Risk assessment tool to inform mitigation measures for international travel in the context of COVID-19

Annex to: Considerations for implementing a risk-based approach to international travel in the context of COVID-19

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World Health Organization

Background

This document provides detailed guidance on how to implement risk mitigation measures for the gradual resumption of international travel in the context of COVID-19 by conducting a risk assessment using a mixed-methods approach, including both quantitative and qualitative data.

This risk assessment methodology is most useful for destination countries experiencing community transmission, for which the primary concern is to not overwhelm health system capacity, not to eliminate transmission.

This tool should be read in conjunction with the WHO interim guidance documents "Considerations for implementing a risk-based approach to international travel in the context of COVID-19" and "Considerations for implementing and adjusting public health and social measures in the context of COVID-19" (1).

It should be noted that this tool is subject to piloting exercises, which may result in its updating and upgrading. It may be refined based on user experience.

Assumptions

The following basic assumptions have been made for the development of this risk assessment tool:

- All people who travel carry the same infection risk as other people in the country from which the travel originates. The travellers who stay only for brief periods of transit do not present the same risk as the populations of transit countries, provided there is limited or no interaction with others because of adherence to recommended public health and social measures, such as physical distancing, hand hygiene, respiratory etiquette and appropriate mask use.
- Healthy people who choose to travel present, on average, no greater infection risk than the general population in the departure country, as symptomatic individuals and case contacts may have been isolated and quarantined and prevented from travelling. In addition, infected symptomatic travellers who attempt to travel may be detected by pre-departure measures. Thus, calculations based on general population incidence present a 'worst-case' scenario and offer a margin of safety.
- For the purpose of this risk assessment, travellers are treated as a homogeneous group, i.e., risk is assumed to be independent of the purpose of travel, of nationality and of other individual factors.
- It is assumed that the vast majority of individuals will not travel while symptomatic, either due to self-selection or because they have been isolated according to public health policies of the origin country. Thus, the major drivers of travel-related SARS-CoV-2 translocations result from travel by asymptomatic and pre-symptomatic persons. For purposes of the risk assessment, a median five days incubation period is used (2). This means that people who are newly infected may travel for five days before their symptoms manifest. Therefore, the COVID-19 prevalence among travellers is calculated to be five times that of the incidence of the country of departure.
- The incidence of COVID-19 is assumed to be higher than identified cases captured by current surveillance systems, even in the presence of robust surveillance. However, it can be assumed that this under-detection is roughly equivalent in departure and destination locations that have the same transmission status (e.g. community transmission); thus, the contribution of asymptomatic cases (estimated at approximately 20% if all cases (3)) is largely cancelled out in calculations of relative risk. Further, since the majority of undetected cases are not expected to place an additional burden on a health system, they are not used in the calculations in this assessment. This assumption is not valid with regard to the possibility that unrestricted travel of asymptomatic individuals will lead to re-seeding in locations with no cases, imported/sporadic cases or a small number of cluster cases. If this is a potential issue, additional risk mitigation measures are needed.
- As noted above, for countries experiencing community transmission, there is little rationale for more stringent measures imposed on travellers arriving from countries with lower or equal projected case incidence than on the general population in the country of destination However, if the health system capacity in a country is critically low, and inbound travel is a major contributor to the population volume, it may be necessary to implement more stringent measures to limit travel or impose quarantine measures for travellers from other countries with higher COVID-19 circulation to prevent any further burden on the health system in the country of destination from additional imported COVID-19 cases or other health needs.

- Travel into and out of a country does not lead to significant net immigration. However, assessments can take into account any net increase in population related to travel by separately calculating the projected incidence through arrivals (incidence in departure country multiplied by inbound travel volume) and the projected incidence of departing travellers (incidence in destination country multiplied by outbound travel volume).
- In most countries, arriving travellers represent a small proportion of the population at any given time. Consequently, even if travellers from some countries present a significantly higher infection risk than the domestic population, the overall level of transmission will be elevated only slightly if high incidence is already present in the arrival country. Using accurate and up-to-date travel volume allows for a more precise characterization of the increased risk.

Mixed-methods risk assessment

This section provides Member States with practical guidance on how to implement a mixed-methods risk assessment for in-bound travel. A multi-sectoral and multi-disciplinary team composed of national authorities, and sub-national representatives as needed and applicable should be assembled to conduct the risk assessment. The team should include individuals from: health (public health, laboratories, clinical management), customs, migration, security, finances, tourism, foreign affairs, legal counsel, risk communication/community engagement and conveyance and points of entry operators. Support for conducting the risk assessments may be sought from the relevant WHO Country Office and/or Regional Office.

Figure 1 below illustrates an algorithm that can be used to achieve the following:

1. Determine the reported 14-day COVID-19 incidence per 100 000 population in the COUNTRY OF ORIGIN and in the COUNTRY OF DEPARTURE (4). For the sake of efficiency, start by assessing those countries with which the resumption of travel is strategically important. Assess it alongside other key indicators when they are available (e.g. mortality[1], testing positivity ratio, testing rates and testing strategy). Take into consideration any necessary corrections to reported incidence (see Limitations and Annex 1, below). Review trends in incidence in both countries to estimate what the incidence is likely to be in both locations by the time that changes to travel measures can be operationalized[2].
2. Multiply by 5/14 (five days' median incubation period[3] divided by two weeks) to determine prevalence in travellers and determine net risk per traveller in both countries.
3. Compare 14-day case incidence per 100 000 population and net risk per traveller in both countries.
4. Calculate the travel volume from the COUNTRY OF DEPARTURE, totalled across all routes (air, land and sea).
5. Multiply net risk per traveller by volume of travel to determine additional burden of COVID-19 cases.
6. Repeat Steps 1–5 for all COUNTRIES of DEPARTURE of interest and estimate total potential added burden of COVID-19.
7. Determine whether YOUR COUNTRY has adequate capacities to detect and cope with the potential additional burden of COVID-19 cases while maintaining other essential health services.
    - Recommended indicators and thresholds on what constitutes "adequate" capacities in the context of COVID-19 include:
        - <75% occupied hospital beds
        - decreasing trend of case fatality rate of resolved (i.e., outcome known) hospitalized cases
        - 2+ persons tested per 1000 population per week, averaged over a two-week period
        - 80%+ cases for which an investigation has been conducted within 24 hours of identification
        - high (nearly universal) adherence to public health and social measures.
    - Further details on these specific indicators and others recommended to guide this decision are included in the WHO guidance "Considerations for implementing and adjusting public health and social measures in the context of COVID-19" (1).
8. Based on your country's acceptable increased burden, potential increases to that burden and benefits of allowing travel from each country, make a final assessment about the countries from which you will allow international travel during the period of the current risk assessment.

It should be noted that the resulting increased burden associated with travellers is measured in percent increases in incidence *per 14 days*, which must be compounded over the length of time that international travel is allowed.

[1] While reported COVID-19 deaths per week may be less influenced by surveillance capacity, and is widely available, this indicator lags by 2-3 weeks behind incidence, so it is not considered useful for as the main indicator for risk assessment; however, it can be used as a correction factor to estimate under-reporting of incident cases.

[2] Should data from countries of departure not be available or be uncertain, countries may wish to consider implementation of supplementary travel-related measures in line with the considerations outlined in section 3 of this document.

[3] A 5-days median incubation period is used to estimate prevalence; this should not be confused with the 14-day maximum incubation period used for determining duration of interventions.

Limitations

There are limitations to this mixed-methods approach to risk assessment that should be acknowledged and taken into account throughout this exercise. The reported 14-day case incidence per 100 000 population is proposed as the main epidemiological indicator to be used, given its wide and consistent availability across all countries worldwide[4]. However, it should be interpreted with caution, particularly in light of differences in testing strategies. In some countries, for example, only severe cases are tested because of limited resources.

Other key indicators can be used if they are available and are of value for decisions beyond international travel. WHO encourages Member States to report mortality[5], testing positivity ratio, testing rates and testing strategy. For some countries, the reported incidence may need to be 'corrected' for calculation purposes. Further information on these additional indicators is available in the WHO guidance "Considerations for implementing and adjusting public health and social measures in the context of COVID-19" (1). In addition, minor fluctuations in case numbers may have a larger impact on incidence in smaller countries[6]. Additional qualitative and situational information – including the implementation of and adherence to public health and social measures – should be used to complement the algorithm illustrated in Figure 1 and complete the risk assessment.

The algorithm assumes that the virus type being transmitted in the country of departure is one of the commonly circulating variants of SARS-CoV-2. The emergence of any virus variant with confirmed changes to epidemiologic or clinical characteristics (e.g. higher transmissibility or virulence) requires a dedicated risk assessment.

Assessing total travel volume between a country of departure and the country of destination

Total travel volume between countries is the sum of travel volume across the individual routes (air, land and sea). Travel volume can be obtained in coordination with Points of Entry operators and/or immigration authorities.

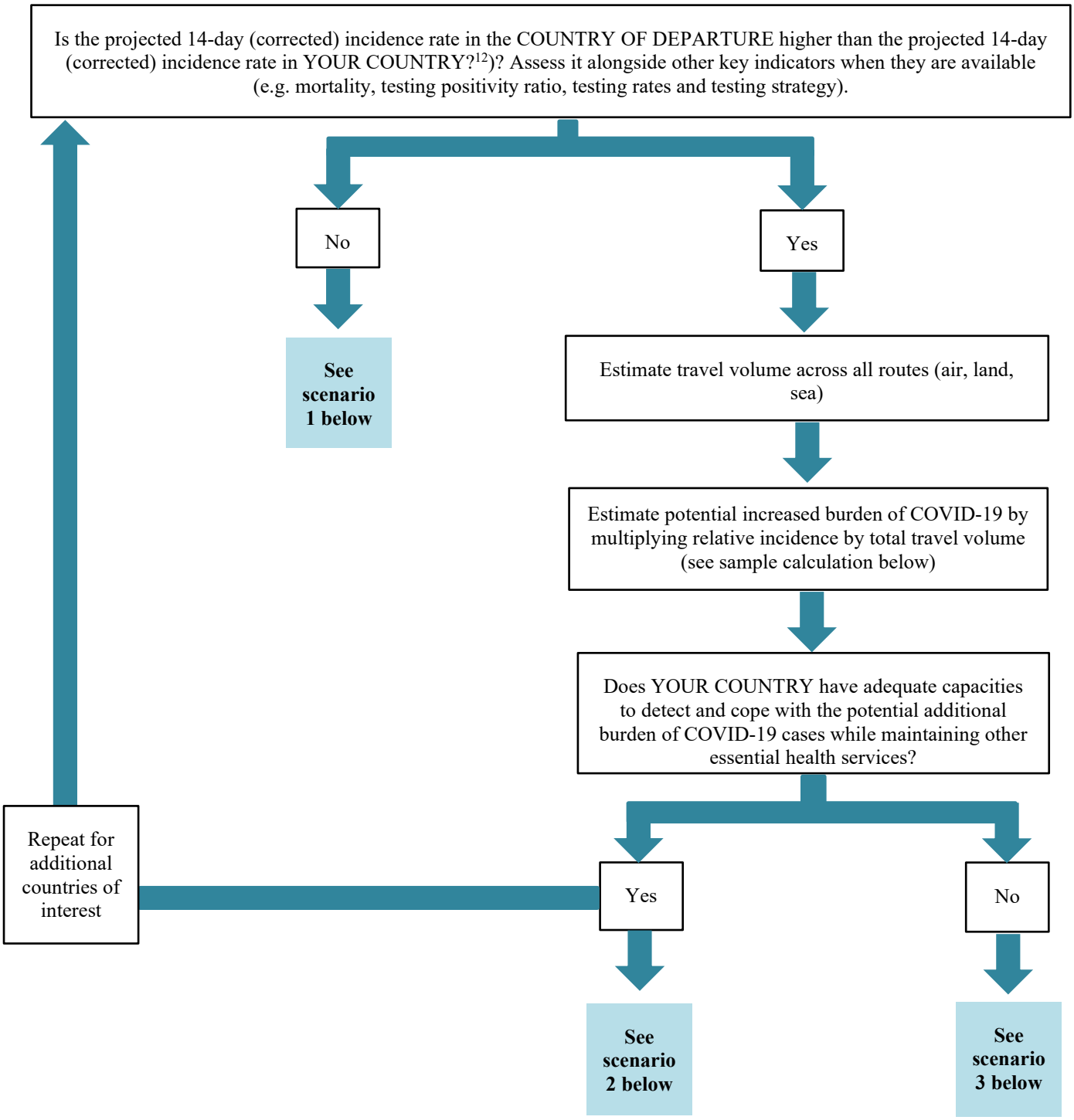
It is important to note that changes to travel measures (e.g. removal of arrival quarantine requirements) will have a rapid effect on travel volume. Consequently, the travel volume must be reassessed continually.

Figure 1. Algorithm to implement a risk-based approach to the gradual resumption of international in-bound travel in the context of COVID-19

[4] The transmission classification is not proposed for several reasons: it is a subjective assessment and thus difficult to compare quantitatively; it is designed primarily for internal risk assessment, and its use in shaping travel policy could bring undue political influence to the transmission self-assessment; and there is currently no mechanism by which countries can ascertain the 'community transmission' sub-classifications (i.e. CT1 – 4) of other countries, and so most countries would find themselves within the same larger 'community transmission' category, unable to compare risks.

[5] While reported COVID-19 deaths per week may be less influenced by surveillance capacity, and is widely available, this indicator lags by 2-3 weeks behind incidence, so it is not considered useful for as the main indicator for risk assessment; however, it can be used as a correction factor to estimate under-reporting of incident cases.

[6] For populations below approximately 300 000 persons, volatility in incidence may render it unreliable for assessing transmission risk. In larger destination countries, the number of arrivals from such low-population countries or areas of departure will be unlikely to have a significant impact on ongoing local community transmission; thus, it is usually unnecessary to impose restrictions on arrivals from such locations. Small countries with substantial travel volume from such countries or areas with unreliable incidence data should attempt to assess the risk using a combination of other information as described above.



Scenario 1: In this scenario, the COUNTRY OF DEPARTURE (or sum of multiple countries assessed) has a projected case incidence lower than or equal to that of YOUR COUNTRY.

- For inbound travel, the impact of imported cases from the COUNTRY(IES) OF DEPARTURE on the epidemiological situation in YOUR COUNTRY is relatively low.
- Only basic travel-related risk mitigation measures are recommended.
- If YOUR COUNTRY has no (active) cases, imported/sporadic cases or a small number of clusters and a low risk tolerance, the need for supplementary measures may be weighed in line with the considerations outlined in the section on risk mitigation measures for resuming travel.

Scenario 2: In this scenario, the COUNTRY OF DEPARTURE (or sum of multiple countries assessed) has a projected case incidence higher than YOUR COUNTRY, and YOUR COUNTRY has adequate capacities to cope with the increased burden.

- For inbound travel, the impact of imported cases from the COUNTRY(IES) OF DEPARTURE on the epidemiological situation in YOUR COUNTRY may be high in relative terms, depending on the travel volume(s). However, YOUR COUNTRY has adequate capacities to cope with the increased burden.
- In addition to the basic travel-related risk mitigation measures, supplementary measures may be implemented in YOUR COUNTRY to reduce the impact of importation, in line with the considerations outlined in the risk mitigation section of this document. These supplementary measures may be less stringent given the public health and health system response capacity in YOUR COUNTRY and based on your risk tolerance level.

Scenario 3: In this scenario, the COUNTRY OF DEPARTURE (or sum of multiple countries assessed) has a case incidence higher than YOUR COUNTRY, and YOUR COUNTRY does not have adequate capacities to cope with an increased burden.

- For inbound travel, the impact of imported cases from the COUNTRY(IES) OF DEPARTURE on the epidemiological situation in YOUR COUNTRY may be relatively high, depending on travel volume(s).
- In addition, YOUR COUNTRY does not have adequate capacities to cope with the additional burden.
- Basic and supplementary travel-related risk mitigation measures are recommended in YOUR COUNTRY to reduce the impact of importation, in line with the considerations outlined in the risk mitigations section of this document.
- Consideration may be given to allowing international travel from selected countries assessed, as long as the total increased burden does not exceed available capacities (see sample calculations below).

These scenarios are dynamic; national authorities should continuously review and update their risk assessments. The implementation of risk mitigation measures is also highly dependent on countries' level of risk tolerance.

Sample calculations for the quantitative part of the mixed-methods assessment

Note: calculations are rounded so as not to imply precision where none is possible due to the assumptions and simplifications involved in this algorithm. These calculations are based on reported incidence, as available from covid19.who.int. Two simple methods for 'correcting' incidence are provided in Examples 4 and 5. An alternative is to use one of several publicly available tools for modeled incidence (5) in calculations; it should be noted, however, that estimates do not exist or have low confidence for some countries. If this latter approach is used, the modeled incidence must be used throughout the calculations (e.g. for both countries) so as not to distort the final calculated percent increase in burden.

Example 1 – Country A

In this example, DEPARTURE COUNTRY A has a lower incidence than YOUR COUNTRY. Both countries are assessed to have robust surveillance. The incidence has been stable in both countries for several weeks.

YOUR COUNTRY

Cases per 14 days: 20 000

Population: 4 500 000

Incidence per 100 000 = 20 000/4 500 000 = 444

Probability of an individual passenger leaving your country being a pre-symptomatic case = 444/100 000 x 5/14 = 0.16%

DEPARTURE COUNTRY A

Cases per 14 days: 40 000

Population: 18 000 000

Incidence per 100 000 = 40 000/18 000 000 = 222

Probability of an individual passenger arriving to your country being a pre-symptomatic case = 222/100 000 x 5/14 = 0.08%

Relative incidence (COUNTRY A: YOUR COUNTRY) = 222/444 = 0.5

Net risk per traveller (risk due to arrivals from Country A – risk due to departures) = 0.08%-0.16% = -0.08%

Assessment: No further calculations are needed, as allowing travel from Country A does not increase your incidence of COVID-19.

Example 2 – Country B

In this example, YOUR COUNTRY and DEPARTURE COUNTRY B have a large difference in incidence but a low travel volume. Both countries are assessed to have robust surveillance. The incidence has been stable in both countries for several weeks.

YOUR COUNTRY (same calculations as in Example 1)

Cases per 14 days: 20 000

Population: 4 500 000

Incidence per 100 000 = 20 000/4 500 000 = 444

Probability of an individual passenger leaving your country being a pre-symptomatic case = 444/100 000 x 5/14 = 0.16%

DEPARTURE COUNTRY B

Cases per 14 days: 770 000

Population: 70 000 000

Incidence per 100 000 = 770 000/70 000 000 = 1100

Probability of an individual passenger arriving to your country being a pre-symptomatic case = 1100/100,000 x 5/14 = 0.39%

Relative incidence (COUNTRY B: YOUR COUNTRY) = 1100/444 = 2.5

Net risk per traveler (risk due to arrivals from Country B – risk due to departures) = 0.39%-0.16% = 0.23%

Biweekly volume of travelers between COUNTRY B and YOUR COUNTRY: 5,000

Net number of pre-symptomatic travelers arriving in YOUR COUNTRY from COUNTRY B = 5000 x 0.23% = 12

Net increase in biweekly incidence in YOUR COUNTRY associated with travelers from COUNTRY B = 12/20 000 = 0.06%

Example 3 – Country C

In this example, YOUR COUNTRY and DEPARTURE COUNTRY C have a small difference in incidence but a large travel volume. Both countries are assessed to have robust surveillance. The incidence has been stable in both countries for several weeks.

YOUR COUNTRY (same calculations as in Example 1)

Cases per 14 days: 20 000

Population: 4 500 000

Incidence per 100 000 = 20 000/4 500 000 = 444

Probability of an individual passenger leaving your country being a pre-symptomatic case = 444/100 000 x 5/14 = 0.16%

DEPARTURE COUNTRY C

Cases per 14 days: 63 600

Population: 12 000 000

Incidence per 100 000 = 63 600/12 000 000 = 530

Probability of an individual passenger arriving to your country being a pre-symptomatic case = 530/100000 x 5/14 = 0.19%

Relative incidence (COUNTRY C: YOUR COUNTRY) = 530/444 = 1.2

Net risk per traveller (risk due to arrivals from Country C – risk due to departures) = 0.19%-0.16% = 0.03%

Biweekly volume of travellers between COUNTRY C and YOUR COUNTRY: 100 000

Net number of pre-symptomatic travellers arriving in YOUR COUNTRY from COUNTRY C = 100 000 x 0.03% = 30

Net increase in biweekly incidence in YOUR COUNTRY associated with travellers from COUNTRY C = 30/20 000 = 0.15%

Assessment: As compared with Country B, despite having only a marginally higher incidence, Country C's high travel volume results in a larger net increase in burden.

Example 4 – Country D

In this example, DEPARTURE COUNTRY D has a rising incidence rate, so projections are necessary. In your setting, it takes approximately two weeks to operationalize changes to travel measures.

YOUR COUNTRY (same calculations as in Example 1)

Cases per 14 days: 20 000

Population: 4 500 000

Incidence per 100 000 = 20 000/4 500 000 = 444

Probability of an individual passenger leaving your country being a pre-symptomatic case = 444/100 000 x 5/14 = 0.16%

DEPARTURE COUNTRY D

Current cases per 14 days: 30 000

Average biweekly change over past 4 weeks: +10% per 14 days

Projected cases per 14 days in two weeks: 33 000

Population: 5 000 000

Incidence per 100 000 = 33 000/5 000 000= 660

Probability of an individual passenger arriving to your country being a pre-symptomatic case = 660/100 000 x 5/14 = 0.24%

Relative incidence (COUNTRY D: YOUR COUNTRY) = 660/444 = 1.5

Net risk per traveller (risk due to arrivals from Country D – risk due to departures) = 0.24%-0.16% = 0.08%

Biweekly volume of travellers per week between COUNTRY D and YOUR COUNTRY: 20 000

Net number of pre-symptomatic travellers arriving in YOUR COUNTRY from COUNTRY D = 20 000 x 0.08% = 16

Net increase in biweekly incidence in YOUR COUNTRY associated with travellers from COUNTRY D = 16/20 000 = 0.08%

Example 5 – Country E

In this example, the testing rate in DEPARTURE COUNTRY E is very low, and thus, reported incidence may not reflect the actual epidemiologic situation. Hence, an incidence correction factor is used. Incidence has been stable, so no projection is needed.

YOUR COUNTRY (same calculations as in Example 1)

Reported cases per 14 days: 20 000

Population: 4 500 000

Reported incidence per 100 000 = 20 000/4 500 000 = 444

Probability of an individual passenger leaving your country being a pre-symptomatic case = 444/100 000 x 5/14 = 0.16%

Number of tests conducted biweekly: 135 000

DEPARTURE COUNTRY E

Reported cases per 14 days: 10 000

Population: 9 000 000

Reported Incidence per 100 000 = 10 000/9 000 000 = 111

Number of tests conducted biweekly: 35 000

Incidence correction factor assuming similar testing strategy)

= (population country E / your population) x (your tests / tests country E) =

9 000 000 / 4 500 000) x (135 000 / 35 000) = 7.7

Corrected incidence: 111 x 7.7 = 855

Probability of an individual passenger arriving to your country being a pre-symptomatic case = 855/100 000 x 5/14 = 0.3%

Relative incidence (COUNTRY E: YOUR COUNTRY) = 855/444 = 1.9

Net risk per traveller (risk due to arrivals from Country E – risk due to departures) = 0.3%-0.16% = 0.14%

Biweekly volume of travellers between COUNTRY E and YOUR COUNTRY: **50 000**

Net number of pre-symptomatic travellers arriving in YOUR COUNTRY from COUNTRY E = 50 000 x 0.14% = 70

Net increase in biweekly incidence in YOUR COUNTRY associated with travellers from COUNTRY E = 70 / 20 000 = **0.35%**

Example 6 – Country F

In this example, the testing rate in DEPARTURE COUNTRY F is not available and reported incidence is considered to be unreliable, so the number of reported COVID-19 deaths is used as a correction factor for incidence. Incidence has been stable, so no projection is needed.

YOUR COUNTRY (same calculations as in Example 1)

Reported cases per 14 days: 20 000

Population: 4 500 000

Reported incidence per 100 000 = 20 000/4 500 000 = 444

Probability of an individual passenger leaving your country being a pre-symptomatic case = 444/100 000 x 5/14 = 0.16%

Biweekly deaths per 100 000: 10

DEPARTURE COUNTRY F

Reported cases per 14 days: 7000

Population: 4 500 000

Reported incidence per 100 000 = 7 000/4 500 000 = 156

Biweekly deaths per 100 000 per week: 20

Incidence correction factor (assuming the true case fatality rate is equivalent in both countries):

(your incidence / your deaths) / (incidence country F/ deaths country F) = (444/10) / (156/20) = 5.7

Corrected incidence: 156 x 5.7 = 889

Probability of an individual passenger arriving to your country being a pre-symptomatic case = 889/100 000 x 5/14 = 0.32%

Relative incidence (COUNTRY F: YOUR COUNTRY) = 889/444 = 2.0

Net risk per traveller (risk due to arrivals from Country F – risk due to departures) = 0.32%-0.16% = 0.16%

Biweekly volume of travellers per week between COUNTRY F and YOUR COUNTRY: 50 000

Net number of pre-symptomatic travellers arriving in YOUR COUNTRY from COUNTRY F = 50 000 x 0.16% = 80

Net increase in biweekly incidence in YOUR COUNTRY associated with travellers from COUNTRY F = 80/20 000 = 0.4%

Example of decision-making process

In this example, the total estimated additional incidence per week from DEPARTURE COUNTRIES B, C, D, E and F is calculated, and a decision is made about the countries to which unrestricted travel is allowed.

Net increase in biweekly incidences associated with travellers with unrestricted travel from Country B + Country C + Country D + Country E + Country F = 0.06% + 0.15% + 0.08% + 0.35% + 0.4% = ~1.04% total increase in cases per 14 days. Assuming no further changes in incidence in any of the example countries or other reason for a change in incidence in your country, the total percent increase in cases after a period of 12 weeks (six biweekly periods) would be close to 1.04 x 6 =~ 6.4.%

Based on the above calculations, Country E is expected to contribute the largest share of increased incidence, and Country B the least. Each country's contribution to increased incidence should be weighed against the benefits to allowing unrestricted travel from that country. The total increased incidence that can be tolerated by the health system also must be taken into account.

For example, if it is determined that the health system could tolerate a 25% increase in incidence over 12 weeks, all of the example departure countries could be allowed unrestricted travel. If only a 5% increase in incidence could be tolerated, an assessment of the burden versus benefits of allowing unrestricted travel would have to be made for each country, and a combination of the countries selected.

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WHO continues to monitor the situation closely for any changes that may affect this interim guidance. Should any factors change, WHO will issue a further update. Otherwise, this interim guidance document will expire 2 years after the date of publication.

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