Final PhD Thesis Report

MACE

Mathematical models for cystic echinococcosis control and surveillance evaluation

Responsible OHEJP Partner: University of Surrey

Contributing OHEJP partners: ISS

Contributing external partners: Not Applicable

GENERAL INFORMATION

European Joint Programme full title	Promoting One Health in Europe through joint actions on foodborne zoonoses, antimicrobial resistance and emerging microbiological hazards.
European Joint Programme acronym	One Health EJP
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DOCUMENT MANAGEMENT

PhD Report	Final PhD Thesis Report Y5 (2022)
PhD Reference	PhD 07 - MACE
PhD candidate	Mahbod Entezami
PhD Lead Supervisor	Dr Joaquin M. Prada
PhD second supervisor	Dr Giovanni Lo Iacono
Other supervisor (s)	Dr Adriano Casulli
Due month of the deliverable	M66
Actual submission month	M66
Type *R: Document, report* *DEC: Websites, patent filings, videos, etc.; OTHER*	R
Dissemination level *PU: Public (default)* *CO: confidential, only for members of the consortium (including the Commission Services).*	**PU** *This is the default setting. This report will be entirely copied into One Health EJP Work Package 6 Deliverable D6.18 - Thesis Reports of up to 17 PhD studentships.*
Dissemination *Author's suggestion to inform the following possible interested parties.*	OHEJP WP 1 ☐ OHEJP WP 2 ☐ OHEJP WP 3 ☐ OHEJP WP 4 ☐ OHEJP WP 5 ☐ OHEJP WP 6 ☒ OHEJP WP 7 ☐ Project Management Team ☒ Communication Team ☐ Scientific Steering Board ☐ National Stakeholders / Program Owners Committee ☐ EFSA ☐ ECDC ☒ EEA ☐ EMA ☐ FAO ☐ WHO ☒ WOAH ☒ Other international stakeholder(s): …… Social Media: …… **Other recipient(s):** ……

INTRODUCTION

CONFIDENTIALITY

Due to University Regulations, this report summarizes the work carried out in the MACE project at a high level. The complete details will be publicly available once the Thesis is completed and approved.

1. PhD Project team composition

PhD student: Mahbod Entezami
University at which the PhD is registered: University of Surrey
Lead PhD Supervisor: Dr Joaquin M. Prada
Second Supervisor: Dr Giovanni Lo Iacono
Other Supervisors: Dr Adriano Casulli
Date for PhD thesis submission: July 2023

2. Abstract

Cystic echinococcosis (CE) is a zoonotic disease of global relevance that leads to significant morbidity and economic losses in the livestock industry. Effective intervention and surveillance strategies are essential and available for controlling and preventing the spread of this disease. As a Neglected Tropical Disease (NTD), one of the main obstacles of control and surveillance is resource constraints and lack of sustainable investments. The Modelling Approaches for Cystic Echinococcosis (MACE) project aims to address these issues by utilizing an interdisciplinary approach that combines spatial analysis, individual-based transmission modelling, and stakeholder elicitation techniques.

A spatial model was designed to investigate the spatial heterogeneity of CE infection in different livestock species across farms and was implemented in central and southern Italy. The model allowed the identification of disease “hot spots” at high spatial resolution between multiple Italian provinces, while also highlighting species-specific infection risk. A total of 3141 animal samples from abattoirs were collected and used to predict the probability of infection in farms. Areas of high infection rates were found in the regions of Sardinia, Sicily and Salerno province. The resulting maps of infection risk will be valuable for targeted intervention efforts and further surveillance programmes, enabling efficient allocation of resources and optimized disease control strategies. This study was carried out in collaboration with Prof. Rinaldi and her team from the University of Naples, she is the director of the WHO Collaborating Centre for Diagnosis of Intestinal Helminths and Protozoa and works closely with the local ministries.

An individual-based CE transmission model in a farms was developed and implemented in the context of a resource constrained setting using the province of Rio Negro, Argentina as a case study. The model captures key aspects of the parasite life cycle and host interactions, allowing for the evaluation of intervention strategies such as anthelmintic treatment and vaccination, while accounting for individual-level heterogeneities. The results contribute to the increase in insights into the effectiveness of these strategies in reducing disease prevalence, assisting policymakers in making evidence-based decisions for CE management. This study was carried out in close collaboration with Ministry of Health officials from Rio Negro. Further analysis of intervention costings will be conducted to allow for economically viable strategies.

A socio-economic study was carried out involving an elicitation survey to assess stakeholders' willingness to invest/disinvest in surveillance sensitivity for infectious diseases in a One Health context. The survey explored this at different levels of surveillance sensitivity and with different uncertainties as to the outcomes of the decisions being made. Understanding these priorities and financial constraints is key to identify the most acceptable and cost-effective surveillance strategies. The findings will contribute to the development of tailored intervention plans that balance the need

for sensitivity and cost effectiveness and was presented at a European One Health conference, attended by key partners from the OHEJP.

The MACE project's integrated approach, combining spatial analysis, transmission modelling, and social-economic elicitations, offers a comprehensive framework for understanding the complex dynamics of CE transmission and control. The project's findings will be instrumental in guiding the development and implementation of effective intervention and surveillance strategies, ultimately contributing to the reduction of disease burden and economic impact of CE on affected communities. The MACE project represents a development in the field of zoonotic disease management, laying the ground to improve both human and animal welfare in regions affected by cystic echinococcosis. Through innovative modelling techniques and stakeholder engagement, the project provides a solid foundation for evidence-based decision-making in the design and implementation of targeted intervention and surveillance strategies.

1. Thesis Chapters

a. Chapter 1 – Introduction – Literature review and summarising the project objectives. (D-PhD07-6.1)

A comprehensive the literature review and objectives was already uploaded as part of deliverable MACE.Y2.A to Zenodo: DOI : 10.5281/zenodo.4722737

The main objectives of the project were as follows:

- *Develop an individual-based model for CE that is calibrated for settings in South America, accounting for individual heterogeneity.*
- *Develop a Geostatistical model to estimate prevalence of CE at fine spatial scales.*
- *Combine both the individual-based and Geostatistical models to inform nation-wide surveillance programmes at small spatial scales (below state level).*
- *Conduct an economic analysis to understand the financial burden of CE.*
- *Use the results of the economic analysis for a cost-effectiveness analysis for a range of possible control interventions.*
- *Conduct an elicitation questionnaire to assess the value stakeholders place on surveillance sensitivity and detection of incident CE cases.*
- *Generate realistic control scenarios, accounting for the epidemiology of the disease, the economic viability of the proposed interventions, and their likely acceptance by stakeholders.*

b. Chapter 2 – Geospatial analysis of CE in Italy- Investigating the probability of infection in Italian farms using a spatial model. (D-PhD07-6.2)

Introduction: Cystic echinococcosis (CE) is a zoonotic parasite caused by the cestode Echinococcus granulosus sensu lato (s.l.) which predominantly affects livestock. The disease is endemic in central-southern and insular Italy, with CE particularly infecting sheep, goats, cattle, and water buffalo. The spatial distribution of CE in endemic regions is not widely understood, with surveillance efforts varying across the region.

Methods: In this study, we investigated the spatial distribution of CE in livestock using samples from farms across different livestock species using a Stochastic Partial Differential Equations (SPDE) model. Samples were collected during a survey conducted in the area of central-southern and insular Italy between the years 2019 – 2021.

Results: A total of 3141 animal samples (126 goats, 601 sheep, and 2414 cattle and water buffalo) were inspected for Echinococcus s.l. cysts through routine surveillance in abattoirs by post-mortem visual examination, palpation, and incision of target organs. The geographic location of the farm of origin (a total of 2,878) for each sample was recorded. CE prevalence of 46.0% (1,323/2,878) was estimated at the farm level with 78.3% (462/590) of farms with sheep, 28.6% (36/126) of farms with goats, 36.5% (747/2,049) of farms with cattle, and 23.5% (102/434) of farms with water buffalo infected.

Discussion: The spatial model evaluated the probability of infection in farms across the sampled regions, with the distribution of CE showing high clustering of infected cattle farms in Sardinia and Sicily regions, and sheep farms in Salerno province (Campania region). The output of this study can be used to identify CE hot-spots and to improve surveillance and control programs in endemic areas of Italy.

DOI: 10.3389/fitd.2022.1034572

c. Chapter 3 – Transmission model – Evaluating the effectiveness of intervention for CE in the setting of South American farms. (D-PhD07-6.4)

The chapter presents an individual-based transmission model developed to simulate the transmission of Cystic Echinococcosis (CE) within a farm setting in Rio Negro, Argentina. This comprehensive model encompasses the vital elements of the parasite life cycle and host interactions and assimilates comprehensive information regarding disease dynamics culled from a broad spectrum of literature, which enables the assessment of various intervention strategies, such as anthelmintic treatment and vaccination. As one of the only individual-based models developed for CE, it incorporates disease dynamic attributes such as age dependant cyst fertility, individual host heterogeneity of cysts and worm burden in hosts. To calibrate the model to its aforementioned setting, the farming practices of the region were reproduced and the model was fitted to reflect the host prevalence in the region, based on field data. This Chapter is being finalised, and the implementation of this model will yield insight into the effectiveness of intervention strategies, revealing their potential to reduce the prevalence of CE. As such, the outcomes of this study will provide substantial evidence that could aid policymakers in making informed decisions regarding the management of CE. The findings underscore the value of utilizing such individual-based models in the understanding and control of parasitic diseases.

d. Chapter 4 – Interventions for CE – Extension on the scenarios evaluated using the transmission model considering intervention costs.(D-PhD07-6.4)

The chapter introduces an extended version of the previously developed individual-based transmission model, further expanding the scope of evaluated intervention strategies for Cystic Echinococcosis (CE) and incorporating their respective costings using findings from a scoping review that we recently published [DOI: 10.1371/journal.pntd.0010568]. This expansion enables a more nuanced and practical exploration of various interventions, considering not only their biological effectiveness in reducing disease prevalence but also their economic feasibility. This Chapter is being finalised, and the results from this expanded model will offer a comprehensive understanding of the cost-effectiveness of each strategy, thus providing valuable insights for policymakers. The discussion suggests that such cost-inclusive models can be instrumental in making evidence-based decisions that balance both the health and financial impacts of different strategies in managing parasitic diseases like CE.

e. Chapter 5 – Elicitation – Investigating the investment preferences of stakeholders for surveillance sensitivity. (D-PhD07-6.3)

This pilot study focuses on understanding the valuation of changes in surveillance sensitivity by public-health officials using tools like Willingness to Pay (WTP) and Willingness to Accept (WTA). An online survey was designed to estimate these values for two levels of surveillance sensitivity, considering a societal perspective typically funded by state or local authorities. Participants were asked to provide their perspectives on the cost and value of a surveillance system for non-specific non-zoonotic diseases. The study found that stakeholders were willing to invest a relative increase of 2.48% to 2.77% in their budget for every 1% increase in sensitivity, while for every 1% decrease in sensitivity, they expected a relative reduction of 2.48% to 1.87% in costs. The study revealed a risk aversion towards disinvestment in disease surveillance programs. Despite certain limitations, like a small sample size and a cognitively demanding survey, the study emphasizes the importance of understanding stakeholder biases and preferences in disease surveillance investment decisions, especially in the context of One Health disease surveillance systems. The research underscores the necessity of further exploration of economic evaluations of these systems and the determination of

appropriate investment/disinvestment thresholds. A manuscript has been prepared based on this chapter and is currently under review by collaborators.

f. Chapter 6 – Discussion- Assessing the impact of the project and further works.

The MACE project, through its comprehensive approach involving transmission modeling, spatial analysis, and socio-economic evaluations, provides an evidence-based framework to understand and control the complex dynamics of Cystic Echinococcosis (CE) transmission. The findings of this PhD thesis offer valuable insights that can impact the development and implementation of effective intervention and surveillance strategies, thus reducing the disease burden and economic effects of CE on affected communities. The project makes use of disease dynamics data from prior studies and introduces innovative methodologies to improve human and animal welfare in regions suffering from CE. However, the thesis acknowledges the need for additional research to coalesce the components of the study for optimal results. The methodology introduced in Chapter 2 can be used to map disease prevalence in any country with data containing multiple samples from single farms. Prevalence data can be used in conjuncture with the mathematical model for spatially localised evaluations of different intervention strategies. The model is versatile and can be modified to fit different contexts, enabling region-specific assessments, however, this requires further analysis using field data from the specified region. For a comprehensive understanding of stakeholder investment preferences, the method discussed in Chapter 5 will need to be applied to disease-specific scenarios, considering different surveillance and intervention programs. An audience familiar with budget management and the disease of interest would need to be identified, with only minor adaptation to the questionnaire, investment preferences for surveillance of the specific disease can be obtained. This approach will provide insights into the acceptable cost thresholds for various surveillance and intervention strategies.

2. PhD project self-evaluation

The initial objectives of my PhD project were to develop an advanced mathematical model to capture the transmission of CE in South America. This model was to be informed by studies addressing various gaps in the existing literature related to CE, including the fine spatial distribution of the disease, the costings of CE surveillance and control, and the investment preferences of stakeholders in intervention and surveillance. To meet these objectives, training in coding, mathematical modelling, spatial modelling, cost-effective analysis, and survey development was required.

The original plan underwent some adjustments in the first year, primarily driven by the opportunity to attend the 4th ICAHS conference. This conference was seen as a potential venue to develop a survey to investigate the investment preferences of key stakeholders. Thus, my focus in the first year gravitated towards the literature review and the development of the elicitation survey, causing the model development to be pushed to the second year. However, the cancellation of the 4th ICAHS conference due to the COVID-19 pandemic led to a delay in conducting the survey.

I was able to establish a collaboration with the Commission of Zoonosis in Uruguay, initially aimed at analysing data from that year's surveillance programme. Unfortunately, the surveillance programme was also halted due to the pandemic, leading us to pivot our collaboration towards planning for the subsequent year's surveillance programme. A spatial model and an efficient data collection methodology were developed in preparation for this, but a lack of funding post-COVID-19 put the project on hold. Despite these challenges, I was able to adapt the methodology and redesign it for a new collaboration with colleagues in Italy.

In addition to these collaborations, my leadership and contribution to several peer-reviewed articles presenting novel research in the field are notable achievements. My research was presented at various conferences, in both poster and oral forms, with one presentation winning the "Best Oral Presentation" award. I also developed new skills in programming (R, Python, Java) and mathematical, spatial, and statistical modelling.

The most prominent challenge faced was the impact of the COVID-19 pandemic, which led to cancellations and delays in several planned activities. Despite these circumstances, I was able to adapt and adjust the project's direction multiple times, demonstrating resilience and resourcefulness. The ability to establish productive collaborations and contribute meaningfully to the field, even amidst such adversities, is a testament to the project's resilience and my personal growth.

Overall, I believe that this PhD project has catalysed a significant development in my skills and capabilities as an academic researcher. The project has yielded novel research contributions to the field, and despite the adversities brought about by the COVID-19 pandemic, has persevered and adapted to continue moving forward. I am eager to continue contributing to the field and further developing my skills and expertise.

3. Progress of the project: milestones and deliverables

Deliverables

PhD reference	PhD Project deliverable number	Deliverable name *(Original name, if different from the actual one)*	Delivery date from AWPs (month)	Date delivered (month)	Comments	Integrative categories*
D-PhD07-6.1		Draft of review of surveillance and control tools for CE	M37	M37	DOI : 10.5281/zenodo.4722737	
D-PhD07-6.2		Spatial-Temporal Model of CE validated in Italy and Iran	M49	M60	*DOI: 10.3389/fitd.2022.1034572*	
D-PhD07-6.3		Questionnaire to Elicit WTP/WTA of One Health Surveillance Activities	M52	M66	*The methodology and structure of the questionnaire has been fully developed. The questionnaire has been conducted within the 4th ICAHS conference. A short communication was written from the results and its subsequent analysis, It is currently being expanded to be published as a research article.*	
D-PhD07-6.4		Final draft of publication with the model and control scenarios	M50	M65	*The model transmission has been developed and parameterised. Fitting and incorporating control scenarios is also been completed. The article currently being written as a research article.*	

** Categories of Integrative activities : 1. Design and implementation of surveillance and control activities; 2. Harmonised protocols and applied best practice; 3. Databases of reference materials and data, incl. metadata; 4. Standardised data formats, aligned data analysis for interpretation of surveillance data; 5. Sharing and communication of surveillance data; 6. Sharing of best intervention activities); 7. Prevention: aligned use of facilities and models; 8. Other (please specify);*

Milestones

PhD reference	Milestone number	Milestone name	Delivery date from AWPs	Actual delivery date	Achieved	Comments
	MACE.Y2.A	Relevant literature on surveillance and control of CE identified	M23	M23	YES	Relevant literature was identified. Draft document included in student's Confirmation report (due M39)
	MACE.Y2.B	Training in Mathematical modelling	M36	M36	YES	Some training activities delayed due to COVID
	MACE.Y3.A	Fitted model of CE to data from Uruguay	M37	M37	YES	First iteration of statistical model fitted to Uruguay historical data. This work could not continue further due to COVID. Pivoted to Fitting transmission model in Argentina and statistical model in Italy.
	MACE.Y3.B	Simulations of different control scenarios	M44	M64	YES	Simulations to be run once transmission model is fitted
	MACE.Y4.B	Eastern European data	M40	M48	YES	Due to COVID, engagement with stakeholders has been challenging. Different data was identified and data from Italy and Argentina was used.
	MACE.Y5.A	Online polls with stakeholders completed	M36	M44	YES	Poll finalised. Deployment pending.

4. Interactions with JRPs/JIPs or with external (global, EU, national or regional) relevant projects or initiatives such as national action plans (AMR, Zoonoses etc.), national and international surveillance programmes.

We have collaborated with Professor Majid Fasihi Harandi from the Kerman University of Medical Sciences in Iran, with the studies they are conducting on cystic echinococcosis within the region's dog population. Another collaborator is Prof Laura Rinaldi from the University of Naples who is involved with one of our research articles (DOI: 10.1371/journal.pntd.0010568), as they provided the field data from across central and southern Italy required train the spatial model.

We also engaged informally with members of the MATRIX OHEJP project. As there was some activities around *Echinococcosis Multilocularis* surveillance which our work could be extended to. We have since been in contact with colleagues from APHA (UK) who assisted in conducting the elicitation survey and PIWET (Poland).

We have also extensively engaged with Ministry of Health officials in Peru, Argentina, Chile, Brazil and Uruguay, with potential future collaborations generated through this project.

5. Interactions with OHEJP stakeholders

In terms of OHEJP stakeholders, this project is a close collaboration between UoS and ISS, Rome. We are working closely with Dr. Adriano Casulli from the Istituto Superiore di Sanità in Italy, who leads the MEmE JRP.

We have been in touch with Dr Benadette Abela, who is the Team leader for Neglected Zoonotic Diseases at the World Health Organisation headquarters in Geneva.

6. Added value and benefits during PhD resulting from being part of the OHEJP doctoral programme and consortium

Participation in the OHEJP has significantly enhanced the quality and scope of my data-driven doctoral research. The multitude of educational workshops and conferences provided by the programme have not only facilitated the development of my research competencies, but also offered a wealth of networking opportunities. Many lectures within these OHEJP workshops have directly addressed essential training elements for my PhD, including the acquisition of requisite data for spatial modeling and the foundational principles of Susceptible, Infected, Recovered (SIR) models.

Moreover, my inclusion in such a diverse consortium has immensely broadened my perspective, providing a more nuanced understanding of complex global health issues. The consortium's collective of passionate and inspirational academics and researchers has been a powerful motivator in my scholarly development. As I progress in my career, the extensive network of academics and professionals I've connected with through OHEJP will undoubtedly serve

as a valuable resource. These enriching experiences and relationships cultivated within the OHEJP have thus added substantial value and benefits to my PhD journey.

7. Transferrable skills and Training

Name of Training Event	Topic	Dates (DD/MM/YY)	Organising Institute
Name of training	*Key topic(s)*	*Date of training*	*Name of organisers*
OHEJP Summer School 2020	One Health	17 August 2020 - 28 August 2020	OHEJP
Writing Coherently	Writing techniques	12 February 2020	University of Surrey Doctoral College
Driving your Doctorate	How to get the most out of your PhD	12 February 2020	University of Surrey Doctoral College
Engaging with you Literature: Finding Literature	Finding Literature for your projects	6 February 2020	University of Surrey Doctoral College
Welcome to your Doctorate	Introduction to your PhD	7 February 2020	University of Surrey Doctoral College
Python for Data Science and Machine Learning Bootcamp	Basic Python coding for Data analysis and visualization	27 January 2020	Udemy
Judgement & Decision-making Lecture	Decision making from a Psychological view	9 March 2020	University of Surrey
Stage 3 Spanish	The Spanish Language	September 2020 – August 2021	Global Graduates Award
Writing a Confirmation Report	Confirmation process	12 January 2021	University of Surrey Doctoral College

Confirmation process - virtual	Confirmation process	07 December 2020	University of Surrey Doctoral College
Writing A Confirmation Report	Advice on writing the confirmation report	12/Jan/2021	University of Surrey - Doctoral College
GGA Spanish Stage 3	Spanish Language	29/Sept/2020 – 5/May/2021	Universtiy of Surrey - Global graduate award
OHEJP Summer School 2021	One Health	26th July – 6th August 2021	OHEJP

8. Ethical Reviews

Comments of Ethics Advisors, January 2020	Comments PhD Project Supervisor, mid-2020	Comments of Ethics Advisors, October 2020
Non EU countries **(Argentina and Peru)** -The beneficiary must provide details on the material which will be imported to/exported from EU and confirm that the adequate authorisations have been obtained. -As low middle income countries are participating in the study, the beneficiary must confirm that fair benefit-sharing arrangements with local stakeholders are ensured during the project (cf the Global code of conduct for research in resource-poor settings – www.globalcodeofconduct.org)	The project is using historical data that has already been collected through the ongoing control and surveillance programme in Rio Negro, Argentina and in Uruguay. The data is collected following standard protocols that have been approved in the countries (Argentina & Uruguay). Animal welfare is managed through the guidelines approved in the country. There are no physical materials transferred to the University of Surrey/EU, we only receive the data in silico (i.e. csv/excel files). The lead of the group in Argentina, Prof. Edmundo Larrieu, is registered as an external	No further comments.

This project states that the beneficiary will collect "data" from sheep and dogs. Further details are needed on the researcher's interaction and 'use' of a legal animals (e.g. sheep and dogs). If these are not experimental animals as defined in Directive 2010/63/EU they are still legal animals through national animal welfare laws so please comment on any implications for the animals. Please describe how the animals' welfare are protected and considered (e.g. if the dogs or sheep are affected when collecting data. Are any animals restricting for data collection etc). Please confirm if there are any impacts on the animals. Please provide a statement on the 3Rs aspects of this work If Ethical Approval is required please state which Research Ethics Committee this will be sent to, in the EU and non-EU countries.	supervisor, which ensures fair benefit-sharing of all the outputs. Outcomes are also communicated with the local authorities (Echinococcosis surveillance and control programme in Rio Negro). A MoU is currently being drafted with the collaborators in Uruguay.	

9. Scientific Publications

Publication date	Publication title	Authors	DOI reference	Zenodo reference	Is OHEJP acknowledged?	Is it a Green Open Access? *please specify embargo length	Is it a Gold Open Access?
December 2022	The spatial distribution of	Mahbod Entezami 1*,	*DOI: 10.3389/fitd.2022.1034572*		Yes	No	Yes

	cystic echinococcosis in Italian ruminant farms from routine surveillance data	Martina Nocerino 2, Jo Widdicombe 1,Antonio Bosco 2, Giuseppe Cringoli 2, Adriano Casulli 3,4,Giovanni Lo Iacono 1, Laura Rinaldi 2 and Joaquin M. Prada 1					
28 Jan 2022	Investigating Seasonality and Spatial Clustering of Dog-Mediated Rabies in Nigeria	Rebecca D. Williams Ruth Alafiatayo Olaniran Alabi Mahbod Entezami Daniel L. Horton Emma L. Taylor Columba T. Vakuru Olasoju Taiwo Abel Ekiri Joaquin M. Prada	DOI: 10.2139/ssrn.4003084		yes	no	Yes
May 31, 2022	Quantifying spillover risk with an integrated bat-rabies dynamic modeling framework	Eva Janouˇskov´a1 , Jennifer Rokhsar1 , Manuel Jara2 , Mahbod Entezami1 , Daniel L. Horton1	DOI: 10.22541/au.165402909.96757900/v1		yes	yes	no

		, Ricardo Augusto Dias3 , Gustavo Machado2 , and Joaquin Prada1					
July 7, 2022	The economic evaluation of Cystic echinococcosis control strategies focused on zoonotic hosts: A scoping review	Jo Widdicombe ,María-Gloria Basáñez,Mahbod Entezami,Daniel Jackson,Edmundo Larrieu,Joaquín M. Prada	DOI: 10.1371/journal.pntd.0010568		yes	no	Yes
16 August 2022	Records of Human Deaths from Echinococcosis in Brazil, 1995–2016	Michael Laurence Zini Lise 1,Jo Widdicombe 2,*ORCID,Claudia Ribeiro Zini Lise 3,Stefan Vilges de Oliveira 1ORCID,Eduardo Pacheco de Caldas 1,Mahbod Entezami 2,Joaquín M. Prada 2ORCID,Nilton	DOI: 10.3390/vetsci9080436		yes	no	Yes

		Ghiotti 4,5,Rosângela Rodrigues e Silva 6,Katherina A. Vizcaychipi 7 andVictor Del Rio Vilas 2,8					

10. Specific outcomes to highlight in dissemination and communications

Outcomes (deliverable, publication, folder, tool, etc.) of the project that might be suited for communication purposes to various audiences, for instance food safety or AMR scientists, national and international stakeholders, specific professionals, the general public, etc.

D-PhD07-6.2 – Highlights the probability of infection if CE in farms in central-southern Italy. Important for food safety and planning surveillance activities in Italy.

Are there any outcomes of this project that are already discussed or even implemented and in use at any institute of the project consortium, at stakeholders' organisations (ECDC, EFSA, EMA, EEA, FAO, OIE, WHO), or at the level of national authorities?

The project outcomes are actively being discussed with the Ministry of Health officials in Rio Negro, Argentina, who run the programme. In particular, we are finalising the evaluation of different intervention regimes, that can then be implemented in the field to improve the cost-effectiveness of the programme. Such outcomes can the be extended to other settings.

11. One Health impact

CE is a One Health issue and requires a One health approach to effectively control. Interventions have to consider infection in animal hosts and the environmental contamination to be able to reduce infections in humans. The MACE project, with its comprehensive approach to understanding and managing cystic echinococcosis (CE), offers several direct and indirect impacts. It presents improved methodologies for risk assessment and management through its spatial model and individual-based transmission models. The spatial model, which identifies CE hotspots in livestock species across Italian farms, can be adapted to other zoonotic diseases and regions, providing a valuable tool for surveillance programmes. The individual-based transmission model simulates CE transmission in a farm setting, providing a platform to assess intervention strategies, which can also be adapted for other diseases, enhancing understanding and informing policy decisions.

The MACE project has established collaborations with many professionals working on one health topics. Professor Majid Fasihi Harandi from Kerman University of Medical Sciences in Iran and Professor Laura Rinaldi from the University of Naples. They have also engaged with members of the MATRIX OHEJP project and have been in contact with colleagues from APHA (UK) and PIWET (Poland). In terms of OHEJP stakeholders, this project is a close collaboration between UoS and ISS, Rome. We are working closely with Dr. Adriano Casulli from the Istituto Superiore di Sanità in Italy, who leads the MEmE JRP. The project has also been in touch with Dr. Benadette Abela, the Team leader for Neglected Zoonotic Diseases at the World Health Organization headquarters in Geneva. Furthermore, extensive engagement has occurred with Ministry of Health officials in Peru, Argentina, Chile, Brazil, and Uruguay, leading to potential future collaborations. These collaborations have allowed the project to expand its studies on cystic echinococcosis, share research articles, and explore activities related to surveillance and management of the disease. Moreover, some of the methods developed during this thesis have supported work in a different disease context (Rabies), another NTD.

The data generated from the MACE project is a valuable addition to existing databases for risk assessment. The robust data from Italy and Argentina, regarding infection rates, host interactions, and intervention effectiveness, can be utilized by these international stakeholders to update their risk assessment protocols and strategies. This evidence-based data can influence international policy and guidelines on CE management, making the MACE project highly relevant to these stakeholders.

The stakeholder elicitation survey provides insights into the socio-economic factors influencing surveillance and intervention strategies. Understanding these factors can help in the development of more acceptable and cost-effective strategies, especially in resource-limited settings.

12. List of dissemination and communication activities

Please fill in one table per event you attended/organised during the entire life span of the project. Please make sure they are registered online on the OneHealth EJP webpage:
https://surveys.sciensano.be/index.php/754325?lang=en
If relevant (for instance flyer, video, etc.) please include hyperlink.

Name of the activity:	*Annual One Health European Joint Project (OHEJP) Scientific Meeting 2022. (3MT competition, Roundtable talk, and Poster presentation)*

Date:	*11 - 13 April 2022*		
Place:	*Orvieto Italy*		
Specify the Dissemination and Communication activities linked to the One Health EJP project for each of the following categories			
	Yes / No		*Yes / No*
Organisation of a Conference	*No*	***Participation to a Conference***	*Yes*
Organisation of a Workshop	*No*	***Participation to a Workshop***	*No*
Press release	*No*	***Participation to an Event other than a Conference or a Workshop***	*No*
Non-scientific and non-peer-reviewed publication (popularised publication)	*No*	***Video/Film***	*No*
Exhibition	*No*	***Brokerage Event***	*No*
Flyer	*No*	***Pitch Event***	*No*
Training	*No*	***Trade Fair***	*No*
Social Media	*No*	***Participation in activities organized jointly with other H2020 projects***	*No*
Website	*No*	***Other***	*Yes*
Communication Campaign (e.g. Radio, TV)	*No*		
Specify the estimated number of persons reached, in the context of this dissemination and communication activity), in each of the following categories			
	Number		*Number*
Scientific Community (Higher Education, Research)		***Media***	
Industry		***Investors***	
Civil Society		***Customers***	
General Public		***Other***	
Policy Makers			

Name of the activity:	*ICAHS 4 (Poster presentation and Questionnaire conducting)*		
Date:	*3 - 5 May 2022*		
Place:	*Copenhagen Denmark*		
Specify the Dissemination and Communication activities linked to the One Health EJP project for each of the following categories			
	Yes / No		*Yes / No*
Organisation of a Conference	*No*	***Participation to a Conference***	*Yes*
Organisation of a Workshop	*No*	***Participation to a Workshop***	*No*
Press release	*No*	***Participation to an Event other than a Conference or a Workshop***	*No*
Non-scientific and non-peer-reviewed publication (popularised publication)	*No*	***Video/Film***	*No*
Exhibition	*No*	***Brokerage Event***	*No*
Flyer	*No*	***Pitch Event***	*No*
Training	*No*	***Trade Fair***	*No*
Social Media	*No*	***Participation in activities organized jointly with other H2020 projects***	*No*
Website	*No*	***Other***	*Yes*

Communication Campaign (e.g. Radio, TV)	*No*		
Specify the estimated number of persons reached, in the context of this dissemination and communication activity), in each of the following categories			
	Number		*Number*
Scientific Community (Higher Education, Research)		***Media***	
Industry		***Investors***	
Civil Society		***Customers***	
General Public		***Other***	
Policy Makers			

Name of the activity:	*BSP Spring meeting (Poster presentation)*		
Date:	*21-25 March 2022*		
Place:	York England		
Specify the Dissemination and Communication activities linked to the One Health EJP project for each of the following categories			
	Yes / No		*Yes / No*
Organisation of a Conference	*No*	***Participation to a Conference***	*Yes*
Organisation of a Workshop	*No*	***Participation to a Workshop***	*No*
Press release	*No*	***Participation to an Event other than a Conference or a Workshop***	*No*
Non-scientific and non-peer-reviewed publication (popularised publication)	*No*	***Video/Film***	*No*
Exhibition	*No*	***Brokerage Event***	*No*
Flyer	*No*	***Pitch Event***	*No*
Training	*No*	***Trade Fair***	*No*
Social Media	*No*	***Participation in activities organized jointly with other H2020 projects***	*No*
Website	*No*	***Other***	*Yes*
Communication Campaign (e.g. Radio, TV)	*No*		
Specify the estimated number of persons reached, in the context of this dissemination and communication activity), in each of the following categories			
	Number		*Number*
Scientific Community (Higher Education, Research)	***750***	***Media***	
Industry		***Investors***	
Civil Society		***Customers***	
General Public		***Other***	
Policy Makers			

Name of the activity:	*5 minute oral presentation*
Date:	*6-7th July 2022*

Place:	Guildford, University of Surrey, England		
Specify the Dissemination and Communication activities linked to the One Health EJP project for each of the following categories			
	Yes / No		*Yes / No*
Organisation of a Conference	*No*	***Participation to a Conference***	*Yes*
Organisation of a Workshop	*No*	***Participation to a Workshop***	*No*
Press release	*No*	***Participation to an Event other than a Conference or a Workshop***	*No*
Non-scientific and non-peer-reviewed publication (popularised publication)	*No*	***Video/Film***	*No*
Exhibition	*No*	***Brokerage Event***	*No*
Flyer	*No*	***Pitch Event***	*No*
Training	*No*	***Trade Fair***	*No*
Social Media	*No*	***Participation in activities organized jointly with other H2020 projects***	*No*
Website	*No*	***Other***	*Yes*
Communication Campaign (e.g. Radio, TV)	*No*		
Specify the estimated number of persons reached, in the context of this dissemination and communication activity), in each of the following categories			
	Number		*Number*
Scientific Community (Higher Education, Research)	***150***	***Media***	
Industry		***Investors***	
Civil Society		***Customers***	
General Public		***Other***	
Policy Makers			

Name of the activity:	*BAVP Conference (10 minute Oral Presentation)*		
Date:	*8-9th September 2022*		
Place:	Belfast, Northern Ireland		
Specify the Dissemination and Communication activities linked to the One Health EJP project for each of the following categories			
	Yes / No		*Yes / No*
Organisation of a Conference	*No*	***Participation to a Conference***	*Yes*
Organisation of a Workshop	*No*	***Participation to a Workshop***	*No*
Press release	*No*	***Participation to an Event other than a Conference or a Workshop***	*No*
Non-scientific and non-peer-reviewed publication (popularised publication)	*No*	***Video/Film***	*No*
Exhibition	*No*	***Brokerage Event***	*No*
Flyer	*No*	***Pitch Event***	*No*
Training	*No*	***Trade Fair***	*No*
Social Media	*No*	***Participation in activities organized jointly with other H2020 projects***	*No*
Website	*No*	***Other***	*Yes*
Communication Campaign (e.g. Radio, TV)	*No*		
Specify the estimated number of persons reached, in the context of this dissemination and communication activity), in each of the following categories			
	Number		*Number*

Scientific Community (Higher Education, Research)	*70*	*Media*	
Industry		*Investors*	
Civil Society		*Customers*	
General Public		*Other*	
Policy Makers			

Name of the activity:	Annual One Health European Joint Project (OHEJP) Scientific Meeting 2020. (Presentation of poster and participation in 3MT competition)		
Date:	*May 2020*		
Place:	*virtual*		
Specify the Dissemination and Communication activities linked to the One Health EJP project for each of the following categories			
	Yes / No		*Yes / No*
Organisation of a Conference	*No*	***Participation to a Conference***	*No*
Organisation of a Workshop	*No*	***Participation to a Workshop***	*No*
Press release	*No*	***Participation to an Event other than a Conference or a Workshop***	*No*
Non-scientific and non-peer-reviewed publication (popularised publication)	*No*	***Video/Film***	*No*
Exhibition	*No*	***Brokerage Event***	*No*
Flyer	*No*	***Pitch Event***	*No*
Training	*No*	***Trade Fair***	*No*
Social Media	*No*	***Participation in activities organized jointly with other H2020 projects***	*No*
Website	*No*	***Other***	
Communication Campaign (e.g. Radio, TV)	*No*		
Specify the estimated number of persons reached, in the context of this dissemination and communication activity), in each of the following categories			
	Number		*Number*
Scientific Community (Higher Education, Research)	***750***	***Media***	*0*
Industry	***0***	***Investors***	*0*
Civil Society	***0***	***Customers***	*0*
General Public	***0***	***Other***	*0*
Policy Makers	***0***		

Name of the activity:	SVM online research celebration event 2020		
Date:	*September 2020*		
Place:	*virtual*		
Specify the Dissemination and Communication activities linked to the One Health EJP project for each of the following categories			
	Yes / No		*Yes / No*

Organisation of a Conference	*yes*	***Participation to a Conference***	*yes*
Organisation of a Workshop	*No*	***Participation to a Workshop***	*No*
Press release	*No*	***Participation to an Event other than a Conference or a Workshop***	*yes*
Non-scientific and non-peer-reviewed publication (popularised publication)	*No*	***Video/Film***	*No*
Exhibition	*No*	***Brokerage Event***	*No*
Flyer	*No*	***Pitch Event***	*No*
no ***Training***	*No*	***Trade Fair***	*No*
Social Media	*No*	***Participation in activities organized jointly with other H2020 projects***	*No*
Website	*No*	***Other***	*No*
Communication Campaign (e.g. Radio, TV)	*no*		

Specify the estimated number of persons reached, in the context of this dissemination and communication activity), in each of the following categories			
	Number		*Number*
Scientific Community (Higher Education, Research)	***50***	***Media***	*0*
Industry	***0***	***Investors***	*0*
Civil Society	***0***	***Customers***	*0*
General Public	***0***	***Other***	*0*
Policy Makers	***8***		