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Risk ranking of foodborne parasites: State of the art

Brecht Devleesschauwer[a,*], Martijn Bouwknegt[b], Pierre Dorny[c,d], Sarah Gabriël[e], Arie H. Havelaar[f], Sophie Quoilin[a], Lucy J. Robertson[g], Niko Speybroeck[h], Paul R. Torgerson[i], Joke W.B. van der Giessen[j], Chiara Trevisan[c]

[a] Department of Public Health and Surveillance, Scientific Institute of Public Health (WIV-ISP), Brussels, Belgium
[b] Group Quality Assurance/R&D, Vion, Boxtel, The Netherlands
[c] Department of Biomedical Sciences, Institute of Tropical Medicine, Antwerp, Belgium
[d] Laboratory of Parasitology, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium
[e] Department of Veterinary Public Health and Food Safety, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium
[f] Emerging Pathogens Institute, Institute for Sustainable Food Systems, Animal Sciences Department, University of Florida, Gainesville, FL, USA
[g] Parasitology, Department of Food Safety and Infection Biology, Faculty of Veterinary Medicine, Norwegian University of Life Sciences, Adamstuen Campus, Oslo, Norway
[h] Institute of Health and Society (IRSS), Université Catholique de Louvain, Brussels, Belgium
[i] Section of Epidemiology, Vetsuisse Faculty, University of Zürich, Switzerland
[j] Centre for Zoonoses and Environmental Microbiology, National Institute for Public Health and the Environment, Bilthoven, The Netherlands

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ABSTRACT

In a time of increasing threats and decreasing financial resources, monitoring and controlling all possible foodborne hazards at the same time and to the same extent has become more challenging than ever. Therefore, attention is increasingly being paid to the so-called "risk ranking" methods that enable decision makers to focus on the most important foodborne hazards — even when time is limited and knowledge incomplete. In this review paper, we provide an overview of the most common quantitative methods and metrics used for ranking the risks associated with foodborne parasites and present the state of the art on risk ranking exercises for foodborne parasites.

A number of risk ranking metrics and methods are available, ranging from simple approaches that can be used to assess the health or economic impact of a foodborne parasitic disease, to more complicated but more comprehensive multi-criteria assessments. For health impact assessment, measures of population health such as disease occurrence and number of deaths; Disability-Adjusted Life Years (DALYs) measuring the healthy life years lost; and Quality-Adjusted Life Years (QALYs) measuring the number of life years lived in optimal health, are described. For economic impact assessment, applied approaches that measure the cost-of-illness from a societal perspective and stated preference methods are outlined. Finally, Multi-Criteria Decision Analysis (MCDA), which can be used to integrate multiple metrics and criteria into a single ranking, is described.

These risk ranking methods for foodborne parasites are increasingly performed to aid priority setting at global, regional, and national levels. As different stakeholders have their own prioritization objectives and beliefs, the outcome of such exercises is necessarily context-dependent. Therefore, when designing a risk ranking exercise for foodborne parasites, it is important to

Abbreviations: DALY, Disability-Adjusted Life Year; FAO, Food and Agriculture Organization of the United Nations; GBD, Global Burden of Disease; MCDA, Multi-Criteria Decision Analysis; QALY, Quality-Adjusted Life Year; SMPH, Summary Measure of Population Health; WHO, World Health Organization; WTA, Willingness-to-accept; WTP, Willingness-to-pay; YLD, Year Lived with Disability; YLL, Year of Life Lost

* Corresponding author at: Department of Public Health and Surveillance, Scientific Institute of Public Health (WIV-ISP), Rue Juliette Wytsmanstraat 14, 1050 Brussels, Belgium.
E-mail addresses: brechtdv@gmail.com, brecht.devleesschauwer@wiv-isp.be (B. Devleesschauwer).

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choose the metrics and methods, as well as what to rank, in the light of the predefined context of the question being addressed and the target audience.

1. Introduction

In a time of increasing threats (or recognition, c.q., perception thereof) and decreasing financial resources, it has become more challenging than ever to monitor and control all possible foodborne hazards at the same time and to the same extent (Speybroeck et al., 2015). Consequently, attention is being increasingly directed on methods that enable decision makers to focus on the most important foodborne hazards — even when time is limited and knowledge incomplete (Stella et al., 2013). These exercises are often labeled "risk ranking", but may differ widely in their intention, scope and methodology. According to the Codex Alimentarius, risk is defined as "a function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard(s) in food" (CAC (Codex Alimentarius Commission), 1999). However, severity can be quantified in different ways — it may, for instance, be defined as the health or economic impact of the adverse health effects. Furthermore, the function can take many different shapes — ranging from a mere sum to complicated weighted averages. As a result, the concept of "risk", and thus "risk ranking", is not as standardized as it should be. However, the same goal, which is to accomplish an internally consistent and comparable set of risk estimates allowing ranking, and thus prioritization among a given number of hazards, is shared in all risk ranking exercises.

Foodborne parasitic diseases present some unique challenges, including their often prolonged incubation period and association with chronic sequelae. Furthermore, as most foodborne parasitic diseases are not notifiable, their true importance is often under-reported and under-recognized (Torgerson et al., 2015). In this review paper, we aim to provide an overview of the most common quantitative methods and metrics used for ranking foodborne parasites according to their associated risks. We also provide the state of the art on risk ranking exercises for foodborne parasites. For further information on risk ranking, readers are kindly referred to Brookes et al. (2015), who discuss risk ranking in the context of decision science, and to O'Brien et al. (2016) and Van der Fels-Klerx et al. (2016), who discuss risk ranking methods for infectious and foodborne diseases, respectively.

2. Health impact

2.1. Methods and metrics

Quantifying health impacts may be based on disease occurrence (prevalence or incidence) or on the number of deaths (mortality). However, these unidimensional or *simple* measures of population health do not provide a complete picture of the impact of foodborne parasites on human health as they do not combine the impacts of morbidity and mortality, thus precluding a comparative ranking of diseases with high morbidity, but low case-fatality, such as chorioretinitis due to toxoplasmosis, and highly lethal diseases such as alveolar echinococcosis (Batz et al., 2012; Devleesschauwer et al., 2015a). Furthermore, disease severity, defined by the impact on quality of life and the duration of the symptoms, as well as the expected residual life expectancy at the age of death, should be accounted for when quantifying burden of disease. Indeed, certain parasitic infections may be very common, but their clinical impact may be minimal. For instance, infections with a highly prevalent parasite such as the pinworm, *Enterobius vermicularis*, have a very low burden because most of the cases are mild to asymptomatic and self-limiting (Knopp et al., 2012).

In order to overcome the limitations of simple measures such as incidence and mortality, *summary* measures of population health (SMPHs) have been developed as an additional way of expressing information for quantifying disease burden. The Disability-Adjusted Life Year (DALY) is currently the most widely used SMPH in public health research. Originally developed to quantify and compare the burden of diseases, injuries, and risk factors within and across countries, the DALY summarizes the occurrence and impact of morbidity and mortality in a single metric (Devleesschauwer et al., 2014a). The DALY is the key measure in the Global Burden of Disease (GBD) studies and has been officially adopted by the World Health Organization (WHO) for reporting on health information (Murray et al., 2012; WHO (World Health Organization), 2017).

The DALY is a health gap measure, measuring the quantity of healthy life years lost due to a disease or injury against some idealized health profile. DALYs are calculated by adding the number of years lived with disability adjusted for the severity of the disease (YLDs) and the number of years of life lost due to premature mortality (YLLs):

YLD = Number of incident cases × Duration until remission or death × Disability Weight.

YLL = Number of deaths × Residual life expectancy at the age of death.

An alternative formula for calculating YLDs was introduced by the GBD 2010 study (Murray et al., 2012):

YLD = Number of prevalent cases × Disability Weight.

This formula reflects a prevalence perspective instead of an incidence perspective. The incidence perspective assigns all health outcomes, including those in future years, to the initial event (e.g., exposure to a certain foodborne parasite). This approach therefore reflects the future burden of disease resulting from current events. In the prevalence perspective, on the other hand, the health status of a population is assessed at a specific point in time, and prevalent diseases are attributed to initial events that happened in the past. This approach thus reflects the current burden of disease resulting from previous events. Although both perspectives are valid, the incidence perspective is more appropriate for foodborne parasites, as it is more sensitive to current epidemiological trends, including the effects of intervention measures (Murray, 1994; Devleesschauwer et al., 2015a).