies[21,74,82] Italy (Aug - Oct 2020), Uganda (May 2020), Korea (Mar 2020)	These studies reported that the PPV ranged from 23.3% (95% CI: 10.1–45.0) to 69.6%, depending on the test.	**Very low** ⨁◯◯◯ Inconsistency
Outcome category: 4. Secondary outcomes			

Outcome	Number of studies	Summary of findings	Certainty of evidence
Infectious disease transmission outcomes	6 Observational studies[26,28,49,74,76,86] Qatar (Mar – Aug 2020), Uganda (May 2020), Vietnam (Mar 2020), Japan (Mar 2020), Japan (Aug 2020), Japan (Feb 2020)	These studies reported conflicting evidence regarding infectious disease transmission. One study reported that when travel restrictions, including screening, were reduced, the prevalence of imported variants increased, and succeeded in eliminating all other local lineages. A second study reported that mandatory testing at arrival may reduce contact tracing duration and should be considered as an integrated screening tool for flight passengers from high-risk areas when entering low-transmission settings with limited contact tracing capacity. A third study reported that a higher 14-day average incidence in the countries of stay was associated with higher test positivity (1.64 [1.16–2.33] and 3.13 [1.88–5.23] for those from countries and areas where the 14-day average incidence was from 10 to <100 and ≥100 cases per million, respectively). A fourth study reported that the median time to the first of two consecutive negative PCR-based assays was 13 days for asymptomatic cases and 19 days for symptomatic cases (p = 0.002). Two other studies reported strict policies did not prevent the introduction of new strains and that thermal screening lacks sensitivity to reliably detect COVID-19 (sensitivity: 9.9% (95% CI: 7.4–13.0), specificity: 99.5% (95% CI: 99.3–99.6, negative predictive value: 93.9 (95% CI: 93.3–94.4), positive likelihood ratio: 19 (95% CI: 12.4– 29.1), negative likelihood ratio: 0.9 (95% CI: 0.88–0.93).	**Very low** ⨁◯◯◯ Inconsistency
Healthcare utilization	1 Observational study[10] Canada (Nov 2020)	This Canadian study reported that among participants with positive tests, 2% were hospitalized, but none required critical care or died.	**Low** ⨁⨁◯◯

Outcome	Number of studies	Summary of findings	Certainty of evidence
Resource requirements	3 Observational studies[36,37,72] China (Mar 2020), USA (Feb/ Mar 2020), USA (Jun 2020)	These studies reported that routine testing was costly and resource intensive. The first study reported that 872 health-care workers staffed hospital designated for arrivals, including 102 physicians (specialists in respiratory medicine, infectious disease, critical care medicine, pediatrics or traditional Chinese medicine), 728 nurses and 42 technicians. The second study reported that during a 7-week period, staff members devoted an estimated 1,694 total person-hours (equivalent to six employees working full-time for 7 weeks) processing travelers; 34% of these person-hours occurred outside regular working hours. The third study reported that during Jun – Nov 2020, up to 22 screening personnel and five testing personnel per day were required. The associated budget was $26 million for Jun – Dec and nonresident travelers were required to pay $250 for post-arrival testing.	**Low** ⊕⊕◯◯
Resource requirements	1 Ecological study[91] 5 African Countries (May 2020)	This study reported that with a basic setup (one centrifuge, two PCR machines) 4 – 6 lab staff can process ~400 samples per shift and diagnosis can be made within 8-hrs.	**Low** ⊕⊕◯◯

Table 5. GRADE Summary of Findings - Quarantine

Disease: COVID-19 **Interventions:** implementing quarantine; implementing a highly stringent quarantine **Comparators:** no measure; implementing an alternative measure (e.g., screening); implementing a less stringent quarantine

Outcome	**Number of studies** **Countries (dates implemented)**	**Summary of findings**	**Certainty of evidence**
Outcome category: 1. Cases avoided due to measure			
Number or proportion of cases in the community	1 Observational study[93] South Korea (Apr 2020)	The association between 14-day quarantining all travelers from overseas countries and the cumulative number of COVID-19 cases reported in South Korea is: B=−0.226, 95% CI=−0.231, −0.222, Chi^2 7933.630, Significance=0.	**Low** ⨁⨁◯◯
Number or proportion of cases in the community	1 Ecological study[45] Six countries (Dec 2019 – Apr 2020)	This study reported a negative association between strict (early) travel restrictions, including mandatory quarantine, using digital tools on the number of deaths per 100,000.	**Low** ⨁⨁◯◯

Outcome	Number of studies Countries (dates implemented)	Summary of findings	Certainty of evidence
Number or proportion of imported or exported cases	1 Observational study[10] Canada (Nov 2020)	This Canadian study reported that quarantine did not appear to fully protect against transmission to contacts. Travelers who received a negative first result and were allowed to leave quarantine did not cause a greater number of secondary infections than those who remained in 14-day quarantine.	**Very low** ⨁◯◯◯
Number or proportion of deaths	1 Ecological study[47] 165 countries (Jan – Jul 2020)	This study reported that the enactment of any international travel controls, including quarantine, delayed the time in which cumulative incidence rates or deaths peaked. However, enactment of the most stringent control was not associated with a reduced time to peak death or cumulative incidence of 5 cases/ 100,000 persons	**Low** ⨁⨁◯◯
Outcome category: 2. Shift in epidemic development			
Epidemic curve peak	1 Observational study[28] Japan (Feb 2020)	This study reported that the epidemic curve shows infections were occurring amongst Australians before ship-based quarantine and screening commenced. The illness peaked around 3–5 days after quarantine started which supports previous findings that the movement restrictions placed on 5 February reduced the risk of infection among those passengers who had no known close contact with an infected individual.	**Low** ⨁⨁◯◯

Outcome	Number of studies Countries (dates implemented)	Summary of findings	Certainty of evidence
Epidemic curve peak	1 Ecological study[47] 165 countries (Jan – Jul 2020)	This study reported that early implementation of international travel controls led to a mean delay of 5 weeks in the first epidemic peak of cases. Although travel restrictions did not prevent the virus from entering most countries, delaying its introduction bought valuable time for local health systems and governments to prepare to respond to local transmission.	**Low** ⨁⨁◯◯
Outcome category: 3. Cases detected due to the measure			
Number or proportion of cases detected	25 Observational studies[5-7,10,12,16,25,26,28,30,32,35,53,61,64,67,71,75,79,83-85,94-96] Afghanistan, Australia, Bahrain, Canada, China, Dubai, Germany, Japan, Mauritius, New Zealand, Pakistan, South Korea, Taiwan, Thailand, UK, Vanuatu	Across studies, the proportion of cases detected by screening ranged from 0 to 100%. This differed markedly based on the screening modality (e.g., symptoms, thermal, etc.). In general, the more invasive screening procedures (e.g., PCR testing) had a higher sensitivity than less invasive procedures (e.g., syndromic screening).	**Very low** ⨁◯◯◯ Inconsistency
Outcome category: 4. Secondary outcomes			

Outcome	Number of studies Countries (dates implemented)	Summary of findings	Certainty of evidence
Infectious disease transmission outcomes	4 Observational studies[11,26,28,49] Qatar (Mar – Aug 2020), Canada (Mar 2020), Japan (Mar 2020), Japan (Feb 2020)	These studies reported that quarantining had mixed results. One study reported that when travel restrictions were reduced, the prevalence of imported variants increased, and succeeded in eliminating all other local lineages. The second study reported that transmission lineage size was greatly reduced after a quarantine order for returning travelers was enacted. The third study reported that even after strict quarantine policy was implemented, 12 distinct strains (10% of all strains) were still introduced. The fourth study reported that the relative risk of testing positive from an exposure to a known case during ship-based quarantine was 6.18 (95% CI 1.96–19.46).	**Very low** ⊕◯◯◯ Inconsistency
Resource requirements	1 Observational study[89] Taiwan (Mar 2020)	This study reported that quarantining was costly with 13% of quarantined travelers receiving telehealth service with an associated cost of US $193,938, which equated to US $894 per traveler.	**Low** ⊕⊕◯◯
Adverse effects	4 Observational studies [6,7,32,97] Tunisia (NR), New Zealand (Aug 2020 – Feb 2021), Australia/ New Zealand (Apr – Jun 2020), Australia (Nov 2020 –Jun 2021)	These studies reported that quarantining was potentially harmful to the quarantined individuals and staff. The first study reported that 19% of surveyed quarantined individuals had symptoms of clinical insomnia. The second study reported 22 quarantine system failures in Australia and 10 in New Zealand. The third study reported that facility staff tested positive for COVID-19. The fourth study reported on breaches in quarantine facilities stemming from housing international travelers.	**Low** ⊕⊕◯◯

Table 6. Canada and related countries* – GRADE Summary of Findings – Border closures/ travel restrictions for reducing or stopping cross-border travel

Disease: COVID-19 Interventions: implementing border closures/ travel restrictions for reducing or stopping cross-border travel; maintaining the measure; early implementation of the measure; implementing a highly stringent measure Comparators: no measure; relaxation of the measure; late implementation of the measure; implementing a less stringent measure

Outcome	Number of studies	Summary of findings	Certainty of evidence
Outcome category: 1. Cases avoided due to measure			
Number or proportion of imported or exported cases	1 Observational study[18] Greece (NR)	The proportion of imported strains was 41%, 11.5%, and 8.8% during the three periods of sampling, namely, March (no border closures/ travel restrictions), April to June (strict border closures/ travel restrictions), and July to September (lifting of border closures/ travel restrictions based on thorough risk assessment), respectively. The findings reveal low levels of onward transmission from imported cases during summer and underscore the importance of targeted public health measures that can increase the safety of international travel during a pandemic	**Low** ⨁⨁◯◯
Outcome category: 2. Shift in epidemic development			
No studies provided evidence for this outcome category.			

Effectiveness of border closures/ travel restrictions, screening and/ or quarantine to control the international spread of COVID-19

Outcome	Number of studies	Summary of findings	Certainty of evidence
Outcome category: 3. Cases detected due to the measure			
Number or proportion of cases detected	3 Observational studies[31,32,35] UK (Mar 2020), New Zealand (Aug 2020 – Feb 2021), Netherlands (NR)	Of these 3 studies, most (n = 2) reported benefits of border closures/ travel restrictions with up to 40% (rate ratio 0.60, 95% CI 0.37 to 0.95) lower rate of contacts with travel restrictions. The remaining study reported no decrease in imported cases even when border closures/ travel restrictions were implemented.	**Very low** ⨁◯◯◯ Inconsistency
Outcome category: 4. Secondary outcomes			
Infectious disease transmission outcomes	1 Observational study[15] Germany (Jan 2020)	This study reported several new mutations had emerged post-travel-ban and were on the rise in specific countries.	**Low** ⨁⨁◯◯
User acceptability	1 Observational study[13] Cyprus (NA)	This study reported that most (>90% of individuals surveyed) believe that strict border closures/ travel restrictions are a necessary measure for reducing rates of new cases.	**Low** ⨁⨁◯◯

* As mentioned above, this is an arbitrary dichotomy with potential historical, geographic, and political bias, the country list was finalized only after consultation with decision-makers and content experts.

Table 7. Canada and related countries* – GRADE Summary of Findings – GRADE Summary of Findings – Screening at borders

Disease: COVID-19

Interventions: implementing entry and/ or exit symptom/ exposure-based screening; implementing entry and/ or exit test-based screening; implementing a highly stringent screening measure

Comparators: no measure; implementing an alternative measure; implementing a less stringent screening measure

Outcome	Number of studies	Summary of findings	Certainty of evidence
Outcome category: 1. Cases avoided due to measure			
Number or proportion of imported or exported cases	1 Observational study[18] Greece (NR)	This study reported that the proportion of imported strains decreased the most with targeted public health measures including entry testing (8.8% from 41%).	**Low** ⨁⨁◯◯
Number or proportion of cases seeded by imported cases	1 Observational study[10] Canada (Nov 2020)	This Canadian study reported that on average, one contact was identified for each infected participant, with 22 cases of secondary transmission, irrespective of first test result (positive leading to quarantine – negative leading to no refusal of entry).	**Low** ⨁⨁◯◯
Proportion of secondary cases	1 Observational study[20] Ireland (Dec 2020)	This study reported that 7% of flight close contacts (41% had COVID) were PCR positive within 2 weeks. The positivity rate was higher in longer flights (>5-hr duration).	**Low** ⨁⨁◯◯
Outcome category: 2. Shift in epidemic development			

Effectiveness of border closures/ travel restrictions, screening and/ or quarantine to control the international spread of COVID-19

Outcome	Number of studies	Summary of findings	Certainty of evidence
Epidemic curve peak	1 Observational study[28] Japan (Feb 2020)	This study reported that the epidemic curve shows infections were occurring amongst Australians before ship-based quarantine and screening commenced. The illness peaked around 3–5 days after quarantine started which supports previous findings that the movement restrictions placed on 5 February reduced the risk of infection among those passengers who had no known close contact with an infected individual.	**Low** ⨁⨁◯◯
Outcome category: 3. Cases detected due to the measure			
Number or proportion of cases detected	26 Observational studies[5,7-10,14,16,17,19-28,30,32-37,87] Australia, Bulgaria, Canada, France, Germany, Greece, Ireland, Italy, Japan, New Zealand, Spain, UK, USA	Across studies, the proportion of cases detected by screening ranged from 0 to 100%. This differed markedly based on the screening modality (e.g., symptoms, thermal, etc.). In general, the more invasive screening procedures (e.g., PCR testing) had a higher sensitivity than less invasive procedures (e.g., syndromic screening).	**Very low** ⨁◯◯◯ Inconsistency
Positive predictive value (PPV)	1 Observational study[21] Italy (Aug - Oct 2020)	This study reported that the PPV of the rapid antigen test was estimated to be 23.3% (CI 10.1 to 45.0).	**Low** ⨁⨁◯◯
Outcome category: 4. Secondary outcomes			

Outcome	Number of studies	Summary of findings	Certainty of evidence
Infectious disease transmission outcomes	3 Observational studies[26-28] Japan (Mar 2020), Japan (Aug 2020), Japan (Feb 2020)	These studies reported conflicting evidence regarding infectious disease transmission. One study reported that a higher 14-day average incidence in the countries of stay was associated with higher test positivity (1.64 [1.16–2.33] and 3.13 [1.88–5.23] for those from countries and areas where the 14-day average incidence was from 10 to <100 and ≥100 cases per million, respectively). A second study reported that the median time to the first of two consecutive negative PCR-based assays was 13 days for asymptomatic cases and 19 days for symptomatic cases (p = 0.002). Even so, the third study reported that strict policies did not prevent the introduction of new strains.	**Very low** ⨁◯◯◯ Inconsistency
Healthcare utilization	1 Observational study[10] Canada (Nov 2020)	This Canadian study reported that among participants with positive tests, 2% were hospitalized, but none required critical care or died.	**Low** ⨁⨁◯◯
Resource requirements	2 Observational studies[36,37] USA (Feb/ Mar 2020), USA (Jun 2020)	These studies reported that routine testing was costly and resource intensive. The first study reported during a 7-week period, staff members devoted an estimated 1,694 total person-hours (equivalent to six employees working full-time for 7 weeks) processing travelers; 34% of these person-hours occurred outside regular working hours. The second study reported that during Jun – Nov 2020, up to 22 screening personnel and five testing personnel per day were required. The associated budget was $26 million for Jun – Dec and nonresident travelers were required to pay $250 for post-arrival testing.	**Low** ⨁⨁◯◯

* As mentioned above, this is an arbitrary dichotomy with potential historical, geographic, and political bias, the country list was finalized only after consultation with decision-makers and content experts.

Table 8. Canada and related countries – GRADE Summary of Findings – GRADE Summary of Findings - Quarantine

Disease: COVID-19 **Interventions:** implementing quarantine; implementing a highly stringent quarantine **Comparators:** no measure; implementing an alternative measure (e.g., screening); implementing a less stringent quarantine

Outcome	Number of studies Countries (dates implemented)	Summary of findings	Certainty of evidence
Outcome category: 1. Cases avoided due to measure			
Number or proportion of imported or exported cases	1 Observational study[10] Canada (Nov 2020)	This Canadian study reported that quarantine did not appear to fully protect against transmission to contacts. Travelers who received a negative first result and were allowed to leave quarantine did not cause a greater number of secondary infections than those who remained in 14-day quarantine.	**Low** ⊕⊕◯◯
Outcome category: 2. Shift in epidemic development			
Epidemic curve peak	1 Observational study[28] Japan (Feb 2020)	This study reported that the epidemic curve shows infections were occurring amongst Australians before ship-based quarantine and screening commenced. The illness peaked around 3–5 days after quarantine started which supports previous findings that the movement restrictions placed on 5 February reduced the risk of infection among those passengers who had no known close contact with an infected individual.	**Low** ⊕⊕◯◯

Outcome	Number of studies Countries (dates implemented)	Summary of findings	Certainty of evidence
Outcome category: 3. Cases detected due to the measure			
Number or proportion of cases detected	23 Observational studies[5-8,10,12,14,16,17,19,22-26,28,29,32,33,35-37,95] Australia, Bulgaria, Canada, France, Germany, Greece, Italy, Japan, New Zealand, UK, USA	Across studies, the proportion of cases detected by screening ranged from 0 to 100%. This differed markedly based on the screening modality (e.g., symptoms, thermal, etc.). In general, the more invasive screening procedures (e.g., PCR testing) had a higher sensitivity than less invasive procedures (e.g., syndromic screening).	**Very low** ⨁◯◯◯ Inconsistency
Outcome category: 4. Secondary outcomes			
Infectious disease transmission outcomes	3 Observational studies[11,26,28] Canada (Mar 2020), Japan (Mar 2020), Japan (Feb 2020)	These studies reported that quarantining had mixed results. The first study reported that transmission lineage size was greatly reduced after a quarantine order for returning travelers was enacted. The second study reported that even after strict quarantine policy was implemented, 12 distinct strains (10% of all strains) were still introduced. The third study reported that the relative risk of testing positive from an exposure to a known case during ship-based quarantine was 6.18 (95% CI 1.96–19.46).	**Very low** ⨁◯◯◯ Inconsistency

Outcome	Number of studies Countries (dates implemented)	Summary of findings	Certainty of evidence
Adverse effects	3 Observational studies [6,7,32] New Zealand (Aug 2020 – Feb 2021), Australia/ New Zealand (Apr – Jun 2020), Australia (Nov 2020 –Jun 2021)	These studies reported that quarantining was potentially harmful to the quarantined individuals and staff. The first study reported 22 quarantine system failures in Australia and 10 in New Zealand. The second study reported that facility staff tested positive for COVID-19. The third study reported on breaches in quarantine facilities stemming from housing international travelers.	**Low** ⨁⨁◯◯

* As mentioned above, this is an arbitrary dichotomy with potential historical, geographic, and political bias, the country list was finalized only after consultation with decision-makers and content experts.

Appendix 1. Search Strategies.

Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations and Daily <1946 to April 13, 2022>

1. exp Coronavirus/ 133810
2. Coronavirus Infections/ 45391
3. COVID-19.rs. 17
4. severe acute respiratory syndrome coronavirus 2.os. 17
5. (2019 nCoV or 2019nCoV or 2019-novel CoV).ti,ab,kf. 1953
6. (Coronavir* or corona virus* or Middle East Respiratory Syndrome* or MERS or Severe Acute Respiratory Syndrome* or SARS*).ti,ab,kf. 151537
7. COVID 19.mp. 235659
8. (COVID19 or COVID 2019).ti,ab,kf. 2782
9. (nCov 2019 or nCov 19).ti,ab,kf. 696
10. or/ 1-9 [Set 1: Coronaviruses] 271392
11. Air Travel/ 514
12. Travel/ 27069
13. (border? adj3 (clos* or restrict* or control* or measure?)).ab,kf. 1459
14. ((isolat* or quarantin*) adj6 (exposed or suspected or travel* or airport? or border?)).ti,ab,kf. 9047
15. ((mobility or movement*) adj2 (reduc* or restrict*)).ti,ab,kf. 11812
16. ((questionnaire* or RT-PCR or screen* or surveil* or test* or telethermographic* or temperature or thermal imag* or thermal scan* or thermomet* or thermograph*) adj4 (traveller? or entr* or exit or border? or airport?)).ti,ab,kf. 6136
17. (travel* or border?).ti. 28658
18. (travel adj4 (measure? or intervention? or NPI?)).ab,kf. 604
19. (travel* adj3 (restrict* or reduc* or control* or limit* or lockdown? or ban*)).ab,kf. 2724
20. visa?.ti,ab,kf. 2473
21. or/ 11-20 [Set 2: Travel measures] 76948
22. and/ 10,21 [Sets 1 & 2] 4379
23. epidemiologic studies/ or exp case control studies/ or exp cohort studies/ or cross-sectional studies/ 2904592
24. ((case control$ or case-control$ or cohort or cohort analy$ or cross sectional or cross-sectional or epidemiologic$ or follow up or longitudinal or observational) adj3 (study or studies)).tw. 1052800
25. (case report adj2 form$).tw. 1869
26. or/ 23-25 [Observational study designs] 3288474
27. 22 and 26 [Observational studies + Travel restrictions + COVID] 490
28. consensus/ or (consensus development conference or consensus development conference, nih or guideline).pt. [Guidelines] 45581
29. abstract report/ or (congress or meeting abstract or poster).pt. [Conference abstracts] 67033
30. case study/ or letter/ or historical article/ or (blog or book review or case reports or catalog or clinical conference or clinical trial, veterinary or collected correspondence or comment or editorial or essay or handbook or historical article or index or interview or introductory journal article or laboratory manual or lecture or lecture note or letter or news or newspaper article or observational study, veterinary or patient education handout or personal narrative or practice guideline or randomized controlled trial, veterinary or textbook).pt. [Other publication types] 4738796

Effectiveness of border closures/ travel restrictions, screening and/ or quarantine to control the international spread of COVID-19

31. (exp animal experiment/ or exp animal model/ or exp transgenic animal/ or animal/ or chordata/ or vertebrate/ or tetrapod/ or amniote/ or exp amphibia/ or mammal/ or exp reptile/ or therian/ or placental mammals/ or exp marsupial/ or euarchontoglires/ or exp xenarthra/ or primate/ or exp scandentia/ or haplorhini/ or exp prosimian/ or simian/ or exp tarsiiform/ or catarrhini/ or exp platyrrhini/ or ape/ or exp cercopithecidae/ or hominid/ or exp hylobatidae/ or exp chimpanzee/ or exp gorilla/ or (animal or animals or pisces or fish or fishes or catfish or catfishes or sheatfish or silurus or arius or heteropneustes or clarias or gariepinus or fathead minnow or fathead minnows or pimephales or promelas or cichlidae or trout or trouts or char or chars or salvelinus or salmo or oncorhynchus or guppy or guppies or millionfish or poecilia or goldfish or goldfishes or carassius or auratus or mullet or mullets or mugil or curema or shark or sharks or cod or cods or gadus or morhua or carp or carps or cyprinus or carpio or killifish or eel or eels or anguilla or zander or sander or lucioperca or stizostedion or turbot or turbots or psetta or flatfish or flatfishes or plaice or pleuronectes or platessa or tilapia or tilapias or oreochromis or sarotherodon or common sole or dover sole or solea or zebrafish or zebrafishes or danio or rerio or seabass or dicentrarchus or labrax or morone or lamprey or lampreys or petromyzon or pumpkinseed or pumpkinseeds or lepomis or gibbosus or herring or clupea or harengus or amphibia or amphibian or amphibians or anura or salientia or frog or frogs or rana or toad or toads or bufo or xenopus or laevis or bombina or epidalea or calamita or salamander or salamanders or newt or newts or triturus or reptilia or reptile or reptiles or bearded dragon or pogona or vitticeps or iguana or iguanas or lizard or lizards or anguis fragilis or turtle or turtles or snakes or snake or aves or bird or birds or quail or quails or coturnix or bobwhite or colinus or virginianus or poultry or poultries or fowl or fowls or chicken or chickens or gallus or zebra finch or taeniopygia or guttata or canary or canaries or serinus or canaria or parakeet or parakeets or grasskeet or parrot or parrots or psittacine or psittacines or shelduck or tadorna or goose or geese or branta or leucopsis or woodlark or lullula or flycatcher or ficedula or hypoleuca or dove or doves or geopelia or cuneata or duck or ducks or greylag or graylag or anser or harrier or circus pygargus or red knot or great knot or calidris or canutus or godwit or limosa or lapponica or meleagris or gallopavo or jackdaw or corvus or monedula or ruff or philomachus or pugnax or lapwing or peewit or plover or vanellus or swan or cygnus or columbianus or bewickii or gull or chroicocephalus or ridibundus or albifrons or great tit or parus or aythya or fuligula or streptopelia or risoria or spoonbill or platalea or leucorodia or blackbird or turdus or merula or blue tit or cyanistes or pigeon or pigeons or columba or pintail or anas or starling or sturnus or owl or athene noctua or pochard or ferina or cockatiel or nymphicus or hollandicus or skylark or alauda or tern or sterna or teal or crecca or oystercatcher or haematopus or ostralegus or shrew or shrews or sorex or araneus or crocidura or russula or european mole or talpa or chiroptera or bat or bats or eptesicus or serotinus or myotis or dasycneme or daubentonii or pipistrelle or pipistrellus or cat or cats or felis or catus or feline or dog or dogs or canis or canine or canines or otter or otters or lutra or badger or badgers or meles or fitchew or fitch or foumart or foulmart or ferrets or ferret or polecat or polecats or mustela or putorius or weasel or weasels or fox or foxes or vulpes or common seal or phoca or vitulina or grey seal or halichoerus or horse or horses or equus or equine or equidae or donkey or donkeys or mule or mules or pig or pigs or swine or swines or hog or hogs or boar or boars or porcine or piglet or piglets or sus or scrofa or llama or llamas or lama or glama or deer or deers or cervus or elaphus or cow or cows or bos taurus or bos indicus or bovine or bull or bulls or cattle or bison or bisons or sheep or sheeps or ovis aries or ovine or lamb or lambs or mouflon or mouflons or goat or goats or capra or caprine or chamois or rupicapra or leporidae or lagomorpha or lagomorph or rabbit or rabbits or oryctolagus or cuniculus or laprine or hares or lepus or rodentia or rodent or rodents or murinae or mouse or mice or mus or musculus or murine or woodmouse or apodemus or rat or rats or rattus or norvegicus or

guinea pig or guinea pigs or cavia or porcellus or hamster or hamsters or mesocricetus or cricetulus or cricetus or gerbil or gerbils or jird or jirds or meriones or unguiculatus or jerboa or jerboas or jaculus or chinchilla or chinchillas or beaver or beavers or castor fiber or castor canadensis or sciuridae or squirrel or squirrels or sciurus or chipmunk or chipmunks or marmot or marmots or marmota or suslik or susliks or spermophilus or cynomys or cottonrat or cottonrats or sigmodon or vole or voles or microtus or myodes or glareolus or primate or primates or prosimian or prosimians or lemur or lemurs or lemuridae or loris or bush baby or bush babies or bushbaby or bushbabies or galago or galagos or anthropoidea or anthropoids or simian or simians or monkey or monkeys or marmoset or marmosets or callithrix or cebuella or tamarin or tamarins or saguinus or leontopithecus or squirrel monkey or squirrel monkeys or saimiri or night monkey or night monkeys or owl monkey or owl monkeys or douroucoulis or aotus or spider monkey or spider monkeys or ateles or baboon or baboons or papio or rhesus monkey or macaque or macaca or mulatta or cynomolgus or fascicularis or green monkey or green monkeys or chlorocebus or vervet or vervets or pygerythrus or hominoidea or ape or apes or hylobatidae or gibbon or gibbons or siamang or siamangs or nomascus or symphalangus or hominidae or orangutan or orangutans or pongo or chimpanzee or chimpanzees or pan troglodytes or bonobo or bonobos or pan paniscus or gorilla or gorillas or troglodytes).ti,ab,kf.) not (human/ or (human$ or man or men or woman or women or child or children or patient$).ti,ab,kf.) 4983419

32. or/ 28-31 [Exclusions] 9677596
33. 27 not 32 471
34. limit 33 to english language 462
35. limit 34 to yr="2020 -Current" 411
36. remove duplicates from 35 409

Embase <1974 to 2022 April 13>

1. 1 coronaviridae/ 1353
2. 2 exp coronavirinae/ 83888
3. 3 exp coronavirus infection/ 226785
4. 4 (2019 nCoV or 2019nCoV or 2019-novel CoV).ti,ab,kw. 1961
5. 5 (Coronavir* or corona virus* or Middle East Respiratory Syndrome* or MERS or Severe Acute Respiratory Syndrome* or SARS*).ti,ab,kw. 159514
6. 6 COVID 19.af. 232399
7. 7 (COVID19 or COVID 2019).ti,ab,kw. 4643
8. 8 (nCov 2019 or nCov 19).ti,ab,kw. 733
9. 9 or/ 1-8 [Set 1: Coronaviruses]305704
10. 10 air transportation/ 249
11. 11 aviation/ 7955
12. 12 travel/ 55702
13. 13 (border? adj3 (clos* or restrict* or control* or measure?)).ab,kw. 1595
14. 14 ((isolat* or quarantin*) adj6 (exposed or suspected or travel* or airport? or border?)).ti,ab,kw. 10726
15. 15 ((mobility or movement*) adj2 (reduc* or restrict*)).ti,ab,kw. 15433
16. 16 ((questionnaire* or RT-PCR or screen* or surveil* or test* or telethermographic* or temperature or thermal imag* or thermal scan* or thermomet* or thermograph*) adj4 (traveller? or entr* or exit or border? or airport?)).ti,ab,kw. 7476
17. 17 (travel* or border?).ti. 31550
18. 18 (travel adj4 (measure? or intervention? or NPI?)).ab,kw. 679
19. 19 (travel* adj3 (restrict* or reduc* or control* or limit* or lockdown? or ban*)).ab,kw. 3276
20. 20 visa?.ti,ab,kw. 2723
21. 21 or/ 10-20 [Set 2: Travel measures] 119602
22. 22 and/ 9,21 [Sets 1 & 2] 6226
23. 23 clinical study/ or family study/ or longitudinal study/ or cohort analysis/ or (prospective study/ not randomized controlled trials/) 1722508
24. 24 ((case control$ or case-control$ or cohort or cohort analy$ or cross sectional or cross-sectional or epidemiologic$ or follow up or longitudinal or observational) adj3 (study or studies)).tw. 1470479
25. 25 or/ 23-24 [Observational study designs] 2619013
26. 26 22 and 25 [Observational studies + Travel restrictions + COVID] 794
27. 27 consensus/ or (consensus development conference or consensus development conference, nih or guideline).pt. [Guidelines] 85819
28. 28 abstract report/ or (congress or meeting abstract or poster).pt. [Conference abstracts] 89541
29. 29 case study/ or letter/ or historical article/ or (blog or book review or case reports or catalog or clinical conference or clinical trial, veterinary or collected correspondence or comment or editorial or essay or handbook or historical article or index or interview or introductory journal article or laboratory manual or lecture or lecture note or letter or news or newspaper article or observational study, veterinary or patient education handout or personal narrative or practice guideline or randomized controlled trial, veterinary or textbook).pt. [Other publication types] 2033949
30. 30 (exp animal experiment/ or exp animal model/ or exp transgenic animal/ or animal/ or chordata/ or vertebrate/ or tetrapod/ or amniote/ or exp amphibia/ or mammal/ or exp reptile/ or therian/ or placental mammals/ or exp marsupial/ or euarchontoglires/ or exp xenarthra/ or primate/ or exp

scandentia/ or haplorhini/ or exp prosimian/ or simian/ or exp tarsiiform/ or catarrhini/ or exp platyrrhini/ or ape/ or exp cercopithecidae/ or hominid/ or exp hylobatidae/ or exp chimpanzee/ or exp gorilla/ or (animal or animals or pisces or fish or fishes or catfish or catfishes or sheatfish or silurus or arius or heteropneustes or clarias or gariepinus or fathead minnow or fathead minnows or pimephales or promelas or cichlidae or trout or trouts or char or chars or salvelinus or salmo or oncorhynchus or guppy or guppies or millionfish or poecilia or goldfish or goldfishes or carassius or auratus or mullet or mullets or mugil or curema or shark or sharks or cod or cods or gadus or morhua or carp or carps or cyprinus or carpio or killifish or eel or eels or anguilla or zander or sander or lucioperca or stizostedion or turbot or turbots or psetta or flatfish or flatfishes or plaice or pleuronectes or platessa or tilapia or tilapias or oreochromis or sarotherodon or common sole or dover sole or solea or zebrafish or zebrafishes or danio or rerio or seabass or dicentrarchus or labrax or morone or lamprey or lampreys or petromyzon or pumpkinseed or pumpkinseeds or lepomis or gibbosus or herring or clupea or harengus or amphibia or amphibian or amphibians or anura or salientia or frog or frogs or rana or toad or toads or bufo or xenopus or laevis or bombina or epidalea or calamita or salamander or salamanders or newt or newts or triturus or reptilia or reptile or reptiles or bearded dragon or pogona or vitticeps or iguana or iguanas or lizard or lizards or anguis fragilis or turtle or turtles or snakes or snake or aves or bird or birds or quail or quails or coturnix or bobwhite or colinus or virginianus or poultry or poultries or fowl or fowls or chicken or chickens or gallus or zebra finch or taeniopygia or guttata or canary or canaries or serinus or canaria or parakeet or parakeets or grasskeet or parrot or parrots or psittacine or psittacines or shelduck or tadorna or goose or geese or branta or leucopsis or woodlark or lullula or flycatcher or ficedula or hypoleuca or dove or doves or geopelia or cuneata or duck or ducks or greylag or graylag or anser or harrier or circus pygargus or red knot or great knot or calidris or canutus or godwit or limosa or lapponica or meleagris or gallopavo or jackdaw or corvus or monedula or ruff or philomachus or pugnax or lapwing or peewit or plover or vanellus or swan or cygnus or columbianus or bewickii or gull or chroicocephalus or ridibundus or albifrons or great tit or parus or aythya or fuligula or streptopelia or risoria or spoonbill or platalea or leucorodia or blackbird or turdus or merula or blue tit or cyanistes or pigeon or pigeons or columba or pintail or anas or starling or sturnus or owl or athene noctua or pochard or ferina or cockatiel or nymphicus or hollandicus or skylark or alauda or tern or sterna or teal or crecca or oystercatcher or haematopus or ostralegus or shrew or shrews or sorex or araneus or crocidura or russula or european mole or talpa or chiroptera or bat or bats or eptesicus or serotinus or myotis or dasycneme or daubentonii or pipistrelle or pipistrellus or cat or cats or felis or catus or feline or dog or dogs or canis or canine or canines or otter or otters or lutra or badger or badgers or meles or fitchew or fitch or foumart or foulmart or ferrets or ferret or polecat or polecats or mustela or putorius or weasel or weasels or fox or foxes or vulpes or common seal or phoca or vitulina or grey seal or halichoerus or horse or horses or equus or equine or equidae or donkey or donkeys or mule or mules or pig or pigs or swine or swines or hog or hogs or boar or boars or porcine or piglet or piglets or sus or scrofa or llama or llamas or lama or glama or deer or deers or cervus or elaphus or cow or cows or bos taurus or bos indicus or bovine or bull or bulls or cattle or bison or bisons or sheep or sheeps or ovis aries or ovine or lamb or lambs or mouflon or mouflons or goat or goats or capra or caprine or chamois or rupicapra or leporidae or lagomorpha or lagomorph or rabbit or rabbits or oryctolagus or cuniculus or laprine or hares or lepus or rodentia or rodent or rodents or murinae or mouse or mice or mus or musculus or murine or woodmouse or apodemus or rat or rats or rattus or norvegicus or guinea pig or guinea pigs or cavia or porcellus or hamster or hamsters or mesocricetus or cricetulus or cricetus or gerbil or gerbils or jird or jirds or meriones or unguiculatus or jerboa or jerboas or jaculus or chinchilla or chinchillas or beaver or beavers or castor fiber or castor canadensis or

sciuridae or squirrel or squirrels or sciurus or chipmunk or chipmunks or marmot or marmots or marmota or suslik or susliks or spermophilus or cynomys or cottonrat or cottonrats or sigmodon or vole or voles or microtus or myodes or glareolus or primate or primates or prosimian or prosimians or lemur or lemurs or lemuridae or loris or bush baby or bush babies or bushbaby or bushbabies or galago or galagos or anthropoidea or anthropoids or simian or simians or monkey or monkeys or marmoset or marmosets or callithrix or cebuella or tamarin or tamarins or saguinus or leontopithecus or squirrel monkey or squirrel monkeys or saimiri or night monkey or night monkeys or owl monkey or owl monkeys or douroucoulis or aotus or spider monkey or spider monkeys or ateles or baboon or baboons or papio or rhesus monkey or macaque or macaca or mulatta or cynomolgus or fascicularis or green monkey or green monkeys or chlorocebus or vervet or vervets or pygerythrus or hominoidea or ape or apes or hylobatidae or gibbon or gibbons or siamang or siamangs or nomascus or symphalangus or hominidae or orangutan or orangutans or pongo or chimpanzee or chimpanzees or pan troglodytes or bonobo or bonobos or pan paniscus or gorilla or gorillas or troglodytes).ti,ab,kf.) not (human/ or (human$ or man or men or woman or women or child or children or patient$).ti,ab,kf.) 4674225

31. 31 or/ 27-30 [Exclusions] 6798658
32. 32 26 not 31 769
33. 33 limit 32 to english language 765
34. 34 limit 33 to yr="2020 -Current" 721
35. 35 remove duplicates from 34 704

WHO COVID-19 Global literature on coronavirus disease (search.bvsalud.org/ global-literature-on-novel-coronavirus-2019-ncov)

Strategy:

(ti:(border OR borders OR travel*)) OR (tw:(border* AND (clos* OR restrict* OR control* OR measure*))) OR (tw:((isolat* OR quarantin*) AND (exposed OR suspected OR travel* OR airport* OR border*))) OR (tw:((mobility OR movement*) AND (reduc* OR restrict*) AND travel*)) OR (tw:((questionnaire* or "RT-PCR" or screen* or surveil* or test* or telethermographic* or temperature or "thermal image" or "thermal images" or "thermal imaging" or "thermal scan" or "thermal scans" or "thermal scanning" or thermomet* or thermograph*) AND (traveller* OR entr* OR exit OR border* OR airport*))) OR (tw:(travel AND (measure* OR intervention* OR NPI*))) OR (tw:(travel* AND (restrict* OR reduc* OR control* OR limit* OR lockdown* OR ban*))) OR (tw:(visa OR visas)) (2167)

Filters applied:

Databases: WHO COVID, medRxiv, ELSEVIER, bioRxiv, LILACS, Grey literature, Lanzhou University/ CNKI, WPRIM (Western Pacific), SSRN, ProQuest Central, PREPRINT-SCIELO, PubMed, ArXiv

Language: English

Year: 2020-2022

Cochrane COVID-19 Study Register (COVID-19.cochrane.org)

1. (border* AND (close or closed or closing or closure* or restrict*)) 245
2. ((isolate or isolating or isolation* or quarantin*) AND (travel or traveling or travell* or airport* or border*)) 1041
3. ("reduced mobility" OR "reduced movement" OR "movement reduction" OR "mobility restriction" OR "mobility restrictions" OR "restricted mobility" OR "movement restriction" OR "movement restrictions" OR "restricted movement" or "travel restrictions" or "travel restriction" or "restricted travel" or "restricted traveling" or "retricted travelling" or "reduced travel" or "reduced traveling" or "reduced travelling" or "travel reduction" or "travel reductions") 757
4. ((questionnaire* or "RT-PCR" or screen* or surveil* or test* or telethermographic* or temperature or "thermal image" or "thermal imaging" or "thermal scan" or "thermal scans" or "thermal scanning" or thermomet* or thermograph*) AND (traveller* or "port of entry" or "ports of entry" or "point of entry" or "points or entry" or border* or airport*)) 653
5. (travel AND (intervention* or NPI*)) 891
6. ((travel or traveling or travell*) AND (limit* or lockdown* or ban or bans or banning or banned)) 983
7. (visa* or "border controls" OR "border control" OR "controlling borders" OR "controlling the border" or "travel measures" or "border measures") 116
8. (border* AND (close or closed or closing or closure* or restrict*)) or ((isolate or isolating or isolation* or quarantin*) and (travel or traveling or travell* or airport* or border*)) or ("reduced mobility" OR "reduced movement" OR "movement reduction" OR "mobility restriction" OR "mobility restrictions" OR "restricted mobility" OR "movement restriction" OR "movement restrictions" OR "restricted movement" or "travel restrictions" or "travel restriction" or "restricted travel" or "restricted traveling" or "retricted travelling" or "reduced travel" or "reduced traveling" or "reduced travelling" or "travel reduction" or "travel reductions") or ((questionnaire* or "RT-PCR" or screen* or surveil* or test* or telethermographic* or temperature or "thermal image" or "thermal imaging" or "thermal scan" or "thermal scans" or "thermal scanning" or thermomet* or thermograph*) and (traveller* or "port of entry" or "ports of entry" or "point of entry" or "points or entry" or border* or airport*)) or (travel AND (intervention* or NPI*)) or ((travel or traveling or travell*) and (limit* or lockdown* or ban or bans or banning or banned)) or (visa* or "border controls" OR "border control" OR "controlling borders" OR "controlling the border" or "travel measures" or "border measures") 2912 references