

Literature screening report

Border health measures to combat the COVID-19 epidemic in international travel (question of impact and efficiency)

<i>Report submission date:</i>	16.09.2022
<i>Responsible author:</i>	Kristen Jafflin, PhD
<i>Affiliation:</i>	Swiss TPH
<i>Co-authors:</i>	Sonja Merten , MD MPH PhD
<i>Coordination contact:</i>	Jorgen Bauwens (SSPH+)

Abstract

Question 1: Policy recommendations and current practices in select countries:

Policy recommendations from the WHO and ECDC see limited circumstances in which travel restrictions or other health border measures, including testing, could be considered. In particular, the WHO recommends risk-based assessments, and the ECDC recommends considering measures in specific circumstances like, for example, when trying to slow the spread of a new variant of concern. In August 2022, most countries have lifted most or all pandemic related travel restrictions. Of the 35 countries whose policies we reviewed, only the USA and Canada maintained significant restrictions, in particular vaccination requirements for entry for some travellers and, for Canada, quarantine and testing requirements for unvaccinated travellers.

Question 2: Scientific and academic literature on the efficacy of:

(1) Border closures and travels bans:

Numerous studies, including review studies, broad cross-national comparative studies, single country studies and modelling studies, examined the efficacy of border closures and flight bans. Most studies find that border closures, in particular, helped contain or slow the spread of COVID-19, particularly when enacted early in the course of the pandemic before community spread was established. However, assessments of evidence from review studies generally find that the quality of studies is low. Notably, a

recent study using the best available cross-national data did not find that border closures were effective. However, one major weakness of this study was its failure to control for the pandemic situation in country when borders measures were enacted, despite findings from previous studies that suggest that these measures are most effective when enacted early, before substantial disease transmission is established in countries enacting them. Other studies with high-quality evidence, including 2 studies using genetic sequencing of COVID-19 test results to trace lineages, continue to point to the efficacy of border measures.

(2) Quarantine and Testing and Screening Protocols for Travellers:

Studies generally find that quarantine combined with tests is an effective measure for preventing importation of COVID-19 cases. Studies using observational data find that single-test regimes, while effective at identifying some cases, miss a large number of latent infections. Multiple test regimes are more effective, particularly when combined with quarantine. In a multiple-test scenario, antigen tests perform as well or better than PCR tests at identifying cases, as multiple tests reduce the risk of missing cases due to their lower sensitivity, and the more rapidly available results allows testing later in the virus's incubation period.

(3) Other Health Measures:

Mask-wearing during air travel can reduce COVID-19 transmission in aircraft.

Question 3: Indicators used to assess efficacy of measures:

Indicators used varied by study type and focus. Cross-nationally comparative studies and some single-country studies were particularly likely to use indicators like COVID-19 incidence rates or growth rates. Studies of the efficacy of traveller testing and quarantine protocols often focused on the number of cases detected by implemented measures.

Question 4: Measures recommended or discouraged by scientific literature:

Evidence remains inconclusive, but suggests that travel bans and border closures can be effective if implemented early. Testing protocols are generally effective at identifying a certain percentage of cases and avoiding importation. They are most effective when combined with quarantine. Antigen tests can perform as well as PCR tests when part of protocols involving multiple tests.

Question 5: Non-health impacts of border measures:

Border health measures have a wide array of negative non-health impacts.

Content

Abstract	1
Content	3
<i>Preamble</i>	3
Background	4
Questions addressed	4
Methodology	5
Results and Findings	6
Scientific and academic literature on efficacy of: (1) border closures and travel bans, (2) quarantine and testing and screening protocols for travellers, and (3) other health measures, like passenger locator forms	8
Indicators Used to Assess Efficacy of Measures	14
Measures recommended or discouraged by scientific literature	15
Non-health impacts of border health measures	17
References	18

Preamble

A large number of scientific publications become available on a daily basis, reflecting the rapid development of knowledge and progress of science on COVID-19 related issues. Leading authorities should base decisions or policies on this knowledge; hence they need to master the actual state of this knowledge. Due to the large number of publications shared daily, decision makers heavily depend on accurate summaries of these publications, in the different public health domains. Therefore, the authors of this report were mandated by the Swiss School of Public Health plus (SSPH+), on request of the Federal Office of Public Health (FOPH), to inform the FOPH on recent findings from the literature.

Background

Since the beginning of the global COVID-19 pandemic, countries have employed a variety of travel restrictions or other border measures in an attempt to limit the spread of COVID-19 or favourably impact the development of the pandemic. Measures employed varied from travel restrictions on travellers from affected countries, complete border closures, various health screening regimes (most recently including requirements for recent negative COVID-19 tests before travel), quarantine measures for travellers, and vaccination requirements. Currently, many countries have lifted or significantly reduced travel restrictions, but the emergence of new variants or of new pandemic waves may create a situation in which they are considered again. To this end, it would be helpful to reflect on the state of knowledge about the impact of travel measures used to date. This report provides an overview of existing recommendations and the existing scientific and academic literature on travel restrictions related to the control of COVID-19 and an overview of current international recommendations and best practices concerning border measures.

Questions addressed

- Overview and comparison of international policy recommendations and best practices concerning border measures
- Scientific and academic literature on the efficacy of:
 - Border closures and travel restrictions
 - Quarantine and testing and screening protocols for travellers
 - Other health measures, like passenger locator forms
- What indicators are used to assess efficacy of measures?
- Which measures are largely recommended or discouraged, based on the scientific and academic literature?
- Scientific and academic literature on the role of cross-border commuters in the spread of COVID-19
- Scientific and academic literature on the non-health impacts of border health measures

Methodology

Literature review focusing on evidence-based literature on the impact or projected impact of border control measures on COVID-19 disease transmission. Search strategy:

- Epistemonikos COVID-19 Evidence database, extracted articles flagged under “Prevention or treatment/Public health/Travel-related measures/Border closures”, “.../Entry and exit screening”, “.../Travel advice” and “.../Airport screening”
- Epistemonikos COVID-19 Evidence database: search terms: border, border closures, flight bans, travel + quarantine, travel + testing, travel + tracking
- Cochrane Special Collections: Coronavirus (COVID-19): infection control and prevention measures → 2 relevant Cochrane reviews identified
- PubMed search using term: (((COVID-19[MeSH Major Topic] OR (SARS-COV-2[MeSH Major Topic])) AND (travel[Title/Abstract])) OR (border[Title/Abstract])) and restricting to meta-analysis, RCT, reviews and systematic reviews published in the last year

Searches identified 2215 articles. After eliminating duplicates, 612 remained. Based on a review of the abstracts, 106 articles were kept for full article review, of which 59 were retained for analysis after reviewing the full article.

Results and Findings

Policy Recommendations and Current Practices in Selected Countries

Summary:

Policy recommendations from the WHO and ECDC see limited circumstances in which travel restrictions or other health border measures, including testing, could be considered. In particular, the WHO recommends risk-based assessments, and the ECDC recommends considering measures in specific circumstances like, for example, when trying to slow the spread of a new variant of concern. In August 2022, most countries have lifted most or all pandemic related travel restrictions. Of the 35 countries whose policies we reviewed, only the USA and Canada maintained significant restrictions, in particular vaccination requirements for entry for some travellers and, for Canada, quarantine and testing requirements for unvaccinated travellers.

Results:

The latest update to WHO guidance on policies related to international travel in the context of the COVID-19 pandemic was released in July 2021 [60], accompanied by a technical annex providing guidance on implementing risk-based measures [61]. The recommendations cover three main issues: (1) vaccination and proof of recovery, (2) testing and quarantine for international travellers, and (3) other key considerations.

WHO recommends against requiring proof of vaccination against COVID-19 as a condition of travel. It also recommends that quarantine and testing requirements be lifted for fully-vaccinated travellers and for those who had COVID-19 in the 6 months preceding travel. It recommends that unvaccinated travellers be offered alternatives, such as testing requirements, to allow travel.

WHO recommends using a risk-based approach to testing and quarantine for international travellers that avoids treating travellers as a priority group for testing, particularly in contexts where testing resources are limited. They note that any quarantine measures should also be risk-based and that quarantine should be implemented in a manner that respects travellers rights and dignity and minimizes distress.

WHO further recommends that any measures implemented ensure that essential international travel remains possible, that countries conduct regular and thorough risk assessments and update policies as appropriate, publicly communicate international travel measures in a timely and adequate manner, urge travellers to adopt protective measures like mask-wearing, hand-hygiene

and physical distancing, and explore bilateral or multilateral agreements to facilitate the recovery of socioeconomic activities that require international travel, like tourism and cross-border workforces.

The European Centre for Disease Prevention and Control (ECDC) issued guidance on COVID-19 quarantine and testing for travellers in March 2021 [62], with a particular focus on these measures in the context of ongoing vaccination campaigns in Europe and the emergence of the Delta variant. Given this context, the guidance focuses on the utility of quarantine and testing of travellers to help in ongoing control efforts, and in particular to slow the spread of variants of concern. Under these circumstances, the guidance recommends considering quarantine and testing of travellers coming from areas with high-transmission of variants of concern to areas where those variants were not circulating widely. In the absence of testing, it recommends a 14-day quarantine. With regards to testing, it recommends a combination of pre-departure and post-arrival testing, specifically no more than 2-days prior to departure and then 5-7 days after arrival. Combining testing and quarantine enable shorter quarantine periods, with the ECDC recommending pre-departure testing, followed by a 5 to 7 day quarantine with release based on a negative test at the end of the period.

In August 2022, few countries whose policies we reviewed had any health related border measures related to the COVID-19 pandemic in place. We reviewed policies in all EU or Schengen countries in addition to the UK, Israel, the USA and Canada. No EU or Schengen country has travel restrictions in place, nor did the UK, and Israel currently only requires a passenger locator form. Canada and the USA have more extensive requirements. The USA requires proof of vaccination from non-resident adults. Some exemptions are in place, although some exempted travellers may need to test and quarantine. Canada requires all travellers to submit a passenger locator form. In addition, non-citizen and permanent residents must provide proof of vaccination to travel to Canada, and unvaccinated travellers (including citizen and permanent residents) must follow quarantine and testing procedures, including 3 tests and a 14-day quarantine.

Scientific and academic literature on efficacy of: (1) border closures and travel bans, (2) quarantine and testing and screening protocols for travellers, and (3) other health measures, like passenger locator forms

Summary:

Border Closures and Travel Bans:

Numerous studies, including review studies, broad cross-national comparative studies, single country studies and modelling studies, examined the efficacy of border closures and flight bans. Most studies find that border closures, in particular, helped contain or slow the spread of COVID-19, particularly when enacted early in the course of the pandemic before community spread was established. However, assessments of evidence from review studies generally find that the quality of studies is low. Notably, a recent study using the best available cross-national data did not find that border closures were effective. However, one major weakness of this study was its failure to control for the pandemic situation in country when borders measures were enacted, despite findings from previous studies that suggest that these measures are most effective when enacted early, before substantial disease transmission is established in countries enacting them. Other studies with high-quality evidence, including 2 studies using genetic sequencing of COVID-19 test results to trace lineages, continue to point to the efficacy of border measures.

Quarantine and Testing and Screening Protocols for Travellers:

Studies generally find that quarantine combined with tests is an effective measure for preventing importation of COVID-19 cases. Studies using observational data find that single-test regimes, while effective at identifying some cases, miss a large number of latent infections. Multiple test regimes are more effective, particularly when combined with quarantine. In a multiple-test scenario, antigen tests perform as well or better than PCR tests at identifying cases, as multiple tests reduce the risk of missing cases due to their lower sensitivity, and the more rapidly available results allows testing later in the virus's incubation period.

Other Health Measures:

Mask-wearing during air travel can reduce COVID-19 transmission in aircraft.[enter summary here](#)

Results:

Border Closures and Travel Bans:

Five review studies examined border closures and flight bans specifically [3, 5-7, 12], including reviews of articles published up to June 2021, with most studies examined covering early periods in the pandemic. All reviews that assessed quality of evidence found it low or very low quality, but findings across studies consistently showed that certain travel restrictions had positive effects. Border closures and restrictions on travel from affected areas were identified as particularly effective measures. The one review that considered contextual factors[6] notes that measures effectiveness is likely to be higher when implemented early. They note: “When community transmission is established, our findings suggest that governments should consider coupling border closure with other physical distancing policies to reduce transmission and number of cases.”

All 10 of the cross-national comparison articles we reviewed looked at border closures and/or flight bans. 3 looked specifically at the effect of border closures or air-border closures [14-16], 4 looked at the effect of non-pharmaceutical measures, including border closures [17-20], 2 looked at general factors associated with different cross-national experiences of the pandemic [21, 22], and one looked at the effect of COVID-19 NPIs on influenza transmission [23]. Most studies examined the early phases of the pandemic. Only two studies include data from 2021 in their analyses [16, 21].

Seven studies found that border measures had a positive effect on pandemic development in at least some circumstances, as did the study examining the effect of COVID-19 NPI measures on influenza transmission [23]. Two studies found that border measures were effective early in the pandemic (1st wave or pre-vaccination), but had no effect later [17, 18]. Similarly, the two studies that considered pandemic situation when measures were implemented found that border measures were most effective when implemented early in the course of the pandemic [19, 22]. Two studies found that border closures were generally not effective [15, 16].

Notably, the best study in the group, which covered the longest time period, the largest number of countries and used the most sophisticated measure of border policies, found that only the most extreme border closure measures (total border closure with exceptions only for essential travel) had a negative effect on COVID-19 growth rates, with other measures having no effect [16]. The study of influenza transmission found the same [23]. However, this study did not consider the pandemic situation in the country when measures were implemented. As many studies have found that border

measures are most effective when implemented when disease burden in country is very low, but are less effective when transmission is already well established, this omission may account for the difference between the findings and the many studies that have shown positive effects of border measures.

Seven of the single country studies reviewed addressed the efficacy of border closures or flight bans. Two examined efficacy of different types of border measures [33] or of NPIs including border measures [34], and two looked at the effect of COVID-19 measures on other infectious diseases, specifically dengue, influenza [35, 36]. In addition, two studies used genetic sequencing to trace importation and the effect of early control efforts [38, 39].

Two studies leveraged differences in policies implemented in different regions of a single country to examine the effect of various NPIs on the pandemic, including one study that compared experiences in Victoria and South Australia to assess the impact of NPIs, including border closures, on COVID-19 case numbers [34]. They found that border closures were effective if implemented when case numbers were low, but not when case numbers were high.

Two studies examining dengue in China [35] and influenza in New Zealand [36] add to the body of literature finding that border closures prompted by the COVID-19 pandemic also helped control the spread of these diseases. In both cases, 2020 border closures were accompanied by very notable reductions in annual incidence of those diseases.

Finally, two studies leveraged knowledge acquired through genetic sequencing of early COVID-19 cases in Québec [38] and Switzerland [39] to retrace when and where early cases arrived from and to assess the impact of NPIs on pandemic development. Both found that border measures were effective at reducing imports or preventing transmission. The Swiss study estimated that border closures led to an 86-98% reduction in case imports, while the Québec study found that viral lineages introduced after self-isolation mandates for travellers did not generate large transmission lineages. Analysis revealed that the particularly large 1st wave of the pandemic in Québec was due to heavy transmission of lineages that were already established before most non-pharmaceutical interventions, including border measures, were implemented, again pointing to the importance of early intervention for border measures to be effective.

Four modelling studies used disease models to assess the impact of border closures and other NPIs on the 1st wave of the pandemic in Hong Kong [44], in a hypothetical country [41], in Iran [43] and in Italy and Switzerland [42]. While all studies found that the measures implemented helped save lives or slow the spread of COVID-19, the two that modelled counterfactual situations (e.g., what would have happened in the absence of measures) are the most informative, as they enable the researchers to estimate the effects of interventions more precisely. For example, the study looking at the impact of NPIs in Iran estimated that there would have been a ten-fold increase in infections and deaths without measures, and that implementing the measures a week earlier would have led to a 30% reduction in both. The study modelling the impact of the closure of the border between Switzerland and Italy similarly estimated a large increase in cases (2.7-fold) in the absence of the closure, and fewer cases (12% decrease) if the border had been closed 2-weeks earlier.

A fifth modelling study modelled the effect of different types of flight bans on the spread of Omicron globally [55]. It estimated that coordinated, global bans or voluntary isolation of the origin country of a variant were the most effective strategies for containing the spread of a new variant.

Uncoordinated bans would not be effective due to the interconnected nature of the global aviation system.

Quarantine and screening and test protocols for travellers:

A sizeable literature also examines the efficacy of measures such as quarantine and different disease screening methods, including both health questionnaires or symptom checks and more recent methods using PCR or antigen testing for COVID-19.

Reviews looking at the effectiveness of travel measures included quarantine of travellers, exit and entry screening, and combined measures among the measures examined [1-3, 6, 12]. As most studies occurred early in the pandemic, very few examined test-based screening, like universal screening of travellers with tests like RT-PCR and antigen tests. In addition, none of the reviews examined the efficacy of COVID-19 vaccination requirements for travellers. All reviews that assessed quality of evidence found it low or very low quality, but studies identified quarantine of travellers, along with border closures and travel bans, as particularly effective measures. Entry and exit screening were less so. In particular, screening using thermal scanning or screening for symptoms via temperature checks or questionnaires were ineffective. Test-based screening works

better, but still risks missing a large number of infected individuals. Test-based screening combined with quarantine was more effective at identifying all infected travellers.

Due to a lack of data on testing regimes, no cross-national research examines the efficacy of these measures. Only two studies included quarantine measures [16, 21], with neither finding them effective. However, datasets used do not differentiate between different types of quarantine regimes.

Six single-country studies examine the efficacy of PCR testing for COVID-19, alone or in combination with quarantine [25-30]. Studies examining COVID-19 testing of travellers examined cases detected as their primary outcome. Secondary outcomes in different studies included the test positivity rate, cost per case detected and number of cases of secondary transmissions, cases detected in vaccinated versus unvaccinated travellers and variants identified. Four studies included information about results from multiple tests [25, 29, 30, 40], allowing identification of how many cases would be missed by pre-departure or arrival testing only. In all cases, the majority of positive cases (57-75%) were identified during the first test (generally on arrival), with a substantial minority identified thereafter. One study with testing at arrival, on day 7 and on day 14 found that 94% of positive cases were either on arrival or by day 7 [40]. Only one study compared cases detected in vaccinated and unvaccinated travellers, finding that partially and fully vaccinated travellers were less likely to test positive than unvaccinated travellers [30]. That same study also sequenced a large number of tests to determine which variants were present among travellers, finding a diverse array of variants. A larger proportion of vaccinated travellers with breakthrough infections had high-risk variants (including Delta) than unvaccinated travellers.

Six modelling studies also estimate the efficacy of different testing and quarantine regimes [45-49], either modelling the impact of different testing and quarantine regimes or seeking to identify a regime that would have a specified effect. Several studies compared the efficacy of PCR and antigen testing regimes [45, 46, 48, 59]. While antigen tests are less sensitive than PCRs, and thus identify fewer cases, in single-use scenarios, multiple studies estimate that they outperform or perform equally well as PCRs in multi-use scenarios due to the rapid availability of results. Two studies further modelled scenarios that accounted for vaccination status [48, 59], estimating that vaccinated travellers pose lower import risks than unvaccinated travellers. Of these, only the most recent [48] attempts to account for the impact of more transmissible variants by increasing break-

through infection rates 20-fold from estimates in clinical trials. It also estimates risks separately for all WHO-approved vaccines, leading for the most complete estimates of the efficacy of different testing and quarantine situations for the current circumstances.

Conclusions from modelling studies were highly dependent on model parameters and implementing countries' risk profiles. While models found some circumstances in which multiple COVID-19 tests and quarantine were deemed unnecessary, many also recommended testing at multiple time intervals combined with quarantine as a safer option.

Other health measures, like passenger locator forms:

No studies reviewed assessed the efficacy of passenger locator forms. However, two review studies found evidence of COVID-19 transmission in aircraft [9, 11], and one reported evidence that mask-wearing reduced attack rates.

Indicators Used to Assess Efficacy of Measures

Summary:

Indicators used varied by study type and focus. Cross-nationally comparative studies and some single-country studies were particularly likely to use indicators like COVID-19 incidence rates or growth rates. Studies of the efficacy of traveller testing and quarantine protocols often focused on the number of cases detected by implemented measures.

Results:

Indicators used vary considerably by study type and focus. Reviews mentioned five broad categories of outcomes used in reviewed studies: (1) cases detected, (2) cases avoided, (3) outbreak progression (e.g., reducing the peak, delaying surges, etc.), (4) critical cases and mortality, and (5) imported disease.

The studies varied in the sophistication of the health measures and border closure measures they included. Some looked at total case counts, with or without controls for population size [14, 21, 24], whereas others focused on daily or weekly incidence or incidence rates [15, 19]. However, the most frequently used measures were growth rates or other measures examining the change in COVID-19 incidence rates over time [16-18]. Two studies used a simple binary variable indicating whether borders were closed [15, 22], with the remaining studies using more or less sophisticated categorical variables. 4 studies used a 3-category variable (no closure, partial ban, full ban) [14, 17, 18, 20], two a 5-category measure [21, 23], and one an 8-category measure [16]. While all studies examined time-varying effects, only two studies considered the pandemic situation when measures went into effect [19, 24]. While border control measures varied in the number of measures included, none included restrictions on entry based on COVID-19 test results, sophisticated measures of quarantine policies, or vaccination requirements for travel.

Single-country studies examining COVID-19 testing of travellers examined cases detected as their primary outcome. Secondary outcomes in different studies included the test positivity rate, cost per case detected and number of cases of secondary transmissions, cases detected in vaccinated versus unvaccinated travellers and variants identified. Other studies used incidence rates or growth rates.

Measures recommended or discouraged by scientific literature

Summary:

Evidence remains inconclusive, but suggests that travel bans and border closures can be effective if implemented early. Testing protocols are generally effective at identifying a certain percentage of cases and avoiding importation. They are most effective when combined with quarantine. Antigen tests can perform as well as PCR tests when part of protocols involving multiple tests.

Results:

The evidence does not allow firm conclusions about which measures are most effective. However, they do suggest circumstances under which measures may be more or less effective. With regards to border closures or travel bans, studies of travel bans and quarantines suggest that they are most effective (or only effective) when implemented early, before a disease (or variant) is established in the country implementing them.

There is more agreement in studies of testing, which all find that testing identifies cases and prevents a certain amount of case importation. They further find that protocols involving multiple antigen tests are preferable to protocols involving multiple PCR tests [45,48,49], and that a combination of testing and shorter quarantines can perform as well or better than protocols involve quarantines with no testing [29, 30, 40]. However, there is little evidence of how testing protocols effect broader pandemic dynamics.

Role of cross-border commuters in spread of COVID-19

Summary:

Studies of cross-border pandemic dynamics in open border areas find three distinct patterns, including symmetry (similar pandemic dynamics on both sides of the border), asymmetry without spillover (distinct dynamics on different sides of the border), and asymmetry with spillover (distinct dynamics with a tendency towards convergence).

Results:

We were unable to identify any studies that specifically examined the role of cross-border commuters in the spread of COVID-19. However, two studies examined cross-border dynamics in the pandemic, including one focusing on the border between Nepal and India [32] and one looking at 10 different border regions in Germany [31]. We consider the German study to be the most relevant for Switzerland. It found 3 distinct patterns of relationships: (1) symmetry (similar incidence rates on both sides of the border), (2) asymmetry without spillover effects (distinct patterns that don't converge), and (3) asymmetry with spillover effects (differences across borders that tend to converge). The pattern found in the India-Nepal study could be described as asymmetry with spillover effects. Findings suggest that cross-border dynamics vary, even when border policies are broadly similar. While the German study did not examine reasons for the different dynamics observed, they may be due to different levels of cross-border integration in the different border regions examined.

Non-health impacts of border health measures

Summary:

Border health measures have a wide array of negative non-health impacts.

Results:

In our limit search for literature on non-health impacts of border health measures, we found one scoping review of the literature on unintended health and societal consequences [4]. It reviewed the literature published up to the end of 2020, identifying 23 articles eligible for review, suggesting a need for further study of these questions. The reviewed articles reported a wide array of negative and a smaller number of positive unintended impacts. Negative effects included negative effects on the mental health of people affected by measures, negative financial effects, stigma and discrimination faced by people crossing borders, supply chain disruptions, reduced trade, reduced revenue from industries affected by travel measures (especially tourism), among others.

References

1. Nussbaumer-Streit, B., et al., Quarantine alone or in combination with other public health measures to control COVID-19: a rapid review. *Cochrane Database of Systematic Reviews*, 2020(9).
2. Chetty, T., et al., A rapid review of the effectiveness of screening practices at airports, land borders and ports to reduce the transmission of respiratory infectious diseases such as COVID-19. *South African Medical Journal*, 2020. 110(11): p. 1105-1109.
3. Burns, J., et al., International travel-related control measures to contain the COVID-19 pandemic: a rapid review. *The Cochrane database of systematic reviews*, 2021. 3(3): p. CD013717.
4. Klinger, C., et al., Unintended health and societal consequences of international travel measures during the COVID-19 pandemic: a scoping review. *Journal of travel medicine*, 2021. 28(7): p. 1-17.
5. Movsisyan, A., et al., Travel-related control measures to contain the COVID-19 pandemic: an evidence map. *BMJ open*, 2021. 11(4): p. e041619.
6. Bou-Karroum, L., et al., Public Health Effects of Travel-Related Policies on the COVID-19 Pandemic: A Mixed-Methods Systematic Review. *The Journal of Infection*, 2021. 83: p. 413-423.
7. Grépin, K.A., et al., Evidence of the effectiveness of travel-related measures during the early phase of the COVID-19 pandemic: a rapid systematic review. *BMJ Global Health*, 2021. 6(3): p. e004537.
8. Ayouni, I., et al., Effective public health measures to mitigate the spread of COVID-19: a systematic review. *BMC public health*, 2021. 21(1): p. 1015.
9. Rosca, E.C., et al., Transmission of SARS-CoV-2 associated with aircraft travel: a systematic review. *Journal of travel medicine*, 2021. 28(7): p. 1-14.
10. Khatib, A.N., S. McGuinness, and A. Wilder-Smith, COVID-19 transmission and the safety of air travel during the pandemic: a scoping review. *Current Opinion Infectious Diseases*, 2021. 34(5): p. 415-422.
11. Kelly, D., N. Bambury, and M. Boland, In-flight transmission of wild-type SARS-CoV-2 and the outbreak potential of imported clusters of COVID-19: a review of published evidence. *Globalization and Health*, 2021. 17(1): p. 93.
12. Abou-Setta, A.M., et al., Border closure and travel restrictions to control the spread of COVID-19: an update to a Cochrane review. *medRxiv*, 2022.
13. Wu, Q., et al., Effects of COVID-19 Non-Pharmacological Interventions on Dengue Infection: A Systematic Review and Meta-Analysis. *Front Cell Infect Microbiol*, 2022. 12: p. 892508.
14. Gordon, D.V., R.Q. Grafton, and S.I. Steinshamn, Cross-country effects and policy responses to COVID-19 in 2020: The Nordic countries. *Economic Analysis and Policy*, 2021. 71: p. 198-210.

15. Emeto, T.I., F.O. Alele, and O.S. Ilesanmi, Evaluation of the effect of border closure on COVID-19 incidence rates across nine African countries: an interrupted time series study. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 2021. 115: p. 1174-1183.
16. Shiraef, M.A., et al., Did border closures slow SARS-CoV-2? *Scientific reports*, 2022. 12(1): p. 1709.
17. Huy, L.D., et al., The Effects of Non-Pharmaceutical Interventions on COVID-19 Epidemic Growth Rate during Pre- and Post-Vaccination Period in Asian Countries. *International journal of environmental research and public health*, 2022. 19(1139).
18. Costa, D., S. Rohleder, and K. Bozorgmehr, Impact of non-pharmaceutical interventions on COVID-19 incidence and deaths: cross-national natural experiment in 32 European countries. *medRxiv*, 2022.
19. Zweig, S.A., et al., Impact of Public Health and Social Measures on the COVID-19 Pandemic in the United States and Other Countries: Descriptive Analysis. *JMIR public health and surveillance*, 2021. 7(6): p. e27917.
20. Kaimann, D. and I. Tanneberg, What containment strategy leads us through the pandemic crisis? An empirical analysis of the measures against the COVID-19 pandemic. *PloS one*, 2021. 16(6): p. e0253237.
21. Fraiman, J.B., E. Ludwin-Peery, and S. Ludwin-Peery, The majority of the variation in COVID-19 rates between nations is explained by median age, obesity rate, and island status. *medRxiv*, 2021.
22. Katarzyna, J., A. Samuel, and T. Mondher, Factors influencing the COVID-19 daily deaths peak across European countries. *medRxiv*, 2020.
23. Qiu, Z., et al., The effectiveness of governmental nonpharmaceutical interventions against COVID-19 at controlling seasonal influenza transmission: an ecological study. *BMC infectious diseases*, 2022. 22(1): p. 331.
24. Jabłońska, K., S. Aballéa, and M. Toumi, Factors influencing the COVID-19 daily deaths' peak across European countries. *Public health*, 2021. 194: p. 135-142.
25. Adu, B., et al., SARS-CoV-2 detection among international air travellers to Ghana during mandatory quarantine. *Ghana medical journal*, 2021. 55(2 Suppl): p. 48-50.
26. Bastani, H., et al., Efficient and targeted COVID-19 border testing via reinforcement learning. *Nature*, 2021. 599: p. 108-113.
27. Salih, D.A., et al., SARS-CoV-2 and RT-PCR testing in travelers: results of a cross-sectional study of travelers at Iraq's International Borders. *Disaster medicine and public health preparedness*, 2022: p. 1-9.
28. Grunér, M., M. Nordberg, and K. Lönnroth, Problems associated with mass border testing of COVID-19. *Scandinavian journal of public health*, 2021. 50: p. 22-25.
29. Lunney, M., et al., COVID-19 infection among international travellers: a prospective analysis. *BMJ open*, 2021. 11(6): p. e050667.

30. Williams, G.H., et al., SARS-CoV-2 testing and sequencing for international arrivals reveals significant cross border transmission of high risk variants into the United Kingdom. *EClinicalMedicine*, 2021. 38: p. 101021.
31. Chilla, T., et al., COVID-19 incidence in border regions: spatiotemporal patterns and border control measures. *Public health*, 2021. 202: p. 80-83.
32. Kamat, A. and A. Sah, Early Detection of COVID-19 Waves From Cases in a Neighboring Country With an Open Border. *Frontiers in public health*, 2021. 9: p. 739738.
33. Chen, Z., et al., The effect of the synchronized multi-dimensional policies on imported COVID-19 curtailment in China. *PLoS one*, 2021. 16(6): p. e0252224.
34. Milazzo, A., et al., The impact of non-pharmaceutical interventions on COVID-19 cases in South Australia and Victoria. *Australian and New Zealand journal of public health*, 2022. 46: p. 482-487.
35. Li, N., et al., Assessing the impact of COVID-19 border restrictions on dengue transmission in Yunnan Province, China: an observational epidemiological and phylogenetic analysis. *The Lancet regional health. Western Pacific*, 2021. 14: p. 100259.
36. Huang, Q.S., et al., Impact of the COVID-19 nonpharmaceutical interventions on influenza and other respiratory viral infections in New Zealand. *Nature communications*, 2021. 12(1): p. 1001.
37. Ali, K., et al., A cross-sectional investigation of the mental health and wellbeing among individuals who have been negatively impacted by the COVID-19 international border closure in Australia. *Globalization and health*, 2022. 18(12).
38. Murall, C.L., et al., A small number of early introductions seeded widespread transmission of SARS-CoV-2 in Québec, Canada. *Genome Medicine*, 2021. 13(1): p. 169.
39. Nadeau, S.A., et al., Swiss public health measures associated with reduced SARS-CoV-2 transmission using genome data. *medRxiv*, 2021.
40. Goel, V., et al., COVID-19 international border surveillance at Toronto's Pearson Airport: a cohort study. *BMJ open*, 2021. 11(7): p. e050714.
41. Kabir, K.A., A. Chowdhury, and J. Tanimoto, An evolutionary game modeling to assess the effect of border enforcement measures and socio-economic cost: Export-importation epidemic dynamics. *Chaos, solitons, and fractals*, 2021. 146: p. 110918.
42. Grimée, M., et al., Modelling the effect of a border closure between Switzerland and Italy on the spatiotemporal spread of COVID-19 in Switzerland. *Spatial statistics*, 2021. 49: p. 100552.
43. Nakhaeizadeh, M., et al., Impact of Non-pharmaceutical Interventions on the Control of COVID-19 in Iran: A Mathematical Modeling Study. *International journal of health policy and management*, 2021.
44. Kwok, W.C., et al., Modelling the impact of travel restrictions on COVID-19 cases in Hong Kong in early 2020. *BMC public health*, 2021. 21(1878).

45. Dickens, B.L., et al., Determining quarantine length and testing frequency for international border opening during the COVID-19 pandemic. *Journal of travel medicine*, 2021. 28(7): p. 1-10.
46. Chevalier, J.M., et al., Optimal use of COVID19 Ag-RDT screening at border crossings to prevent community transmission: a modeling analysis. *medRxiv*, 2021.
47. Bays, D., E. Bennett, and T. Finnie, Extending upon: What effect might border screening have on preventing importation of COVID-19 compared with other infections? - Considering the additional effect of post-arrival isolation. *medRxiv*, 2021.
48. Lee, F.W., J. Wang, and C.J. Wang, A Testing and Quarantine Algorithm for Individual International Travelers Using Published Data on WHO-Approved Vaccines and Bayes' Theorem. *Vaccines*, 2022. 10(902).
49. Steyn, N., et al., Managing the risk of a COVID-19 outbreak from border arrivals. *Journal of the Royal Society, Interface*, 2021. 18(177): p. 20210063.
50. He, G., et al., When and How to Adjust Non-Pharmacological Interventions Concurrent with Booster Vaccinations Against COVID-19 - Guangdong, China, 2022. *China CDC weekly*, 2022. 4(10): p. 199-206.
51. Yu, Z., et al., Reopening International Borders without Quarantine: Contact Tracing Integrated Policy against COVID-19. *International journal of environmental research and public health*, 2021. 18(14).
52. van Gemert, C., et al., Mathematical Modeling for Removing Border Entry and Quarantine Requirements for COVID-19, Vanuatu. *Emerging infectious diseases*, 2022. 28(5): p. 1053-1055.
53. Lou, J., et al., Cost Benefit Analysis of Alternative Testing and Quarantine Policies for Incoming Travellers During the Covid-19 Pandemic. *SSRN*, 2021.
54. Zachreson, C., et al., COVID-19 in low-tolerance border quarantine systems: Impact of the Delta variant of SARS-CoV-2. *Science advances*, 2022. 8(14): p. eabm3624.
55. Sun, X., et al., On the Effectiveness of Flight Ban Strategies in the Fight Against COVID-19 Variants of Concern. *SSRN*, 2022.
56. Ko, Y., et al., Multi-faceted analysis of COVID-19 epidemic in the Republic of Korea considering Omicron variant: Mathematical modeling-based study. *medRxiv*, 2022.
57. Kwak, G.H., L. Ling, and P. Hui, Deep reinforcement learning approaches for global public health strategies for COVID-19 pandemic. *PloS one*, 2021. 16(5): p. e0251550.
58. Beresniak, A., et al., The FLURESP European Commission project: Cost-Effectiveness assessment of eight public health measures against influenza in Italy: is there an interest in COVID-19 pandemic? *ResearchSquare*, 2022.
59. Steyn, N., et al., Effect of vaccination, border testing, and quarantine requirements on the risk of COVID-19 in New Zealand: A modelling study. *Infectious Disease Modelling*, 2021. 7: p. 184-198.

Literature screening report: Border health measures to combat the COVID-19 epidemic in international travel – 16.09.2022 – K. Jafflin, Sonja Merten.

60. World Health Organization (WHO), Policy considerations for implementing a risk-based approach to international travel in the context of COVID-19. 2021, World Health Organization: Geneva, Switzerland.

61. (WHO), W.H.O., Technical considerations for implementing a risk-based approach to international travel in the context of COVID-19: Interim guidance. 2021, World Health Organization: Geneva, Switzerland.

62. European Centre for Disease Prevention and Control (ECDC), ECDC Technical Report: Guidance for COVID-19 quarantine and testing for travellers. 2021, ECDC: Stockholm, Sweden.

All references: .ris file