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Prioritisation of zoonotic diseases for coordinated surveillance systems under the One Health approach for cross-border pathogens that threaten the Union

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Abstract

In the context of the initiative 'CP-g-22-04.01 Direct grants to Member States' authorities', EFSA was requested to develop and conduct a prioritisation of zoonotic diseases, in collaboration with Member States, to identify priorities for the establishment of a coordinated surveillance system under the One Health approach. The methodology developed by EFSA's Working Group on One Health surveillance was based on a combination of multi-criteria decision analysis and the Delphi method. It comprised the establishment of a list of zoonotic diseases, definition of pathogen- and surveillance-related criteria, weighing of those criteria, scoring of zoonotic diseases by Member States, calculation of summary scores, and ranking of the list of zoonotic diseases according to those scores. Results were presented at EU and country level. A prioritisation workshop was organised with the One Health subgroup of EFSA's Scientific Network for Risk Assessment in Animal Health and Welfare in November 2022 to discuss and agree on a final list of priorities for which specific surveillance strategies would be developed. Those 10 priorities were Crimean-Congo haemorrhagic fever, echinococcosis (both *E. granulosus* and *E. multilocularis*), hepatitis E, influenza (avian), influenza (swine), Lyme borreliosis, Q-fever, Rift Valley fever, tick-borne encephalitis and West Nile fever. 'Disease X' was not assessed in the same way as other zoonotic diseases on the list, but it was added to the final list of priorities due to its relevance and importance in the One Health context.

Keywords: prioritisation, decision-making, ranking, scoring, zoonoses, transboundary, emerging

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Summary

Specific resources for Member States (MSs) for setting up a coordinated surveillance system under the One Health approach have been made available by the European Commission in form of a direct grant opportunity ('CP-g-22-04.01 Direct grants to Member States' authorities' of the EU4Health Programme). The proposed surveillance shall focus on zoonotic diseases (excluding food-borne zoonotic diseases and those that are only relevant due to their antimicrobial resistance) and include the collection of samples in animals and the environment.

The European Food Safety Authority (EFSA) received a mandate and was tasked by European Commission to develop and perform a prioritisation of zoonotic diseases, based on risk assessment and taking into account the current epidemiological situation, to identify priorities for the coordinated surveillance system under a One Health approach. The methodology was developed by EFSA's Working Group (WG) on One Health surveillance, which brought together expertise in the areas of surveillance, systems thinking, decision-making for risk management, health economics, public health and epidemiology. Several hearing experts contributed with their specific expertise in wildlife, vectors and statistical modelling.

In accordance with the mandate, MSs intending to apply for a direct grant under the initiative 'CP-g-22-04.01' have been involved in the prioritisation process as early as possible. They contributed by providing country-specific data, which were used in the following risk assessment, and have been actively involved in decision-making along the process. Interactive tools and methods, such as proportional piling, were used to foster exchange and involve countries directly.

A combination of multi-criteria decision analysis (MCDA) and the Delphi method was chosen following the recommendations of a literature review on disease ranking tools conducted by EFSA's contractor (ENETWILD consortium, 2022a). First, a list of zoonotic diseases to be considered in the risk assessment was established. According to the mandate, those diseases shall be transboundary ('cross-border'), hence easily transmissible, emerging or re-emerging, and represent a threat to public health in the Union. The WG then defined specific criteria, based on which those zoonotic diseases were assessed. Due to the relatively large number of diseases to be evaluated at this stage of the process, a two-round approach was envisaged. During the first round, pathogen-related criteria were meant to short-list a limited number of diseases which would then be further evaluated based on surveillance-related criteria during the second round. Pathogen-related criteria comprised the likelihood of introduction/(re-)emergence, epidemic potential, conditions for establishment and severity of harm. In the next step, MSs were asked to weigh those four criteria according to their country-specific interests. Finally, each country assessed the list of 45 zoonotic diseases against those pathogen-related criteria in form of a questionnaire survey. EFSA collected and aggregated the results obtained to produce disease rankings at both EU and country level, which were presented to MSs during the prioritisation workshop.

The prioritisation workshop was held online on 14–15 November 2022, bringing together members and observers of the One Health subgroup of EFSA's Scientific Network for Risk Assessment in Animal Health and Welfare. It was the first meeting of the subgroup and gathered 59 participants from 25 countries. Main aims of the workshop were to revise and discuss the outcome of the questionnaire survey, and to agree on a final list of priorities for which specific surveillance strategies within a One Health framework would be developed (EFSA, 2023). After agreeing on a preliminary list of 10 priorities, countries were divided into different groups, according to geographical regions, and discussed the best allocation of resources for those short-listed diseases during four breakout sessions. Those discussions were based on four surveillance-related criteria (feasible, implementable, constructive, beneficial), for which a list of semi-structured questions was formulated.

Based on the outcome of the workshop, a list of 10 priorities and 'Disease X' were considered relevant for the preparation of specific surveillance strategies: Crimean-Congo haemorrhagic fever, echinococcosis (both *E. granulosus* and *E. multilocularis*), hepatitis E, influenza (avian), influenza (swine), Lyme borreliosis, Q-fever, Rift Valley fever, tick-borne encephalitis and West Nile fever.

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1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

The European Commission (EC) has allocated specific resources for Member States (MSs) for setting up a coordinated surveillance system under the One Health approach for cross-border pathogens that threaten the Union. EC is in need of scientific and technical assistance in developing, and keeping updated, a coordinated surveillance methodology for certain zoonoses in animals and the environment under the One Health approach to be performed by MSs. As indicated in the work programme for the initiative 'CP-g-22-04.01 Direct grants to Member States' authorities', this coordinated surveillance will contribute to the scaling up of existing surveillance and the establishment of a One Health surveillance that will provide the animal health and environmental side to complement in full synergy the ongoing initiatives on the human side for integrated surveillance. This implies the need to map existing surveillance for zoonoses in animals and the environment, and to ensure a synergistic and complementary approach in the design of the coordinated surveillance as well as in the implementation thereof by MSs. The results of this surveillance should be collected by the European Food Safety Authority (EFSA) to perform risk assessment aiming at identifying One Health zoonotic risks for the European Union (EU) for which surveillance is needed and allowing for an iterative approach facilitating the review of surveillance priorities.

1.1.1. Terms of Reference (ToRs)

There is a need to set up an EU-coordinated surveillance aimed at identifying One Health risks including emerging and re-emerging zoonotic pathogens based on the background information provided above. In accordance with Article 31 of Regulation (EC) No 178/2002[1], EC asks EFSA for scientific and technical assistance structured in the following way:

A – Design of an EU-coordinated surveillance system under the One Health approach for cross-border zoonotic pathogens that may threaten the Union

1) Review updated relevant scientific literature available related to surveillance for cross-border zoonoses in animals and the environment and perform a mapping of the main existing structured and systematic initiatives for surveillance in the EU for zoonoses in animals and the environment.
2) Assess the main targeted zoonotic risks for the EU based on the current epidemiological situation in the EU, its neighbouring areas and beyond.
3) Address the risks identified, recommend options for sustainable surveillance strategies for MSs indicating its relevant objectives and suitable methodologies, in particular as regards target cross-border pathogens, vectors, scope, sampling methodologies and frequencies, and testing methods taking into account the need for early detection of emerging and re-emerging zoonoses. Such surveillance strategies need to account for:
    a) changes in ecosystems and vector (e.g. ticks) distribution,
    b) domestic animal husbandry practices and interactions with native wildlife,
    c) human travel and trade patterns and practices,
    d) possible future, still unknown, emerging zoonotic diseases ('Disease X'),
    e) avoid duplication with existing initiatives (e.g. foodborne zoonoses, antimicrobial resistance, already co-funded EU surveillance programmes for brucellosis, tuberculosis or rabies) unless complementarities are required (e.g. avian influenza surveillance programme).

B – Collect surveillance data and identify the risks

1) Prepare the data model for collecting the results of the surveillance carried out by MSs.
2) Provide an interface for and collect the surveillance data from the MSs that implement this initiative (e.g. by web services allowing for automated data transfer from existing databases).
3) Make the surveillance results available in an appropriate way both to MSs and stakeholders (see point C2), and to the public.

[1] Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. OJ L 31, 1.2.2002, p. 1–24.

4) Perform a regular risk assessment based on the surveillance data collected which is to be used to review the surveillance priorities and methodologies for the following year(s).

C – Stakeholder involvement

1) Involve experts appointed by MSs that joined this initiative to ensure coordination at EU level, notably for points A2, A3 and B1.
2) Ensure consultation of other relevant stakeholders (from EU institutions/agencies and international organisations).

D – Timeframe

1) Risk assessment (points A1 and A2) and the priorities for surveillance (point A3) to be available for January 2023.
2) Given the iterative nature of this mandate, there is a need, based on the data collected each year (under point B), to review all steps presented in point A on an annual basis from 2023 until the completion of the mandate in 2026.

1.2. Interpretation of the ToRs

ToR A 2. of the mandate requests EFSA to prioritise zoonotic diseases for surveillance in close collaboration with MSs intending to apply for a direct grant under the initiative 'CP-g-22-04.01' of the EU4Health Programme.

The ToRs indicate that respective pathogens shall be transboundary ('cross-border'), hence easily transmissible, and have a certain impact on public health ('threaten the Union'). According to the Food and Agriculture Organization of the United Nations (FAO), transboundary diseases are defined as 'epidemic diseases which are highly contagious or transmissible and have the potential for very rapid spread, irrespective of national borders, causing serious economic and sometimes public health consequences'. In addition, the prioritised diseases shall be emerging or re-emerging, while those that are merely food- or waterborne, or only relevant due to their antimicrobial resistance, shall be excluded. Diseases already targeted by other EU co-funded surveillance programmes may be considered during the prioritisation process, however, only surveillance activities not yet covered by those programmes may be included in this direct grant application.

The mandate requires a rational priority setting approach to assist EU decision-makers in identifying and prioritising diseases more likely to represent a threat to public health in the Union. The most common approach used is disease prioritisation based on certain criteria, which in this case has as main objective the implementation of surveillance programmes for early detection (Humblet et al., 2012).

Since the prioritisation process shall be conducted within a One Health framework, namely considering several different aspects of disease characteristics and impacts (i.e. not only animal or public health impact, but also, as mentioned in ToR A, changes in ecosystems, vector distribution, husbandry practices, wildlife behaviour, and human travel and trade patterns), the most appropriate prioritisation method for this kind of assessment was multi-criteria decision analysis (MCDA), which allows for the integration of information from a range of different sources (Cox et al., 2013).

In accordance with ToR B 1., MSs intending to apply for a direct grant under the initiative 'CP-g-22-04.01' of the EU4Health Programme have been involved in the prioritisation process as early as possible. They were asked to provide relevant country-specific data (e.g. on disease impacts) for the assessment of risks related to the different diseases, and actively involved in output-based discussions and decision-making along the process.

In line with ToR B 2., EFSA also invited the European Centre for Disease Prevention and Control (ECDC) to contribute to the prioritisation process with their specific expertise on public health.

This Scientific Report lays down the principles of the methodology developed for determining the zoonotic diseases for which EFSA will develop specific surveillance strategies to be proposed to MSs.

2. Data and methodologies

2.1. Data

Baseline for the methodology developed was the 'Literature review on disease ranking tools, their characterisation, and recommendations for the method to be used by EFSA' performed by an external contractor specifically for the purpose of the mandate (ENETWILD consortium, 2022a).

For the different assessment steps outlined in the following sections, MSs intending to apply for a direct grant were asked to contribute country-specific data on certain aspects of the diseases considered in the prioritisation process. Those data comprised scientific evidence deriving from peer-reviewed literature (more objective) and grey literature, data and statistics at country level, and information from personal communications (more subjective).

In addition, MSs were provided with general scientific evidence deriving from peer-reviewed literature on those diseases, which was collected by EFSA and an external contractor to inform their decision-making.

2.2. Methodologies

The proposed methodology was developed by EFSA's Working Group (WG) on One Health surveillance, which was specifically established for the purpose of this mandate. It brings together relevant expertise in the areas of One Health surveillance, systems thinking, decision-making for risk management, health economics, public health, and epidemiology. The recruited experts belong to academia, other EU institutions (ECDC) and international organisations (FAO). The WG was regularly joined by a variable number of hearing experts with specific expertise in wildlife, vectors and statistical modelling.

2.2.1. Choice of the methodological approach

Based on the literature review on disease ranking tools performed by EFSA's contractor (ENETWILD consortium, 2022a), a combination of MCDA and the Delphi method was chosen to address EC's request. For a comprehensive risk ranking including novel, emerging and established infections, ECDC recommends MCDA or the Delphi method. Both methods are comprehensive for risk ranking and advantages can be combined at different steps of the process (ECDC, 2015). For example, experts can be consulted by means of the Delphi method to gather data on the prioritisation, and afterwards, MCDA can be used to develop a consensus ranking among the experts. In general, the methodological approach should use criteria reflecting the aim of the prioritisation exercise, engage relevant stakeholders early on in the process, and involve a large and multi-disciplinary group of experts to impede subjectivity and professional bias.

MCDA is a standardised and systematic approach to evaluate and rank different options (e.g. zoonotic diseases) against a set of criteria (e.g. different disease impacts). Since several different aspects need to be considered for the prioritisation of diseases, several criteria had to be established and used. This kind of methodological approach is generally flexible and can easily be adapted to specific scenarios or needs. It is, however, time-consuming, as the input of a large number of experts and several rounds of discussion are needed to define and agree on the criteria for evaluation. Ideally, the same or similar stakeholders as those performing the prioritisation should be involved in the establishment of those criteria. Due to the tight timeline of the mandate and lack of opportunity to involve MSs at an early stage, this task was performed by the WG. In summary, the following steps of a typical MCDA were adapted and applied:

1) identification of all possible options → establishment of a list of zoonotic diseases to be considered in the prioritisation process.
2) definition of criteria to be used to evaluate each option → definition of pathogen- and surveillance-related criteria.
3) weighing of those criteria according to stakeholders' interests → weighing of those criteria according to MSs' interests.
4) scoring of each option based on the information collected to address the criteria → scoring by MSs based on their own expert opinion (more subjective) and information provided by EFSA (more objective).
5) calculation of summary scores for each option by combining all individual criterion weights and scores → aggregation of individual criterion weights and scores for each option to produce summary scores for each zoonotic disease and MSs.
6) ranking of all options according to the obtained summary scores → ranking of zoonotic diseases according to the obtained disease scores.

In addition, the Delphi method was used to support the WG in establishing the list of zoonotic diseases and defining the criteria for evaluation. It comprises several rounds of discussion among a group of experts with the aim of reaching a common consensus. The results of those discussions are

summarised and aggregated at the end of each round to be presented to the group of experts in the subsequent round for further discussion. This process may be repeated several times until common consensus is reached. It may be described as a rather subjective process, which is why it requires a sufficiently large number of experts to produce a more objective outcome on the topic of interest.

Finally, to be more flexible and involve stakeholders in a truly interactive way, proportional piling was used to allow MSs to express their underlying interests without the need to formulate specific criteria to support their decisions. Proportional piling is a participatory approach often used in participatory epidemiology, aiming at comparing and relatively weighing different options against each other. Participants are usually provided with a fixed number of counters that need to be distributed among the set of options. Those options receiving the most counters are considered of higher importance or relevance considering the topic of interest.

2.2.2. Definition of the list of zoonotic diseases

The WG started with the compilation of a list of 125 diseases by merging lists of (potentially) zoonotic and (re-)emerging diseases from different sources (i.e. diseases listed under Regulation (EU) 2016/429[2], listed by the World Organisation for Animal Health (WOAH), included in ECDC's EpiPulse[3] platform), which can be found on Zenodo.[4] After several rounds of discussion among the WG experts, this list was further reduced to a number of 50 (see Section 3.1) by applying specific exclusion criteria: (i) the pathogen is merely food- or waterborne, (ii) the pathogen is only relevant due to its antimicrobial resistance, (iii) the pathogen is not zoonotic or a zoonotic potential is very unlikely/not scientifically proven, (iv) the pathogen has no or only negligible public health impact, (v) the pathogen poses no or only negligible risk of introduction into the EU (i.e. reservoirs or vectors are not present), (vi) the pathogen has no animal host and (vii) the exact pathogen species is not mentioned.

A matrix juxtaposing those 125 diseases with disease-specific arguments on the above criteria is uploaded on Zenodo.[5]

MSs were then asked to further reduce the list of 50 diseases by indicating the 25 diseases they considered of least relevance to their country in terms of the need for implementing surveillance. Those diseases excluded by all MSs in agreement were finally omitted from the prioritisation exercise.

2.2.3. Definition of the evaluation criteria

As mentioned in Section 2.2.1, several criteria were established to compare and rank diseases in order of priority. Since the criteria used should reflect the aim of the prioritisation exercise, they were selected based on their relevance in addressing the request of the mandate: to protect human health by establishing a surveillance system in animals and the environment for the early detection of zoonotic cross-border pathogens that threaten the Union. The criteria used should moreover take into account the interests of all stakeholders concerned within a One Health framework. The WG acted on behalf of MSs intending to apply for a direct grant, as it was not possible to receive their respective nominations for representatives from the different sectors within the timeframe provided by the mandate.

Due to the relatively large number of diseases (i.e. 50) to be evaluated at this stage of the process, a two-round approach was envisaged. During the first round, pathogen-related criteria were meant to short-list a limited number of diseases which would then be further evaluated based on surveillance-related criteria during the second round. While a questionnaire survey for participating MSs was implemented for the first round (see Section 2.2.4), the surveillance-related criteria were envisaged to be discussed during a dedicated prioritisation workshop (see Section 2.2.5).

As a baseline for discussion and the definition of those criteria, the WG considered the specifications of the mandate, the characteristics of the 50 selected diseases, Annex 5 in ENETWILD consortium (2022a) (based on an extensive literature review), and their own expert opinion. In this kind of setting, the criteria used usually cover the following topics: epidemiology, disease prevention/control, zoonotic potential/threat, society, availability of scientific evidence, different disease impacts (animal health, human health, economy/trade).

[2] Regulation (EU) 2016/429 of the European Parliament and of the Council of 9 March 2016 on transmissible animal diseases and amending and repealing certain acts in the area of animal health ('Animal Health Law'). OJ L 84, 31.3.2016, p. 1–208.
[3] https://www.ecdc.europa.eu/en/publications-data/epipulse-european-surveillance-portal-infectious-diseases.
[4] https://doi.org/10.5281/zenodo.7589071.
[5] https://doi.org/10.5281/zenodo.7589021.

In this process, the expertise identified and needed to evaluate the 50 selected diseases based on those criteria included epidemiology, public health, animal health, ecosystem health, risk management, surveillance and economics.

2.2.3.1. Definition of pathogen-related criteria

For the pathogen-related criteria, it was agreed to balance the number of criteria per topic so that all One Health components would be equally represented. Therefore, the disease impacts on animal health, public health, economy and biodiversity were considered equally important. In addition to those disease impacts, the likelihood of introduction/(re-)emergence was considered highly relevant due to the mandate focusing on cross-border pathogens that threaten the Union. Finally, the WG decided to accommodate criteria on the epidemic potential and conditions required for the establishment of diseases in the EU. Criteria on human activity, disease frequency in humans and animals, and cross-species transmission potential were initially included but later removed, as they were either redundant, not adding additional value or not helpful in distinguishing the different diseases. All pathogen-related criteria and sub-criteria defined by the WG are summarised in Table 1.

Table 1: Pathogen-related criteria used to short-list a limited number of diseases

Criterion	Sub-criterion
Likelihood of introduction/(re-)emergence	Proximity to the country
	Pathways of introduction
	Drivers of (re-)emergence
Epidemic potential	Likelihood of human-to-human transmission
	Adaptability of the disease agent
Conditions for establishment	
Severity of harm	Impact on human health
	Impact on animal health
	Impact on animal production
	Impact on biodiversity

For each sub-criterion, a question was phrased to which a qualitative answer (with corresponding quantitative score) can be provided. Thereby, certain measurements were collected, based on which diseases could later be compared and ranked (see Section 2.2.5.2). Some definitions for the wording used in questions and answer options were formulated by the WG. Those definitions were narrow enough to reduce ambiguity among respondents from different sectors or countries. At the same time, the wording of questions and answer options was broad enough to allow for some flexibility and encourage the respondents' own interpretation according to their country-specific situation. All questions, including their respective answer options and definitions thereof, are listed in Table 2.

Table 2: Set of questions to be answered for each disease from the final list of zoonotic diseases (see Section 3.1)

Criterion	Sub-criterion	Question	Definition	Qualitative answer	Quantitative score
Likelihood of introduction/(re-) emergence	Proximity to the country	Where has the disease been reported or suspected (in humans and/or animals) in relation to your country in the last 5 years?	In the country = in your country	In the country	4
			At the country border = in a country bordering with your country	At the country border	3
			In the EU = in a Member State not bordering with your country	In the EU	2
			Outside the EU = in a non-EU country not bordering with your country	Outside the EU	1
			Globally absent = not reported or suspected anywhere in the world (apart from laboratories) in the last 5 years	Globally absent	0
	Pathways of introduction	Which of the following pathways do you consider of concern for the introduction of the disease into your country?[a]	1. Legal trade (animals and animal-derived products, including wildlife) 2. Illegal trade (animals and animal-derived products, including wildlife) 3. Movement of wildlife 4. Movement of arthropod vectors 5. Human migration/travel 6. Import of semen/tissue/body fluids/genetic material 7. Bioterrorism 8. Other pathway(s): please specify[b]	No pathways	0
				1–2	1
				3–4	2
				More than 4	3
				Disease is permanently present in your country[c]	4
	Drivers of (re-) emergence	Which of the following drivers do you consider of concern for the (re-)emergence of the disease in your country?[a]	1. Climate change or extreme climatic conditions (e.g. temperature increase, flooding, water scarcity) 2. Deforestation and/or changes in land use (e.g. changing urban landscapes, wildlife behaviour) 3. Changes in animal production systems or trade patterns (e.g. intensification, pastoralism, wildlife harvesting patterns) 4. Changes in human behaviour (e.g. consumption patterns, recreational activities, role of pets) 5. Other driver(s): please specify[b]	No drivers	0
				1–2	1
				More than 2	2

Criterion	Sub-criterion	Question	Definition	Qualitative answer	Quantitative score
Epidemic potential[(d)]	Likelihood of human-to-human transmission	What is the likelihood of transmission of the disease between humans?		No or negligible human-to-human transmission	0
			Low = transmission generally sporadic, disease generally not resulting in outbreaks	Low	1
			Medium = transmission generally moderate, disease occasionally resulting in small-scale/ localised outbreaks	Medium	2
			High = transmission generally high, disease often resulting in large-scale outbreaks	High	3
	Adaptability of the agent	How quickly does the disease agent adapt, mutate or evolve?		Slow	1
				Fast	2
Conditions for establishment		Are the conditions required for the establishment of the disease present in your country?	Conditions = presence of vectors (for vector-borne diseases) or presence of non-human reservoirs (for non-vector-borne diseases)	Permanently present	2
				Seasonally present	1
				Not present	0
Severity of harm	Impact on human health	How severe is or could be the impact of the disease on human health in your country?	Low = clinical signs generally absent or mild and not leading to long-term impairment, full recovery generally possible without impact on the public health system (e.g. no hospitalisation)	Low	1
			Medium = clinical signs generally moderate and sometimes leading to long-term impairment, sometimes impact on the public health system	Medium	2
			High = clinical signs generally grave and often leading to long-term impairment, including case-fatality, impact on the public health system considerable (e.g. long-term hospitalisation)	High	3
	Impact on animal health	How severe is or could be the impact of the disease on animal health (domestic animals and wildlife) in your country?	Low = clinical signs generally absent or mild, reproduction generally not affected, case-fatality negligible	Low	1
			Medium = clinical signs generally moderate, reproduction sometimes affected, case-fatality generally low	Medium	2
			High = clinical signs generally grave, no or only few treatment options available, reproduction affected, often high case-fatality	High	3

Criterion	Sub-criterion	Question	Definition	Qualitative answer	Quantitative score
	Impact on animal production	How severe is or could be the impact of the disease on animal production in your country?	No impact = the disease does not affect animal species relevant for animal production	No impact	0
			Low = limited or almost no losses to animal production, markets are not affected	Low	1
			Medium = moderate losses to animal production, markets are moderately affected (mainly at regional level)	Medium	2
			High = high losses to animal production, markets of the country or the EU are gravely affected	High	3
	Impact on biodiversity	How many susceptible endangered wildlife species are present in your country?	Only free-ranging wildlife species to be considered (i.e. no zoo or laboratory animals) Susceptible = seropositive and/or clinically affected	None	0
				1–2	1
				More than 2	2

(a): Multiple-choice question: each element from the list was provided with two answer options (yes/no) so that all elements with an affirmative answer could be added up.
(b): Free text.
(c): For those diseases, this question was skipped and the highest score automatically applied.
(d): Questions with pre-filled answers.

In MCDA, the criteria implemented should be independent (i.e. each addressing a single component of the overall topic of interest, a score on one question can be assigned independently of knowledge of the scores on all other questions), answerable (i.e. for all options evaluated), measurable and operational (i.e. can be used to compare the options evaluated). In addition to those characteristics, the WG performed an assessment to verify that the set of criteria was complete and non-redundant. It was found that the first two questions on 'proximity to the country' and 'pathways of introduction' (Table 2) were not independent, which is why the scores on those questions were combined as illustrated in Table 3.

Table 3: Combination of qualitative answers and quantitative scores for two questions on 'proximity to the country' and 'pathways of introduction'

Combination of qualitative answers	Combination of quantitative scores
Disease globally absent REGARDLESS number of pathways	0
Disease outside the EU AND no pathways	1
Disease in the EU (not at country border) AND no pathways	1
Disease at country border AND no pathways	1
Disease outside the EU AND 1–2 possible pathways	2
Disease outside the EU AND 3–4 possible pathways	3
Disease in the EU (not at country border) AND 1–2 possible pathways	3
Disease outside the EU AND more than 4 possible pathways	4
Disease at country border AND 1–2 possible pathways	4
Disease in the EU (not at country border) AND 3–4 possible pathways	5
Disease in the EU (not at country border) AND more than 4 possible pathways	6
Disease at country border AND 3–4 possible pathways	6
Disease at country border AND more than 4 possible pathways	7
Disease in the country	8

2.2.3.2. Weighing of pathogen-related criteria

In the next step, MSs intending to apply for a direct grant under initiative 'CP-g-22-04.01' of the EU4Health Programme were requested to weigh the four pathogen-related criteria displayed in Table 1 according to their country-specific interests and needs. For this purpose, each country was equipped with a table and asked to distribute 100 points among the four criteria according to the relative importance of each in defining priorities for surveillance. The points assigned to each criterion had to sum up to 100 and were used to calculate the country-specific disease scores (see Section 2.2.5.2). Table 4 shows an example of how those 100 points may have been distributed.

Table 4: Example weights provided for the four pathogen-related criteria

Criterion	Points assigned
Likelihood of introduction/(re-)emergence	20
Epidemic potential	50
Conditions for establishment	10
Severity of harm	20

Weighing of criteria should ideally happen at a separate time than their assessment, which is why MSs were requested to submit their country-specific weights before embarking on the prioritisation exercise.

2.2.3.3. Definition of surveillance-related criteria

For the second round, specific surveillance-related criteria were formulated by the WG to be used to steer discussions among participating MSs on the best allocation of resources for the short-listed diseases after the first round (see Section 3.2). They were presented as a list of semi-structured questions, and classified into four criteria:

1) Feasible – Is it feasible, from a technical point of view, to implement a surveillance system for the pathogen? Criteria that could be used to assess feasibility include:
    a) Passive surveillance – Is passive surveillance an option? Pathogens that are good for passive surveillance produce clinical signs, pathology in one or more species that are easily recognisable by veterinarians, physicians or diagnosticians. Pathogens that are not good for passive surveillance produce subclinical or inapparent infections.
    b) Slaughter surveillance – Can infection with the pathogen result in lesions that can be detected during slaughter inspections?
    c) Diagnostic tests – Are highly sensitive and specific diagnostic tests available to detect the pathogen in reservoir hosts, other hosts and vectors?
    d) Vector surveillance – Can abundance of existing or introduction of new vectors be monitored and does that serve the purpose of detecting changes in risk? Alternatively, or additionally, is it possible to capture vectors and test them for the pathogen to estimate changing risk?
    e) Environment sampling – Are options available to detect the pathogen in the environment (e.g. in water or soil)?
    f) Risk-based sampling – Is it possible to identify high-risk areas, populations or population strata in which it is most likely that the pathogen will be introduced into the population?
    g) Citizen science – Can people in the community be mobilised to act as citizen scientists, e.g. to report dead animals or ticks on their dogs (e.g. through mobile phone apps such as iMammalia[6,7])?
2) Implementable – Can your country operationalise a surveillance system for the pathogen? Criteria that could be used to assess the implementability include:
    a) Workforce – Is there a well-trained veterinary system, public health system, wildlife/ conservation system, and environmental health system in place to conduct the surveillance?
    b) Infrastructure – Can already existing infrastructures, including laboratory capacity to test the necessary samples from multiple species, be taken advantage of (e.g. pest/rodent control, vector control, wildlife control, wildlife rescue centres, hunters, sewage systems, rendering plants, road kills)?
    c) Technical expertise – Is there sufficient technical expertise (e.g. epidemiologists, laboratory scientists) to implement a surveillance system?
    d) Legal support – Does the legislative and regulatory governance support the implementation of a surveillance system?
    e) Data sharing – Are there cross-sectoral partnerships that can support a surveillance system for this pathogen?
    f) Combined surveillance – Are there existing surveillance systems that can be adapted to do surveillance for this pathogen?
    g) Cross-sectoral support – Are there cross-sectoral partnerships that can support a surveillance system for this pathogen?
3) Beneficial – Is there a benefit from early detection of the emergence or re-emergence of the pathogen? Criteria that could be used to assess the benefits include:
    a) Early detection – Can the pathogen be detected early enough to prevent the spread of the pathogen before it produces large-scale harm (e.g. because it causes evident clinical signs and/or mortality, because rapid tests are available)?
    b) Early warning – Are there 'signals' that indicate an increased risk of the pathogen spreading to humans (e.g. finding antibodies to arboviruses in sentinel chickens located in city parks before humans become infected)?
    c) Broad surveillance benefits – Can other pathogens be targeted by the surveillance for this pathogen (synergies between different diseases/hosts/geographical locations)?
    d) Contribution to detection of emerging threats – Can the surveillance for this pathogen increase the chance of detecting 'Disease X'?

[6] https://play.google.com/store/apps/details?id=uk.ac.ceh.imammalia&hl=gsw&gl=US.
[7] https://apps.apple.com/us/app/imammalia/id1480199644.

4) Constructive – Does a surveillance system for this pathogen contribute to increasing surveillance capacity? Criteria that could be used to assess constructiveness include:
   a) Cross-sectoral collaboration – Will surveillance for this pathogen foster cross-sectoral collaboration (data exchange and analysis) (e.g. with the public health sector)?
   b) Multi-national collaboration – Will surveillance for this pathogen foster cross-country collaboration (e.g. between neighbouring countries)?
   c) One Health operationalisation – Will surveillance for this pathogen improve One Health operationalisation in your country?
   d) Sustainable surveillance framework – Is surveillance for this pathogen sustainable and/or does it contribute to the sustainability of the surveillance framework in the country (e.g. human and laboratory resources) in general.

2.2.4. Preparation of the questionnaire survey

2.2.4.1. Provision of disease information

General information on the diseases (see Section 2.2.2) was provided to MSs to assist them in getting familiar with the more exotic diseases from the list and those they had only limited knowledge of yet. Therefore, ready-to-use fact-sheets and technical cards were retrieved from the websites of different international organisations: Centers for Disease Control and Prevention (CDC), Center for Food Security and Public Health (CFSPH), European Association of Zoo and Wildlife Veterinarians (EAZWV), ECDC, EFSA, FAO, World Health Organization (WHO). For Eastern equine encephalitis and glanders, the American Association of Equine Practitioners (AAEP) was consulted. For Ebola virus disease and Hendra virus infection, more information was retrieved from the Australian Capital Territory[8] and New South Wales[9] government. Additional literature searches in PubMed and Web of Science were conducted for diseases for which no or only few fact-sheets or technical cards were available: Chikungunya fever, Eastern equine encephalitis, erysipelothricosis, Helvetica spotted fever, Mediterranean spotted fever, murine typhus, Omsk haemorrhagic fever, Powassan virus infection, Scrub typhus, Shuni virus infection, Sindbis fever, St. Louis encephalitis, Thogoto virus infection, tick-borne encephalitis, Usutu virus infection, Venezuelan equine encephalitis, Wesselsbron virus infection, Western equine encephalitis. Those literature searches aimed at retrieving recent review articles by using the name of the disease in the search string and filtering by article type. An additional literature search was performed for *Flaviviruses* in general. All references were collected, downloaded and made available to MSs with the note not to rely exclusively on the information provided by EFSA. Relevant information to answer the questions in Table 2 included in those references was highlighted to save time and facilitate MSs' work with the documents.

For the last question on 'impact on biodiversity', EFSA, through an external contractor, conducted a review of endangered wildlife species that may be affected by the 45 selected diseases (ENETWILD consortium, 2022b). Those wildlife species were classified as near threatened, vulnerable, endangered and critically endangered, based on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species.[10] In addition, their endemicity status for both EU and Europe was indicated. The information presented included the exact taxonomic level of pathogen detection, whether animals living in the wild or in zoos were affected, and the clinical signs they displayed. To answer the respective question, MSs had to verify whether those wildlife species were present in their country or not.

In addition, MSs were requested to refer to their own country-specific data and expert opinion (e.g. on disease impacts), whenever relevant, for assessing the different diseases according to pathogen-related criteria.

2.2.4.2. Provision of a questionnaire

The questionnaire was developed and provided to MSs in Microsoft Excel (uploaded on Zenodo[11]). To increase user-friendliness, drop-down menus, striking colours and features to track the respondents' progress were included. MSs were asked to submit only one document per country, but several respondents per country could work on the same questionnaire. EFSA then collected and analysed the results as described in Section 2.2.3.3.

[8] https://health.act.gov.au/.
[9] https://www.dpi.nsw.gov.au/.
[10] https://www.iucnredlist.org/.
[11] https://doi.org/10.5281/zenodo.7588990.

2.2.4.3. Pre-filling of questions

The answers for two questions on 'epidemic potential' (see Table 2) were pre-filled by EFSA, as they could be objectively answered, to reduce the MSs' workload. However, respondents were given the chance to change those answers given in case they disagreed with them.

For the question on 'likelihood of human-to-human transmission', 'high' was assigned to diseases with airborne transmission (e.g. COVID-19). 'Medium' was assigned to diseases transmitted through contact, which does not necessarily need to be close contact. Such diseases may result in outbreaks (e.g. Ebola virus disease). 'Low' was assigned to diseases requiring close contact with an infected person or their body fluids. Such diseases may result in single cases, especially among family members or caregivers (e.g. Q-fever, glanders). 'No or negligible human-to-human transmission' was assigned when the disease was not considered transmissible between humans or transmission was only possible through the placenta, blood transfusion or organ donation.

For the question on 'adaptability of the agent', 'slow' was assigned to bacteria, parasites and DNA viruses, while 'fast' was assigned to most RNA viruses. The distinction by pathogen type was made due to the difficulty in finding information on respective mutation rates or cut-off values used.

2.2.4.4. Provision of instructions for MSs

MSs were requested to fill in the questionnaire for each of the remaining 45 diseases agreed on in Section 3.1. This comprised 10 questions per disease.

For increased clarity and guidance, they were provided with a set of specific instructions to follow:

- 'Use your own individual judgement and expert opinion when answering the questions. You may reach out to relevant stakeholders and/or experts in your country in case of doubt.'
- 'Take into account your country-specific situation when answering the questions: this should lead your answers.'
- 'There are no 'correct' answers to the questions. Most questions leave room for your own interpretation and allow you to make your 'best guess'.'
- 'If needed, you may refer to the exemplary references provided, but they should not be used as your only source of information.'
- 'For the last question, we provided a table of susceptible IUCN-listed wildlife species (and information on how to use the table) for each of the 45 diseases. You will need to check whether those species are present in your country to answer the question.'
- 'Both questions on the epidemic potential were pre-filled (as they are considered less country-specific) to reduce your workload. Please check if you agree with the given answers or change your answers accordingly.'

In addition, a training session with interested MSs was organised to explain the process, present the tool, and answer all remaining questions.

2.2.5. Preparation of the prioritisation workshop

2.2.5.1. Scope and aim of the workshop

The prioritisation workshop was held online on 14–15 November 2022, bringing together interested parties, MS representatives from different organisations covering the relevant areas of expertise (i.e. animal health, public health, ecosystem health), and observers as part of the One Health subgroup[12] of EFSA's Scientific Network for Risk Assessment in Animal Health and Welfare. The subgroup was established to foster collaboration on non-foodborne zoonotic issues among the different sectors involved, both within and between MSs. It also offers MSs the opportunity to exchange on relevant topics and find partners to form consortia for their direct grant applications. The prioritisation workshop was the first meeting of the subgroup and gathered 59 participants from 25 countries. New and innovative tools for collaboration (i.e. Slack[13] and Miro[14]) were integrated into the agenda of the meeting to stimulate brainstorming and discussion among participants, and to facilitate the decision-making process.

Main aims of the workshop were to revise and discuss the outcome of the questionnaire survey, and to agree on a final list of priorities for which specific surveillance strategies within a One Health

[12] https://www.efsa.europa.eu/de/science/scientific-committee-and-panels/ahaw#networks.
[13] https://slack.com.
[14] https://www.miro.com.

framework would be developed. The agenda and minutes of the meeting were published on the EFSA website.[15,16]

First, participants were welcomed by EFSA and EC, and provided with a general introduction to the mandate and its associated tasks and timelines. They then had the opportunity to learn more about the other participants by creating their own identity cards in Miro. A presentation by EFSA on the methodology developed and the outcome of the questionnaire survey (Figure 4) followed. Different disease ranking exercises on the same list of zoonotic diseases were presented by ECDC (Table 9) and VectorNet.[17] Based on those presentations, a preliminary list of priorities was agreed on (see Section 3.2) and further discussed with the help of surveillance-related criteria (see Section 2.2.3.3). This process is summarised in Figure 1.

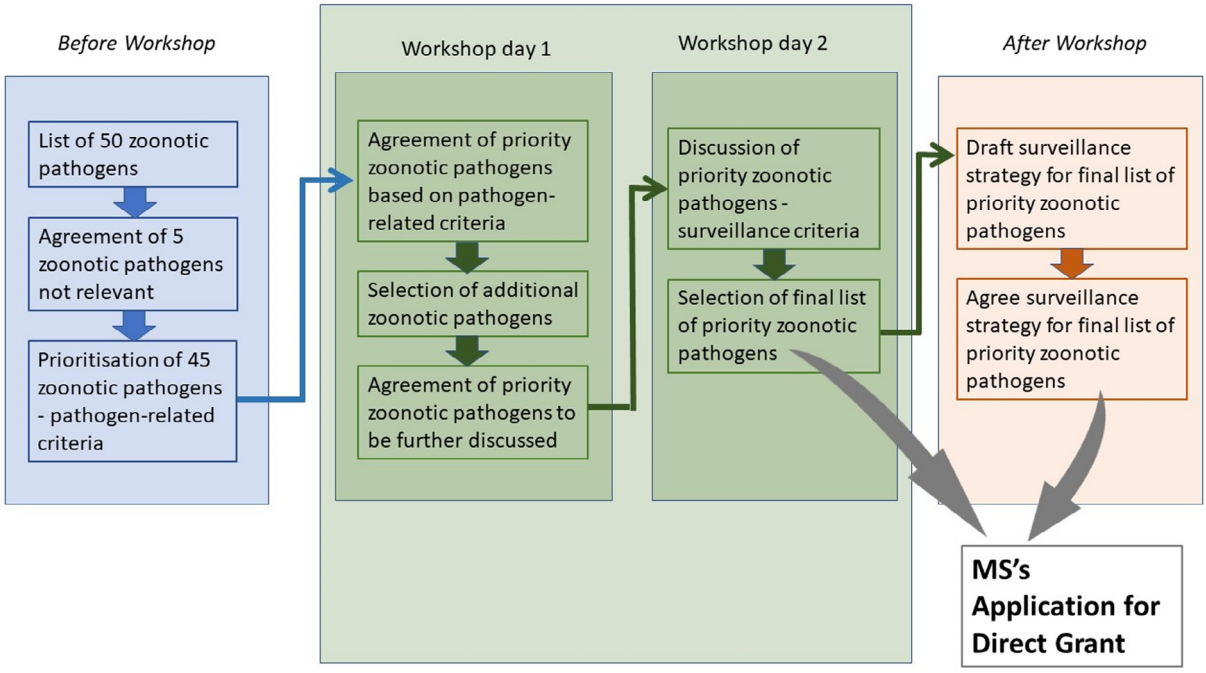


Figure 1: Flow chart of activities conducted before, during and after the prioritisation workshop

2.2.5.2. Aggregation of scores on pathogen-related criteria

The quantitative scores behind the qualitative answers (see Table 2) followed an ordinal scale. To compare and rank the diseases based on those criteria, all scores given for a certain disease were aggregated into an overall disease score per country, taking into account also the assumptions made in Table 3. Those disease scores were then used to rank the diseases in order of priority.

First, criteria and questions were numbered (Table 5) to reference them easily in the following sections.

[15] https://www.efsa.europa.eu/sites/default/files/2022-11/agenda-one%20health-subgroup-network-meeting_14-15-nov-2022.pdf.
[16] https://www.efsa.europa.eu/sites/default/files/2022-12/minutes_OneHealthNetwork_14-15Nov.pdf.
[17] https://www.ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/vector-net.

Table 5: Alphabetical numbering of criteria and questions

Criterion	Criterion number	Sub-criterion	Question number	Criterion score
Likelihood of introduction/(re-) emergence	C1	Proximity to the country AND pathways of introduction[(a)]	ab	$0 \leq s_{ab} \leq 8$
		Drivers of (re-)emergence	c	$0 \leq s_c \leq 2$
Epidemic potential	C2	Likelihood of human-to-human transmission	d	$0 \leq s_d \leq 3$
		Adaptability of the disease agent	e	$1 \leq s_e \leq 2$
Conditions for establishment	C3	Conditions for establishment	f	$0 \leq s_f \leq 2$
Severity of harm	C4	Impact on human health	g	$1 \leq s_g \leq 3$
		Impact on animal health	h	$1 \leq s_h \leq 3$
		Impact on animal production	i	$0 \leq s_i \leq 3$
		Impact on biodiversity	j	$0 \leq s_j \leq 2$

s: criterion score.
(a): See Table 3.

All criterion scores were standardised to range between 0 and 4 ($0 \leq s \leq 4$) before they were aggregated at criterion level by computing the median (Table 6). In case there were only two questions for a certain criterion, the respectively higher criterion score was assigned. Next, criterion scores were multiplied with the criterion weights chosen by MSs (see Table 8; Figure 3) before all weighted scores for a certain disease were added up to produce the respective disease score. As for criterion scores, criterion weights were standardised to range between 0 and 4. If a MS did not provide individual criterion weights, the contribution of the four criteria was considered equal. This analysis was conducted for each MS individually.

Thereby, 45 disease scores ranging between 0 and 16 were computed by country, based on which country-specific rankings of the 45 diseases were produced (see Appendix A). Those disease scores were transformed into normalised scores (0%–100%) for presentation on the x-axis: 100 × (disease score/16).

Table 6: Aggregation procedure for the calculation of a certain disease score (S) for a certain country

Criterion	Sub-criterion	Sub-criterion score	Criterion score (aggregation)	Criterion weight	Disease score (weighted aggregation)
C1	ab	s_{ab}	$S_{C1} = \text{median}(s_{ab}, s_c)$ $0 \leq s_{ab}, s_c, s_{C1} \leq 4$	w_{C1}	$S = (w_{C1} \times s_{C1}) + (w_{C2} \times s_{C2}) + (w_{C3} \times s_{C3}) + (w_{C4} \times s_{C4})$
	c	s_c			
C2	d	s_d	$S_{C2} = \text{median}(s_d, s_e)$ $1 \leq s_d, s_e, s_{C2} \leq 4$	w_{C2}	
	e	s_e			
C3	f	s_f	$S_{C3} = \text{median}(s_f)$ $0 \leq s_f, s_{C3} \leq 4$	w_{C3}	
C4	g	s_g	$S_{C4} = \text{median}(s_g, s_h, s_i, s_j)$ $0 \leq s_g, s_h, s_i, s_j, s_{C4} \leq 4$	w_{C4}	
	h	s_h			
	i	s_i			
	j	s_j			

s: criterion score; *S*: disease score; *w*: weight.
Criterion C2: the median reduces the maximum value.
Criterion C3: the median results to no change.
Weights: criterion weights w_k are defined at country level and are normalised such that: $w_{C1} + w_{C2} + w_{C3} + w_{C4} = 4$. Equal weighting corresponds to $w_{C1} = w_{C2} = w_{C3} = w_{C4} = 1$.

This was followed by the calculation of overall disease scores for the EU, based on which an overall EU ranking of the 45 diseases was produced (Figure 4):

Let n be the number of countries considered at the EU level for this calculation, each with a set of criterion scores ($s_{C1,k}, s_{C2,k}, s_{C3,k}, s_{C4,k}$) and criterion weights ($w_{C1,k}, w_{C2,k}, w_{C3,k}, w_{C4,k}$), with $k = 1, \ldots, n$. A total of $n \times n$ values of disease scores $S_{k,l}$ are generated by aggregating criterion scores from

countrylwith criterion weights from country k. Next, as described above, the disease scores were transformed into normalised scores (0%–100%) and the disease score range, lower and upper disease scores are obtained as S_{ls} = 5%-tile$\{S_{k,l}\}$ and S_{ls} = 95%-tile$\{S_{k,l}\}$, respectively.

2.2.5.3. Agreement on the preliminary list of priorities

The outcome of the questionnaire survey, an overall EU ranking of the 45 diseases (Figure 4), was shared and discussed with MSs at the prioritisation workshop. Individual country-specific rankings had been distributed beforehand.

EFSA then proposed to put forward a preliminary list of priorities for further discussion based on surveillance-related criteria (see Section 2.2.3.3). It was suggested to select the first five diseases from Figure 4 and let MSs assess and select, by proportional piling, another five from the remaining 40 diseases to reach the second day of the workshop with a batch of 10 priorities. Another proposal was to remove the last 10 diseases from Figure 4, and not to consider them further during the assessment by MSs.

ECDC then presented the outcome of a different disease ranking exercise on the list of 50 zoonotic diseases (Table 9), which had been conducted in-house without the involvement of MSs. This exercise aimed at defining whether surveillance in animals would support prevention of the occurrence of diseases with public health relevance. It was entirely based on expert opinion and conducted in parallel with EFSA's prioritisation exercise described in the present report. Three different groups were consulted within ECDC and asked to rank the 50 diseases individually. In a second step, all groups discussed and agreed on a final list of priorities. Criteria considered were mortality and morbidity in humans, the presence of the pathogen and its risk of introduction into Europe and neighbouring countries, the (predicted) presence of arthropod vectors in Europe and neighbouring countries, and applicable prevention and control measures.

Since EFSA's proposal was not adopted unanimously by all MSs, an alternative proposal was developed, which consisted in combining the first 10 diseases from EFSA's prioritisation exercise (with MSs' input) with the nine diseases indicating high priority from ECDC's prioritisation exercise, and to select the first five among those, excluding mostly foodborne pathogens. MSs were then asked to assess and select an additional five from the remaining 40 diseases by proportional piling in Miro. For this purpose, each country was equipped with a set of five buttons, which had to be distributed among the remaining 40 diseases. It was possible to place all or several buttons on the same disease, or to allocate each of them individually. All participants from the same country had to communicate and agree on their selection. EFSA therefore set up country-specific communication channels in Slack for them to discuss and exchange in the background. The five diseases with the most buttons assigned were then put forward to the second day of the workshop (see Section 3.2). Since there were two diseases with the same number of buttons assigned on the fifth position of the ranking, MSs were asked to re-distribute their buttons and make a selection between the two.

2.2.5.4. Agreement on the final list of priorities

The batch of 10 priorities carried over from the first day of the workshop was further discussed based on the surveillance-related criteria listed in Section 2.2.3.3.

Therefore, countries were divided into four groups, according to geographical regions, and assigned to breakout rooms, in which they discussed under the guidance of facilitators from the WG and EFSA. Table 7 displays the distribution of countries by geographical region.

Table 7: Breakout groups for discussion on surveillance-related criteria

Group	Countries
Northern Europe	Denmark, Estonia, Finland, Ireland, Latvia, Lithuania, Norway, Sweden
Eastern Europe	Bulgaria, Croatia, Hungary, Poland, Romania, Slovak Republic
Southern Europe	Greece, Italy, Portugal, Slovenia, Spain
Western Europe	Austria, Belgium, France, Germany, Netherlands

Those discussions were divided into four sessions according to the four surveillance-related criteria: feasible, implementable, beneficial, constructive. After each session, facilitators provided a short summary of common and diverging views of their groups.

Based on those insights, participants were asked to assess and indicate how feasible, implementable, beneficial and constructive they would consider surveillance for each of the 10

priorities. A traffic light system (with green indicating the most and red indicating the least) was designed in Miro for participants to make their selection (Figure 2).

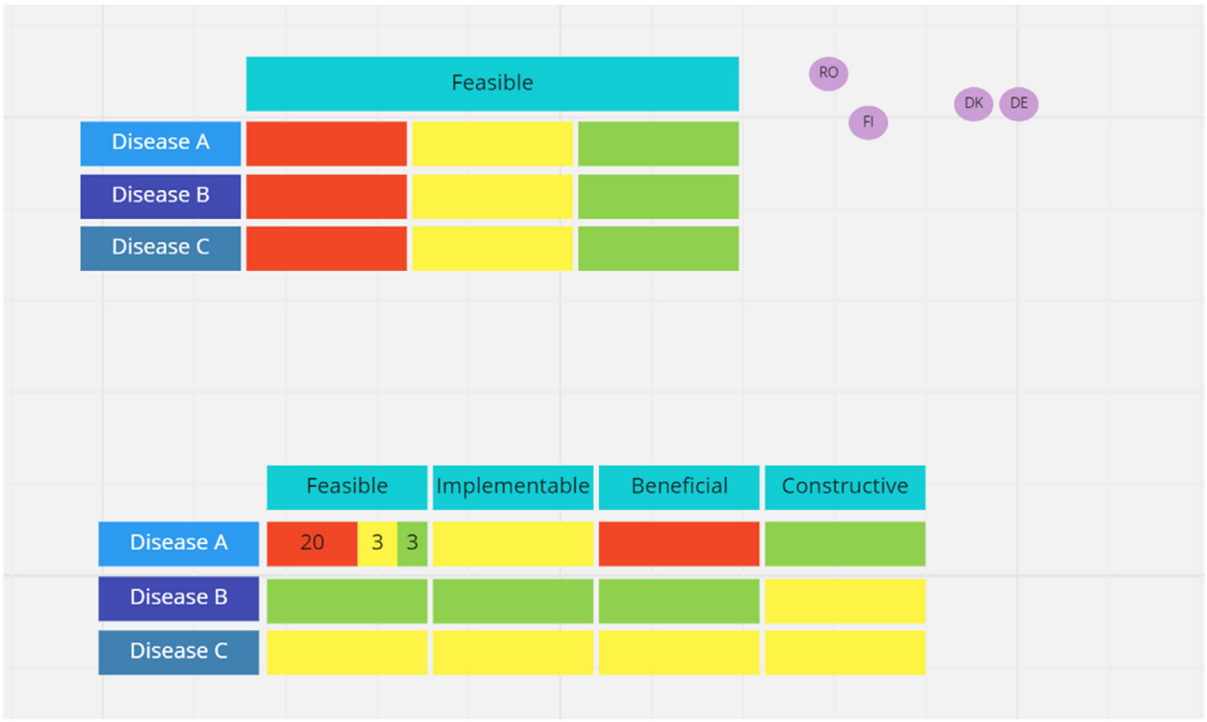


Figure 2: Traffic light system in Miro used for the assessment according to surveillance-related criteria

Again, participants were equipped with buttons, and all participants from the same country had to agree on their country's assessment. The total numbers of buttons for each criterion and disease were counted and summarised for the agreement on a final list of priorities (see Section 3.3).

3. Assessment

3.1. Agreement on the list of diseases to be assessed

As described in Section 2.2.2, 50 zoonotic diseases were kept after the application of specific exclusion criteria:

- Anthrax
- Brucellosis (*B. abortus*, *B. melitensis*, *B. suis*)
- Chikungunya fever
- COVID-19
- Crimean-Congo haemorrhagic fever
- Cryptosporidiosis
- Eastern equine encephalitis
- Ebola virus disease
- Echinococcosis (*E. granulosus*, *E. multilocularis*)
- Erysipelothricosis
- Giardiasis
- Glanders
- Hantavirus infection
- Helvetica spotted fever
- Hendra virus infection
- Hepatitis E
- Influenza (avian)
- Influenza (swine)
- Japanese encephalitis

- Lassa fever
- Leishmaniosis
- Leptospirosis
- Lyme borreliosis
- Lymphocytic choriomeningitis
- Marburg virus disease
- Mediterranean spotted fever
- Middle-East respiratory syndrome (MERS)
- Monkeypox
- Murine typhus
- Nipah virus infection
- Omsk haemorrhagic fever
- Plague
- Powassan virus infection
- Q-fever
- Rabies
- Rift Valley fever
- Severe acute respiratory syndrome (SARS)
- Scrub typhus
- Shuni virus infection
- Sindbis fever
- St. Louis encephalitis
- Thogoto virus infection
- Tick-borne encephalitis
- Toxoplasmosis
- Tularaemia
- Usutu virus infection
- Venezuelan equine encephalitis
- Wesselsbron virus infection
- West Nile fever
- Western equine encephalitis.

Another 63 diseases were removed from the prioritisation exercise, while 12 diseases were flagged as potentially relevant in future:

- Arenavirus infection (other than Lassa fever)
- Bat coronavirus infection
- Bat lyssavirus infection
- Coronavirus infection (other than COVID-19, MERS or SARS)
- Lyssavirus infection (other than rabies)
- Orthobunyavirus infection
- Pappataci fever
- Parapoxvirus infection
- Poxvirus infection
- *Salmonella* Typhimurium infection
- Sodoku
- *Streptobacillus moniliformis* infection.

After MSs had indicated the 25 diseases they considered of least relevance for surveillance, five diseases were excluded by all MSs in agreement:

- Mediterranean spotted fever
- Powassan virus infection
- Scrub typhus
- Thogoto virus infection
- Wesselsbron virus infection.

This resulted in a final number of 45 zoonotic diseases to be assessed by countries participating in the questionnaire survey. 'Disease X' was not assessed in the same way as those diseases, but it was considered during the development of the specific surveillance strategies requested in ToR A 3., which is described in a separate report (EFSA, 2023).

3.2. Assessment of diseases according to pathogen-related criteria

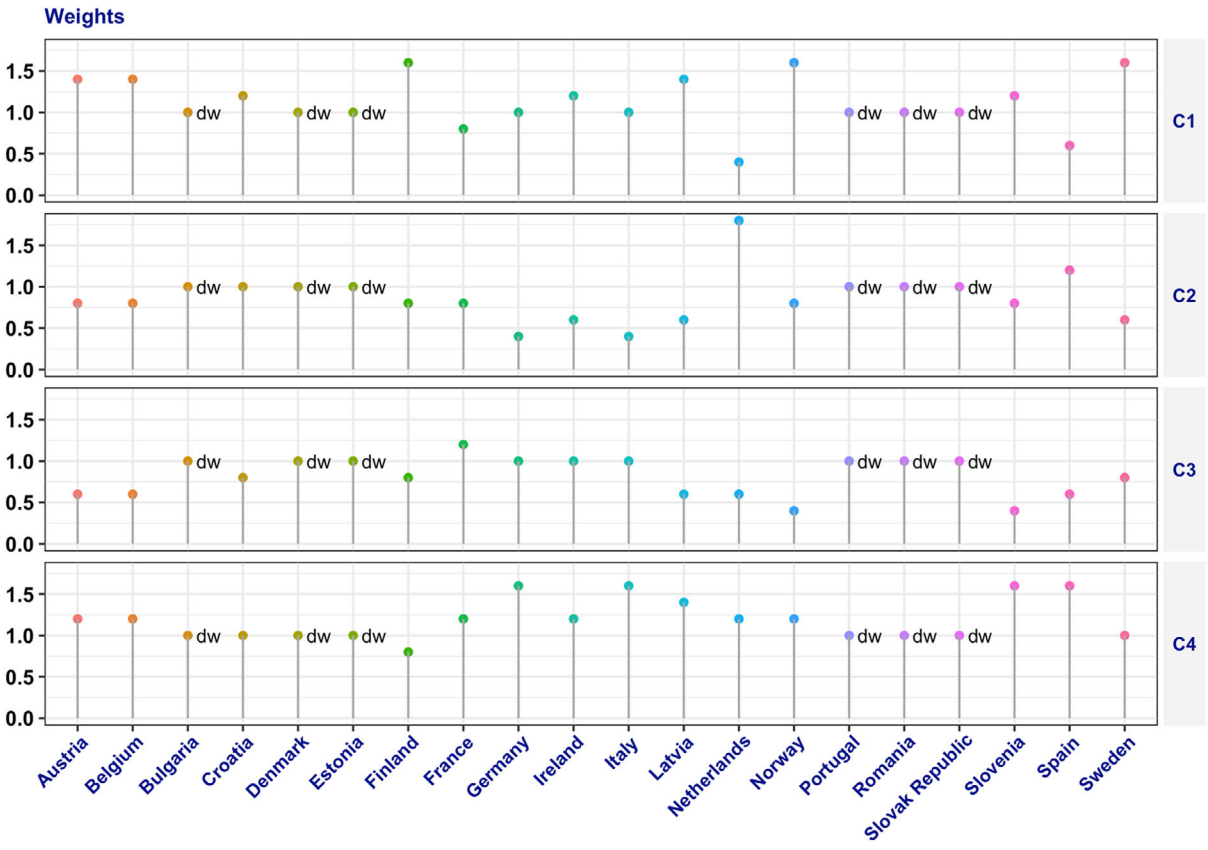
The 45 remaining diseases were assessed by MSs intending to apply for a direct grant under initiative 'CP-g-22-04.01' of the EU4Health Programme. A total of 20 countries filled in the questionnaire (see Section 2.2.4), of which 18 submitted complete results: Austria, Belgium, Bulgaria, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, the Netherlands, Norway, Portugal, Romania, Slovak Republic, Slovenia, Sweden. Croatia and Spain did not answer to all of the diseases.

Individual criterion weights for the four pathogen-related criteria (see Section 2.2.3.2) are displayed in Table 8 and Figure 3. If criterion weights were not provided, the contribution of the four criteria was considered equal (i.e. 'dw' in Figure 3).

Table 8: Individual criterion weights provided by participating countries

Country	w_{C1}	w_{C2}	w_{C3}	w_{C4}
Austria	35	20	15	30
Belgium	35	20	15	30
Croatia	30	25	20	25
Finland	40	20	20	20
France	20	20	30	30
Germany	25	10	25	40
Hungary	30	20	20	30
Ireland	30	15	25	30
Italy	25	10	25	40
Latvia	35	15	15	35
Netherlands	10	45	15	30
Norway	40	20	10	30
Slovenia	30	20	10	40
Spain	15	30	15	40
Sweden	40	15	20	25

w: weight.



C: criterion; dw: default weight.

Figure 3: Individual criterion weights (standardised) provided by participating countries. All weights sum to four for each country

After the calculation of disease scores, 20 individual country rankings (see Appendix A) and an overall EU ranking of the 45 zoonotic diseases were produced (Figure 4).

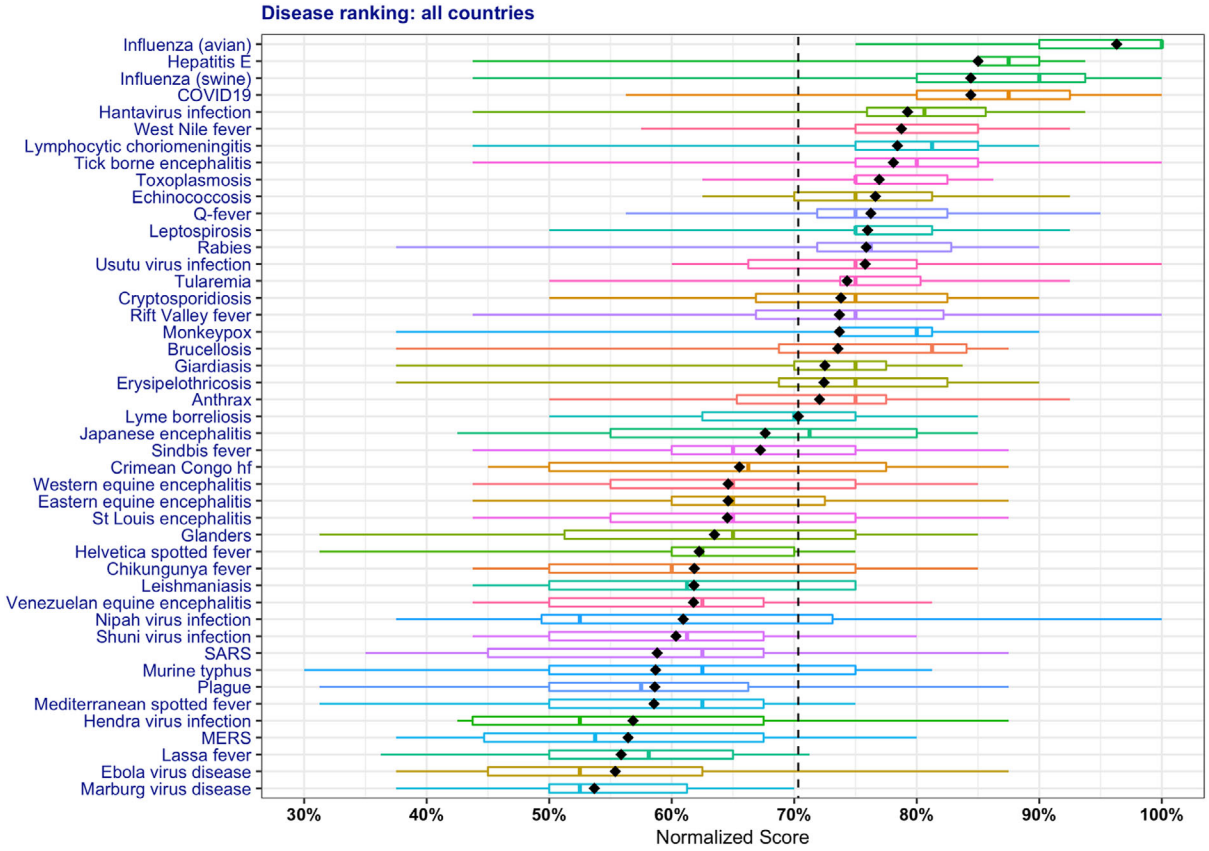


Figure 4: Overall EU ranking of the 45 zoonotic diseases after the questionnaire survey. Black dots represent the mean values

The overall outcome was then compared to the list established by ECDC, which is summarised in Table 9.

Table 9: Outcome of the disease ranking exercise performed by ECDC

Disease	Priority	Comments
Influenza (swine)	4	Pandemic potential, no routine surveillance in animals in place, sporadic human cases reported, high reassortment with seasonal influenza viruses ongoing
Echinococcosis (*E. multilocularis*)	3	Severe disease with long incubation period (5–15 years), geographical distribution in wildlife likely expanding in Europe but studies are limited
Rift Valley fever	3	Severe disease and possibility of emergence in Europe (vector established)
Tick-borne encephalitis	3	Evidence of viral spread and human vaccine available, so animal data could inform public health authorities
West Nile fever	3	Evidence of viral spread and risk for blood safety, so early detection of viral circulation is important
Crimean-Congo haemorrhagic fever	3	Severe disease and emergence in Europe (e.g. Spain)
Leishmaniasis	3	No routine surveillance in animals in place, limited data to assess the emergence
Monkeypox	3	No routine surveillance to detect whether the virus would become enzootic
Influenza (avian)	3	Pandemic potential, monitoring in birds in place. Considered for other animal species (foxes, seals, other carnivores, etc.)

4: surveillance in animals is crucial for public health in the EU; 3: surveillance in animals would support prevention of human cases in the EU.

In agreement with MSs, a combination of both EFSA's and ECDC's outcomes was sought. EFSA therefore proposed to put forward to the second day of the prioritisation workshop the following five diseases:

- Echinococcosis (*E. granulosus*, *E. multilocularis*)
- Influenza (avian)
- Influenza (swine)
- Tick-borne encephalitis
- West Nile fever.

An additional five diseases were selected by MSs by proportional piling (Table 10):

- Q-fever
- Rift Valley fever
- Hepatitis E
- Lyme borreliosis
- Crimean-Congo haemorrhagic fever.

Table 10: Top 5 diseases assessed and selected by countries

Disease	Total number of buttons assigned	Country (number of buttons assigned)
Q-fever	15	Belgium (3), Bulgaria (1), Estonia (1), Finland (1), Greece (1), Hungary (2), Ireland (1), Norway (1), Poland (1), Portugal (1), Romania (1), Sweden (1)
Rift Valley fever	12	Bulgaria (1), Denmark (2), Greece (1), Ireland (1), Italy (1), Netherlands (1), Poland (1), Portugal (2), Spain (2)
Hepatitis E	11	Belgium (1), Croatia (1), Estonia (1), Hungary (1), Ireland (1), Latvia (1), Netherlands (1), Poland (1), Romania (1), Slovenia (2)
Lyme borreliosis	11	Austria (4), Croatia (1), Germany (1), Greece (1), Ireland (1), Latvia (1), Norway (1), Poland (1)
Crimean-Congo haemorrhagic fever	10 → 28[(a)]	Belgium (1), Bulgaria (1), Croatia (2), Denmark (3), France (5), Greece (2), Italy (3), Netherlands (2), Portugal (2), Spain (3), Sweden (4)
Hantavirus infection	10 → 22[(a)]	Austria (1), Croatia (1), Estonia (2), Finland (4), Germany (2), Italy (1), Latvia (3), Norway (3), Poland (1), Romania (1), Slovenia (3)

(a): Total number after buttons had been re-distributed.

This resulted in a preliminary batch of 10 priorities. Disease-specific outcomes of the questionnaire survey are provided in Appendix B.

3.3. Assessment of diseases according to surveillance-related criteria

On the second day of the prioritisation workshop, those 10 priorities were discussed in four breakout sessions dedicated to the four surveillance-related criteria: feasible, implementable, beneficial, constructive. Key aspects of those discussions are depicted in the following sections.

3.3.1. Criterion 'feasible'

3.3.1.1. Northern Europe

Northern European countries considered surveillance for influenza (both avian and swine) and West Nile fever feasible. In case of tick-borne encephalitis, they highlighted difficulties in interpreting results from serosurveillance or vector surveillance when the disease is absent from the country. However, they considered bulk milk and surveillance in dogs as possible options. In terms of echinococcosis, hunting of foxes was not considered feasible by Sweden and Norway, but faeces collection might be possible. Difficulties were also mentioned for Q-fever, as the disease does not show typical clinical signs in animals, and seroconversion does not equal pathogen isolation. Since Rift Valley fever is absent from Northern Europe, these countries considered passive surveillance more feasible than vector surveillance.

3.3.1.2. Eastern Europe

Eastern European countries mentioned that feasibility was linked to the capability of detecting/diagnosing the pathogen/disease in animals or vectors. They considered surveillance for vector-borne diseases generally less feasible. These countries also found early detection more challenging for exotic diseases.

3.3.1.3. Southern Europe

Southern European countries found surveillance feasible for most of the 10 preliminary priorities. They highlighted that most countries had the technical capability, while collaboration and integration with the public and ecosystem health sectors were more challenging.

3.3.1.4. Western Europe

Western European countries found surveillance feasible for most of the 10 preliminary priorities. In case of tick-borne encephalitis, they were unsure about the species to focus on and flagged difficulties associated with the collection of ticks. These countries considered the need to involve many different species for the surveillance for Q-fever.

3.3.2. Criterion 'implementable'

3.3.2.1. Northern Europe

Northern European countries remarked that workforce might generally be a problem for the implementation of surveillance activities. In case of Lyme borreliosis, they found surveillance unsustainable from a government perspective.

3.3.2.2. Eastern Europe

Eastern European countries found surveillance easier to implement when there were already, similar, surveillance systems in place. They also remarked that workforce preparation would be more challenging than acquiring the relevant technical expertise, and that legislation would sometimes represent an issue.

3.3.2.3. Southern Europe

Southern European countries thought that most countries had some of the capacities needed to implement surveillance for most of the 10 preliminary priorities. However, the situation would vary between countries. They highlighted that emergencies (e.g. highly pathogenic avian influenza, COVID-19) pulled resources away, which in turn made routine surveillance activities difficult, a challenge particularly. However, this was considered a greater challenge for smaller countries. Another difficulty was that the relevant infrastructure would be siloed in different ministries, which made sharing of resources and data problematic. These countries flagged the importance of implementing respective legislation to determine follow-up actions on positive diagnoses. Some of the diseases might even need to be made mandatory reportable.

3.3.2.4. Western Europe

Western European countries found surveillance for most of the 10 preliminary priorities implementable. Germany pointed out that the country's federal system was a challenge to implementing any kind of surveillance activities, particularly at regional level. Lack of legal support was also considered problematic by other countries. For Crimean-Congo haemorrhagic fever, e.g., there would be no mandatory reporting in place in animals. The same was mentioned for echinococcosis in some countries. Austria was unsure about the cost–benefit ratio of implementing surveillance for avian influenza.

3.3.3. Criterion 'beneficial'

3.3.3.1. Northern Europe

Northern European countries found surveillance for Crimean-Congo haemorrhagic fever in animals beneficial to protect human health, and the zoonotic potential of tick-borne encephalitis to be underestimated. However, human cases would be easier to diagnose than cases in wildlife or bulk milk samples. It was not considered beneficial to use wild boar for surveillance for swine influenza, but the

areas for surveillance for echinococcosis might be expanded. In case of Rift Valley fever, syndromic surveillance might be performed for abortions. Many benefits were seen for West Nile fever and Lyme borreliosis, for which it would be useful to detect new and more pathogenic strains (plus 'Disease X'). These countries were wondering about benefits associated with surveillance for Hepatitis E and avian influenza.

3.3.3.2. Eastern Europe

Eastern European countries found the use of shared surveillance systems more beneficial, but found that any additional information collected would be of value.

3.3.3.3. Southern Europe

Southern European countries found surveillance in ticks difficult and did not know how and whether surveillance in animals could be used to predict changing risk to humans. These countries were concerned about the introduction of echinococcosis from Ukraine and would consider expanding those surveillance activities. Surveillance for avian and swine influenza, and COVID-19, was considered beneficial and important not only for early detection, but also to detect any changes in those viruses and how those changes might increase the risk of epidemics in humans from spillover events.

3.3.3.4. Western Europe

Western European countries did not find early warning beneficial for Q-fever, Lyme borreliosis or Hepatitis E, as those diseases were already present in most of the regions. However, they mentioned that disease trends could be followed. These countries considered surveillance in ticks beneficial, as several bacterial diseases could be targeted with the same surveillance system. Another useful activity would be to perform genomic analyses for swine pathogens (including Hepatitis E). Benefits in terms of public health were also seen for surveillance for echinococcosis. Screening of foxes might be useful, also in terms of targeting mammals for avian influenza.

3.3.4. Criterion 'constructive'

3.3.4.1. Northern Europe

Northern European countries highlighted their strong interest in surveillance for swine influenza to protect public health.

3.3.4.2. Eastern Europe

Eastern European countries did not find surveillance in animals constructive when prevalence in wild animals was not directly linked to prevalence in domestic animals or humans. It was moreover considered constructive when the legal framework worked in practice, fostering collaboration and human relationships rather than only exchange of information or data between sectors.

3.3.4.3. Southern Europe

Southern European countries pointed out that Italy had a great example of an arbovirus surveillance system (West Nile fever and Usutu virus infection) in place that was able to predict increased risk to all affected involved. No examples of existing cross-border collaboration were known to these countries apart from sharing of information on Crimean-Congo haemorrhagic fever between Portugal and Spain.

3.3.4.4. Western Europe

Western European countries found holistic surveillance systems that were not focused on specific diseases more constructive. An example mentioned for a functioning cross-sectoral collaboration was surveillance for West Nile fever.

3.4. Agreement on the final list of priorities

After countries had assessed the 10 preliminary priorities against the four surveillance-related criteria, the total numbers of buttons assigned were counted and used to produce an overview of the results (Figure 5).

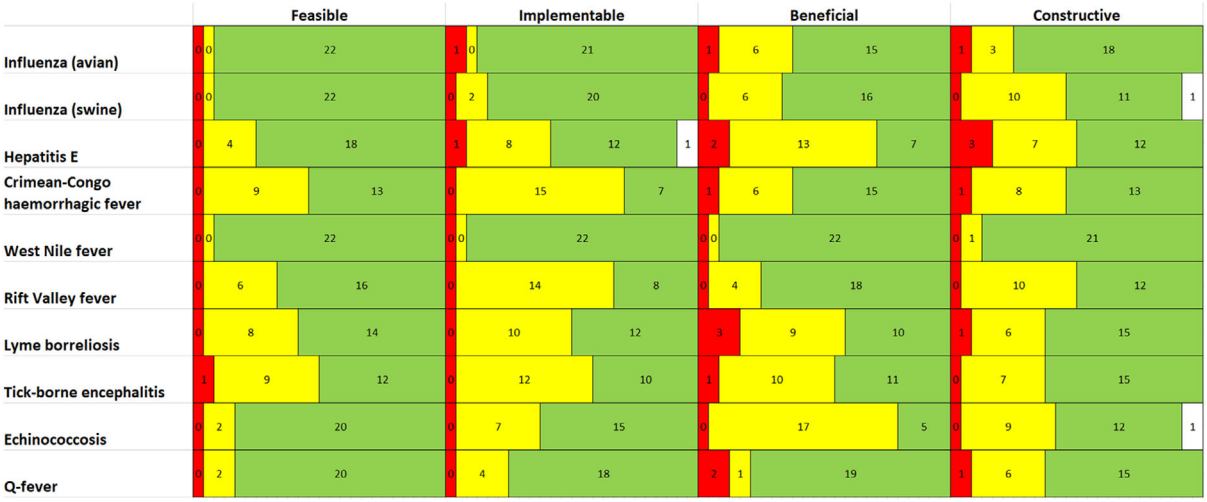


Figure 5: Assessment of diseases against the four surveillance-related criteria

Based on the outcome of this final assessment, the complete list of 10 priorities was considered relevant for the preparation of specific surveillance strategies.

4. Conclusions

The methodology described in this report successfully identified the following 10 priority diseases (in alphabetical order) for which surveillance strategies have been proposed by EFSA (EFSA, 2023):

- Crimean-Congo haemorrhagic fever
- Echinococcosis (both *E. granulosus* and *E. multilocularis*)
- Hepatitis E
- Influenza (avian)
- Influenza (swine)
- Lyme borreliosis
- Q-fever
- Rift Valley fever
- Tick-borne encephalitis
- West Nile fever.

The development of a standardised and systematic methodology is a difficult endeavour, as it needs to respond to many different stakeholders' interests. It is nevertheless important to improve strategic planning. This kind of exercise is heavily influenced by the availability of resources, time, expertise and data (including their quality). The proposed methodology is flexible, i.e. it can be adapted to any country in the EU, and dynamic, as information can be updated.

Possible improvements to the methodology applied in future re-prioritisation exercises include the use of more objective and automated data for the assessment, and the involvement of MSs also in the definition of the criteria to be used. Based on the feedback received from several MSs, the relevance of including zoonotic diseases already endemic in parts of the EU should be re-considered.

To assist in the future re-prioritisation of zoonotic diseases, a living, online risk assessment (l'ORA[18]) tool is being developed. The outputs will be data-driven risk assessments, which will be updated automatically and predict the probability of incursion, spread and impact in MSs. The assessments will be updated according to the latest available information on the disease characteristics, published in peer-reviewed literature, and information collected in other available databases (e.g. on the geographic distribution of the pathogens, the susceptible hosts, their movements, and potential vectors of the pathogens).

[18] https://ted.europa.eu/udl?uri=TED:NOTICE:18325-2023:HTML:EN:HTML&tabId=1&tabLang=en.

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Abbreviations

AAEP	American Association of Equine Practitioners
CDC	Centers for Disease Control and Prevention
CFSPH	Center for Food Security and Public Health
EAZWV	European Association of Zoo and Wildlife Veterinarians
ECDC	European Centre for Disease Prevention and Control
FAO	Food and Agriculture Organization of the United Nations
IUCN	International Union for Conservation of Nature
MCDA	Multi-criteria decision analysis
MERS	Middle-East respiratory syndrome
MS	Member State
SARS	Severe acute respiratory syndrome
ToR	Term of Reference
WG	Working Group
WHO	World Health Organization
WOAH	World Organisation for Animal Health

Appendix A – Individual disease rankings by country

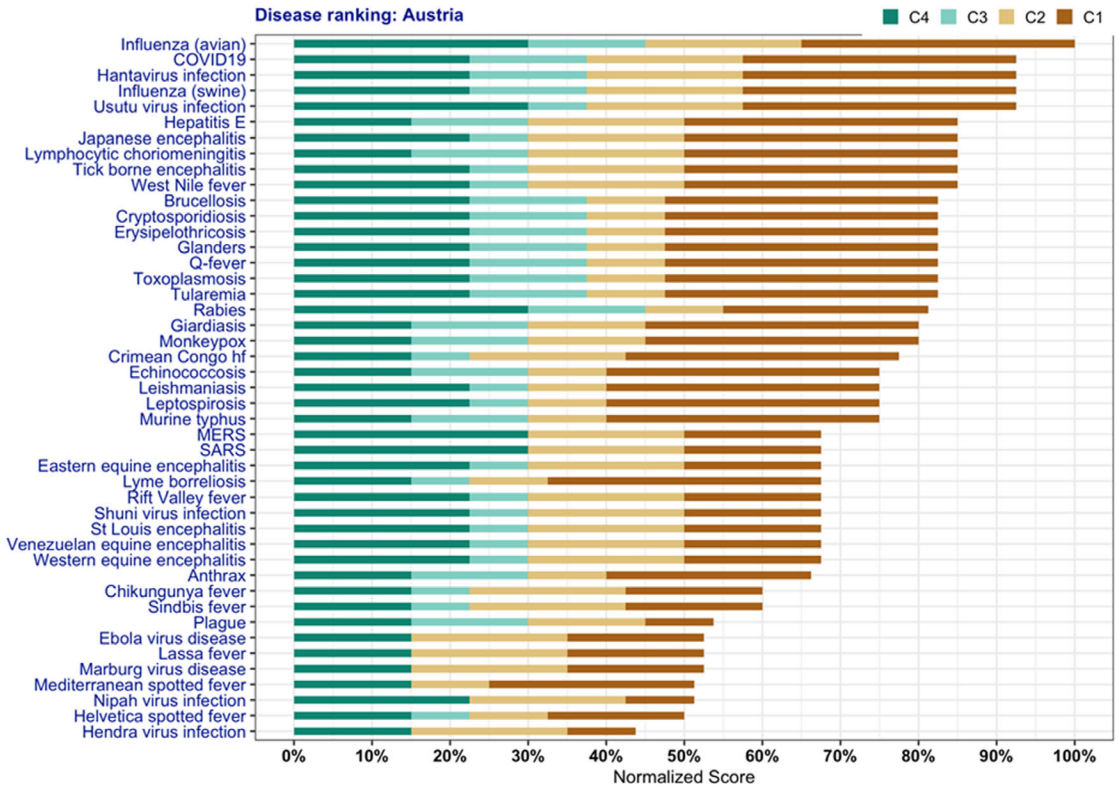

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Figure A.1: Individual disease ranking for Austria

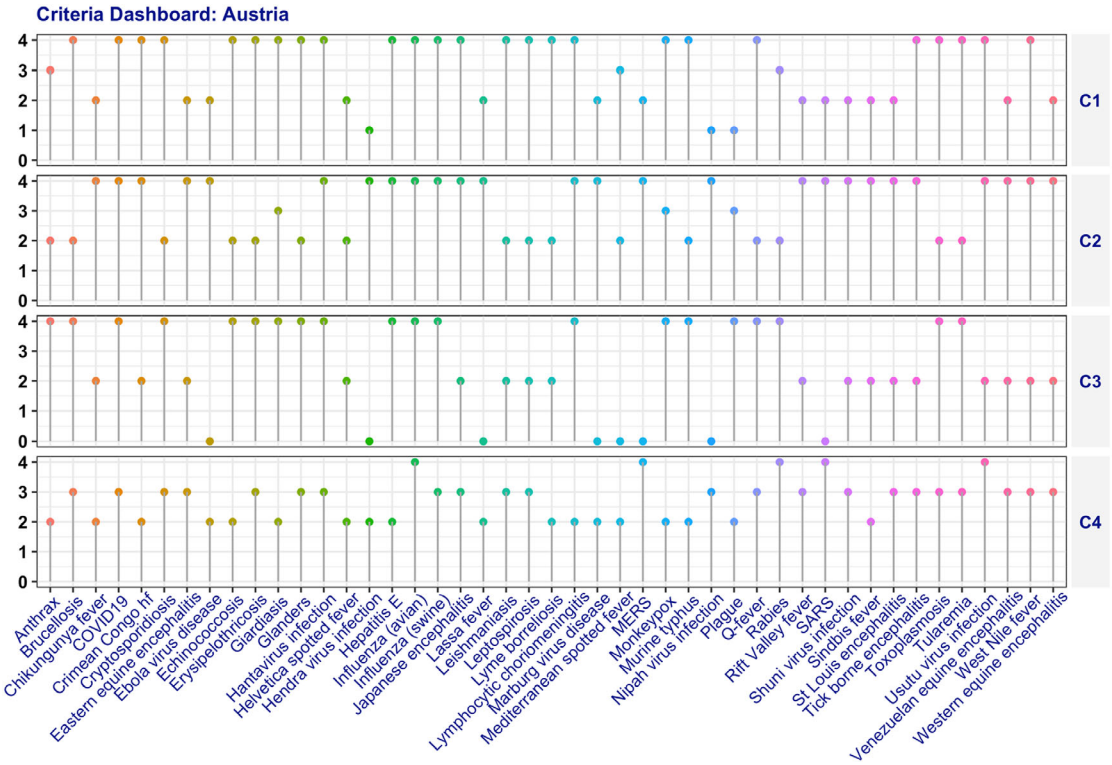

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Figure A.2: Criteria dashboard for Austria

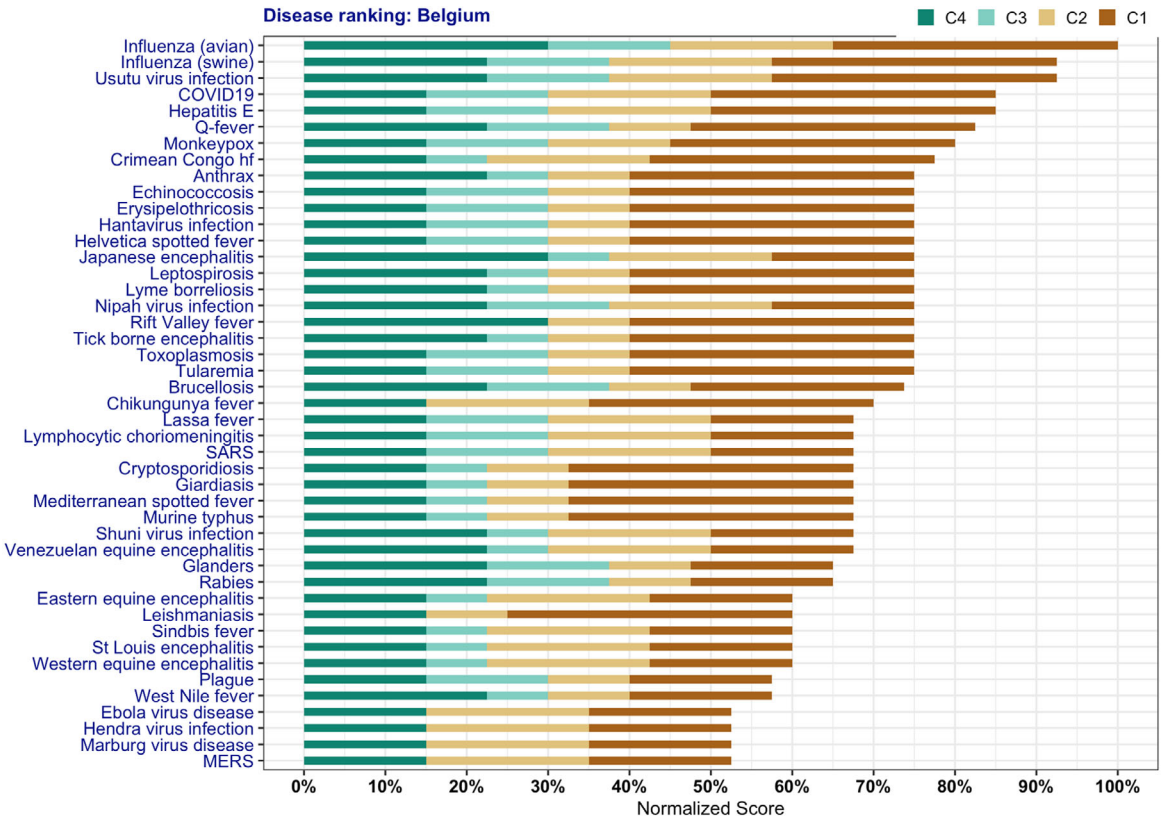

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Figure A.3: Individual disease ranking for Belgium

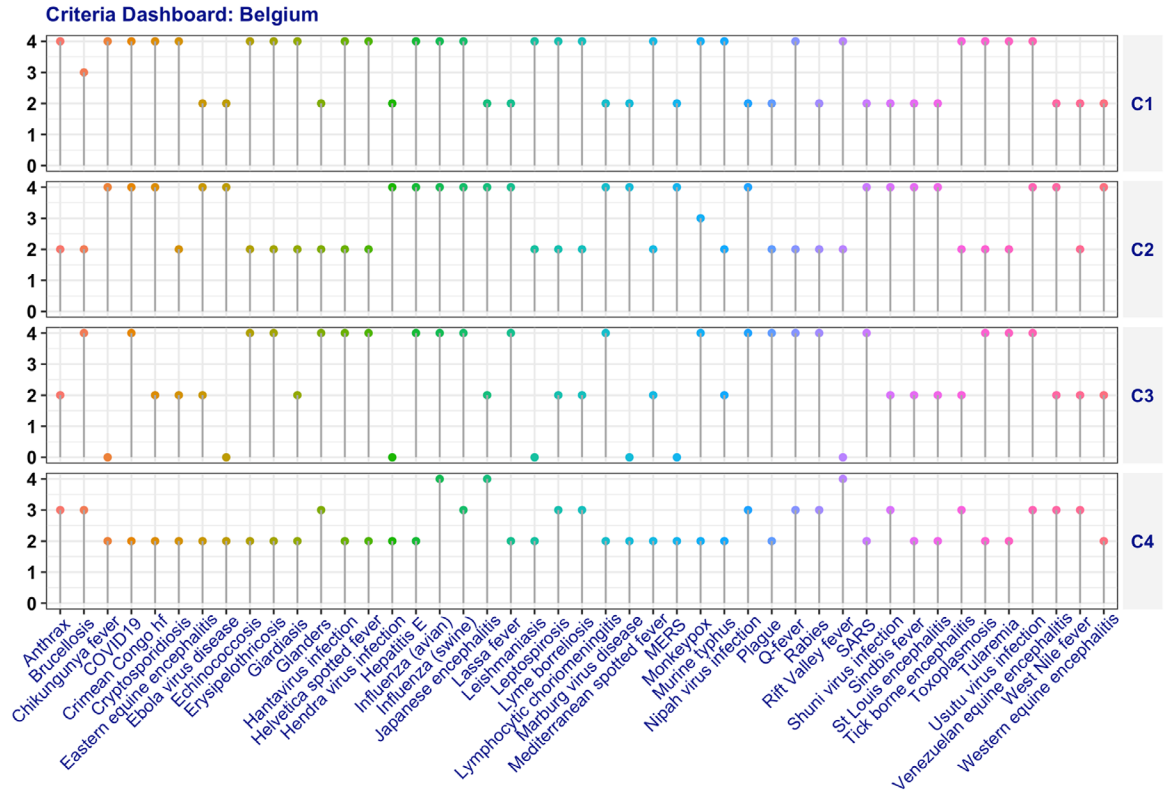

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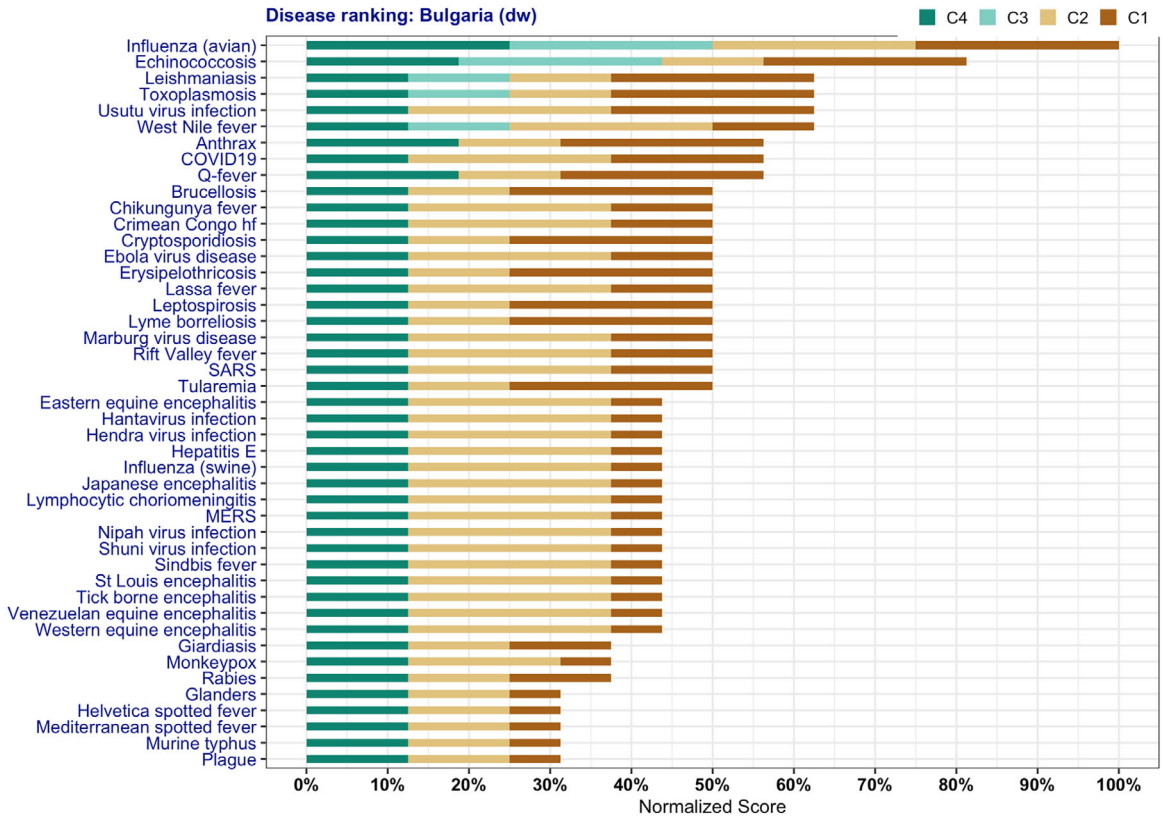
Figure A.4: Criteria dashboard for Belgium



C: criterion; dw: default weights.

Figure A.5: Individual country ranking for Bulgaria

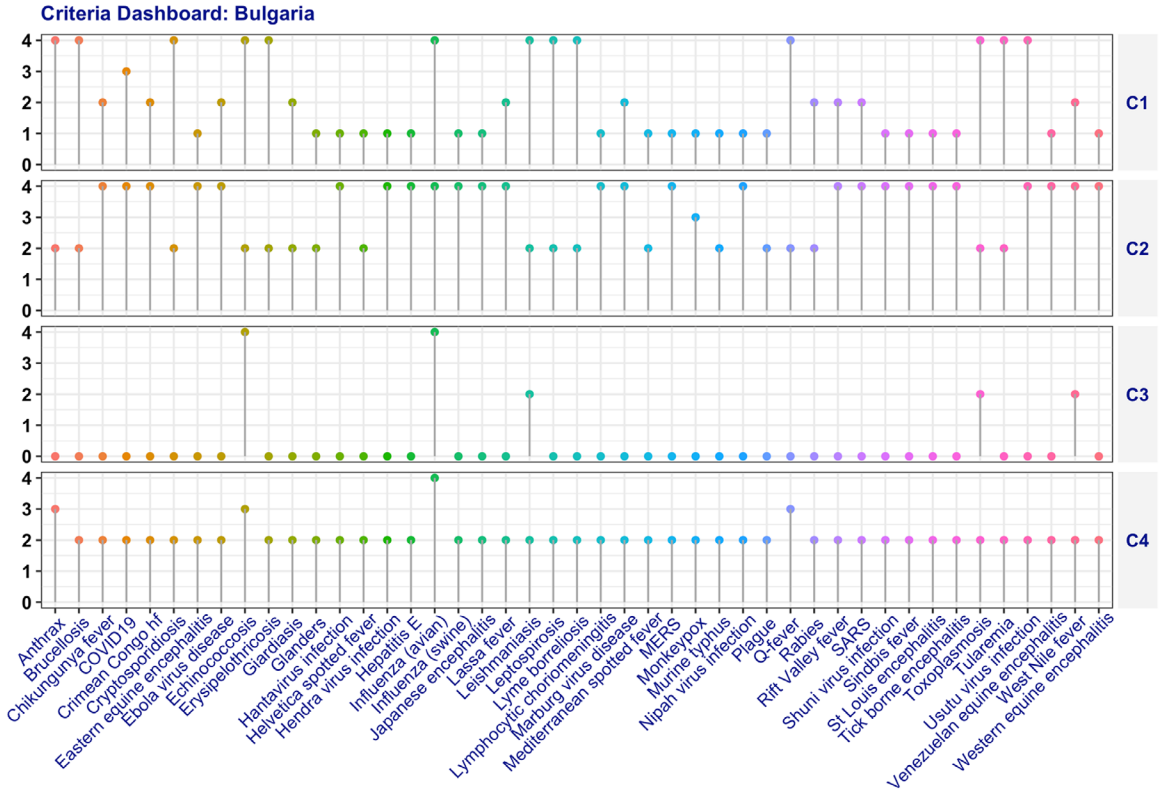


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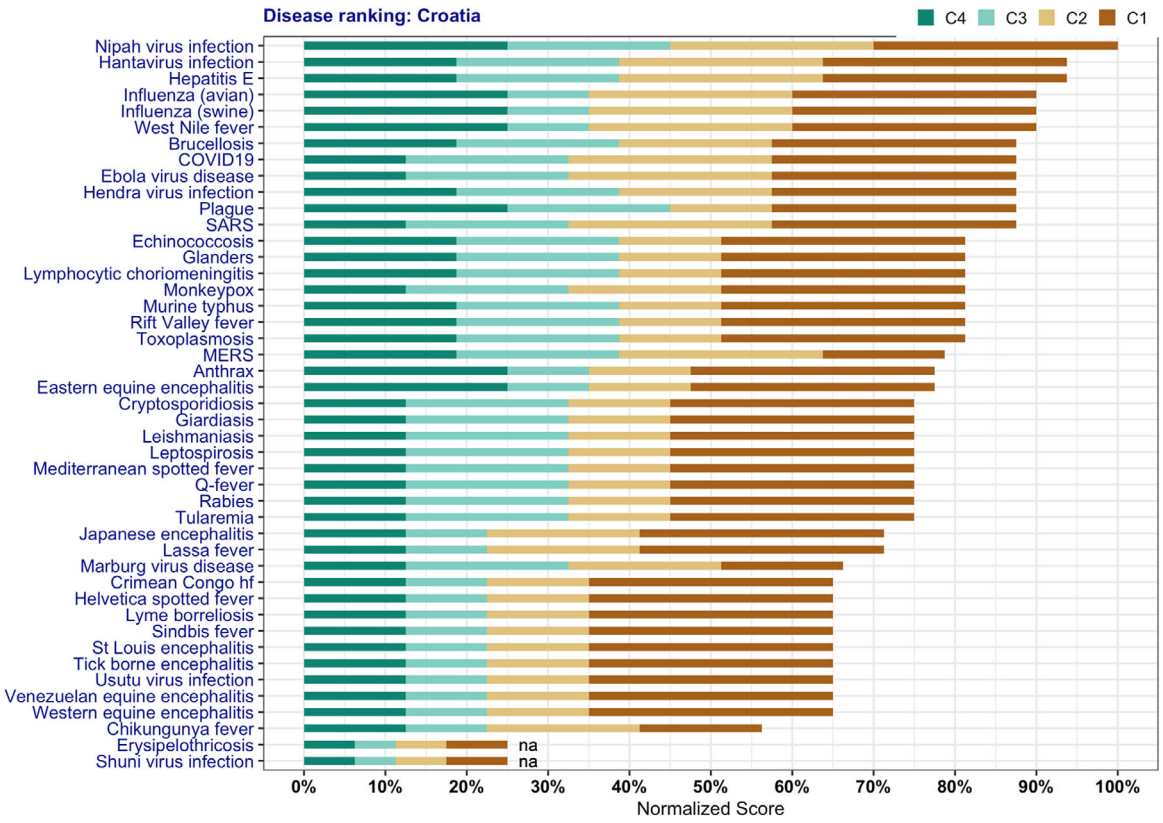
Figure A.6: Criteria dashboard for Bulgaria



C: criterion; na: not available.

Figure A.7: Individual disease ranking for Croatia

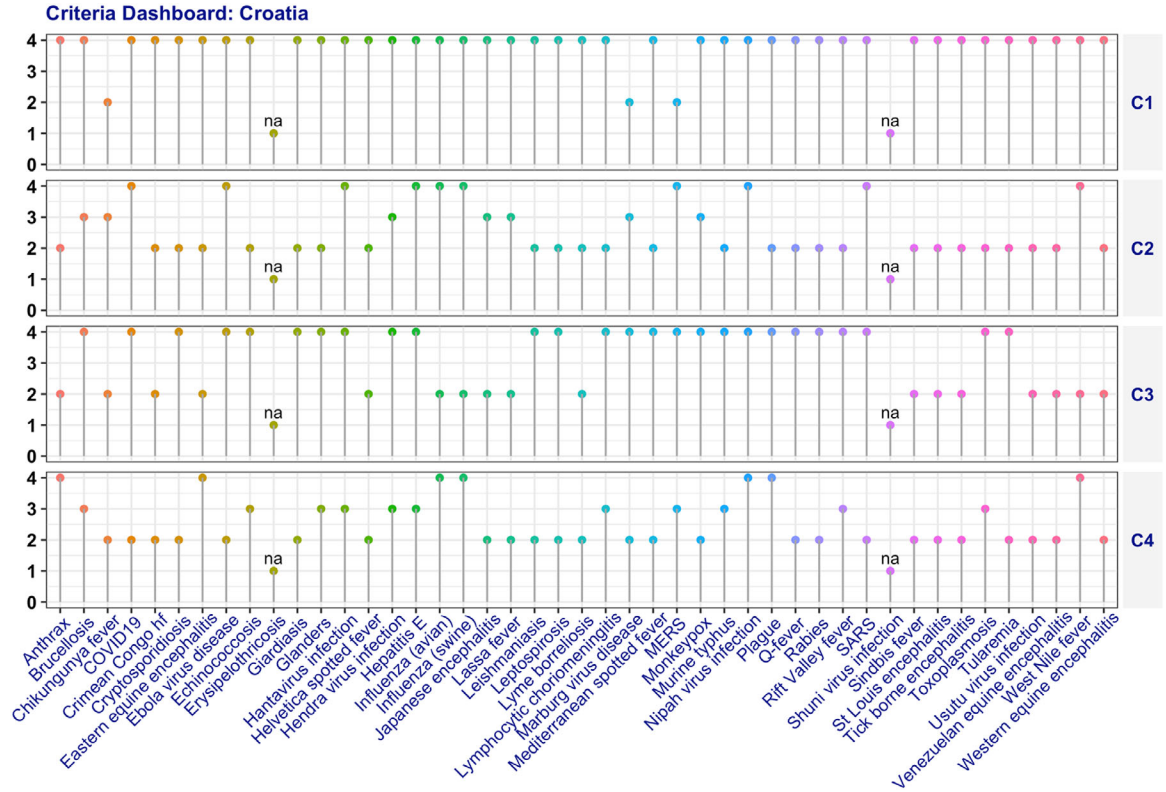


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Figure A.8: Criteria dashboard for Croatia

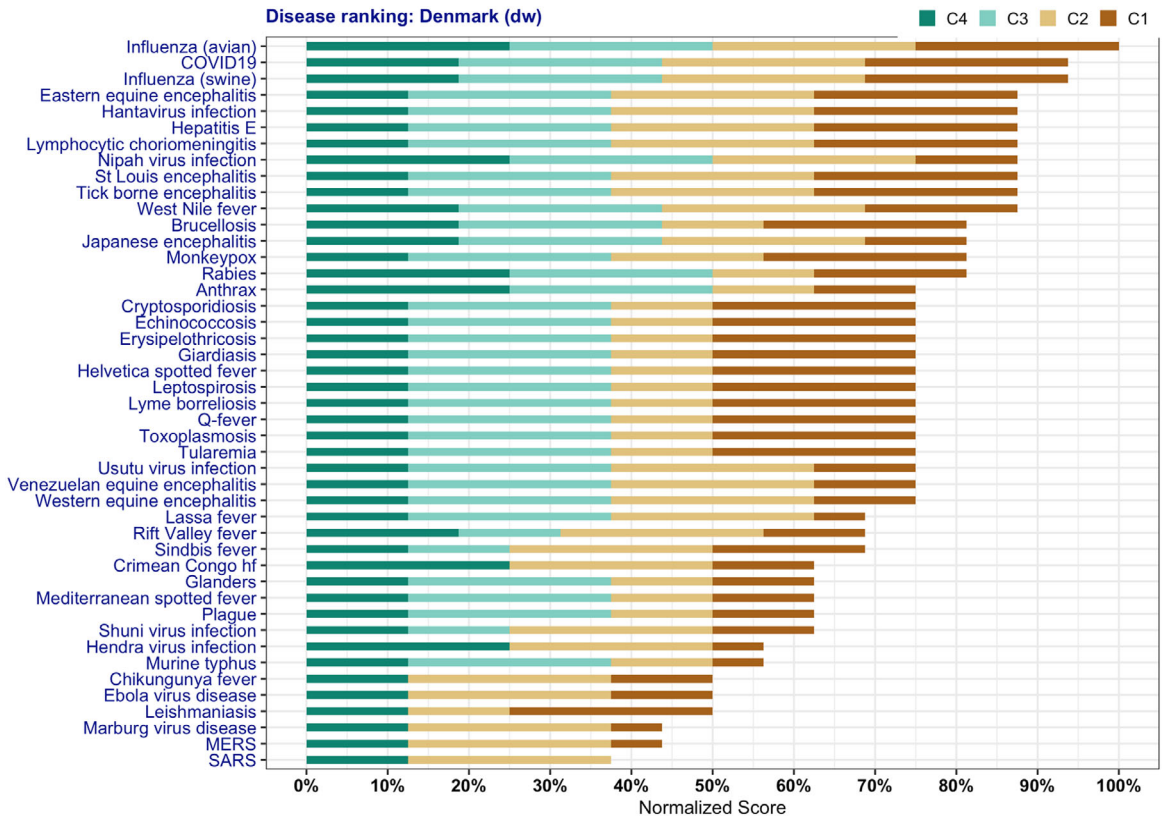

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Figure A.9: Individual disease ranking for Denmark

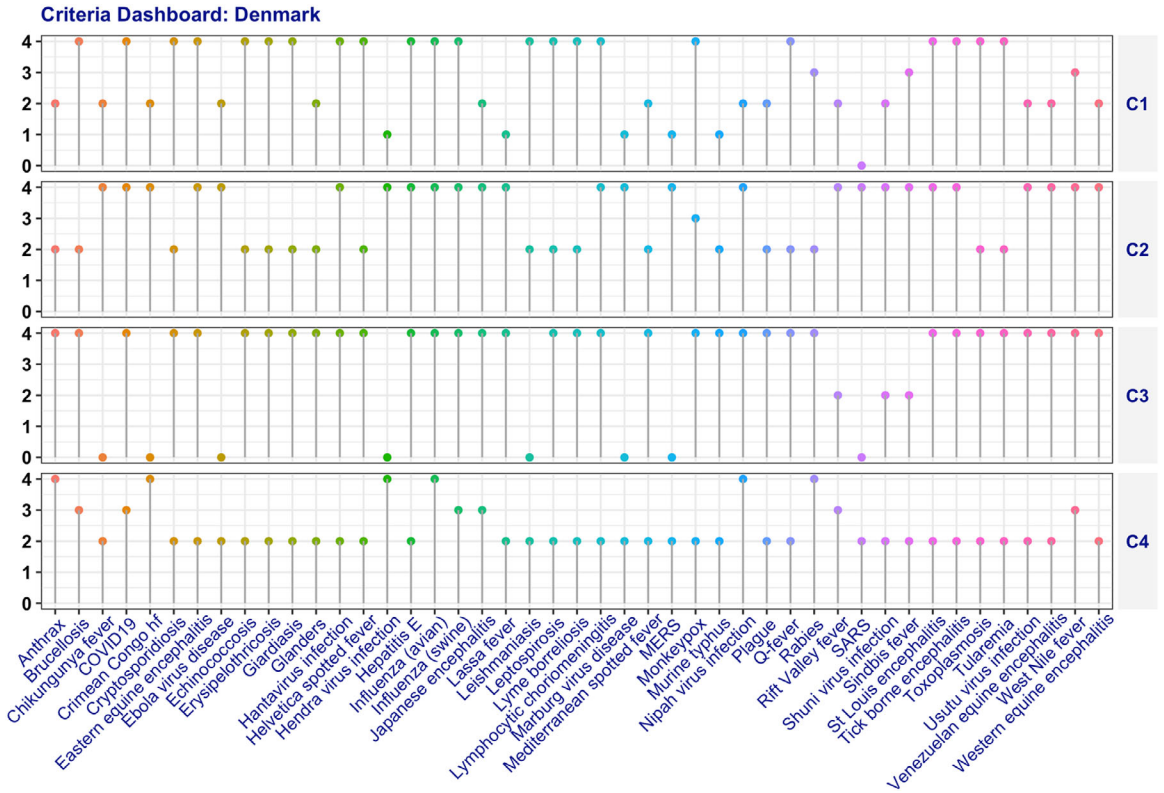

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Figure A.10: Criteria dashboard for Denmark

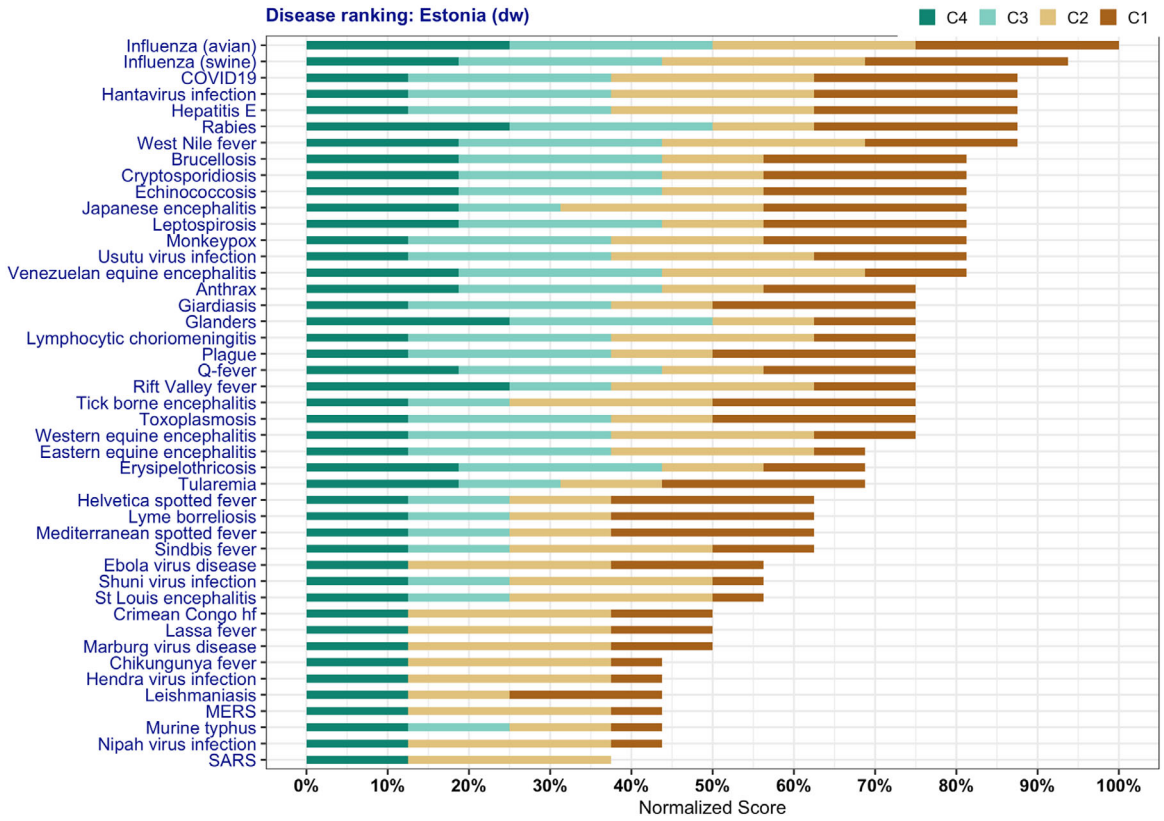

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Figure A.11: Individual disease ranking for Estonia

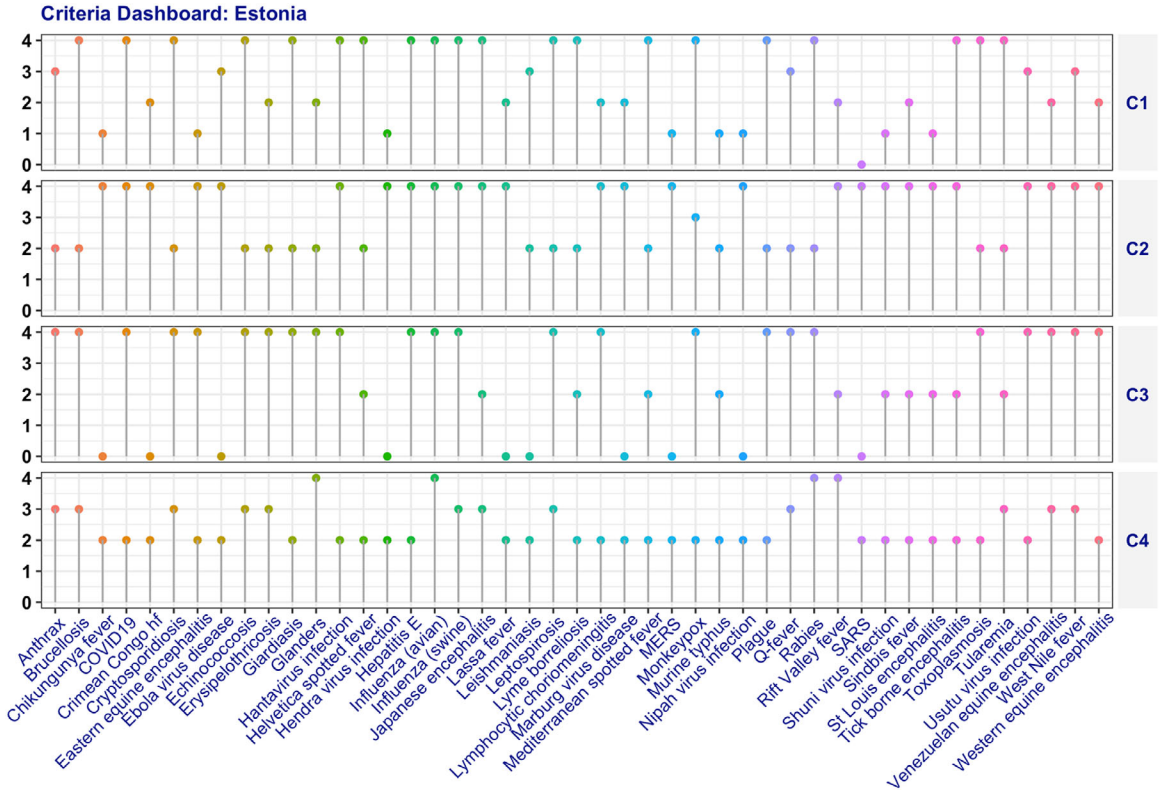

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Figure A.12: Criteria dashboard for Estonia

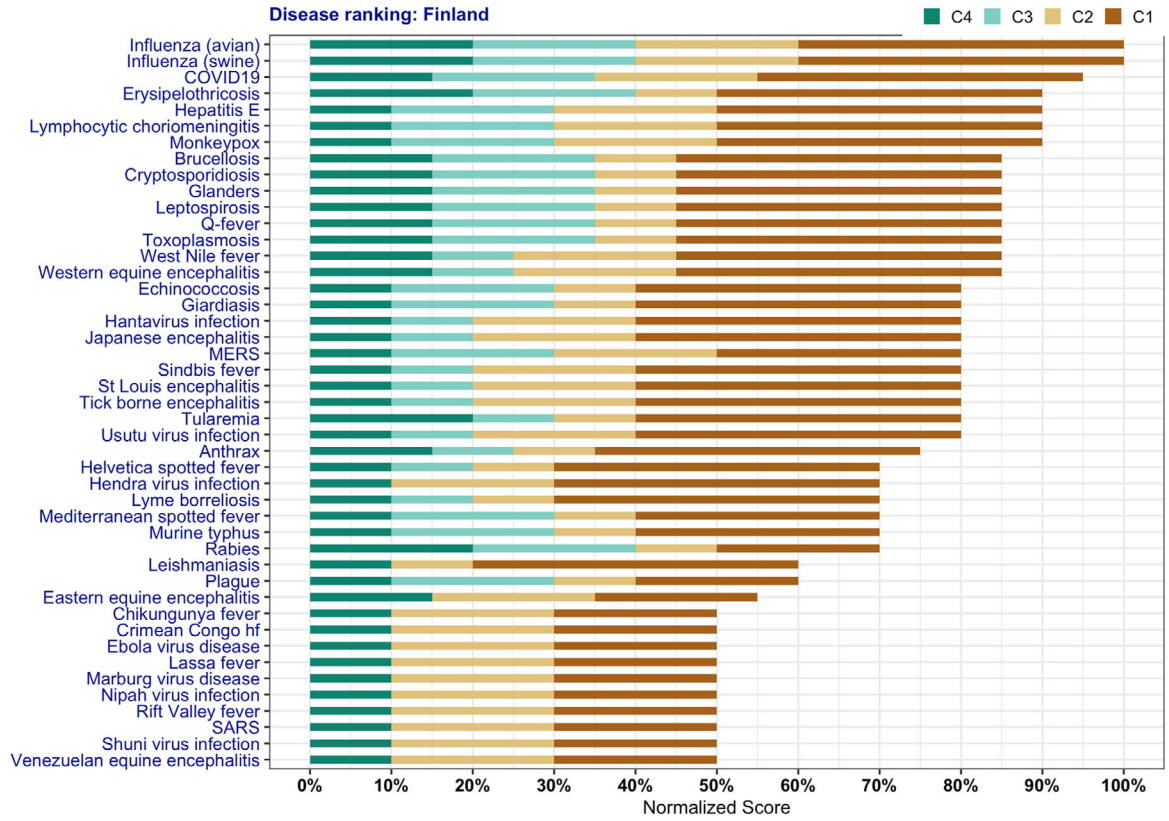

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Figure A.13: Individual disease ranking for Finland

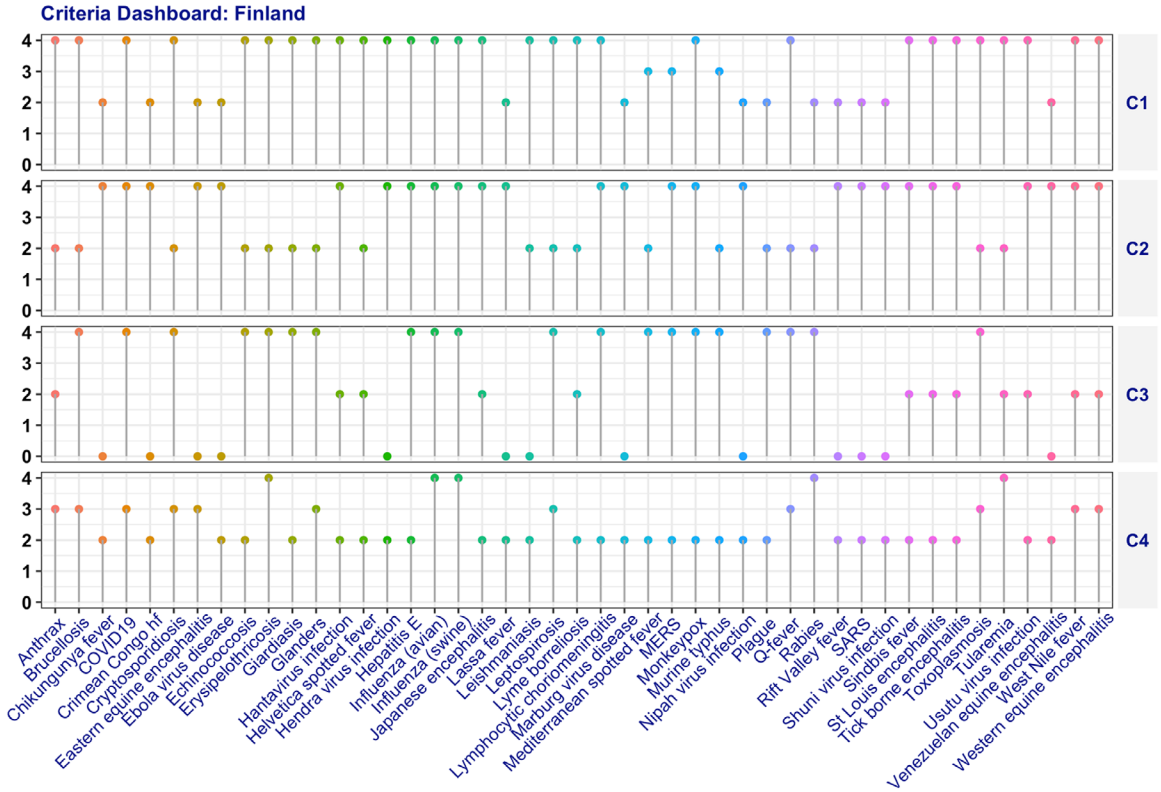

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Figure A.14: Criteria dashboard ranking for Finland

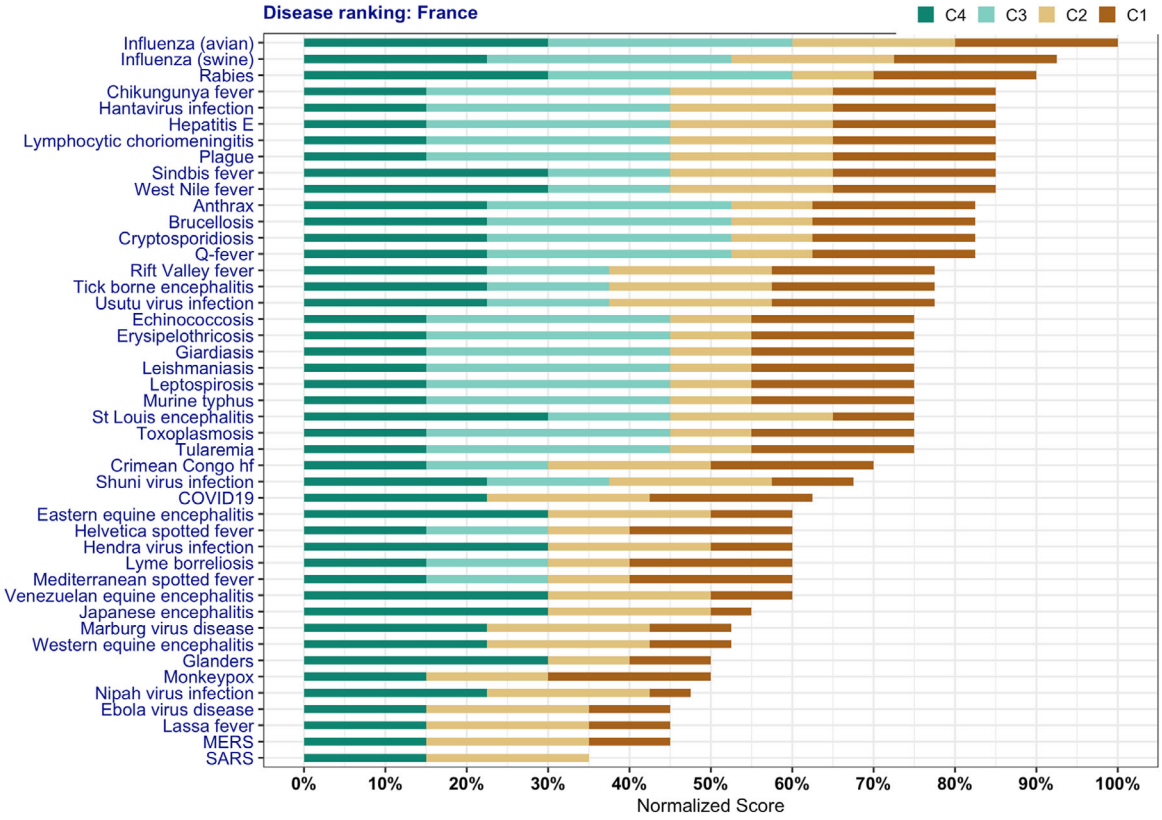

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Figure A.15: Individual disease ranking for France

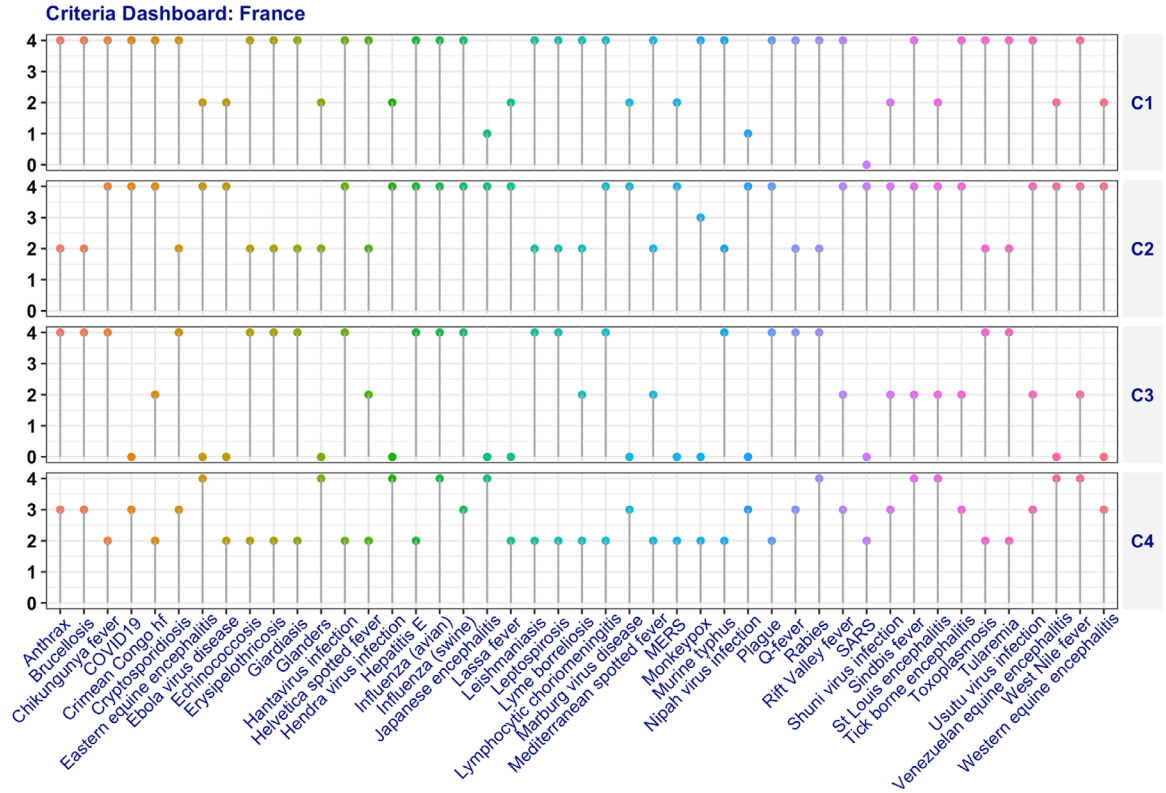

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Figure A.16: Criteria dashboard for France

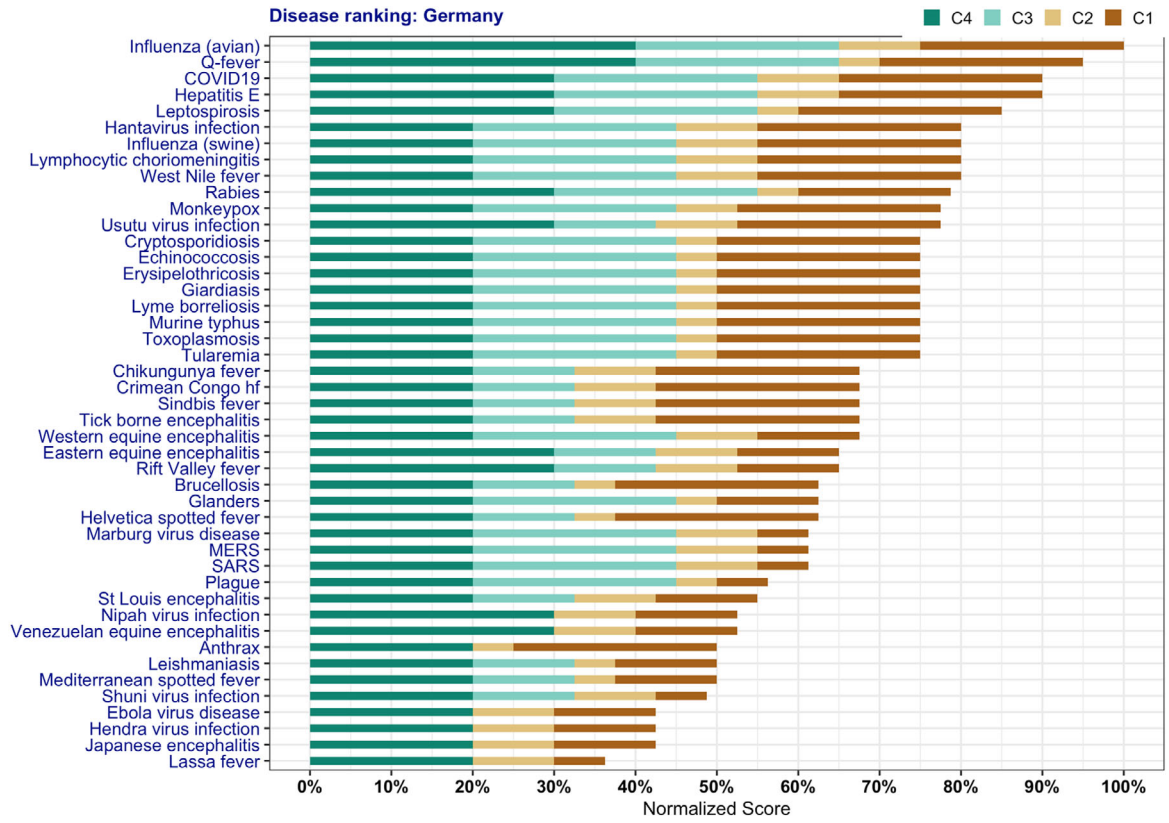

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Figure A.17: Individual disease ranking for Germany

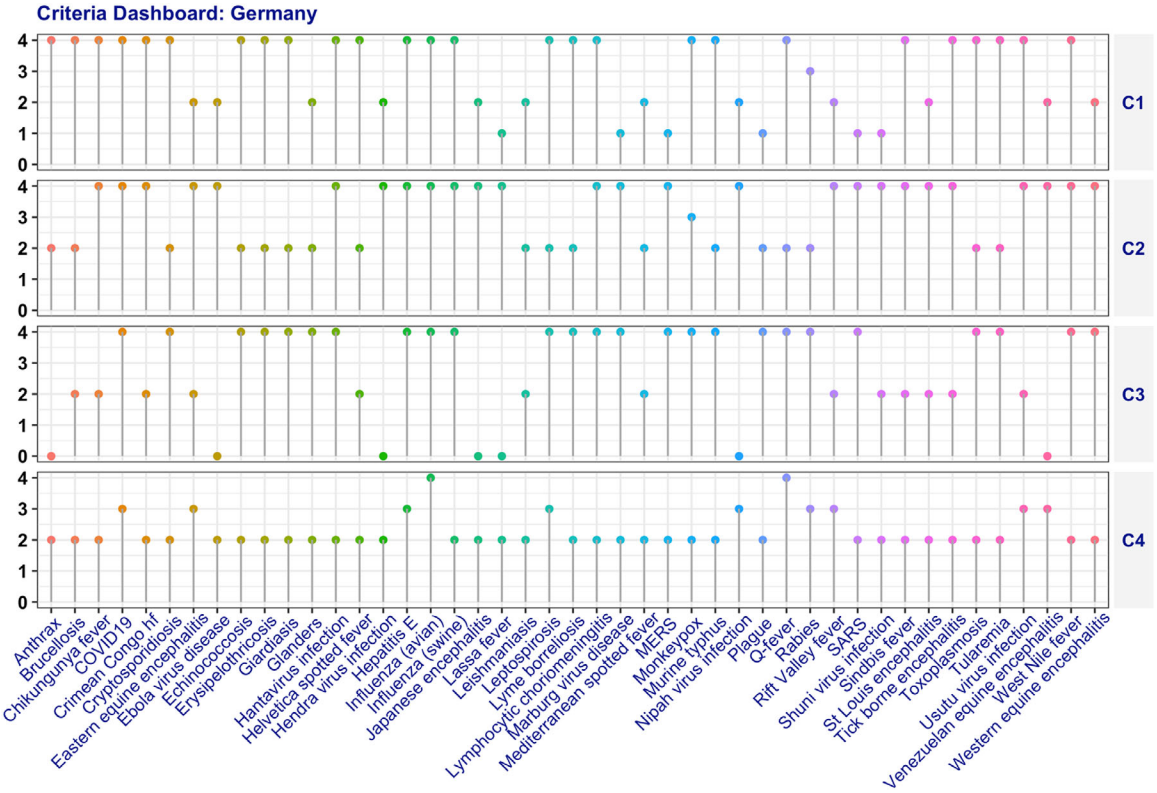

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Figure A.18: Criteria dashboard for Germany

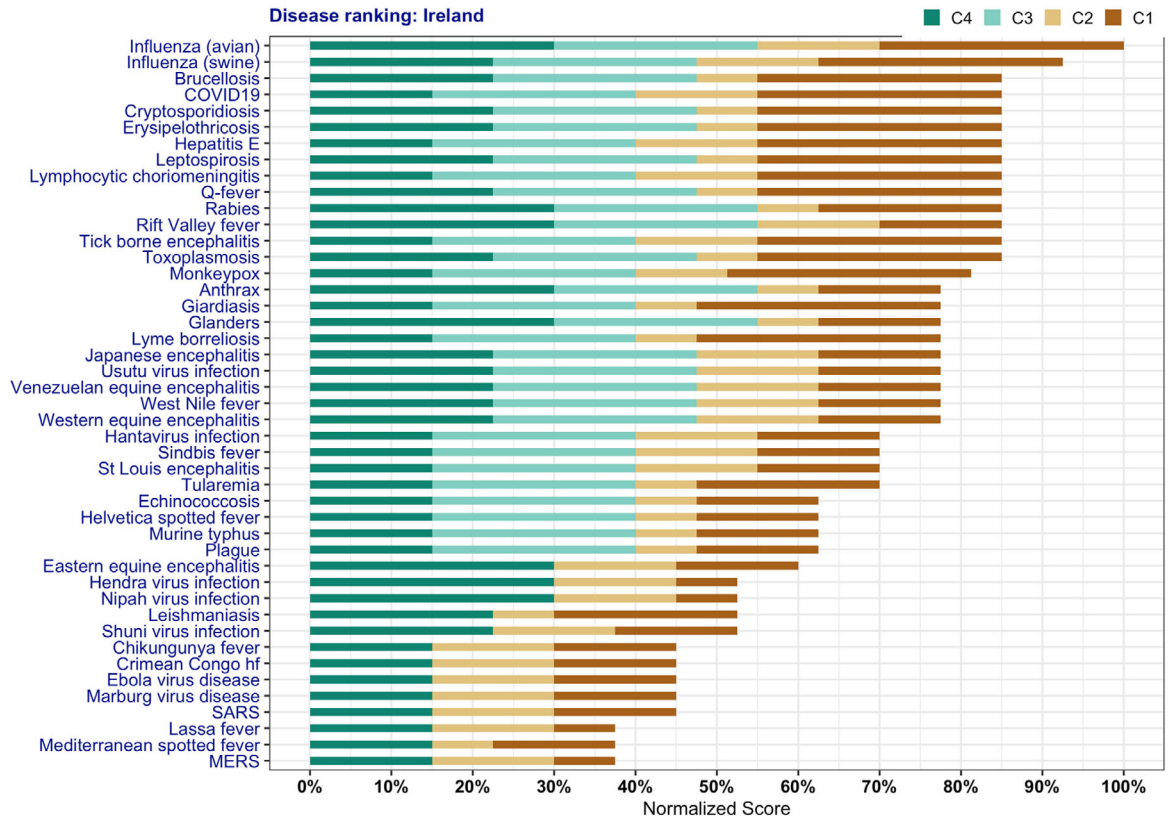

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Figure A.19: Individual disease ranking for Ireland

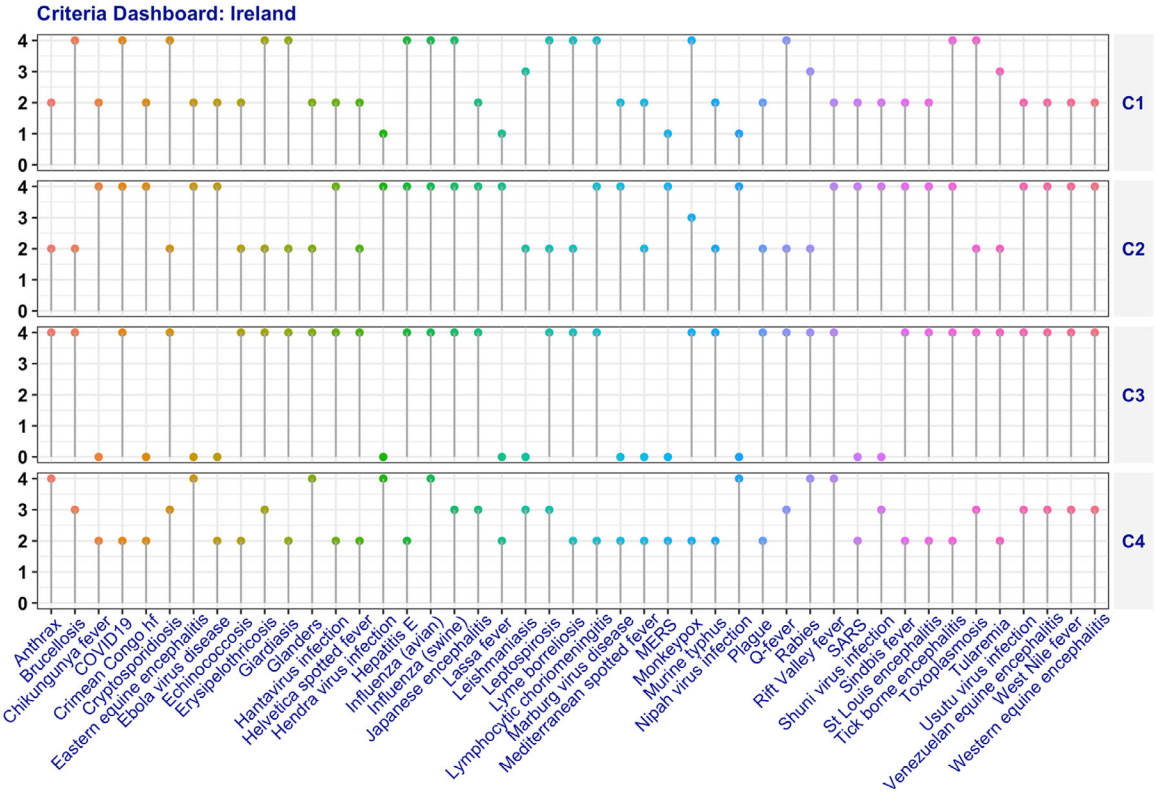

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Figure A.20: Criteria dashboard for Ireland

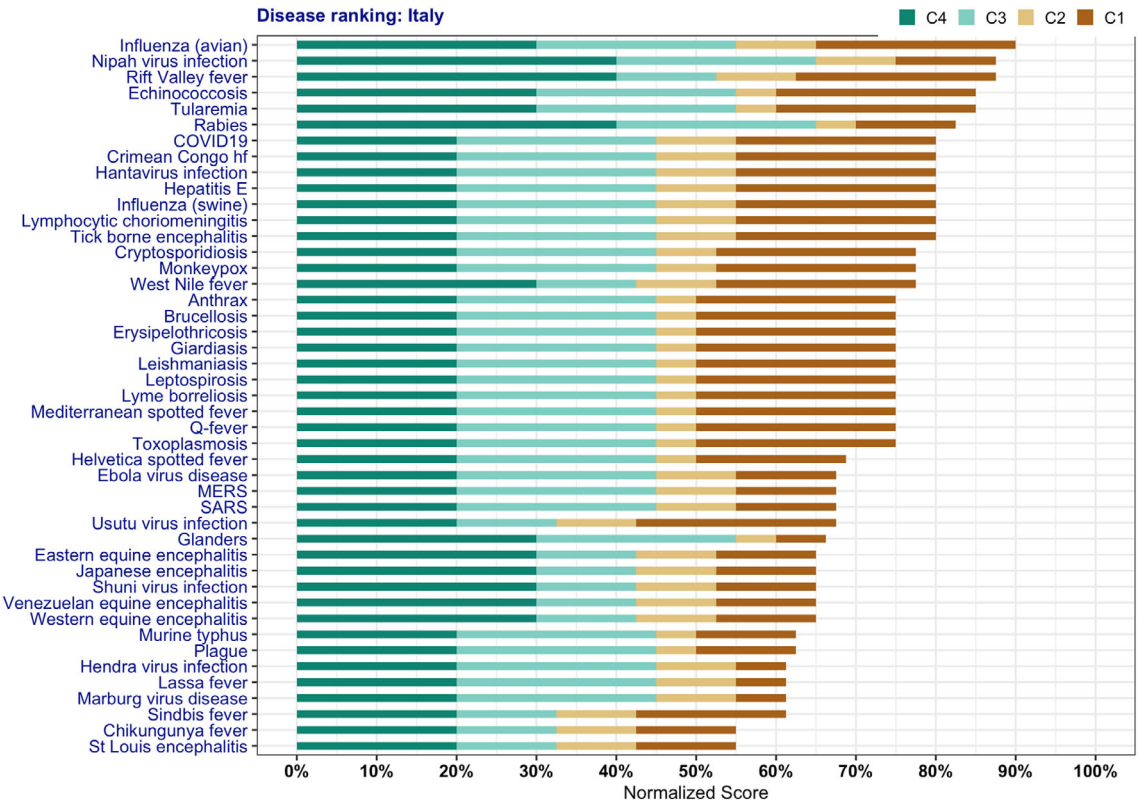

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Figure A.21: Individual disease ranking for Italy

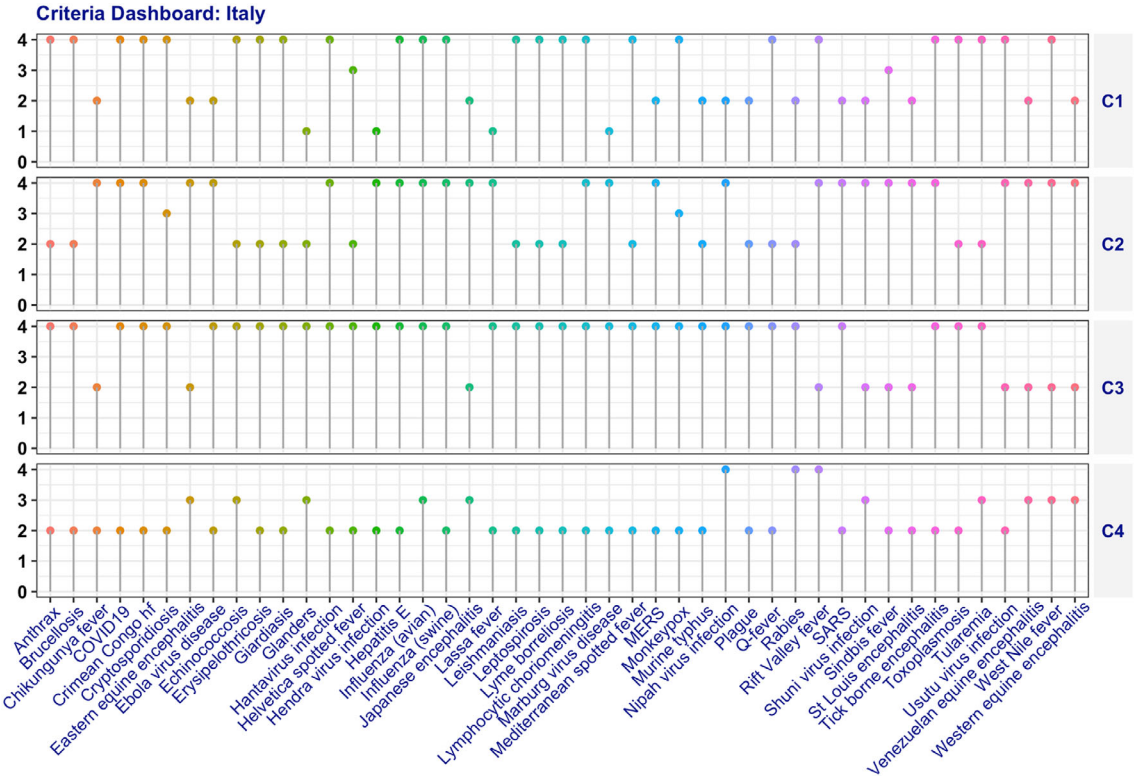

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Figure A.22: Criteria dashboard for Italy

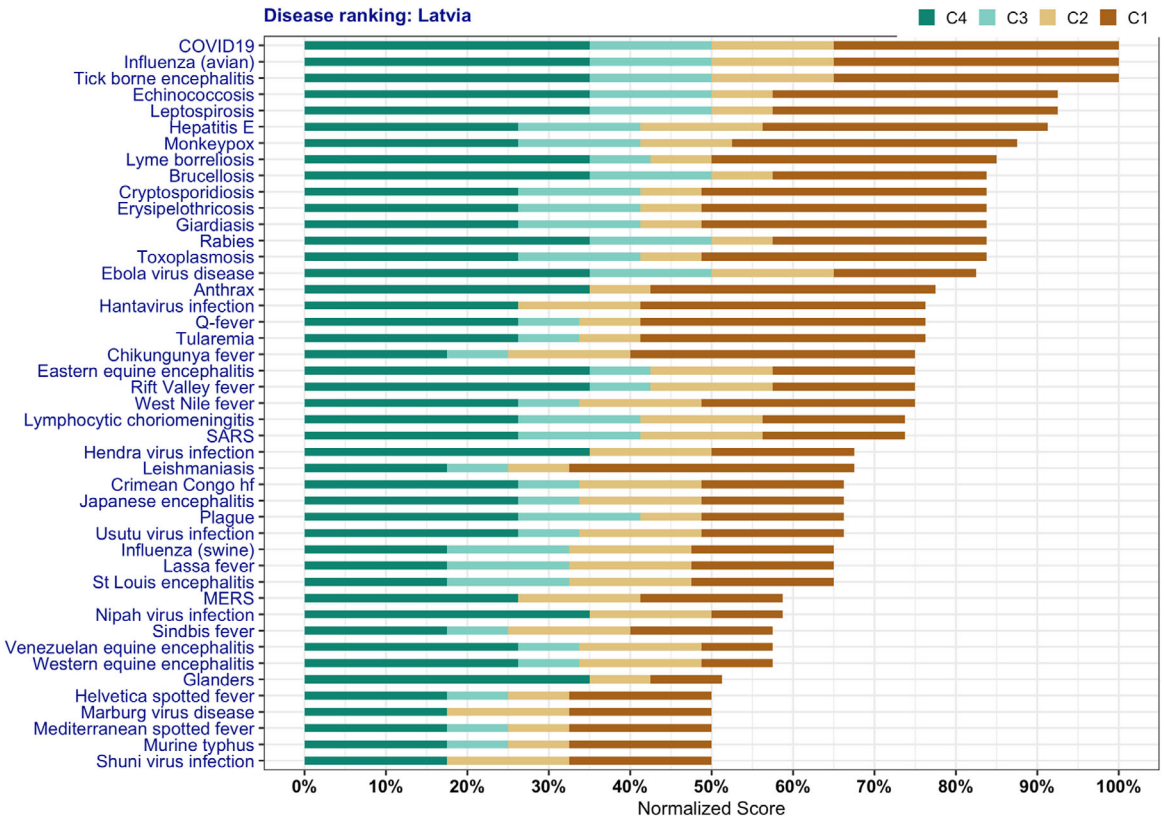

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Figure A.23: Individual disease ranking for Latvia

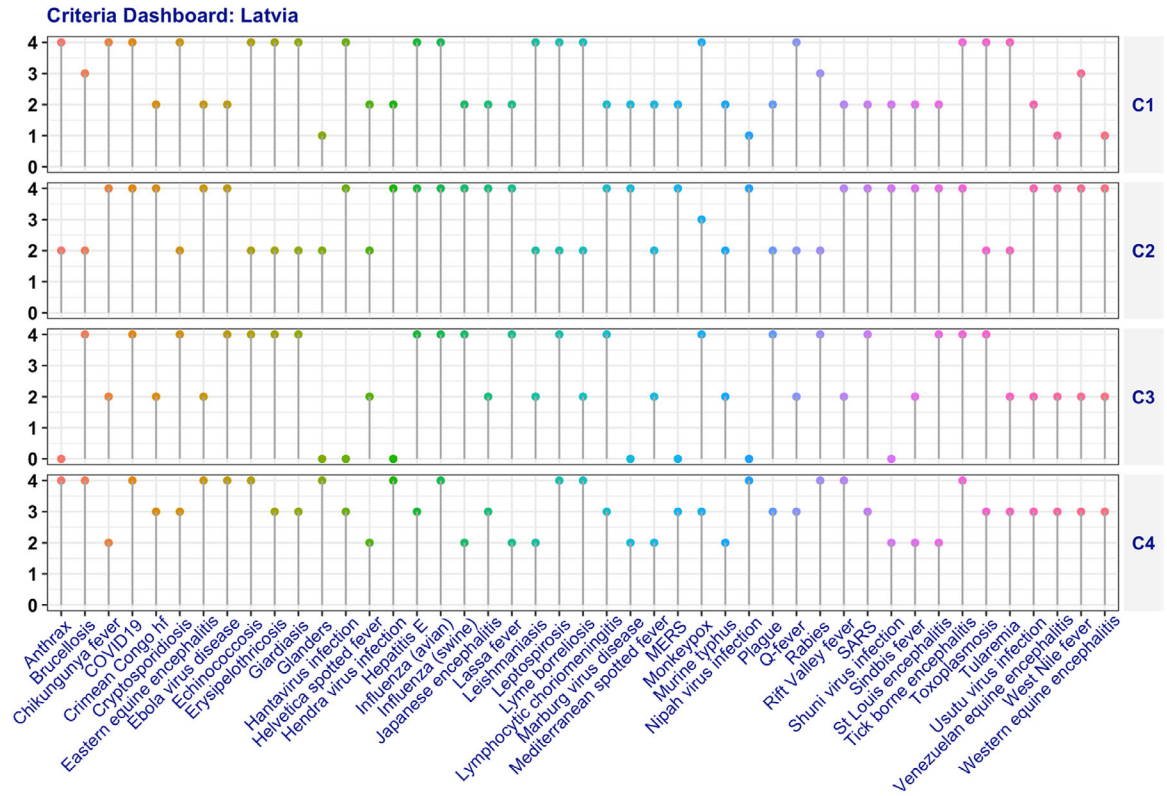

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Figure A.24: Criteria dashboard for Latvia

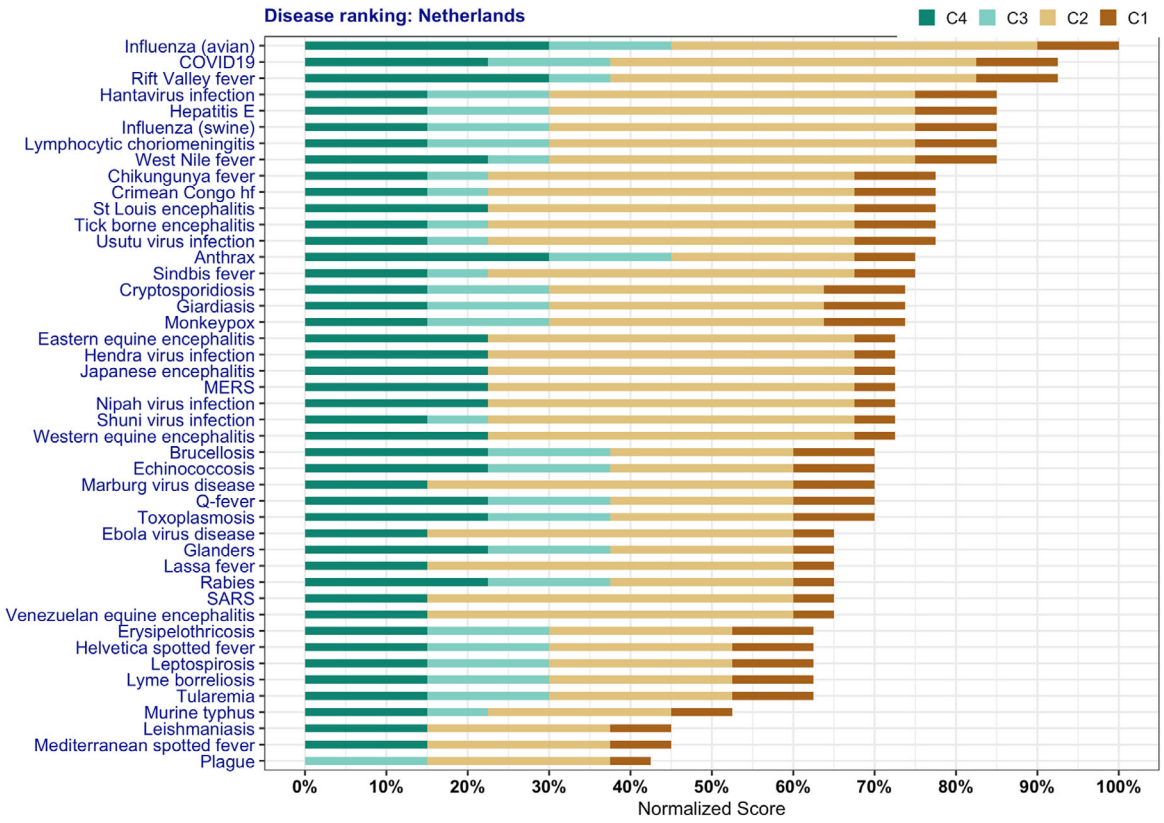

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Figure A.25: Individual disease ranking for the Netherlands

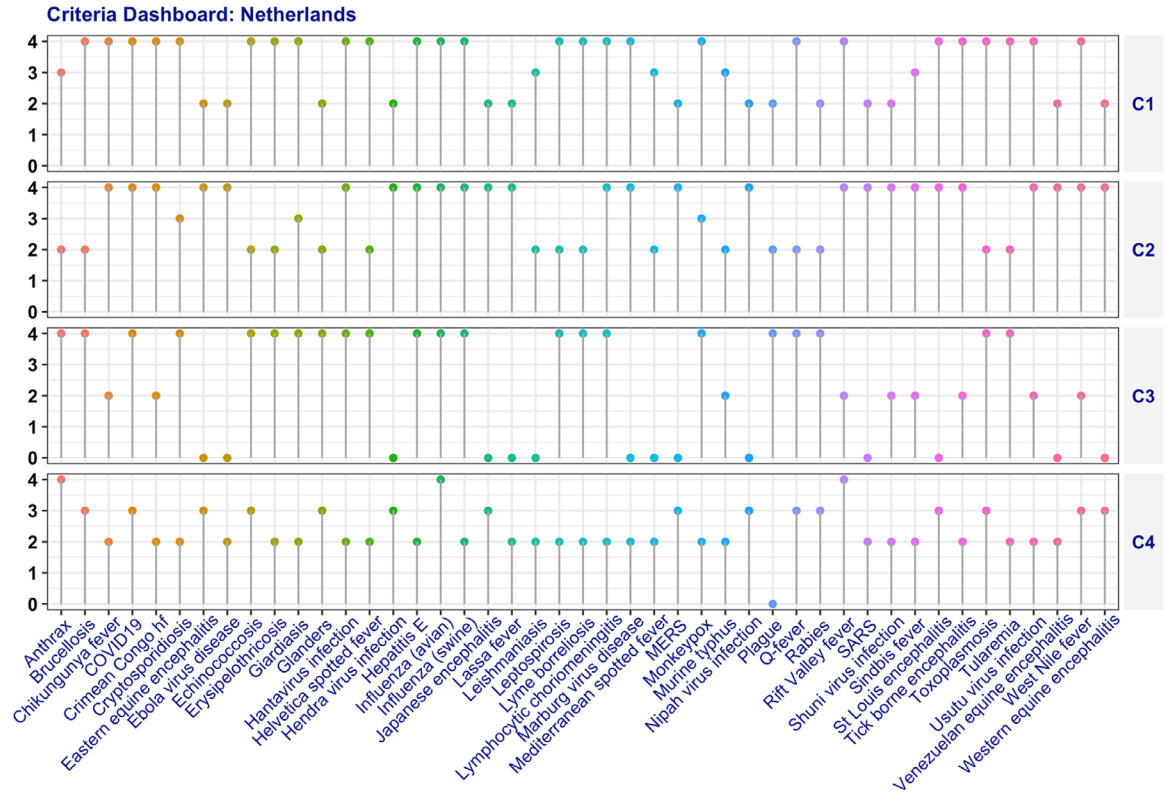

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Figure A.26: Criteria dashboard for the Netherlands

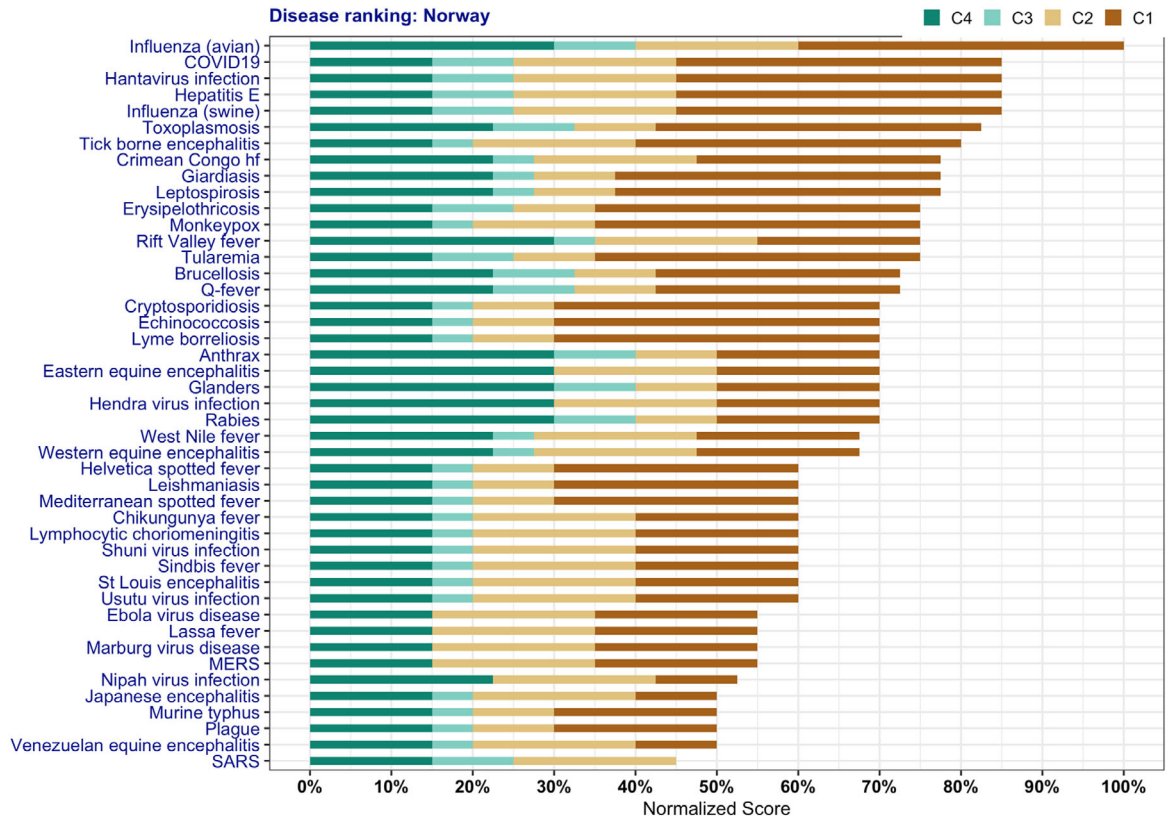

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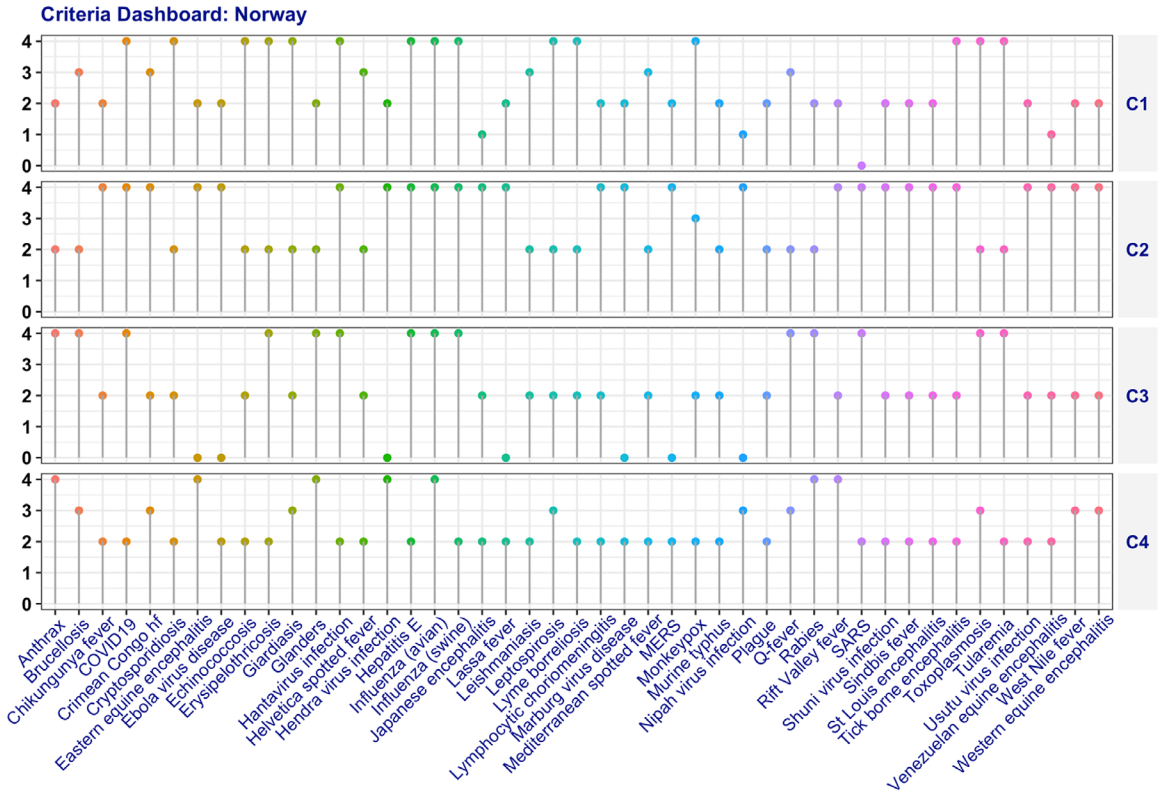
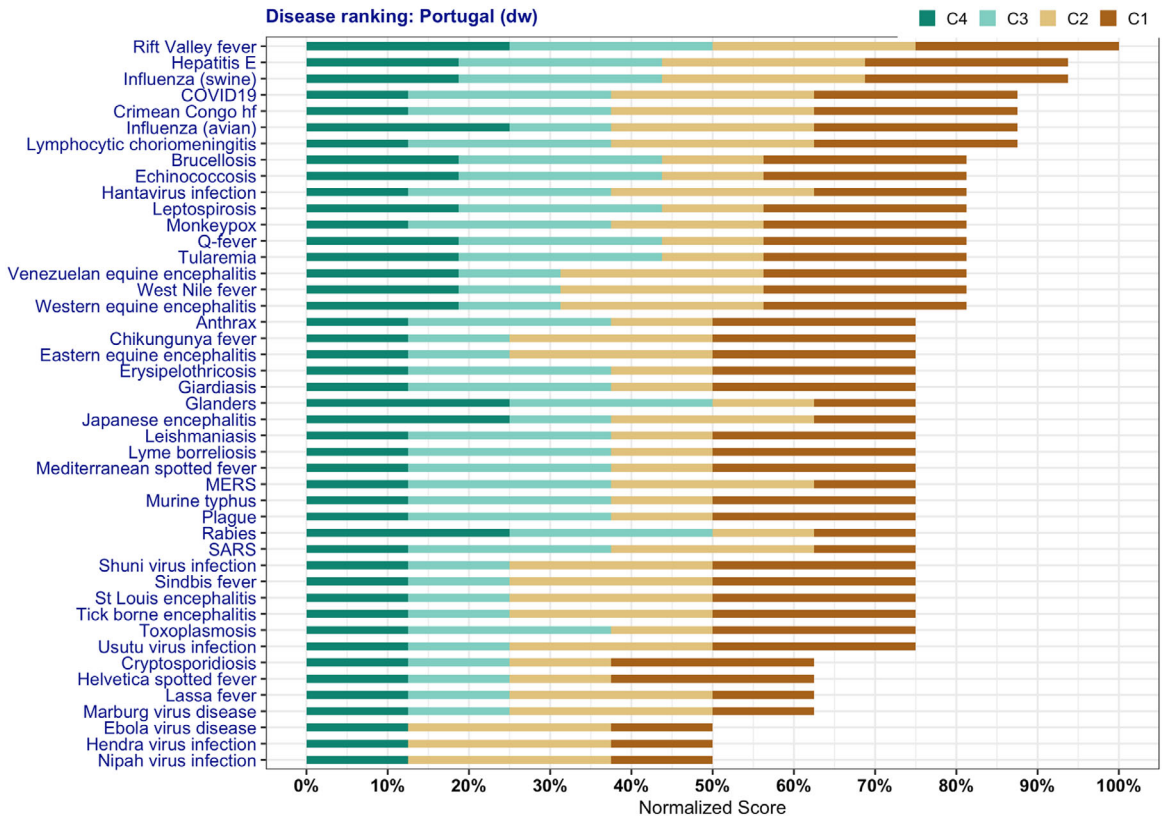
Figure A.27: Individual disease ranking for Norway



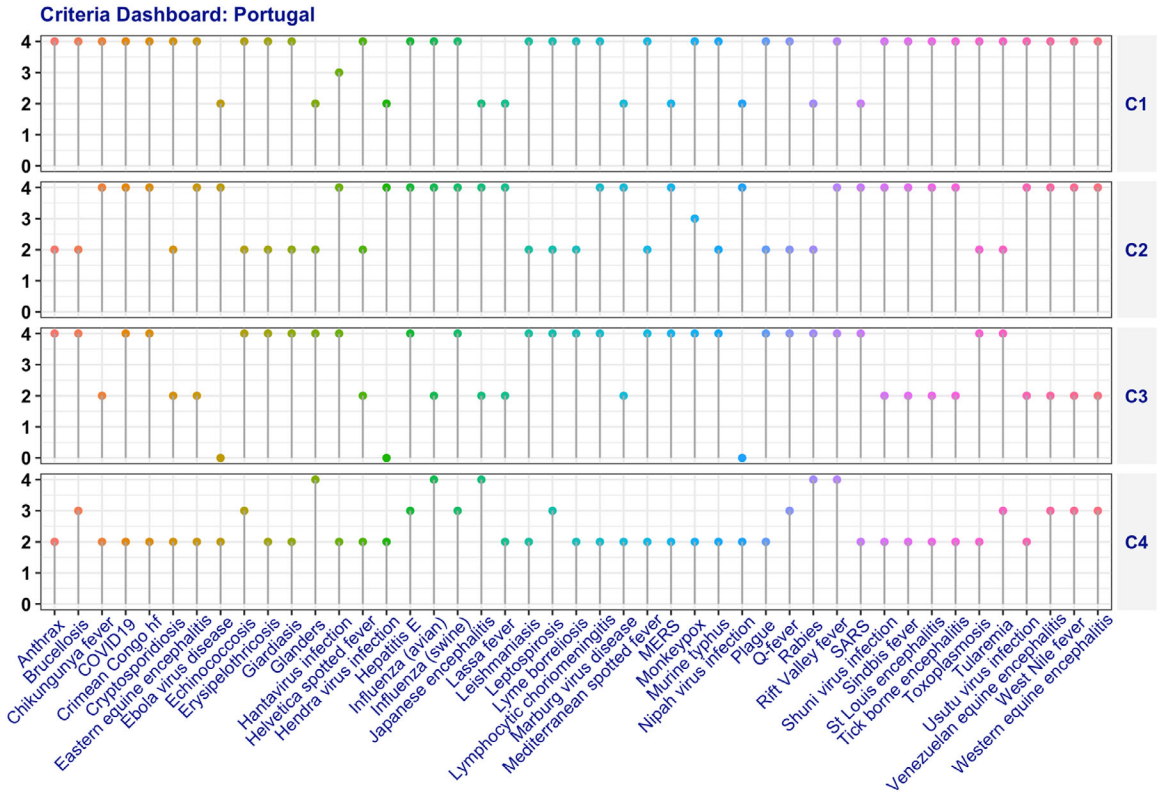
C: criterion.

Figure A.28: Criteria dashboard for Norway



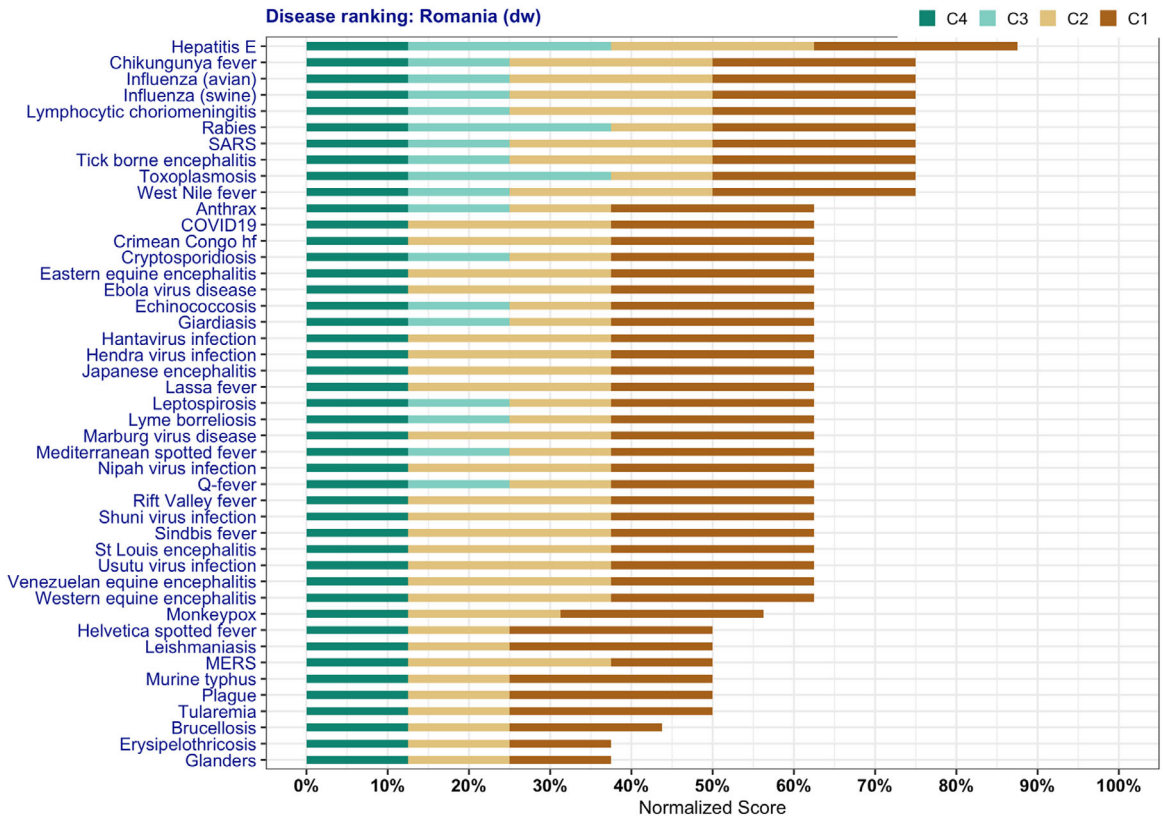
C: criterion; dw: default weights.

Figure A.29: Individual disease ranking for Portugal



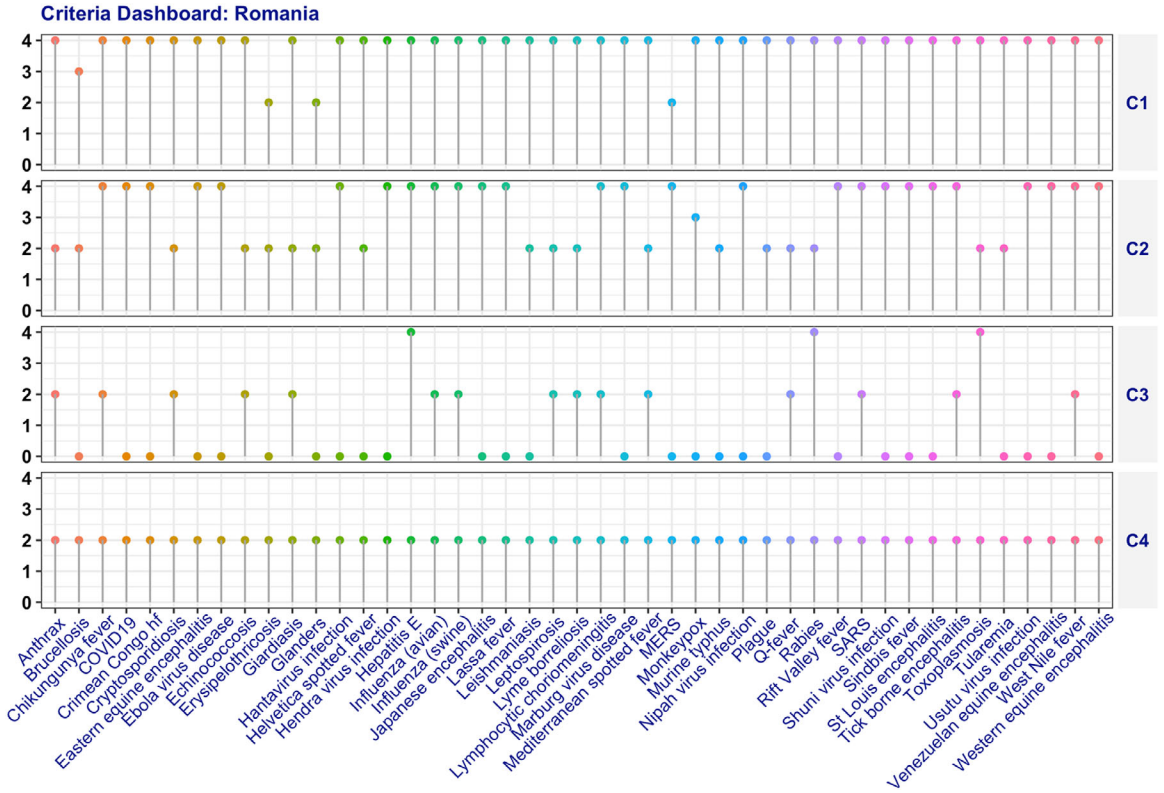
C: criterion

Figure A.30: Criteria dashboard for Portugal



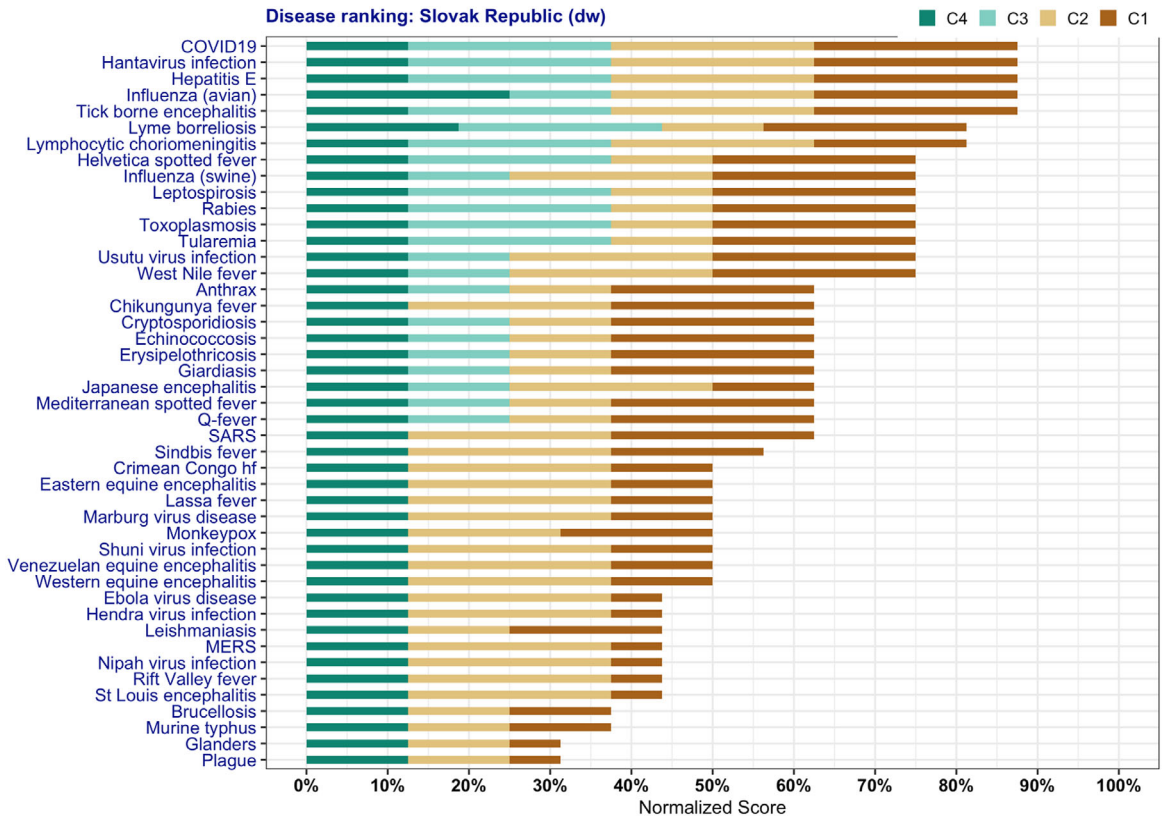
C: criterion

Figure A.31: Individual disease ranking for Romania



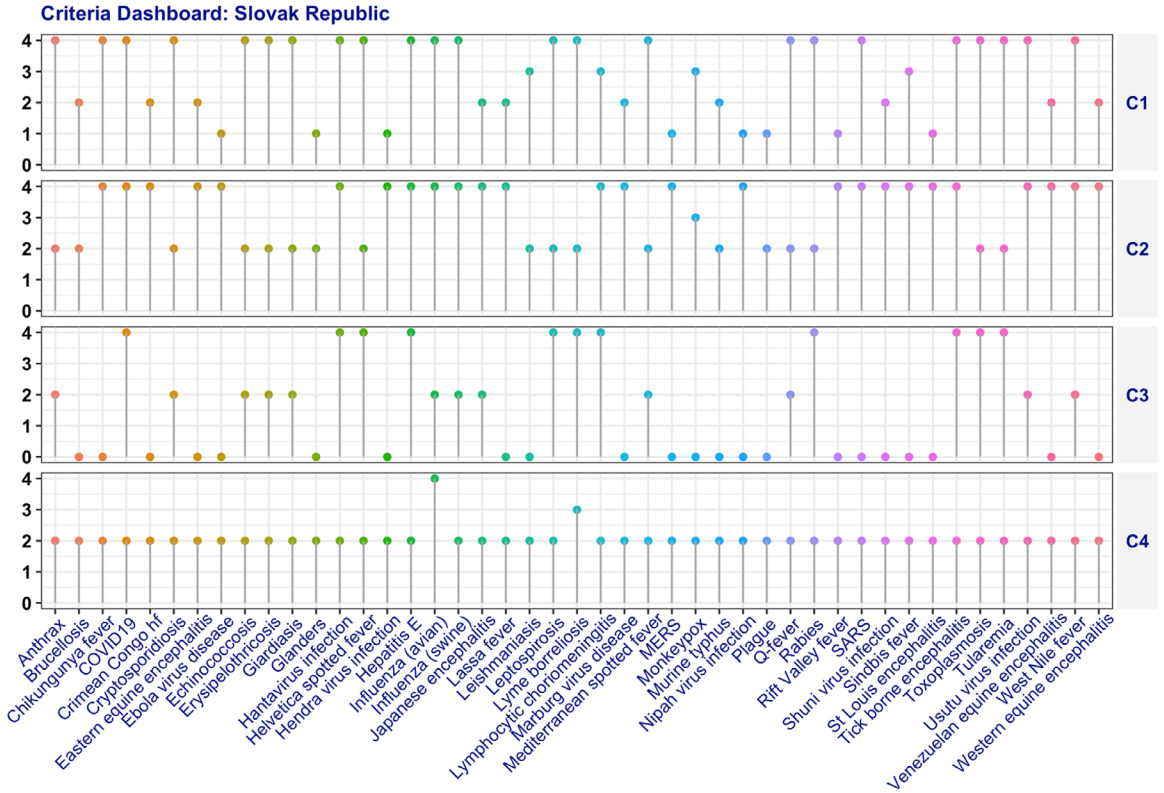
C: criterion

Figure A.32: Criteria dashboard for Romania



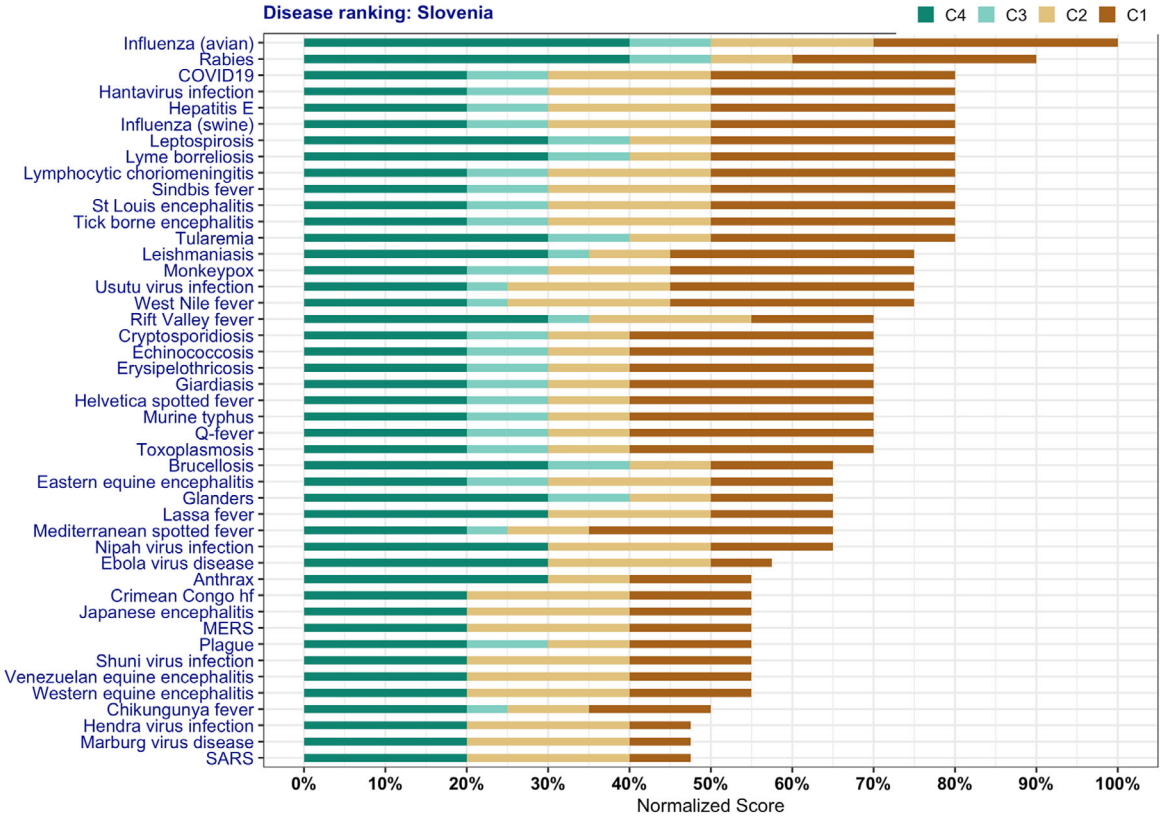
C: criterion; dw: default weights.

Figure A.33: Individual disease ranking for Slovak Republic



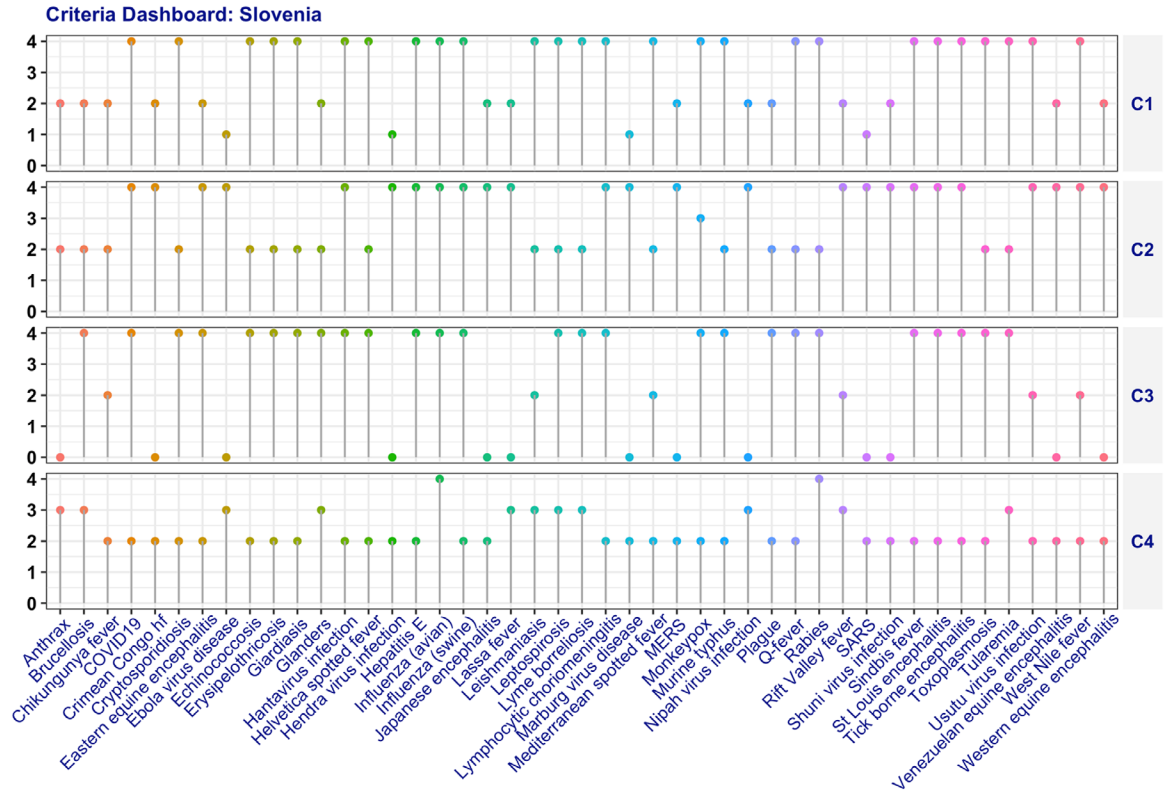
C: criterion.

Figure A.34: Criteria dashboard for Slovak Republic



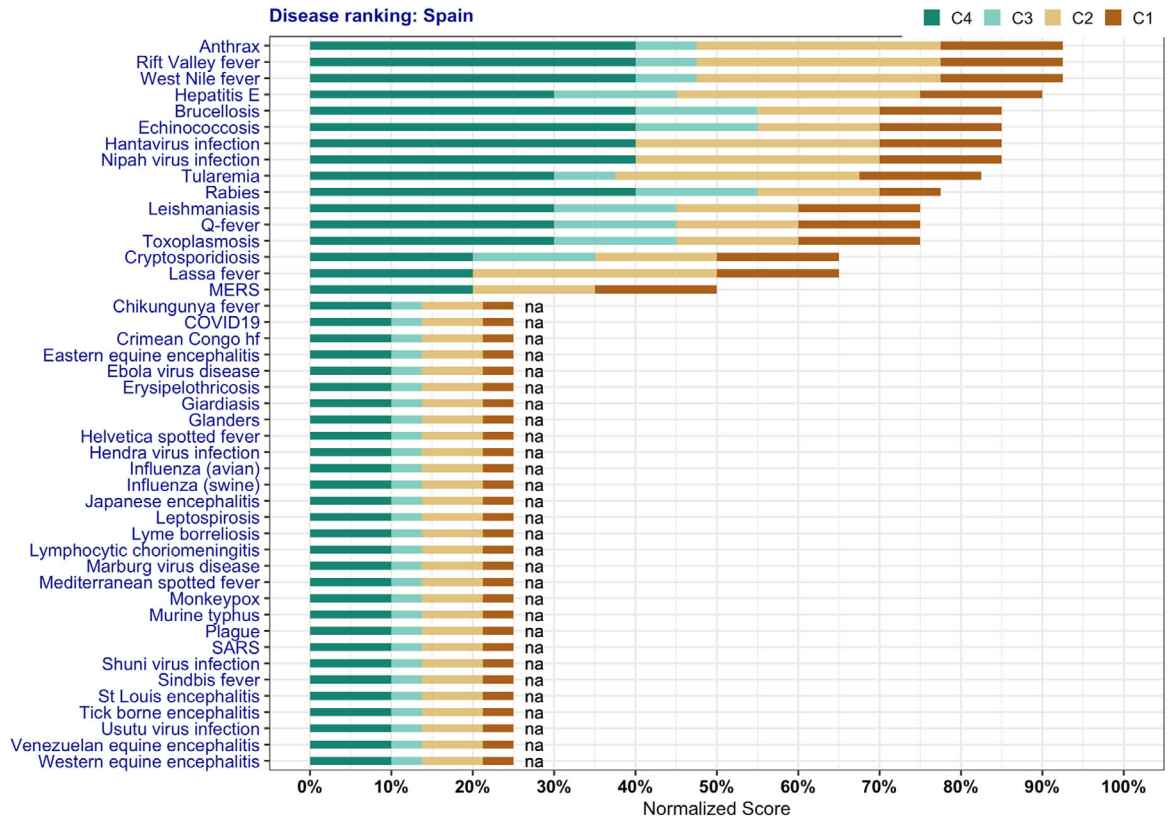
C: criterion.

Figure A.35: Individual disease ranking for Slovenia



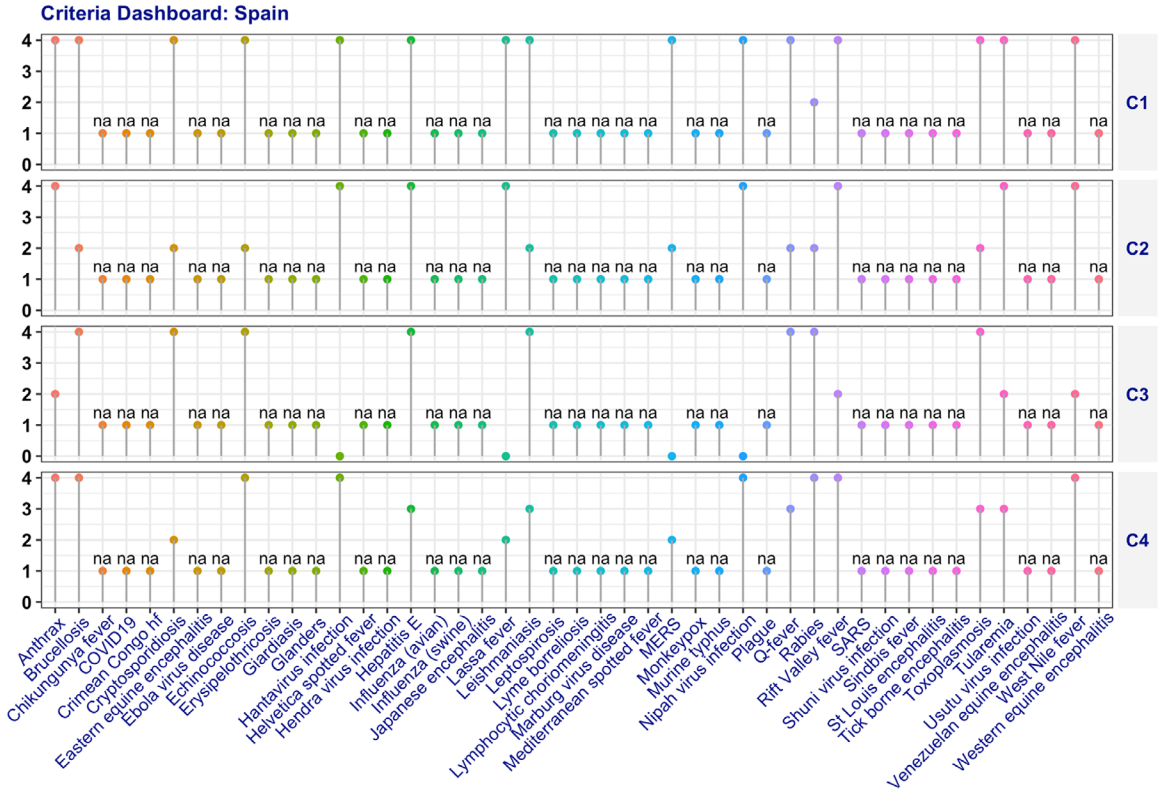
C: criterion.

Figure A.36: Criteria dashboard for Slovenia



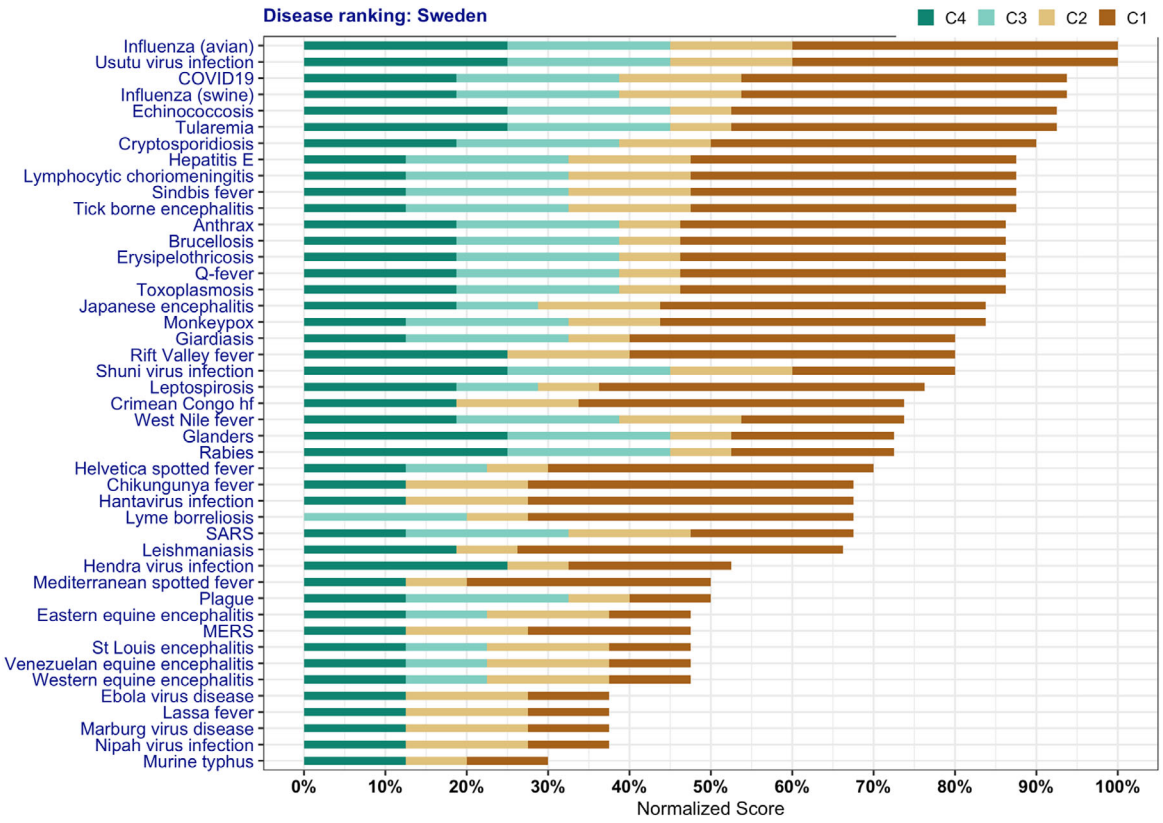
C: criterion; na: not available.

Figure A.37: Individual disease ranking for Spain



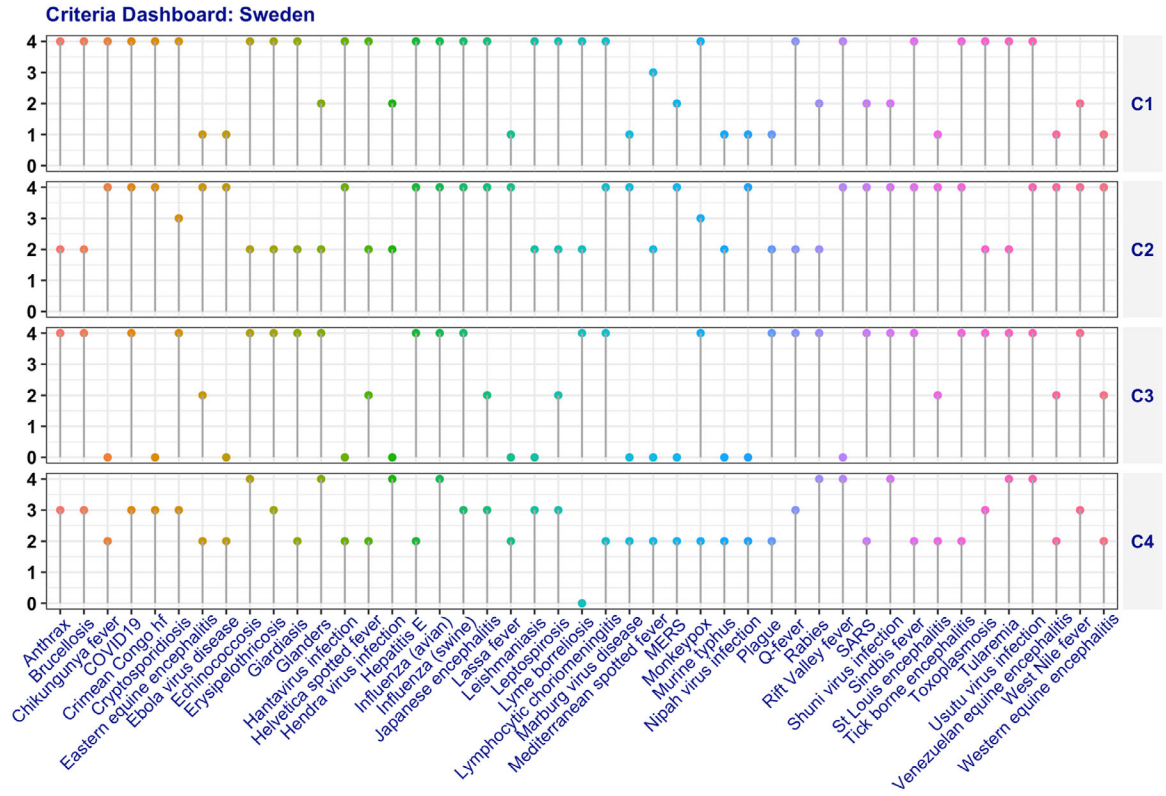
C: criterion; na: not available.

Figure A.38: Criteria dashboard for Spain



C: criterion.

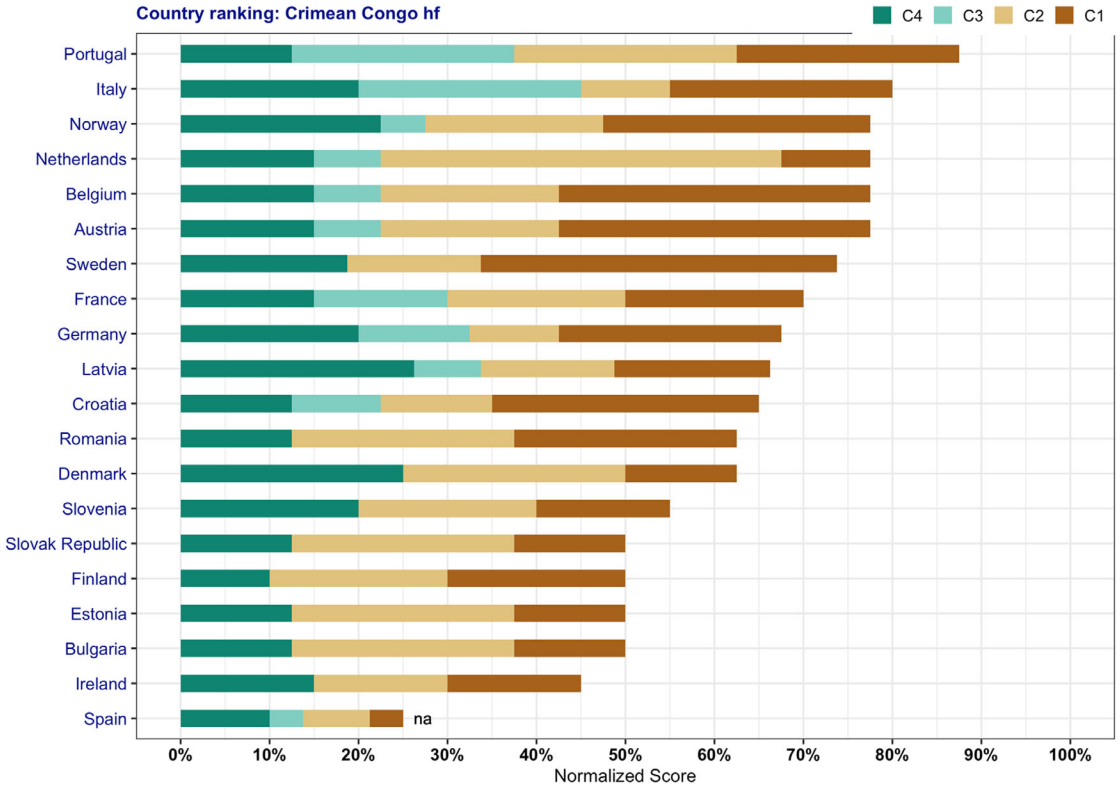
Figure A.39: Individual disease ranking for Sweden



C: criterion.

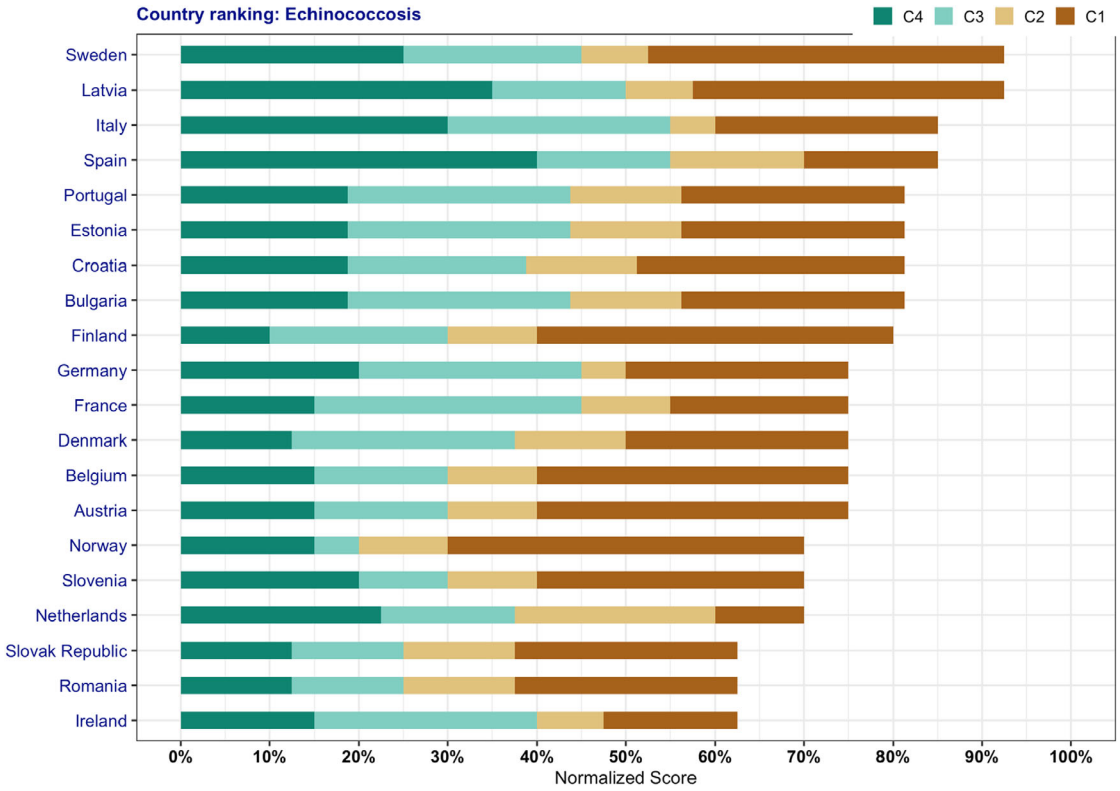
Figure A.40: Criteria dashboard for Sweden

Appendix B – Country rankings for the 10 priority diseases



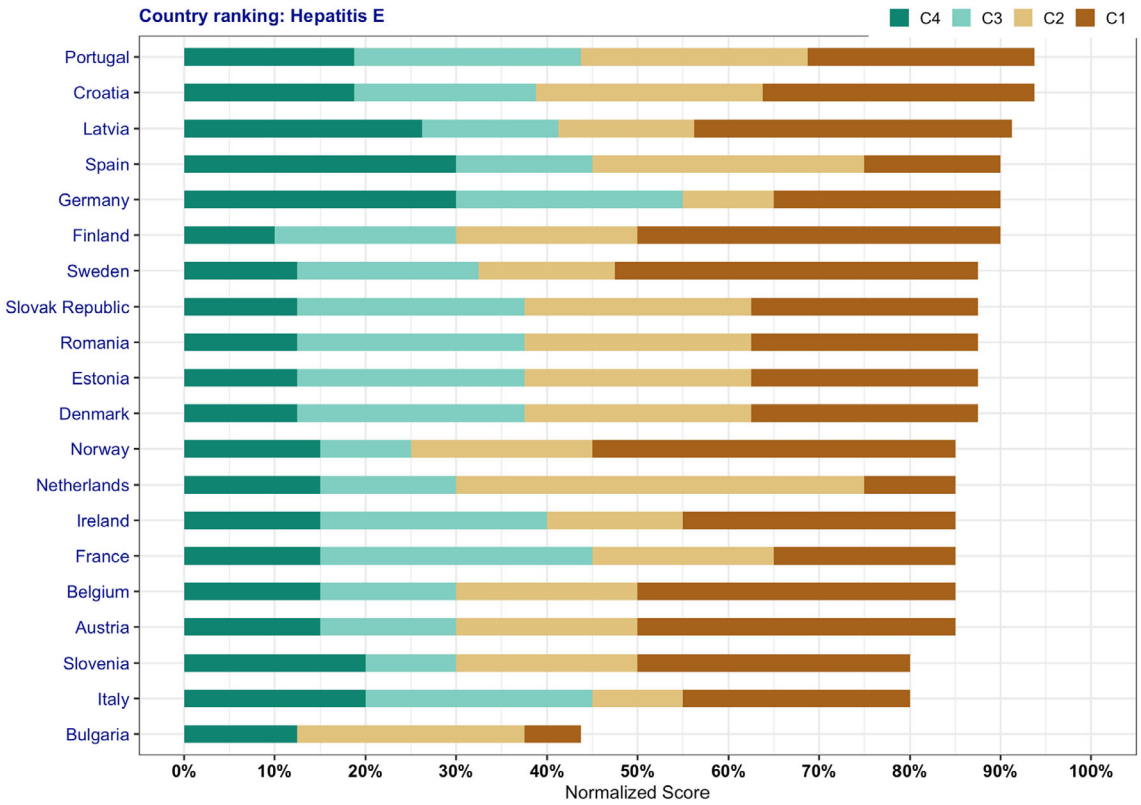
C: criterion.

Figure B.1: Disease-specific ranking for Crimean-Congo haemorrhagic fever



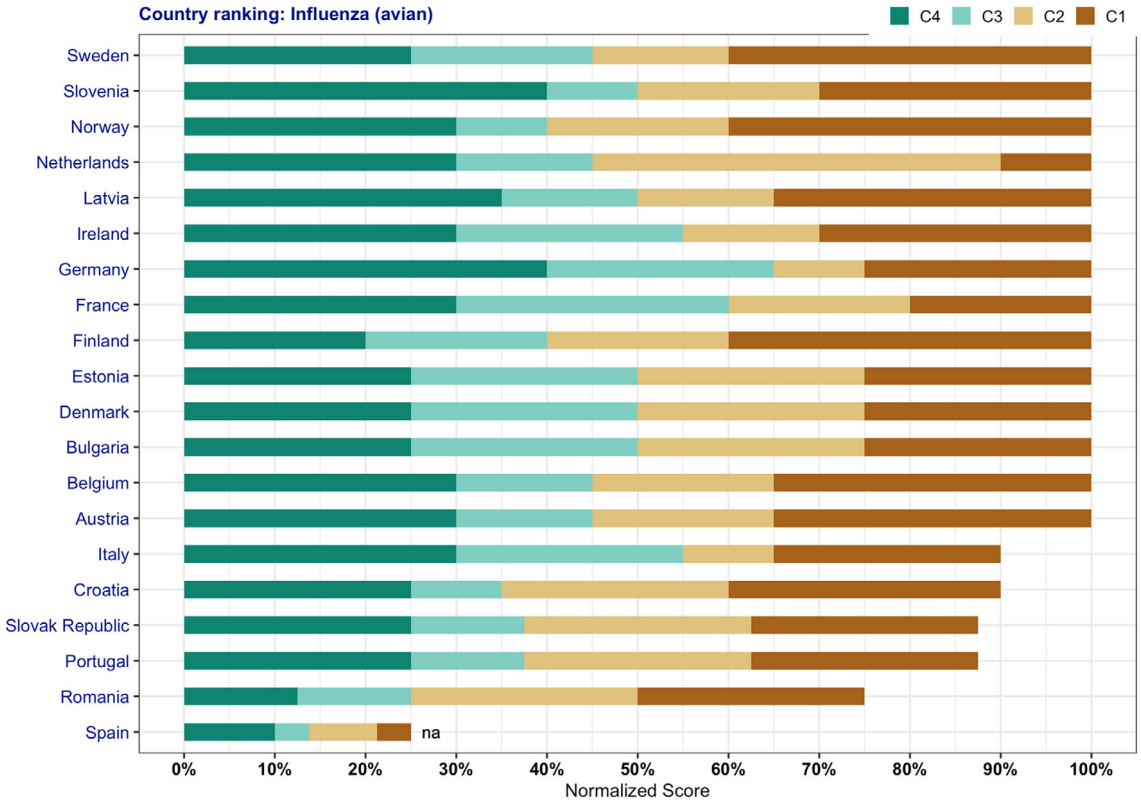
C: criterion.

Figure B.2: Disease-specific ranking for echinococcosis



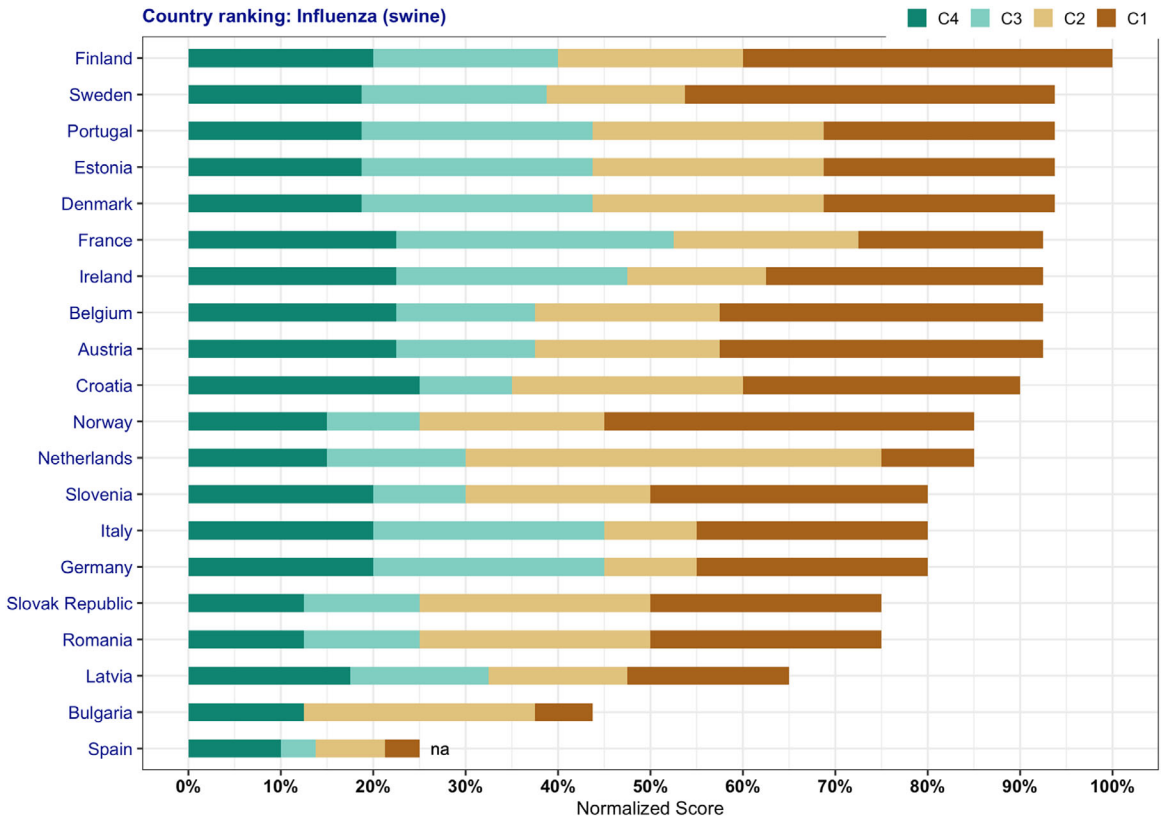
C: criterion.

Figure B.3: Disease-specific ranking for hepatitis E



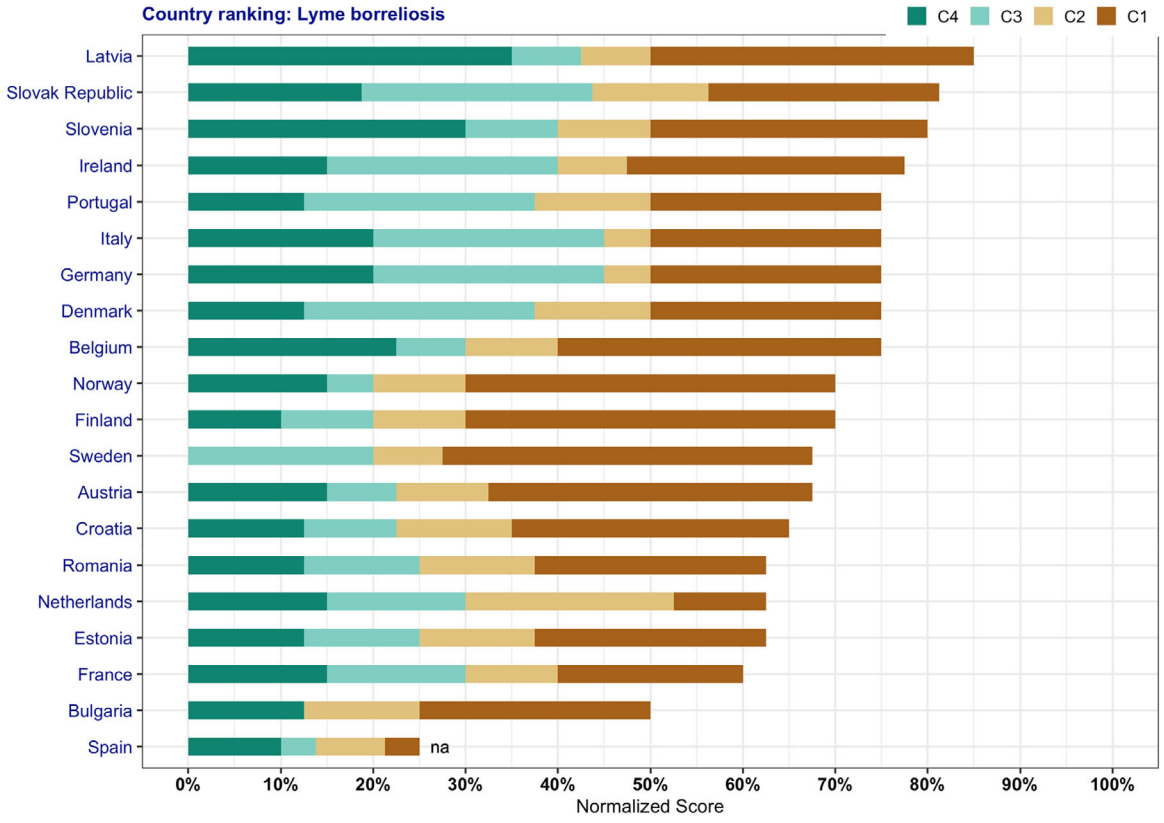
C: criterion.

Figure B.4: Disease-specific ranking for influenza (avian)



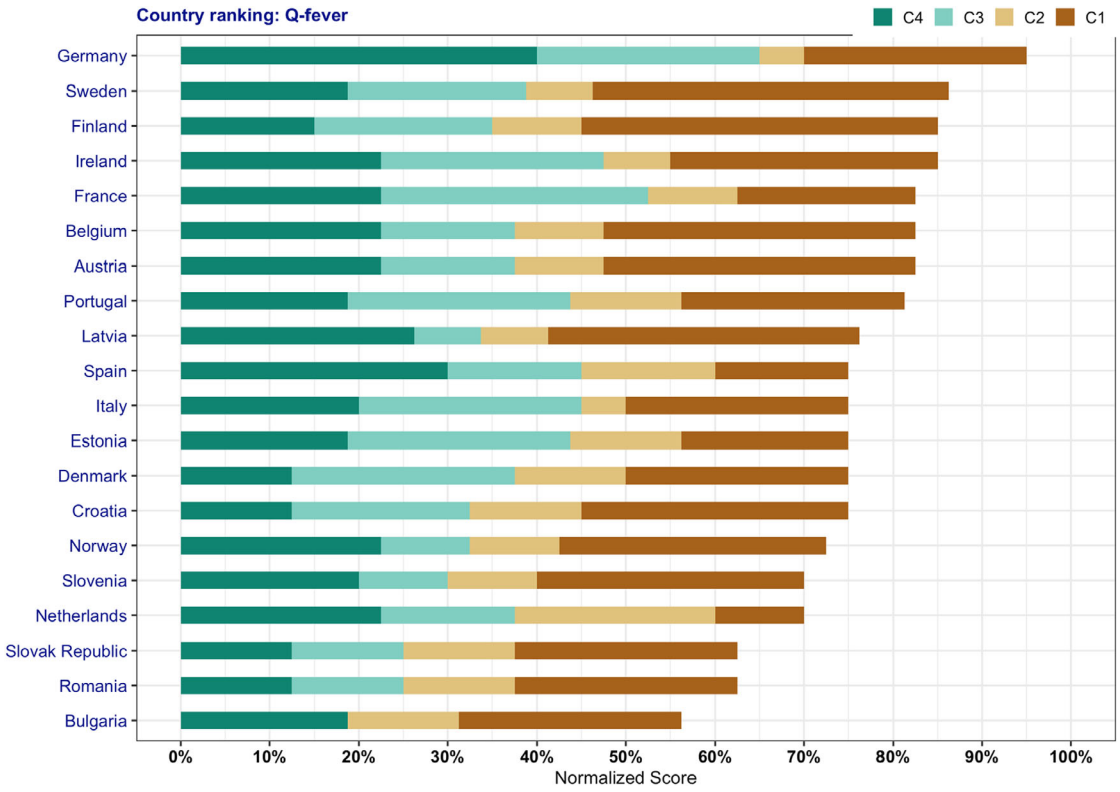
C: criterion.

Figure B.5: Disease-specific ranking for influenza (swine)



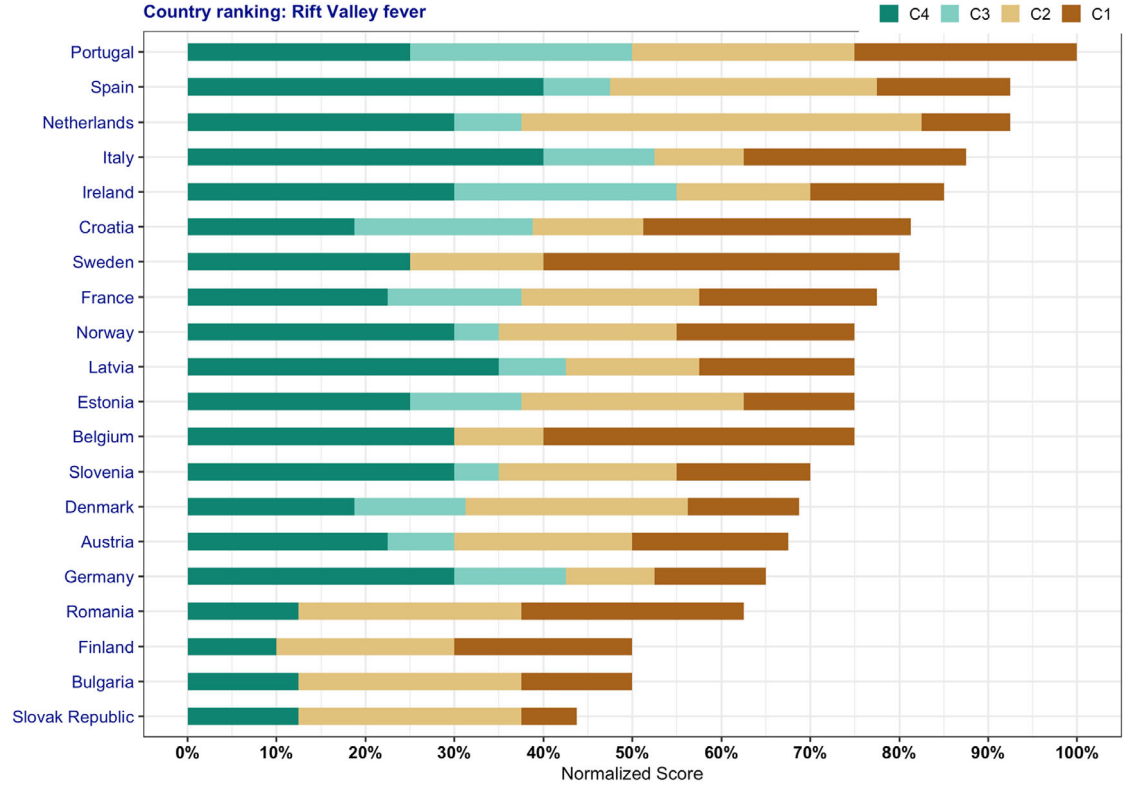
C: criterion.

Figure B.6: Disease-specific ranking for Lyme borreliosis



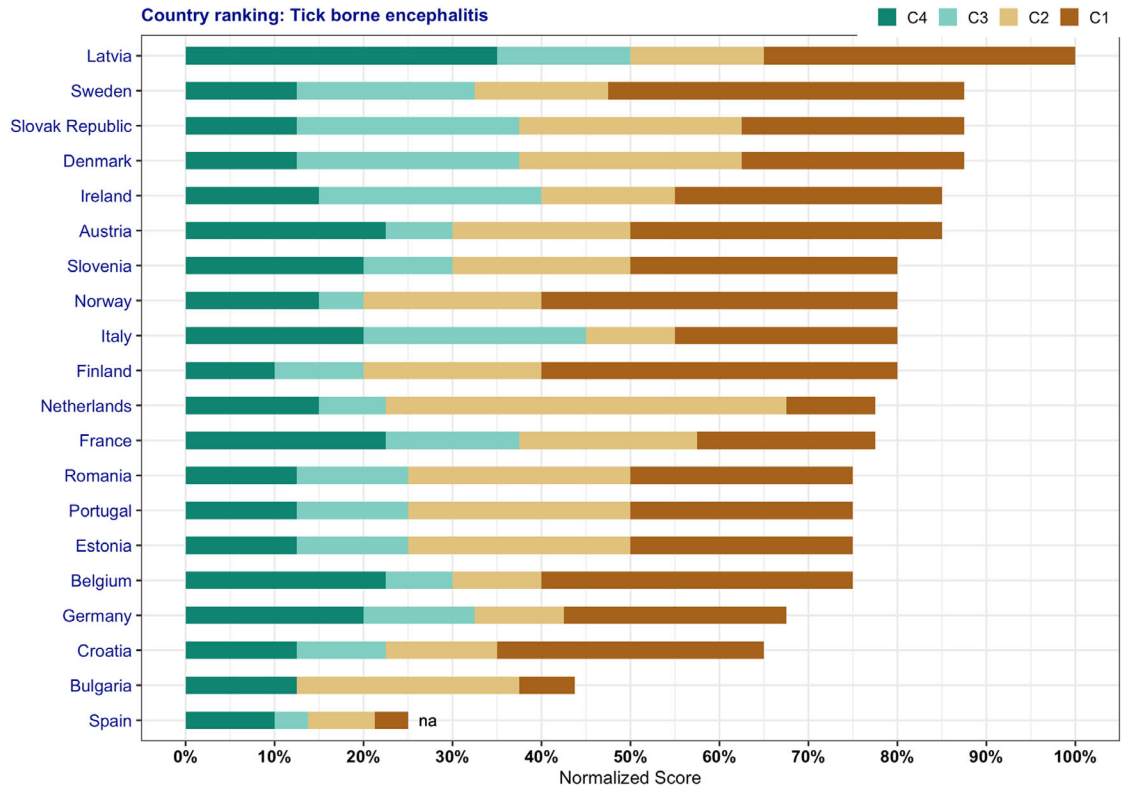
C: criterion.

Figure B.7: Disease-specific ranking for Q-fever



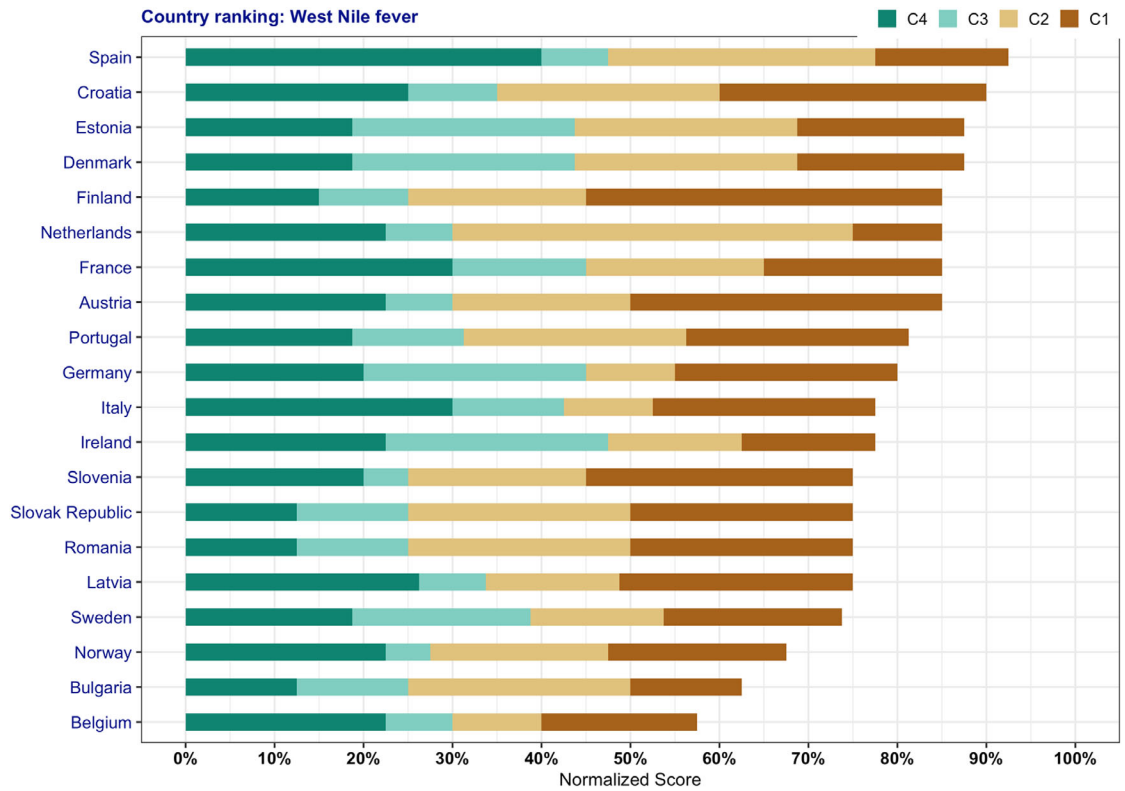
C: criterion.

Figure B.8: Disease-specific ranking for Rift Valley fever



C: criterion.

Figure B.9: Disease-specific ranking for tick-borne encephalitis



C: criterion.

Figure B.10: Disease-specific ranking for West Nile fever