ZIKA VIRUS
Technical report

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Interim Risk Assessment
WHO European Region

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Cover photo: Outline of the map of the WHO European Region (design by João Duarte)

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Executive Summary

Background

On 1 February 2016, the WHO Director-General declared that the recent clusters of cases of microcephaly and neurological disorders associated with Zika virus constitute a Public Health Emergency of International Concern (PHEIC) under the International Health Regulations (2005). In light of the current widespread outbreak occurring in Latin America and the Caribbean, the risk for Zika virus importation and further spread in the European Region should not be underestimated. In order for countries in the European Region to target preparedness work and guide prioritization of activities, a risk assessment for a Zika virus outbreak was undertaken.

Methods

The risk of an outbreak was considered to be the function of two main components: 1) the likelihood of local Zika virus transmission, and 2) the capacity of countries to contain transmission at an early stage. A local transmission likelihood score was derived according to presence and climatic suitability of *A. aegypti* and *A. albopictus* (the two species of *Aedes* mosquitos known to be competent vectors for Zika virus), as well as factors related to introduction and onward transmission of Zika virus such as history of previous arboviral outbreaks, shipping and air connectivity, population density and urbanization. A country capacity score was derived by evaluating four main factors: integrated vector management, clinical surveillance, laboratory capacity, and emergency risk communications.

Main limitations

Following the declaration of the PHEIC there was a need to rapidly assess country capacity in relation to Zika virus. Therefore it was not possible to pilot the questionnaire used to collect data or validate the responses with regards to country capacities. Thus, we cannot exclude that questions may have been subject to interpretation and reporting biases. In addition, country capacities to respond to Zika virus have likely increased since the time of data collection however it was not possible to account for these changes in the analysis. Thus, it should be noted that the capacity score presented is intended to serve as a baseline indicator at the Regional level, and countries are best positioned to assess their individual capacities in line with WHO recommendations according to their respective levels of likelihood for local Zika virus transmission.

In the absence of transmission models for Zika virus in the European Region (at the time of report), proxy indicators were used to derive the likelihood score for local transmission. However the real probability of dissemination of the pathogen once introduced is currently unknown. Comprehensive transmission models are needed in order to more accurately estimate the likelihood of Zika virus transmission.

Results and conclusions

Many countries extending from the Mediterranean basin have a moderate likelihood of local Zika virus transmission. In addition three geographical areas (Madeira Island (Portugal) and the Black Sea coastal areas of Georgia and the Russian Federation) with established populations of *A. aegypti*, were classified as having high likelihood for local Zika virus transmission. Although there was good overall capacity in the Region to contain Zika virus transmission at an early stage, specific capacities reported (integrated vector management, clinical surveillance, laboratory capacity and emergency risk communications) varied substantially at country level. Reported capacity to prevent and rapidly control Zika virus transmission was fairly robust in countries with localized areas with high transmission likelihood.

Recommendations

Countries and regions at high or moderate likelihood of local Zika virus transmission should strengthen and/or maintain their vector control activities through improved entomological surveillance and source reduction strategies. This is particularly relevant for the three areas with *A. aegypti* and should be done before the active mosquito season starts together with enhanced clinical surveillance to rapidly detect local Zika virus transmission. Further, countries are advised to ensure that they have the laboratory capacity to test for Zika virus or have protocols in place to ship blood samples abroad. Lastly, countries are recommended to advise those at risk on how to protect themselves from infection, and mitigate the effects of Zika virus and its complications.

Background

Zika virus infection is a mosquito-borne Flavivirus, transmitted through the bite of an infected mosquito from the *Aedes* genus. Infection is followed by an incubation period estimated to be between 4 and 7 days[1] prior to the development of clinical symptoms, which occurs in only a minority of infected individuals (estimated 20%)[2]. The symptoms of Zika virus infection are similar to those of other arboviruses such as dengue, and include fever, skin rash, conjunctivitis, joint inflammation and pain[3]. The symptoms are usually mild and normally last for 2-7 days. There is no specific treatment or vaccine currently available. The best form of prevention is protection against mosquito bites.

It is widely accepted and believed that the primary *Aedes* species vector of Zika virus outbreak in the Americas is *A. aegypti*[4,5], which is known to be able to transmit other viral diseases such as dengue, chikungunya and yellow fever. *A. albopictus* has been shown to be able to transmit Zika virus in field settings in Africa[6] and in laboratory settings in Singapore[7]. The vector competence (vector's biological capability to transmit a virus)[8] of *A. aegypti* and *A. albopictus* is similar[9]. Notwithstanding, differences in mosquito susceptibility to Zika infection as well as ability to disseminate Zika virus have been shown within the same species of *Aedes* mosquitoes but from distinct locations[9]. Evidence is still lacking on how the European population of *Aedes* mosquitos will adapt to Zika virus.
A. albopictus is considered to have lower vector capacity* than *A. aegypti* for transmitting arboviruses, including Zika; however *A. albopictus* is known to be established in many countries of the European Region[10] and has been implicated in recent arboviral outbreaks in continental Europe[8].

Zika virus was first identified in 1947[11] in rhesus monkeys in the Zika forest of Uganda, and human disease was first identified in 1952 in Uganda and the United Republic of Tanzania. The virus has since caused sporadic disease in Africa and Asia. Zika virus disease outbreaks were reported for the first time in the Pacific in 2007 and 2013 in Yap Island and French Polynesia, respectively. The geographical spread of Zika virus has since been steadily increasing. In 2015, the virus was detected in the continental parts of WHO Region of the Americas, initially in Brazil in May 2015. It then spread widely in that geographical area, and as of 14 April 2016, there were 35 countries or territories reporting local Zika virus transmission[12]. Besides the Americas, Zika virus has been also circulating during 2015-2016 in countries in the African, South East Asian and Western Pacific Regions of WHO.

Circulation of the virus in Brazil in 2015 was temporally and geographically associated with steep increases in the number of babies born with microcephaly and of cases of Guillain-Barré syndrome, a poorly understood condition in which the immune system attacks the nervous system, sometimes resulting in paralysis. In response, on 1 February 2016, the WHO Director-General declared that the recent clusters of cases of microcephaly and neurological disorders in Latin America and the Caribbean constitute a Public Health Emergency of International Concern (PHEIC) under the International Health Regulations (2005).

Imported cases have been reported in several European countries. The European Centre for Disease Prevention and Control (ECDC) is collecting data regarding imported cases to the EU/EAA through the media and official government communication lines. As of 15 April 2016, ECDC has recorded 409 imported cases in 17 EU/EEA countries, amongst which 23 were pregnant women[13]. This data is important as returning travelers infected with Zika virus could initiate local transmission in the presence of established competent vectors. As of 15 April, no autochthonous Zika virus transmission has been reported in the WHO European Region.

Based on a growing body of preliminary research, there is scientific consensus that Zika virus is a cause of microcephaly and Guillain-Barré syndrome[14-28]. However, much is yet to be understood about the magnitude of the risk and the full spectrum of the congenital malformations and neurologic complications caused by Zika virus infection. Nonetheless, the public health impact of a Zika virus disease outbreak is to be considered serious and therefore Member States need to enhance their preparedness and readiness capacity according to their individual risk for a Zika virus disease outbreak.

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* Vector capacity is the efficiency with which the mosquito transmits a disease, which is based on its preferred host, the number of bites (feedings) per cycle of egg production, its longevity, the density of the mosquito population and other factors[5]

Objectives

The main objective of this analysis was to assess the likelihood of local Zika virus transmission at country level in the WHO European Region, to evaluate the existing capacity in the Region to prevent and rapidly control local transmission from developing into a large outbreak (i.e. early containment of transmission), and to assess the composite risk of a Zika virus outbreak in the Region. Assessment of the likelihood of transmission at country-level will inform and target the preparedness work related to Zika virus in the European Region and guide countries' prioritization of activities to prevent a large outbreak of Zika virus.

The specific objectives are:

1. To assess: the epidemiological likelihood of local Zika virus transmission using information on the presence of the *Aedes* vector (specifically, *A. aegypti* and *A. albopictus*) in countries in the WHO European Region; the ecological and environmental viability of vector presence in areas where vector surveillance is absent or in areas where the vector is not present; and Zika virus introduction and transmission;
2. To evaluate Regional capacity to prevent and contain early local transmission using information on the ability of each country to detect Zika virus and local transmission, as well as the ability of each country to rapidly respond before an outbreak occurs;
3. To develop a risk assessment framework combining the assessment of both the likelihood of local Zika virus transmission and country capacity in order to define the risk for a Zika virus outbreak in the Region;
4. To provide recommendations aligned with published WHO guidelines based upon each country's Zika transmission likelihood score.

Assumptions of the Risk Assessment

- According to the available evidence, only *Aedes* species of mosquitos are capable of transmitting Zika virus, therefore other species of mosquitos were not evaluated for the purpose of this risk assessment;
- According to the available evidence *A. albopictus* is considered to have lower vector capacity than *A. aegypti* for transmitting arboviruses, including Zika virus;
- For the purpose of this risk assessment, vector-borne transmission of Zika virus was assumed to be the determinant form of transmission and other forms of transmission were not incorporated; in particular, sexual transmission of Zika virus remains beyond the scope of this risk assessment, but is taken into account in the Recommendations section;
- Climatic suitability models provide information on the potential risk for vector presence;
- Bordering a country with established populations of *Aedes* mosquitos, places countries at a higher level of risk for Zika virus transmission;
- The capacity reported by a country to detect and respond to a potential outbreak is the same across its territories, including specific localized areas with different Zika transmission likelihood;

Methods

The risk of a Zika virus outbreak occurring in the WHO European Region is highly variable across countries and dependent on multiple factors. The risk of an outbreak was considered to be the function of two main components: 1) the likelihood of local Zika virus transmission, and 2) the capacity of the countries to contain transmission at an early stage.

Likelihood of local Zika virus transmission

Presence of the vector (*A. aegypti* and/or *A. albopictus*) countries was considered the most important determinant of likelihood of local Zika virus transmission. Countries were assigned a base score according to whether *A. aegypti*

and/or *A. albopictus* is currently present in respective countries, and suitability of climatic conditions for the vector in those countries where the vector was not present. The highest score was given to countries with current presence of *A. aegypti,* as this is believed to be the primary vector of the current outbreak in the Americas. The vector variable was weighted 10:1 in comparison with additional factors related to introduction and onward transmission of Zika virus, such as history of previous arboviral outbreaks, shipping and air connectivity, population density and urbanization. These factors were weighted equally and scores for each were added to the base score to generate an overall Zika transmission likelihood score according to the following equation.

$$\textit{Local transmission likelihood} = (\textit{vector base score} + \textit{history of previous arboviral outbreak} + \textit{shipping connectivity} + \textit{air connectivity} + \textit{population density} + \textit{urbanization})$$

For those countries without climatic conditions suitable for vector presence, scores from additional variables were not taken into account and they were classified as having no risk for a Zika virus outbreak. Although the factor of 'previous history of arboviral outbreaks' is a compound variable and encompasses other factors also evaluated in the analysis (and as such is a collinear variable), we interpreted it as providing an additional indication of the facility with which arboviral outbreaks can occur among countries with the same or similar vector presence, climatic suitability, etc. This variable therefore captures additional information that is not possible to fully capture with only the other variables. Since the transmission likelihood score is derived from an additive model, rather than a regression model, collinearity was judged not to pose a limitation on inclusion of this factor.

As there are currently only three localized geographical areas in the WHO European Region that have established populations of *A. aegypti*, these areas were evaluated separately from, and in addition to, their corresponding countries. The three additional areas were Madeira Island (Portugal) and the Black Sea coastal areas of Georgia and the Russian Federation.

A description of the factors and sources used to derive each factor score, which were then used to calculate the overall likelihood score of local Zika virus transmission and the scoring framework is summarized in Table 1. Based on the likelihood score, countries and the three additional geographical areas were classified as having: no likelihood (score = 0), very low (>0 ≤ 3), low>3 ≤ 7), moderate likelihood (>7 ≤ 9) or high (>9) likelihood. The scoring categories principally correspond to the vector variable sub-categories.

Capacity of the country to contain transmission at an early stage

In order to assess the capacity of the Region to contain transmission at an early stage, a questionnaire (with official translation in French and Russian) was sent to all 53 Member States plus the Principality of Liechtenstein. The first round questionnaire was sent to the National IHR Focal Points of the non-EU Member States in the WHO European Region on 12 February 2016 to assess the establishment of competent vectors in the region, related Integrated Vector Management (IVM) strategies in place in the country, as well as the clinical surveillance capacity in place for early detection of local transmission of Zika virus disease, laboratory capacity for Zika virus diagnosis and emergency risk communications capacity. On 17 of February 2016 the same questionnaire excluding the questions on laboratory capacity was sent to EU Member States in coordination with ECDC and complementary to the ECDC laboratory questionnaire, which was sent to laboratories in the EU/EEA Member States and some non-EU Member States on 4 February 2016 by ECDC.

Four main factors were evaluated in order to derive a country capacity score: IVM, clinical surveillance, laboratory capacity, and emergency risk communications. These factors were equally weighted and scores from each factor were added to calculate the capacity score. For the IVM factor, in some countries without vector presence, it may be reasonable not to have an IVM plan, so these countries were scored higher than those with vector presence but without an IVM plan. A description of the factors used to calculate the overall capacity score is summarized in Table 2. Based on the capacity score, countries were classified as having: very low (≤2), low (>2 ≤ 4), reasonable (>4 ≤ 6), good (>6 ≤ 8) or very good capacity (>8).

For EU Member States, the questionnaire responses for the establishment of competent vectors were validated against ECDC vector maps of *A. aegypti* and *A. albopictus*.[10]

In order to assess the Regional risk of a Zika virus outbreak, the median Zika transmission likelihood score was plotted against the median country capacity score (Figure 2).

Data management and analysis

Derived variables on likelihood of transmission and country capacity data from the returned questionnaires were first double entered into a Microsoft Excel® file and then imported into Stata 12 (StataCorp®). Stata was used for all analyses. The categories of all the variables were mutually exclusive, i.e. countries could not be classified in more than one category.

Table 1. Summary of factors and sources used to derive the Zika virus transmission likelihood score

	Factor	Description	Score	Explanation and sources
Risk of local Zika virus transmission	**Vector** (*A. Aegypti* or *A. Albopictus*)	Climatic conditions not suitable* for vector presence (No risk for Zika virus outbreak)	0	**Explanation:** Estimated areas of environmental suitability for *A. albopictus* and *A. aegypti* in continental Europe; *A. albopictus* or *A. aegypti* is established in a bordering member state **Sources**: ECDC http://ecdc.europa.eu/en/publications/publications/ter-climatic-suitablility-dengue.pdf[29] http://ecdc.europa.eu/en/healthtopics/vectors/vector-maps/Pages/VBORNET_maps.aspx [10]
		Vector not introduced, climatic conditions only moderately suitable* for *A. aegypti* or *A. albopictus,* and country not bordering another country with established vector	1	
		Vector not introduced, climatic conditions only moderately suitable* for *A. aegypti* or *A. albopictus*, and country bordering another country with established vector	2	
		Vector not introduced, climatic conditions suitable* for *A. albopictus*, and not bordering another country with established vector	3	
		Vector not introduced, climatic conditions suitable* for *A. albopictus*, and country bordering another country with established vector	4	
		Vector not introduced, climatic conditions suitable* for *A. aegypti*, and not bordering another country with established vector	5	
		Vector not introduced, climatic conditions suitable* for *A. aegypti*, and bordering another country with established vector	6	
		A. albopictus is established in the country	7	
		A. aegypti is established in the country	8	
	Capacity for arbovirus transmission	Previous history of local transmission of Dengue or Chikungunya (Yes/No)	0/1	**Source:** WHO Regional Office for Europe http://www.euro.who.int/en/health-topics/communicable-diseases/vector-borne-and-parasitic-diseases/dengue-and-chikungunya[30]
	Shipping connectivity	Liner Shipping Connectivity Index	0-1	**Explanation:** The Liner Shipping Connectivity Index is how well a country is connected to global shipping networks. Based on five components: number of ships, their container-carrying capacity, maximum vessel size, number of services, and number of companies that deploy container ships in a country's port. The maximum index is 100 (represented here as a decimal between 0-1). The index is computed by the United Nations Conference on Trade and Development (UNCTAD). **Source:** World Bank http://data.worldbank.org/indicator/IS.SHP.GCNW.XQ [31]
	Air connectivity	Air Connectivity Index	0-1	**Explanation:** The Air Connectivity Index (as a percentage represented here as a decimal between 0-1) measures the full range of interactions among all countries. **Source:** World Bank https://www.openknowledge.worldbank.org/handle/10986/3486[32]
	Population density	People per km^2	0-1	**Source:** World Bank 2014 http://data.worldbank.org/indicator/EN.POP.DNST [33]
	Urbanization	Percentage of urban population	0-1	**Source:** World Bank http://data.worldbank.org/topic/urban-development [34]

Likelihood categories according to transmission score: No likelihood = 0; Very low >0 ≤ 3; Low >3 ≤ 7; Moderate >7 ≤ 9; High > 9

***ECDC probability of suitability model: not suitable ≤ 0.5; moderately suitable >0.5 ≤ 0.7; suitable >0.7 ≤ 1.0**

Table 2. Summary of factors used to derive the country capacity score

	Factor	Description	Explanation
Capacity for early containment	**Integrated vector management** **(Max score =2.5)**	Entomological surveillance + a plan for integrated vector management	The final score for this variable was calculated based on whether countries had a national entomological surveillance system in place. In case of competent vectors were established, countries were also scored based on the existence of integrated vector management programmes. No country had a plan for IVM without having entomological surveillance.
		Entomological surveillance + without a plan for integrated vector management (for countries without vector presence establishment)	
		Entomological surveillance + without a plan for integrated vector management (for countries with vector presence establishment)	
		No entomological surveillance or plan for integrated vector management	
	Clinical surveillance **(Max score =2.5)**	Surveillance system for clusters of fever and rash + vector-borne disease surveillance system	Clinical surveillance – the final score for this variable was calculated based on whether a surveillance system to detect clusters of fever and rash existed (eg. early warning systems), as well as, if there was a dedicated surveillance system for vector borne diseases.
		Surveillance system for clusters of fever and rash, without a vector-borne disease surveillance system	
		Vector-borne disease surveillance system without a surveillance system for clusters of fever and rash	
		Neither a surveillance system for clusters of fever and rash or a vector-borne disease surveillance system	
	Laboratory **(Max score =2.5)**	PCR and ELISA for Zika virus	For non-EU countries, the final score for this variable was calculated based on the existing capacity for Zika virus diagnosis, assessed by the diagnostic methods available (PCR and/or ELISA). If countries did not have existing capacity, they were assessed based on whether protocols existed to ship blood samples abroad for diagnosis. For EU countries, data on those variables was retrieved from the ECDC's "Survey of laboratory capabilities for the diagnosis of Zika virus in Europe: interim report".
		PCR and ELISA for Arboviruses, but not for Zika virus	
		Existing protocols to ship blood samples abroad for diagnosis	
		No laboratory capacity	
	Emergency Risk Communications **(Max score =2.5)**	Dedicated communications officer/team	The final score for this variable was calculated based on the following indicators: whether there was a dedicated communications officer/team for Zika virus related communications; the groups targeted (general public, travelers, pregnant women, healthcare workers, other sectors/partners) ; the channels being used (web, social media, telephone help lines, etc),; the messages being delivered, including information, public health advice and preparedness; and if there was a mechanism in place to understand public perception.
		Groups targeted	
		Communications channels being used	
		Messages being delivered	
		Mechanism in place to understand public perception	
Categories according to capacity score: Very low ≤2; Low >2 ≤4; Reasonable >4 ≤6; Good >6 ≤8; Very good >8			

Results

Local transmission likelihood: Figure 1 show countries classified according to Zika transmission likelihood score. Three localized geographical areas with established *A. aegypti* were categorized as having a **high likelihood** for Zika transmission: Madeira Island; the Black Sea coastal area of the Russian Federation and the Black Sea coastal area of Georgia. Eighteen countries (33%) were classified as having a **moderate likelihood** due to the fact that they have established populations of *A. albopictus*. Twenty-two countries (41%) were classified as having a **low likelihood** as they do not have known established populations of *Aedes* mosquitoes. Amongst those in this category, three have suitable climatic conditions for *A. aegypti* and are bordering a country with established species of *Aedes* mosquitos, two have suitable climatic conditions for *A. aegypti* and are not bordering a country with established species of *Aedes* mosquitos, eight have suitable climatic conditions for *A. albopictus* and are bordering a country with established species of *Aedes* mosquitos and nine have suitable climatic conditions for *A. albopictus* and are not bordering a country with established species of *Aedes* mosquitos. Nine countries (17%) were classified as having a **very low likelihood**, as the climatic conditions are moderately suitable for presence of *Aedes* mosquitos. Amongst those, one borders a country with established species of *Aedes* mosquitos. Finally, five countries (9%) were classified as having **no likelihood** for Zika virus transmission because the climatic conditions in these countries are not suitable for presence of *Aedes* mosquitos.

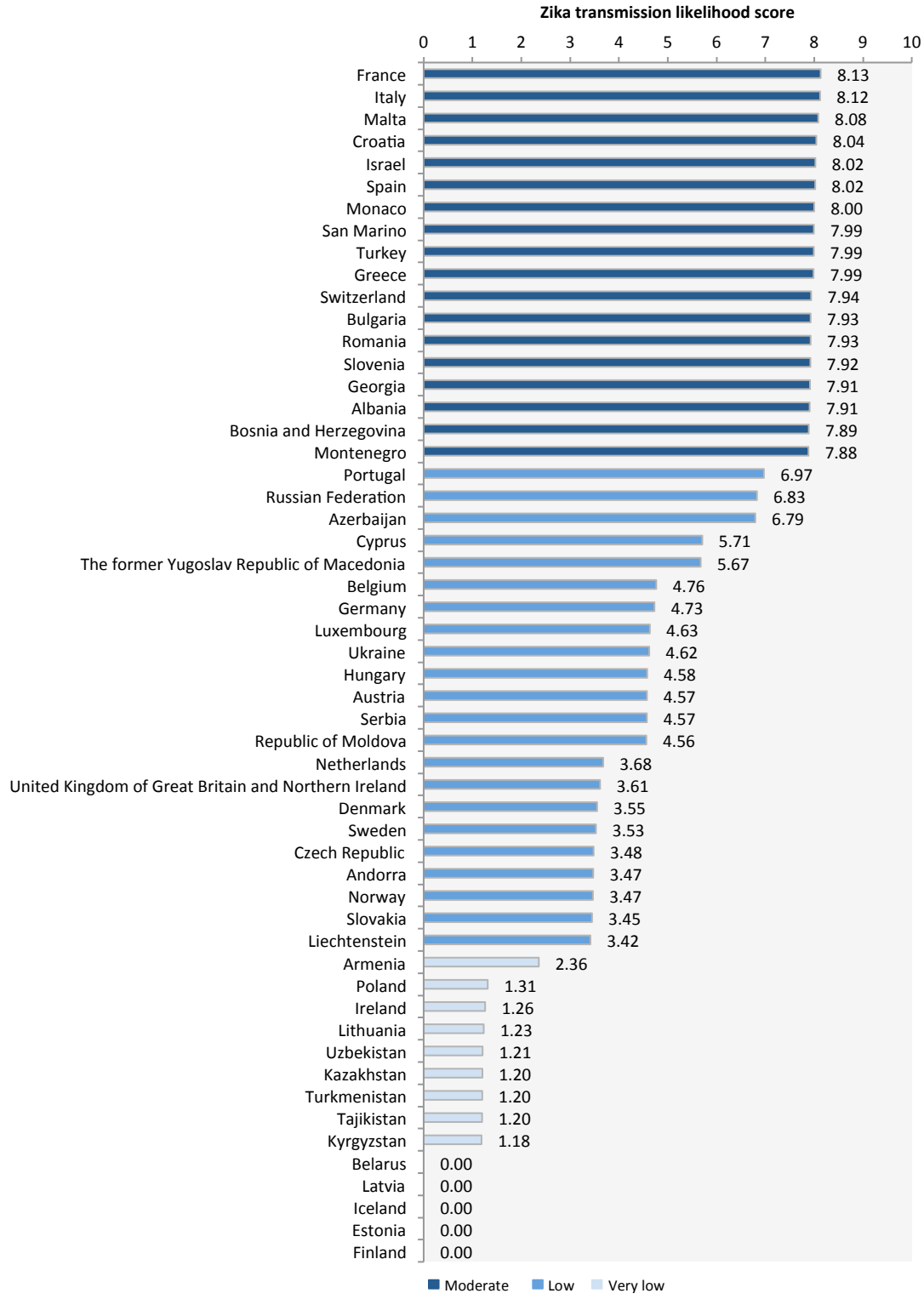
Country capacity: Fifty-one Member States (and the Principality of Liechtenstein) out of the fifty-three Member States (and Principality of Liechtenstein) (96%) responded to the country capacity questionnaire. At the time of report five (9.62%) were in the low capacity category, six (11.54%) in the reasonable capacity category, 27 (51.92%) in the good capacity category and 14 (26.92%) in the very good capacity category.

Integrated Vector Management: 21 countries (40%) reported no entomological surveillance in place; eight countries (15%) reported entomological surveillance systems but no vector management plans; and 26 (50%) reported both entomological surveillance and vector management plans in place. Amongst the countries without entomological surveillance, fifteen had low likelihood for local Zika virus transmission; two had very low likelihood; and four had no likelihood. Amongst those with entomological surveillance but without vector management plans five countries had low likelihood for local Zika virus transmission; two with very low likelihood; and one with no likelihood. All of the countries with localized areas with high likelihood for local Zika virus transmission reported both entomological surveillance and vector management plans in place.

Clinical Surveillance: one country (2%) reported neither early warning surveillance for rash and fever nor surveillance for vector borne diseases; 18 countries (35%) reported surveillance for vector borne diseases but no early warning surveillance for rash and fever, including one localized area classified as having a high likelihood for Zika virus transmission; one country (2%) reported only surveillance for rash and fever and the remaining 35 countries (67%) reported surveillance for rash and fever, as well as vector borne diseases, including two of the localized areas classified as having a high likelihood for Zika virus transmission.

Laboratory capacity: three countries (6%) reported having no established PCR and ELISA capacity for Zika virus or other arboviral infections and no protocol in place to ship blood samples abroad. However all of these countries have a very low or low likelihood for Zika virus transmission. Four countries (8%) reported no established PCR and ELISA capacity for Zika virus or other arboviral infections, but with protocols in place to ship blood samples abroad, of which one was a localized area with a high likelihood for Zika virus transmission. Four countries (8%) reported established PCR and ELISA capacity for other arboviral infections (excluding Zika) but no protocol in place to ship blood samples abroad, of which two have a moderate likelihood for Zika virus transmission. Ten countries (19%) reported established PCR and ELISA capacity for other arboviral infections (excluding Zika) and protocols in place to ship blood samples abroad. And finally 34 countries (65%) reported established PCR and ELISA capacity for Zika virus, including the remaining two localized areas with a high likelihood for Zika virus transmission.

Figure 1. Country classifications according to Zika transmission likelihood score*



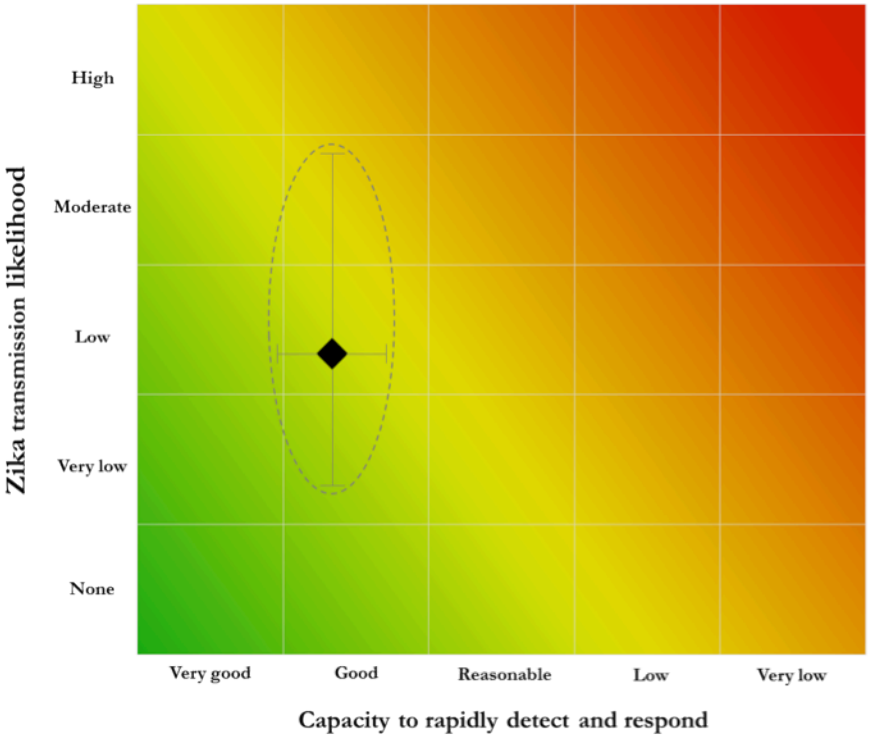
*Three localized geographical areas with established *A. aegypti* were categorized as having a high likelihood for Zika transmission: Madeira Island; the Black Sea coastal area of the Russian Federation and the Black Sea coastal area of Georgia.

Emergency Risk Communication (ERC): Based on questionnaire responses, ERC capacity is generally reasonable across the Region and varies from country to country. The proportion of countries with a dedicated Zika communications officer/team and a risk perception mechanism in place ranged from over two-thirds (68%) to over half (57%) respectively. As for audiences, channels and messages, most of the countries indicated engaging health care workers, a trusted source of public health advice as well as supporting early detection of Zika cases. In particular:

- **Audiences** - All countries segmented the audience and most of them targeted at risk groups (travellers and pregnant women) in addition to the general public; 45 countries (87%) specifically targeted health care workers.
- **Channels** - Almost all countries indicated use of web and 48 (92%) the use of media channels; only about half of the countries indicated use of social media, but most of them (81%) channelled messages through health care workers; over a third (38%) used telephone lines – establishing a direct link with the public - but very few used community channels (e.g. radio or television) as well as smartphones.
- **Messages** – Almost all countries provided information on Zika virus disease and the link to congenital malformations and neurological disorders, as well as public health advice to travellers; two thirds focused on government's action but only 18 countries (35%) provided advice to the community on strategies to eliminate mosquitoes' breeding sites ahead of spring.

Composite risk for an outbreak of Zika virus disease in the WHO European Region: The risk matrix shown in Figure 2 represents the composite risk for an outbreak of Zika virus disease in the European Region, based on the median Zika transmission likelihood score (y-axis) and the median country capacity score (x-axis). The median transmission score was 4.6 (interquartile range (IQR) = 5.3), which corresponds to an overall low likelihood for local Zika virus transmission. The overall median capacity score was 7.3 (IQR=1.7), which corresponds to good capacity overall to contain Zika virus transmission at an early stage. Comparing these two components, the overall risk for an outbreak across the Region is **low to moderate**.

Figure 2. Composite risk for an outbreak of Zika virus disease in the WHO European Region*



* The bars represent the interquartile ranges (between the 1st and 3rd quartiles) of the Zika transmission risk score (y-axis) and the country capacity score (x-axis).

Limitations

Several limitations of this risk assessment should be noted. Following the declaration of the PHEIC there was a need to rapidly assess country capacity in relation to Zika virus. Therefore it was not possible to pilot the questionnaire used to collect data or validate the responses with regards to country capacities. Thus, we cannot exclude that questions may have been subject to interpretation and reporting biases, and there may be additional country capacities not accounted for. In addition, country capacities to respond to Zika have likely increased since the time of data collection however it was not possible to account for these changes in the analysis. Given these limitations, results of country capacities should be interpreted with caution.

As transmission modelling for Zika virus in the European Region has not yet been developed (at the time of report), vector presence, vector climatic suitability and factors related to introduction and onward transmission of Zika virus were used as proxy indicators to estimate a country-level likelihood score for local transmission. One of the assumptions of this analysis was that these variables convey information on the relative levels of likelihood for local transmission of Zika virus given that all countries were evaluated against the same criteria; however the real probability of dissemination of the pathogen once introduced is currently unknown. More comprehensive transmission models are needed in order to more accurately estimate the probabilities of transmission.

Another limitation was that although available published sources were used to determine the establishment of *A. aegypti* and *A. albopictus*, gaps in data exist where entomological surveillance is not well implemented. This limitation was mitigated by accounting for climatic suitability for the vector, however it should be noted that climatic suitability was given a lower base score compared to known vector establishment. Thus it cannot be excluded that the likelihood for local transmission may be higher for some countries particularly in the Mediterranean basin and Black Sea regions where there is an absence of data on *A. aegypti* and/or *A. albopictus* presence, and where transmission likelihood could only be assessed based on climatic suitability and other contributory factors.

Additionally, as only country level data was available, countries were categorized as a whole for their level of transmission likelihood. However, it is likely that vector specificities vary within countries. This limitation is particularly important for large countries such as the Russian Federation, which covers an extensive geographical area and crosses a wide range of latitudes with varying climatic conditions.

Lastly, it was not possible to comprehensively evaluate capacity enablers (such as national policies or availability/lack of availability of resources) in this risk assessment. Therefore there may be an inherent gap between reported capacity and the practical ability to implement detection and response activities in some countries.

Conclusions

Results of this risk assessment highlight that while the overall level of likelihood for local Zika virus transmission and subsequent risk for a widespread Zika virus outbreak is generally low to moderate across the WHO European Region as a whole, the risk varies at country level. Many countries extending from the Mediterranean basin have a moderate likelihood of local Zika virus transmission, in addition to those geographical areas with established populations of *A. aegypti*, that subsequently have high likelihood for local Zika virus transmission.

Although there was good overall capacity in the Region to contain Zika virus transmission at an early stage, specific capacities reported (IVM, surveillance, laboratory and ERC) also varied substantially at country level. Encouragingly, countries with localized areas with high transmission likelihood showed a fairly robust capacity to prevent and rapidly control Zika virus transmission, although it should be noted that not all of them had clinical surveillance and/or laboratory capacity in place.

Recommendations

The following tables describe the main recommendations according to level of transmission likelihood and the four pillars of detection and rapid response to a potential outbreak (IVM, surveillance, laboratory and ERC). Likelihood categories are divided in two groups: 1) high and moderate likelihood, which is targeted to countries with established populations of either *A. aegypti* or *A. albopictus* that would benefit of strengthening their capacity to rapidly detect and respond to local Zika virus transmission; and 2) low, very low and no likelihood, which is targeted to the remaining countries that have moderate, low or no suitability for presence of *Aedes* species and that would benefit from strengthening their capacity to rapidly detect imported cases. These recommendations are not exhaustive and further guidance is available in WHO's specific guidance documents per area.

Countries with high and moderate likelihood

It should be highlighted that countries with high and moderate likelihood should strengthen and/or maintain their IVM activities in order to prevent local transmission of Zika virus, through risk reduction strategies focusing on enhancing vector surveillance and control strategies to decrease vector density according to WHO guidance[35]. This is particularly relevant for the three regions where *A. aegypti* is established and should be performed in advance of the active mosquito season in the months of June onwards[36-38]. This group of countries should also reinforce their clinical surveillance systems in order to promptly detect local transmission of Zika virus and be ready to report to WHO according to current recommendations[39]. Further, countries should ensure that they either have sufficient national capacity and expertise for Zika virus diagnosis according to WHO guidance[40] or have established protocols to ship samples abroad for diagnosis[41]. Lastly, emergency risk communications and community engagement should be addressed in order to enable those at risk to make informed decisions to protect themselves and others from infection, as well as mitigate the effects of Zika virus and its potential complications[42].

High and moderate likelihood of local Zika virus transmission

Integrated Vector Management[35]

- Establish or maintain sentinel surveillance of *Aedes* and collect data regularly;
- If any increase in *Aedes* density is detected, target breeding sites with source reduction;
- Ensure placement of contingency stocks of nationally approved insecticides and equipment, as well as, human resources and funding of to respond to potential outbreaks of arboviruses;
- Prioritise the most productive breeding sites and target control measures;

Clinical Surveillance[39]

- *Aims:* detect imported Zika virus disease cases; detect the beginning of autochthonous transmission; detect instances of Zika virus transmission modes other than vector-borne (i.e. sexual transmission);
- *Tools:* Event based surveillance, indicator based surveillance including syndromic surveillance (i.e. rash and fever); retrospective analysis of stored samples when feasible and applicable;
- *Reporting requirements:* first autochthonous confirmed case, within 24 hours of confirmation; all imported confirmed cases originating from a country/territory where autochthonous transmission has NOT been previously documented, within 24 hours of confirmation; any cases of Zika virus infection with atypical clinical presentations as per WHO case definition[3], cases infected via non-vector-borne transmission or other cases that are able to provide new information to guide the national or global risk assessment (weekly reporting).

Laboratory capacity[40]

- *In countries establishing laboratory capacity for Zika virus diagnosis:* Nucleic acid testing (NAT) in patients presenting with onset of symptoms < 7 days; serology and/or NAT in patients presenting with onset of symptoms ≥ 7 days. Serology is the preferred method in specimens from patients with onset of symptoms >7 days.
- *In countries not establishing laboratory capacity for Zika virus diagnosis:* arrangements should be made to ship samples abroad for diagnosis as per WHO specific guidance[41].

Emergency Risk Communications[42-43]

- Focus on 5 main strands: public communication, translational communication, stakeholder coordination, community engagement, dynamic listening;
- Establish dedicated communications staff/unit on Zika;
- Target messages to key groups (i.e. travellers, pregnant women, general public, health care workers, local policy makers) through the most appropriate channels to reach each of them;
- Assess size of at-risk groups (i.e. women in reproductive age), as well as community knowledge and policies on reproductive health;
- Develop/strengthen a mechanism for risk perception, including Zika and sexual/reproductive health concerns and services, as well as religious views, to feed back into the ERC strategy;
- Focus messages on: information on Zika virus disease and neurological complications; public health advice for at risk groups, including travellers and pregnant women; recommendation on protective measures including vector control and prevention of sexual transmission; and government's action;.
- Be flexible and adaptable as the Zika virus outbreak situation and evidence evolve;
- Engage other sectors. In particular, air, shipping and tourism industries should be targeted and engaged to discuss issues and advice on travel, passenger and cargo aircraft and ship;
- Use operational research to target response in areas of outbreaks or cases, and to better understand high priority groups and communities – the WHO Zika KAP surveys resource pack[44]

Countries with low, very low and no likelihood

Countries with low, very low or no likelihood should focus mainly on the component of emergency risk communications[42] to travellers so that those at most risk are able to make informed decisions to protect themselves when travelling to affected countries. Engaging with health professionals is key in ensuring early detection of imported cases of Zika virus and potential complications. Countries in this group willing to establish laboratory capacity should follow WHO guidance on Zika laboratory diagnosis[40], whereas countries not willing to do so should ensure that they have established protocols to ship samples abroad for diagnosis[41]. Integrated vector management strategies should be adopted according to countries' level of likelihood of Zika virus transmission as described below.

Low, very low and no likelihood of local Zika virus transmission

Integrated Vector Management (applicable only for countries with low and very low likelihood)[35]

- Enhance entomological surveillance at border areas;
- Monitor imported goods (e.g. used tyres, plants), from countries endemic with / receptive to *Aedes*, by quarantine measures to avoid entry of invasive species of mosquitoes;
- Implement vector surveillance and control at points of entry – as per the International Health Regulations (2005) – emphasising non-chemical interventions such as source reduction.

Clinical Surveillance[39]

- *Aims:* detect imported Zika virus disease cases; detect instances of Zika virus transmission modes other than vector-borne (i.e. sexual transmission);
- *Tools:* Event based surveillance, indicator based surveillance including syndromic surveillance, retrospective analysis of stored samples when feasible and applicable;
- *Reporting requirements:* all imported confirmed cases originating from a country/territory where autochthonous transmission has NOT been previously documented, within 24 hours of confirmation; any cases of Zika virus infection with atypical clinical presentations as per WHO case definition[3], cases infected via non-vector-borne transmission or other cases that are able to provide new information to guide the national or global risk assessment (weekly reporting).

Laboratory capacity[40]

- *In countries establishing laboratory capacity for Zika virus diagnosis:* Nucleic acid testing (NAT) in patients presenting with onset of symptoms < 7 days; serology and/or NAT in patients presenting with onset of symptoms ≥ 7

days. Serology is the preferred method in specimens from patients with onset of symptoms >7 days.

- *In countries not establishing laboratory capacity for Zika virus diagnosis:* arrangements should be made to ship samples abroad for diagnosis as per WHO specific guidance[41].

Emergency Risk Communications[42-43]

Focus on 5 main strands: public communication, translational communication, stakeholder coordination, community engagement, dynamic listening;

- Target messages mostly to travellers as well as to the general public, and stakeholders through suitable channels;
- Focus messages on: information on Zika virus disease, modes of transmission (including sexual transmission) and neurological complications; public health advice for travellers (including sexual behaviour); and government's action.
- Be flexible and adaptable as the Zika virus outbreak situation and evidence evolve;
- Engage other sectors. In particular, Air, shipping and tourism industries should be targeted and engaged to discuss issues and advice on travel, passenger and cargo aircraft and ship.

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