"ONE HEALTH IS NOT AN ARRIVAL POINT – IT IS THE STARTING POINT"

UNDERSTANDING POLICY PROCESSES FOR THE INSTITUTIONALISATION OF THE ONE HEALTH APPROACH ACROSS EUROPE

PhD dissertation by
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„Eine allgemeine Verkettung nicht in einfacher linearer Richtung sondern in netzartig verschlungenem Gewebe […] stellt sich allmählich dem forschenden Natursinn dar.“

“A general concatenation, not in a simple linear direction but in a netlike intertwined texture [...] gradually presents itself to the exploring sense of nature.”

- Alexander von Humboldt
Kosmos, Entwurf einer physischen Weltbeschreibung, Band 1, 1845

Foreword and acknowledgments

The journey of this PhD project started at a time when environmental issues like climate change and the loss of biodiversity were newspaper headlines. The problem of antimicrobial resistance gained momentum, as the World Health Organization categorised it as one of the top-ten global health threats in 2019.

However, the focus soon changed, as six months into my PhD project, the COVID-19 pandemic became the all-consuming topic. Fortunately for me, these issues (climate change, antimicrobial resistance, COVID-19) are all at the core of the One Health approach; an approach that connects and aims to promote as well as protect the health of humans, animals, and the environment. An approach that I came to know, criticise, appreciate, and reflect upon.

Of course, the project left me at times confused – to say the least. While finding my way through methodological, theoretical, and empirical options, the COVID-19 pandemic took some decisions from me. But it also opened new avenues, as the need for coordinated interdisciplinary and cross-sector approaches to disease outbreaks – like the One Health approach – became apparent. In other words, the pandemic made the interconnectedness between humans, animals, and the environment clearer: SARS-CoV-2, the virus causing COVID-19, was found in humans and animals. The virus likely originated from a wild animal, and there are several animals that have been infected by humans and vice versa (pets such as cats and dogs, zoo animals like gorillas, and farm animals like minks). The virus has also been found in the environment, spreading through the air, contaminating surfaces, and lingering in sewage. While the COVID-19 outbreak abbreviated my fieldwork, it did highlight the importance of the One Health approach and justified this PhD project.

I hope that the readers of the dissertation and of the individual papers find some inspiration and new perspectives in relation to the One Health approach. I also hope that the presented findings fuel conversations and discussions for the present and future of the One Health approach.

That said, I would like to point out that the project would not have been possible without the help, presence, and expertise of some important people and networks.

I would like to especially thank my supervisor, Olivier Rubin. Thank you for your constant support, your guidance, and your positive character. I am grateful for your input, advice, and honesty throughout my project. My thanks also go to my co-supervisor, Ann Lindberg. While we did not enjoy the same geographical closeness, you managed to provide me with support throughout the project, which opened doors for me, facilitated connections, enabled data gathering, and other practical aspects. This support was invaluable.

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Of course, I would also like to thank my family. My mother, Victoria von Humboldt-Dachroeden, and sister, Miriam von Humboldt-Dachroeden. You both are an invaluable support to me. You have always believed in me and encouraged me. You two are probably my greatest supporters, but you also have never shied away from bringing me back '*auf den Boden der Tatsachen*', when needed. And my step-father, Harry von Humboldt-Dachroeden, who sadly passed away the year before I could tell him that I was going to pursue a PhD. While I often had my own doubts, I know you never would have had a single doubt in your mind that I could do it. I miss you so much!

Christin Schäffer, you have become family, too. I am forever grateful for your continuous interest in what I do, for sharing your thoughts, opinions, and ideas. And for always being there for me.

And of course, my second family, Birgitte Rosendahl Scotland, Mark Scotland and Mathias Rosendahl Scotland. Thank you for including me in the family and for your support and encouragement – it means a lot. And of course, thanks for proofreading, ping-ponging ides, and looking after Theo. You are really wonderful.

Lastly and most importantly, I would also like to express my great appreciation to Nicholas James Scotland, my partner, and Theo, my son. Nick, you provided room for me to share my insecurities, listen to my complaints, you encouraged me, and always supported me. And in return, I forced you to proofread my documents while you were overwhelmed with your own work (or forced you to sit in the car on a rainy, cold day so I could have the (one-room) apartment to myself to hold my first online lecture). Thank you for all you have given me over the years. I am beyond grateful to have you in my life. And Theo! You came into our lives and turned everything upside down. While on maternity leave, you helped me to revise, resubmit, and publish two articles – thank you for your cooperation and patience. You made me learn so much about life and myself, and helped me to step back, giving me the opportunity to put everything into perspective. You mean the world to me!

Abstract

The One Health approach aims to protect and promote health by acknowledging the interconnection between humans, animals, plants, and the environment. To do so, facilitating cross-sector coordination, collaboration and communication is crucial to tackle health challenges like zoonotic disease outbreaks, antimicrobial resistance, food safety hazards, and threats to the ecosystem. Collaborative approaches between the public health, veterinary, and environment sectors lead to enhanced outbreak surveillance, including pandemic detection, preparedness, and responses on local, national, and international levels.

This dissertation sheds light on the drivers and constraints of the implementation of the One Health approach by investigating international non-governmental organisations, European Union (EU) agencies and some EU countries, plus Norway, Switzerland, and the United Kingdom. Additionally, the two country cases, Sweden and Italy, are included to provide concrete examples of One Health institutionalisation by demonstrating agenda setting as well as knowledge translation processes, and the work carried out in government agencies and networks within and across the agencies.

The article-based dissertation contains six papers that address One Health institutionalisation and implementation via different methodological approaches. A bibliometric analysis of the literature highlights challenges of cross-sector collaboration among scientists through publishing patterns and co-citation networks (Paper I). Further, expert interviews were conducted to analyse One Health-related coordination, collaboration, and communication activities via the Swedish and Italian cases (Papers II & VI). This informed the survey study in relation to institutional processes and knowledge translation among scientists and policymakers, which led to the investigation of underlying political structures within institutes (Paper V). The bibliometric analysis (Paper I) and literature review (Paper III) indicate the challenges for the environment sector and governance of the One Health approach. This also informed the survey study that investigated the role of governance, agenda setting, and policymaking for the One Health approach (Papers IV & V).

Through the analyses of the individual papers and their synthesis, the dissertation arrives at three overarching themes for which conclusions are drawn. First, there are institutional barriers for implementing the One Health approach. The main barriers that the dissertation investigated are silo working, agendas, and government agency set-ups. Government agencies can be fragmented and, to approach this, governments must determine clear criteria when establishing ministries and government agencies. To implement cross-sector One Health activities, the analysis points towards establishing institutional One Health strategies and incorporating specific problem definitions when designing One Health projects to tackle coordination issues. Second, there are knowledge translation challenges among scientists and between scientists and policymakers. These challenges must be addressed by leaders, problem brokers, and policy entrepreneurs.

Scientific knowledge must be translated across sectors and to policymakers to create heterophilous networks, use the knowledge that exists within networks, and to provide opportunities for actors from the environment, social, and political science sectors to contribute to the knowledge pool. Third, there is a lack of understanding of the One Health approach. Efforts must be made to comprehend the One Health approach and what it means generally, for institutes and for specific projects. For this, schools should introduce the approach to consolidate the meaning and value that the approach holds for the public. Continuous capacity building for scientists must be performed to strengthen the use and operationalisation of the One Health approach.

Danish abstract

One Health-tilgangen har til formål at beskytte og fremme sundhed ved at anerkende sammenhængen mellem mennesker, dyr, planter og miljøet. Facilitering af tværsektoriel koordinering, samarbejde og kommunikation er afgørende for at håndtere sundhedsudfordringer såsom udbrud af zoonotiske sygdomme, antimikrobiel resistens, fødevaresikkerhedsrisici og trusler mod økosystemet. Samarbejdstilgange mellem folkesundheds-, veterinær- og miljøsektorer fører til forbedret udbrudsovervågning, herunder pandemidetektion, beredskab og reaktion på lokalt, nationalt og internationalt niveau.

Denne afhandling belyser implementeringen af One Health-tilgangen ved at undersøge internationale ikke-statslige organisationer, EU-agenturer og nogle EU-medlemslande samt Norge, Schweiz og Storbritannien. Derudover er to casestudier, Sverige og Italien, inkluderet for at give konkrete eksempler på One Health-institutionalisering ved at forstå offentlige myndigheder, netværker inden for og på tværs af offentlige myndigheder, dagsordensætning og vidensoversættelse blandt forskere.

Den artikelbaserede afhandling indeholder seks artikler, der omhandler One Health-institutionalisering og implementering via forskellige metodiske tilgange. En bibliometrisk analyse af litteraturen fremhæver udfordringerne ved tværsektorielt samarbejde mellem forskere gennem publiceringsmønstre og co-citations-netværker (Paper I). Yderligere blev der gennemført ekspertinterviews for at analysere One Health-relaterede koordinerings-, samarbejds- og kommunikationsaktiviteter via de svenske og italienske cases (Papers II & VI). Dette informerede spørgeskemaundersøgelsen i relation til institutionelle processer og videns-oversættelse blandt forskere og politiske beslutningstagere, som førte til at udforske underliggende politiske strukturer inden for institutter (Paper V). Den bibliometriske analyse (Paper I) og litteraturrevision (Paper III) indikerer udfordringer for miljøsektoren og styringen af One Health-tilgangen. Dette informerede også spørgeskemaundersøgelse, der udforskede rollen af styring, dagsordensætning og politikudformning for One Health-tilgangen (Papers IV & V).

Gennem analyserne og synteserne af artiklerne kommer afhandlingen frem til tre overordnede temaer, som der drages konklusioner fra. For det første er der institutionelle barrierer for implementering af One Health-tilgangen. De mest fremtrædende barrierer, som afhandlingen undersøgte, er siloarbejde, dagsordener og opsætninger af offentlige myndigheder. Statslige styrelser kan være fragmenterede, og derfor skal regeringer fastlægge klare kriterier, når de etablerer ministerier og statslige styrelser. For at implementere tværsektorielle One Health-aktiviteter og håndtere koordineringsproblemer peger analysen på etablering af institutionelle One Health-strategier og indarbejdelse af specifikke problemdefinitioner, når One Health-projekter udformes.

For det andet er der udfordringer med vidensoversættelse blandt forskere og mellem forskere og politiske beslutningstagere. Disse skal løses af ledere, problemmæglere og politiske iværksættere. Videnskabelig viden skal oversættes på tværs af sektorer og til politiske beslutningstagere for at skabe heterofile netværk, bruge den viden, der findes inden for netværker og for at give aktører fra miljø-, samfunds- og statsvidenskabelige sektorer mulighed for at bidrage til videnspuljen.

For det tredje er der en mangel på forståelse af One Health-tilgangen. Der skal gøres en indsats for at forstå One Health-tilgangen, og hvad den betyder generelt for institutter og konkrete projekter. Til dette bør skolerne indføre tilgangen for at konsolidere betydningen og værdien af One Health for offentligheden. Der skal udføres løbende kapacitetsopbygning for forskere til at styrke brugen og operationaliseringen af One Health-tilgangen.

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Abbreviations

AMR	Antimicrobial resistance
DANMAP	Danish Integrated Antimicrobial Resistance Monitoring and Research Programme
ECDC	European Centre for Disease Prevention and Control
EFSA	European Food Safety Authority
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
NGO	Non-governmental organisation
OHEJP	One Health European Joint Programme
UNEP	United Nations Environment Programme
WOAH	World Organisation for Animal Health (formerly known as OIE)
WHO	World Health Organization

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PART I

1. Introduction

Disease outbreaks, epidemics, and pandemics are a historically recurring theme affecting humans and animals around the world. The likelihood of their occurrence is increasing due to climatic and anthropogenic changes, and they are likely to be zoonotic diseases. Approximately 60% of all infectious diseases are estimated to be zoonoses. Zoonoses are diseases or infections that are able to spread between animals and humans (Jones et al., 2008). Countries prepare for zoonoses, other infectious diseases, and health threats differently. While there are similarities in disease prevention and management, there is no coherent approach, not least due to the different health threats facing the countries, depending on a myriad of factors, including climate, geography, culture, and many more (Mayer, 2000). Usually, there are formalised procedures in place to tackle disease outbreaks, often involving government agencies, such as public health and veterinary institutes, as well as municipalities and local-level health services. If animals or plants in the food and feed industry are affected, the industrial and agricultural sectors also become involved (Mazet et al., 2014). To prevent outbreaks, countries have disease surveillance systems in place, often with international reporting obligations, such as to the European Union (EU) or the World Health Organization (WHO) (Villarreal, 2022).

Health threats such as zoonoses are usually events affecting more than one sector or community. Hence, there are usually more sectors involved in addressing them. As described above, the public health and veterinary institutes are usually involved, but environment and food institutes can also contribute. The engagement of those sectors implies the interconnectedness of humans, animals, and the environment in preventing and responding to disease outbreaks. This is in line with the One Health approach, which allows for the inclusion of human health considerations, as well as considerations regarding the health of animals and the environment. One Health is defined as

> an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems. It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent. (OHHLEP et al., 2022, p. 2)

However, the institutional structures and political processes for implementing the One Health approach are unclear. Therefore, this dissertation examines institutional abilities and boundaries to coordinate One Health issues and the political processes in place to address them.

"One Health is not an arrival point, it is the starting point." [1] This statement was made by an expert from the Italian public health institute, and it is an important notion to recognise for institutes as well as politics that use One Health as a rhetorical and institutional approach to addressing health threats. The One Health approach provides tools, techniques, and networks to prevent and prepare for disease outbreaks, using coordinated surveillance, from local to global levels. The health threats that the approach usually encompasses are zoonotic and infectious diseases, as well as antimicrobial resistance (AMR) (Zinsstag et al., 2020). AMR is a global problem and it describes the ability of microbes to resist conventional treatments (e.g., antibiotics) (Baekkeskov et al., 2020). One Health also encompasses health threats relating to environmental issues such as pollution, biodiversity loss and climate change, albeit often to a lesser extent (dos S. Ribeiro et al., 2019).

Implementing and institutionalising the One Health approach can assume different shapes and forms. In this context, institutionalisation means the establishment of structures, processes, and conditions that make the One Health approach tangible and a standard within institutes. On an international level, efforts are undertaken by non-governmental organisations (NGOs) or within the EU, by the European Commission and EU agencies. On a national level, there can be surveillance activities implemented by governments. Industries, schools, and universities can also contribute to realising the One Health approach within countries. On an institutional level, efforts include cross-sector collaboration via research projects or disease outbreak activities. Figure 1 presents examples of One Health approaches on international, national, and institutional levels.

[1] From interview study 2021. Respondent's workplace: Public health institute, Italy.

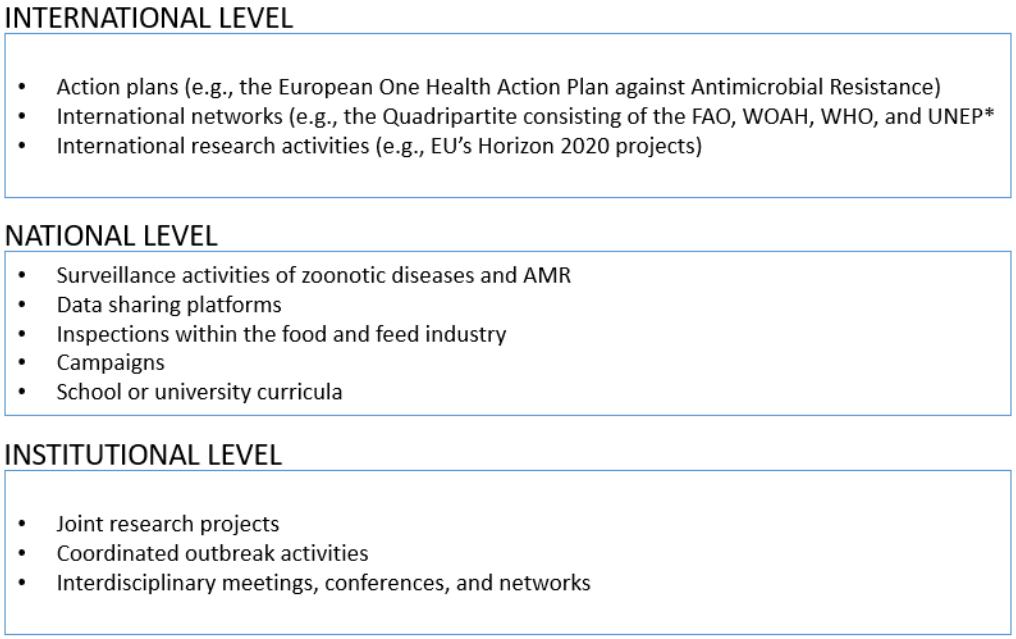

Figure 1: Implementing the One Health approach on international, national, and institutional levels [2]
* FAO: Food and Agriculture Organization of the United Nations, WOAH: World Organisation for Animal Health, UNEP: United Nations Environment Programme

However, implementing the One Health approach raises institutional challenges, which can pertain to connecting different sectors, such as public health, veterinary, environment and food services, which are often categorised under different ministries and, hence, receive different mandates. Mandates for the respective government institutions translate into agendas reflecting specific priorities and interests, which may not align. For example, the health and environmental programmes of governments and institutions are often seen as separate entities that do not influence one another (Manlove et al., 2016). This complicates the possibility of working in an interdisciplinary manner and across sectors towards a combined goal (Craddock & Hinchliffe, 2015; Manlove et al., 2016). Furthermore, institutes and agencies dealing with similar issues at the human–animal–environment interface have different communication infrastructures, priorities, and ambitions to implement the One Health approach. The One Health approach also struggles with data-sharing challenges across sectors, as health- and industry-related information is often sensitive. Further, municipalities and governments often struggle to provide institutions with funding and logistics for interdisciplinary activities (dos S. Ribeiro et al., 2019; Lee & Brumme, 2013). Attracting political attention to One Health issues can be cumbersome, as political decision- and policymakers must consider information from multiple disciplines and sectors. Collaboration across disciplines and sectors also depends on personal relations, willingness, and mutual understandings (Rüegg et al., 2018).

[2] International level: (European Commission, 2017; One Health EJP, 2021; WHO, 2022b); National level: (Haxton et al., 2015; Kelly et al., 2020; Landford & Nunn, 2012; Mazet et al., 2014; Newitt et al., 2018); Institutional level: (Bordier et al., 2021).

The dissertation explores some of the institutional aspects that can challenge the implementation of the One Health approach with the aim to enhance the understanding of the challenges and how to address them. Moreover, it provides insight into opportunities that institutions and politics can use to strengthen the approach. This dissertation investigates international NGOs, EU agencies, some EU countries, plus Norway, Switzerland, and the United Kingdom. The two country cases, Sweden and Italy, are also included. The aspects explored in this research are experienced and expressed by experts (e.g., scientists, policymakers) in the many fields of One Health. Building on interviews in Swedish and Italian public health, veterinary, food, and environment institutes, and on a survey of key health experts across Europe, the research question for the PhD project is:

> **What are the key institutional drivers and constraints on the effective implementation of the One Health approach?**

The research question is supported by analytical steps that represent the methodological approach and establish the process of the project. A first step was a literature review, which was accompanied by a bibliometric analysis that informed subsequent studies. The second analytical step included qualitative research interviews with experts from Sweden and Italy in the public health, veterinary, food, and environment sectors. This provided input for the two cases, Sweden and Italy, in the form of qualitative insights into institutional and political structures impacting the implementation of the One Health approach. The final analytical step was a survey to collect data regarding the governance of the One Health approach in national government and research institutions, ministries, and international organisations (EU agencies and NGOs). This provided insight into One Health policymaking and governance; One Health network interactions and relationships; and specific One Health topics, such as AMR and the engagement of the environment sector. Accumulated, these steps provide different angles and perspectives, which, when synthesised, contribute to answering the research question.

1.1. Roadmap of the dissertation

This dissertation is article-based, meaning that it is based on publications written in the course of the PhD project. The publications comprise five scientific articles and one chapter, which are framed by a *kappe* that introduces the research, the field in which it is placed, theoretical and methodological choices, together with a discussion of how the publications speak together and contribute to research.

PART I:

In this part, the studies conducted for this thesis will be positioned within the scientific literature, theories and methods. Importantly, it will contain the discussion of the results of the papers and their connections. Part I contains the following chapters:

Chapter 1 – Introduction: This chapter introduces the One Health approach and presents the research question. It explains the relevance of the research and background in terms of concepts within One Health, a history of One Health, and an overview of similar approaches.

Chapter 2 – Links and summaries of papers: Here, an overview of the findings of the papers produced during the PhD project is provided. The links between the papers are presented together with the methods, theories, and concepts upon which they are based.

Chapter 3 – Theoretical approaches to One Health: This part presents the theoretical positions of the project, including discussion of the multiple streams approach and knowledge translation. This is complemented with conceptual considerations of One Health, intermediaries (leaders, policy entrepreneurs, and problem brokers), networks, and homophily.

Chapter 4 – Methods: This chapter describes the applied methods, encompassing discussions about the choice of research design, ethical aspects, case selection, research interviews, survey study, and the approaches to analysing the data.

Chapter 5 – Discussion: This chapter discusses the findings and connects the papers to convey a comprehensive understanding of the project in its entirety. It is divided into four subchapters addressing institutional silos; languages of scientists, policymakers, and the public; managing the One Health approach; and theoretical and practical implications as well as inspiration for future research avenues.

Chapter 6 – Conclusion: The conclusion summarises the main points and aspects of the dissertation and concludes based on the combined findings of the papers and in relation to the research question.

PART II:

The last part contains the full-length papers as well as appendices that consist of supplementary material regarding the methods used and declarations regarding paper co-authorship.

1.2. Relevance

The literature examining One Health describes some of the main challenges facing the approach in terms of the interdisciplinary and cross-sector implementation of activities (dos S. Ribeiro et al., 2019). The terms ‘sectors’ and ‘disciplines’ are frequently used in the One Health field. The definition of One Health, referred

to above, continues and emphasises the importance of engaging different sectors, disciplines, actors, and communities to approach interdisciplinary health threats, including broader notions of sustainable development (see full definition in Figure 2) (OHHLEP et al., 2022). Actors engaged in the One Health approach can be found in different sectors, meaning areas of activity that are separated from one another due to their specific topics (e.g., agricultural sector, scientific sector, political sector, industrial sector, public health sector, environment sector, veterinary sector) (Bordier et al., 2021). Such actors can be scientists, bureaucrats, policy actors, health professionals, farmers, etc. (Mazet et al., 2014). Within the sectors are different disciplines, of which the dissertation refers to scientific disciplines. Within public health research, for example, there are epidemiology or health policy disciplines; veterinary research includes food safety and animal welfare; and within environmental research are ecology and biology. Of course, there are also intersections across sectors with the same disciplines but approached with different perspectives (e.g., microbiology and toxicology can be performed within the public health, veterinary, and environmental disciplines).

The many sectors, disciplines, and actors involved highlight the complexity of the One Health approach. The observed national or institutional challenges can relate to funding, capacity, silo thinking, and conveying between science and politics (dos S. Ribeiro et al., 2019). Such challenges can inhibit interdisciplinary and cross-sector collaboration and communication, which can lead to isolated and redundant efforts (Connolly, 2017; Manlove et al., 2016; Mateus et al., 2022). Further, the scientific literature on One Health implementation often pertains to a specific topic, such as a zoonotic disease, or has a one- or two-sided perspective often concentrating only on the medical and veterinary sectors. Hence, scholars have pointed out the need to reshape institutions and processes with the help of leadership to strengthen knowledge sharing and facilitate the coordination of interdisciplinary and cross-sector One Health activities (Connolly, 2017; Stephen & Stemshorn, 2016).

There are international activities aimed at tackling One Health issues, including data gathering, surveillance, and monitoring activities (e.g., by the EU or WHO: ECDC et al., 2017; WHO et al., 2016), and approaches that facilitate guidance and support within countries (FAO et al., 2019). Nonetheless, difficulties are experienced when coordinating and implementing collaborations, guidance, plans, and surveillance activities (dos S. Ribeiro et al., 2019; Munkholm et al., 2021). For instance, data security and sharing regulations often challenge data sharing across sectors and countries. If data sharing is feasible, another issue can be the lack of harmonised data or analytical approaches, which can impede comparisons or slow down research (Asokan & Asokan, 2015; Lebov et al., 2017).

The literature points towards existing legal frameworks and opportunities; for example, the International Health Regulations, an international legal treaty, that can be a useful tool to address some One Health-related topics, specifically in relation to infectious diseases. Specifying the One Health approach within the regulations could establish a more comprehensive One Health strategy that facilitates the harmonisation of standards and surveillance activities (Gostin & Katz, 2016). However, revising the International Health Regulations may prove difficult due to a lack of political will (Rogers Van Katwyk et al., 2020). Local, national, and regional (e.g., the EU) approaches open other legal and regulatory possibilities for implementing the One Health approach. Stewardship programmes have been established, for example for AMR (Aryee & Price, 2015; Keith et al., 2016; Rüegg et al., 2017), One Health action plans (European Commission, 2017), as well as national strategies (Danish Ministry of Health & Ministry of Environment and Food of Denmark, 2017; German Federal Ministry for Economic Cooperation and Development, 2021), and other activities to coordinate surveillance or other One Health-related activities (EFSA & ECDC, 2019; Haxton et al., 2015; Swedish University of Agricultural Sciences, 2022). Nevertheless, the disadvantages include how some of these regulations are non-binding, which can entail inactivity or poor implementation, and scientists also pointed out a lack of education and knowledge for performing some of the activities (dos S. Ribeiro et al., 2019; Garcia & Gostin, 2012).

The literature indicates a missing element that can facilitate the implementation of One Health activities, projects and policies: the social and political science sectors (Craddock & Hinchliffe, 2015; Lapinski et al., 2015; Mazet et al., 2014; Woldehanna & Zimicki, 2015). The social and political sciences offer tools that allow for analyses that include cultural, societal, anthropological, economic, political, and even philosophical perspectives. This can aid our understanding of what One Health means for different projects and in different circumstances. It can determine the importance of specific contexts, organisational structures, and governance processes. Insights into these aspects can contribute to the understanding of local and global realities; institutions in terms of organisation and networks; and political aspects such as science and policy mediation, agenda-setting, policymaking, and implementation (Michalon, 2020; Queenan et al., 2016). Scholars have also pointed out the absence and limited consideration of the legal and ethical sectors (Coghlan et al., 2021; Degeling et al., 2015; Phelan & Gostin, 2017). This dissertation will particularly identify some of the entry points for social, political, and economic scientists and their specific contributions, which are needed to enhance One Health activities.

As described above, scholars have found many challenges for implementing the One Health approach. However, these challenges often represent very broad issues and lack in-depth investigations of the fundamental issues causing or contributing to them. The opportunities and facilitating factors for

implementing the One Health approach in the European context have remained under-explored. This dissertation seeks to address these gaps by advancing scholarly understanding of more specific issues for implementing One Health activities, especially in relation to institutional constraints, governance, leadership, coordination, and knowledge translation. Further, the dissertation addresses the lack of theory for the One Health approach by contributing to the discussion of philosophical and theoretical notions for it. By addressing these gaps in the literature and theory, the aim is to enhance the general understanding of One Health together with the underlying structures necessary to implement the approach.

1.3. Background

The 'One Health' term has been around for a few years, but notions connecting the health of humans, animals, and even the environment can be traced back to the BCE times. The One Health approach distinguishes between humans and animals. Although humans belong to the animal kingdom, this distinction is regularly used, and animals are sometimes described as 'non-human animals'. Discussions about the distinction have been going on for thousands of years (see, e.g., Aristotle et al., 1908), and they explore many philosophical questions regarding consciousness, rationality, and other aspects. For the sake of simplicity, this dissertation refers to animals and humans, albeit with an awareness that humans are technically animals.

The main topics of the One Health approach are zoonotic diseases and AMR, but the environment also plays a pivotal role in facilitating or compromising the health of ecosystems, humans, and animals. A brief overview is provided to highlight the intertwined relationships between humans, animals, and the environment in view of the following One Health topics:

Zoonotic diseases are infectious diseases that can transmit back and forth between animals and humans. Such diseases can emerge locally but can also spread and affect neighbouring and even global communities. Animal-to-human disease transmission can occur in any environment where humans and animals meet, directly or indirectly; for instance, during livestock farming, through contact with wild animals, at markets, and through companion animals. But there are more defined pathways through which zoonotic pathogens (bacteria, viruses, parasites) can spread: They can be vector-borne (via insects), foodborne, waterborne, airborne, and many others (Plowright et al., 2017). Zoonotic diseases are not a new phenomenon. Outbreaks have occurred repeatedly in history, with epidemics and pandemics such as the bubonic plague (1347–1352, still sporadically occurring), the Spanish Flu (1918–1920), Ebola (first discovered in 1976), HIV-1 (first reported case in 1981), and SARS (2002–2004) – just to name a few (Jedwab et al., 2020; Jones et al., 2008). However, how we address outbreaks through prevention, detection, surveillance, and mitigation efforts has changed. We are living in a world that is more connected or globalised via trade, tourism and business (Amuasi et al., 2020). This provides opportunities for pathogens, as the popular phrase 'diseases know no borders' indicates.

A disease can spread from one side of the world to the other in a matter of hours. The spread of COVID-19 was a recent such incident; officially first detected in December 2019 in the Chinese city of Wuhan and facilitated by globalisation, the pathogen quickly travelled around the globe (WHO, 2020). The environment has been a crucial pathway for the spread and transmission of the SARS-CoV-2 virus that causes COVID-19, as it can spread through the air and contaminated surfaces. It was also detected in sewage, including in Italy and the Netherlands (La Rosa et al., 2021; SanJuan-Reyes et al., 2021). The virus transmits between humans but also across species; for example, from humans to pets, and zoo animals (dogs, (big) cats, primates), between humans and livestock (mink), and the likely origin of the virus from wild animals (Fenollar et al., 2021; Hu et al., 2020; Murphy & Ly, 2021).

AMR is another regularly mentioned One Health issue. Simply put, AMR occurs when microbes such as bacteria, fungi, viruses or parasites mutate so that conventional treatments fail (e.g., antibiotics for bacterial infections). The microbes mutate naturally, but there is extra pressure to mutate on them when medicines (like antibiotics) are extensively (mis-)used. When microbes mutate, they can become resistant to the medicines used for treatment. There are few alternative treatments and few possibilities for new drug development, which reduces the options for medications and therapy (Holmes et al., 2016). Hence, AMR threatens the ability to treat infections in humans, animals, and plants around the world and raises global concerns. Plants in horticulture, for example, are affected through the use of pesticides, which can contain antibiotics (Malagón-Rojas et al., 2020). These pesticides can additionally contribute to the spread of AMR in the environment (via soil, water, other plants) (Liao et al., 2021). Further, intensive livestock farming increases the risk of AMR as well as of zoonotic disease outbreaks. In intensive livestock farming practices, thousands of animals can be in close proximity, risking animal welfare and facilitating disease transmission. This can in turn increase the use of antimicrobials, contributing to the spread of resistant microbes between the animals, to humans and in the environment (Coghlan et al., 2021; Klous et al., 2016). There is an occupational hazard of AMR for all involved in agriculture, livestock farming, and meat production; not least for farmers, their families, and slaughterhouse workers, but also the communities near farms (Karesh et al., 2012). Further, antimicrobials are sometimes (unintentionally) misused by human and animal doctors, farmers, and consumers due to a lack of knowledge concerning AMR, prescribing or dosage errors. Misuse, wrong usage and the inadequate disposal of antimicrobials also contribute to the spread of AMR (Hinchliffe et al., 2018; Kahn, 2017).

In addition to zoonotic diseases and AMR, the One Health approach can provide insight into **environmental issues** that are closely linked to human and animal health (Essack, 2018). The environment can impact the spread of pathogens through a myriad of potential pathways, including air, water (e.g., rivers, wastewater),

soil and surfaces (Plowright et al., 2017). Environmental contamination via, for example, toxic metals, toxic compounds (e.g., mycotoxins produced by fungi), pesticides, and microplastic can exacerbate pollution that is harmful for the ecosystem, human, and animal health (V. N. Davies et al., 2021; Frazzoli et al., 2017; Levin et al., 2020; Prata et al., 2021). The climate is an important indicator of environmental changes. Climatic changes like varying temperatures, extreme weather conditions (e.g., droughts, torrential rainfall) affect the health of the environment, animals, and humans alike (Humboldt-Dachroeden & Mantovani, 2021). The consequences of climate change are severe for biodiversity, and it affects the habitats of animals and humans who must adapt or migrate to areas with more favourable conditions (McMahon et al., 2018; McMichael et al., 2012). For example, ticks are moving into warmer regions where they have not previously been detected, which can contribute to the spread of tick-borne diseases (Black & Butler, 2014). Another example is the parasite *plasmodium*, which causes malaria. Garamszegi (2010) has revealed how the parasite benefits from rising temperatures, as they are optimal for reproduction. Hence, wild birds and potentially humans are at an increasing risk of malaria infection due to climate change. Other consequences that are already being experienced include extreme weather conditions, the aftermath of which are often perfect breeding grounds for diseases. Anthropogenic activities can influence the health of the environment. One such activity is deforestation, which once again closes the circle to human and animal health by leading to a loss of biodiversity and to closer animal–human proximity. This destabilises the ecosystem and promotes the spread of zoonotic and infectious diseases (Redford et al., 2021; Wu et al., 2016).

The complex, interconnected, and by no means complete list of aspects of disease-transmission pathways and their impacts indicate the value of a multifaceted approach like One Health. This is highlighted by scientists who have voiced repeated concerns and warnings of AMR, emerging or re-emerging disease outbreaks that can turn into pandemics (e.g., Aryee & Price, 2015; Epstein, 2001; Hsieh et al., 2006; Jones et al., 2008; Majumder et al., 2020; Webster, 1997). Such issues present themselves as natural science and medical challenges, but they also affect societies, economies, and politics (Degeling et al., 2015; Michalon, 2020).

1.3.1. Brief history of the One Health approach

A fundamental consideration of the One Health approach is to shed light on the definition and meaning of One Health, which implies an understanding of the definition(s) of health. This paragraph will not go into detail in this very broad field, merely touching on the surface to give an understanding of the difficulties of defining health for One Health. The WHO defines health as ‘a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity’ (WHO, 2006). However, this definition is tailored to human health, to the individual being, and neglects all non-human animals, as well as the environment (Lerner & Berg, 2015). Establishing broader considerations for health, the Determinants of

Health Model provides explanations for environmental influences on our health (see section 1.2.2) (Barton & Grant, 2006). This is obviously human-centred, but it highlights socio-political considerations as well as the effect that the environment can have on humans and vice versa.

There are few concrete definitions for animal health, and those that exist have different perspectives, such as health connected to the absence/presence of disease, to biological function/malfunction, to homeostasis (which is the balance of physiological processes), to physical and psychological well-being, and to reproduction (Gunnarsson, 2006). There are few definitions emphasising moral considerations for animals (Coghlan et al., 2021). The definitions are usually disconnected from humans and sometimes even pets, as they are 'non-producing' animals (Gunnarsson, 2006).

The health of the environment is also a complex matter. Importantly, this is not to be confused with the term 'environmental health', which refers to a discipline within public health that studies, assesses, and monitors the impact of the environment on human health (European Environment Agency, 2023). The health of the environment might be more closely related to the definition of ecosystem health, which can be understood in a metaphorical or literal manner (Lerner, 2019). The more often used metaphorical definition describes the health of the ecosystem being based on 'goods and services they provide to humans' (Palmer & Febria, 2012, p. 1393). This alone, however, does not give justice to the ecosystem itself and centres again on humans. Instead, the definition, especially when used for the One Health approach, should include the structure of ecosystems that can be evaluated through different indicators, which can 'reflect the existing status or condition of an ecosystem' (Palmer & Febria, 2012, p. 1393).

While this dissertation is not set out to produce a holistic definition of health, particularly health at the human–animal–environment interface, it is important to understand that this requires consideration and attention. It is established that health is not merely the absence of diseases, but it remains difficult to capture all the aspects, dimensions, and layers of health (Lerner, 2019). This is crucial to address for the One Health approach, as it is the basis for each activity and project. Further, it is relevant to mention the different perspectives a One Health activity can have: the individual or the population approach. Human medicine traditionally takes an individual approach, concentrating on the individual in terms of health protection and promotion, and public health focuses on populations (Arah, 2009). Veterinary health uses both population and individual approaches, concentrating on the health outcomes of individual animals, a group of humans or animals, or both (Gibbs & Gibbs, 2013). The environment takes the whole system into account; hence, it is often referred to as an ecosystem approach (Lerner & Berg, 2015). These differentiations and distinctions are important to consider, as they are the building blocks for One Health projects and activities.

As mentioned above (section 1.2), the thought of health being connected across species and environments is no novel concept. The Greek physician Hippocrates (460–367 BCE) integrated comparative medicine practices by studying humans and animals in their anatomy and pathology of diseases (Day, 2011). He emphasised the importance of a clean environment, including the quality of clean water, for 'good health' (Jouanna, 2012). The understanding of the environment, physiology and medicine have advanced greatly since then, not least due to new technologies and notions (e.g., discovery of the DNA (1951 by Rosalind Franklin), development of electron microscopy (1931 by Ernst Ruska and Max Knoll), invention of vaccines (already used in the 16th century and likely before that in China or India, established and popularised by Edward Jenner in 1796), and discovery of antibiotics (already used by ancient Sudanese people and Egyptians from 350 CE, discovered by Alexander Flemming in 1928) (Aminov, 2010; Cramer, 2020; Lombard et al., 2007; Savage et al., 2018)). Further, two new terms that would prove crucial for the One Health approach were coined. The first was 'zoonosis', indicating a link between human and animal diseases, which the German physician and pathologist Rudolf Virchow (1827–1902) introduced. He also emphasised the importance of environmental determinants for health outcomes (Capua & Cattoli, 2018). The second term was coined in 1964 by Calvin Schwabe. He introduced the concept of 'One Medicine' to emphasise the similarities between human and veterinary medicine and to highlight how collaboration can complement the development of each other's sector (Zinsstag et al., 2011). The One Medicine concept was further developed at the 2004 Wildlife Conservation Society symposium 'One World, One Medicine', which highlighted the need for multidisciplinary work to promote surveillance, preparedness, prevention, and emergency systems, and to influence policymaking at the human–animal–ecosystem interface (FAO et al., 2008). In 2010, the FAO, WOAH, and WHO committed to a Tripartite engagement, aiming to achieve 'One Health goals', such as reducing the emergence and spread of diseases through cross-sector collaboration and coordination (FAO et al., 2010). This was followed by a strategic document, which renewed the commitment of the organisations and broadened the work on One Health issues (FAO et al., 2017). In 2019, the Tripartite organisations published a guide to aid member states in implementing and addressing zoonotic diseases and AMR through cross-sector collaboration together with the management and coordination of the One Health approach (FAO et al., 2019). The Tripartite engaged the UNEP to include the environment perspective more explicitly in their efforts, which led to the Tripartite evolving to the Quadripartite. In 2022, this formation was made official in a joint press report (WHO, 2022b). In 2020, the Tripartite initiated the creation of the One Health High-Level Expert Panel. The aim of the 26 international experts is to establish a 'long-term strategic approach to reducing the risk of zoonotic pandemics' and to give policy advice to the Quadripartite (WHO, 2022a). Early in the engagement, the One Health High-Level Expert Panel developed their explanation for what One Health is and arrived at the definition and illustration in Figure 2. The definition has three parts, the first being a

general explanation of One Health, the second points to who is involved and why, and the third describes key concepts, topics, and actors. This definition is used in the dissertation, as it provides a good overview of the One Health approach.

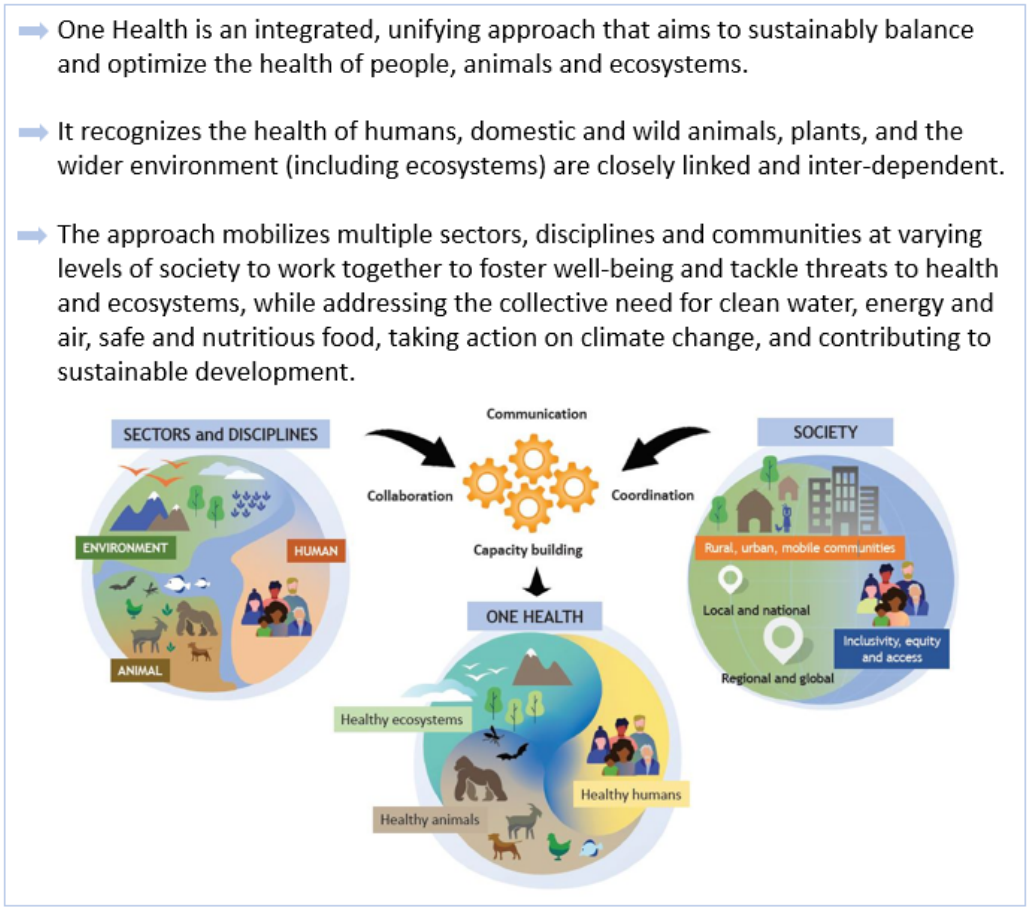

Figure 2: Definition and illustration of the One Health approach (OHHLEP et al., 2022)

Within the EU, the notion of considering health more comprehensively has already been incorporated to some extent since the Brundtland Report, which was a key initiator for considering and integrating sustainable development within policies (European Commission, 2001). The report was published in 1987, and sustainable development plays a key role in promoting resource efficiency, sustainable cities as well as economies and social cohesion (Brundtland, 1987). As sustainable development is mentioned in the latest definition of One Health by the One Health High-Level Expert Panel, and the Brundtland Report mentions the main One Health topics (e.g., the animal ecosystem, human health, environment, and communicable diseases), there are clear parallels between the approaches. Further, the United Nations Millennium Development Goals and the ensuing Sustainable Development Goals shaped EU decision- and policymaking in many policy areas related to the health of humans, animals, and the environment (Grieg-Gran, 2003; Koman et al., 2020). One Health has arrived as a recognised and stand-alone approach in the EU. The EU has

expressed its commitment especially in relation with AMR, and the European One Health Action Plan against AMR was adopted in 2017. Here, the EU pledges to enhance surveillance activities with an inclusive plan across human, animal, and environmental sectors (European Commission, 2017). The European Centre for Disease Prevention and Control (ECDC) has integrated One Health notions by providing input into how to strengthen One Health preparedness strategies (ECDC, 2018). Additionally, the EU zoonoses report has included an explicit One Health perspective since 2018 (EFSA & ECDC, 2019). With funding for interdisciplinary research projects, the EU further aims to increase research and development in One Health or specific One Health topics (e.g., zoonotic diseases like zika virus, AMR, and food systems) (European Commission, 2020).

All in all, One Health appears to represent a well-intentioned approach to tackling interconnected health issues in a globalised world (Garcia & Gostin, 2012); however, the approach has also been criticised. One of the main points of criticism is that the Western-centred idea of health is imposed in (non-Western) contexts in which the relations between humans and animals/the environment are different due to distinct values, farming practices, and economic conditions (Baquero et al., 2021). Power relations are at play, and the effects of colonialism and post-colonialism must be taken into account (Davis & Sharp, 2020). The One Health approach has a global perspective, often focusing on countries, regions, or areas where there are many (emerging) zoonotic diseases. These are often lower-income countries, affected by climate change and (post-)colonialism (Garcia & Gostin, 2012). Although the PhD project focuses on Europe, there is value in considering collisions of Western notions and post-colonialism. Sweden, for example, has an indigenous population: the Sami. Indigenous peoples typically have strong connections with animals and the environment (Garnier et al., 2020). Government rules and regulations sometimes go against the animal- and environment-related practices of indigenous peoples (Bjärstig et al., 2020). This clash emphasises the need for sensitive and careful considerations. There is no one-size-fits-all One Health approach. Contexts, circumstances, and histories must be considered (Garnier et al., 2020). Knowledge from indigenous people is not only important to comprehend how they do things, but they are a valuable contribution to enhancing the knowledgebase of the humans–animals–environment interconnection (Baquero et al., 2021; Garnier et al., 2020).

1.3.2. Other complementary approaches

Other initiatives and notions have similar objectives to the One Health approach. One of these is referred to as **Planetary Health**, which is a field that takes into account the broader socio-economic and political perspectives in relation to the anthropogenic impact of humans on the planet. Hence, the focus is on human health and human systems (political, economic, social, cultural, equity, and equality) (Alonso Aguirre et al., 2019). Animal health and welfare are described, but especially in relation to food production and disease

transmission. The environment is considered, for example regarding sustainability, but mainly in relation to human health outcomes (Lerner & Berg, 2017).

Conversely, **EcoHealth** involves a systems-thinking approach focused on ecosystems, especially on healthy ecosystems that allow for healthy humans and animals. The purpose is to comprehend socio-economic, equity, and ecological (including biodiversity) aspects that affect health. Apart from the natural sciences, the approach employs social sciences as well as anthropology, and it makes an effort to include local and indigenous knowledge (Lerner & Berg, 2017). However, this approach has struggled with 'operation criteria in relation to their design, implementation and evaluation' (Alonso Aguirre et al., 2019, p. 7).

Planetary Health, EcoHealth, and One Health do share some core notions, especially regarding human health. They differ regarding their main focuses, methodological approaches, and scope (Lerner & Berg, 2017). The approaches all struggle with disciplinary silos as well as the lack of coherent, cross-sector data (Hitziger et al., 2021; Leung et al., 2012). For the EcoHealth and One Health approaches, it has been suggested to integrate a systems thinking approach to comprehend the interconnectedness across sectors and actors, to manage knowledge from multiple sources, and to operationalise the approaches (Hitziger et al., 2018; Zinsstag, 2012). This remains a challenge for the approaches, however, as there is a lack of competencies and institutional measures to employ systems thinking. Another aspect that convolutes One Health as well as Planetary Health and EcoHealth is that the approaches involve the natural sciences while affecting many other sectors, such as 'politics (health, agriculture, aquaculture, land management, urbanism, and biological conservation), law, and ethics' (Destoumieux-Garzón et al., 2018, p. 10). The involvement of those disciplines is still not very widespread, albeit crucial as a fundamental element in the planning and implementing of the approaches (Degeling et al., 2015; Lapinski et al., 2015).

Barton and Grant (2006) presented their further-developed **Determinants of Health Model**. Based on the layered model of Whitehead and Dahlgren (1991), it includes detailed health determinants such as lifestyle factors, social networks, equity, socio-economic, cultural, political, as well as environmental conditions. In the model, the individual human is inside an ecosystem within its own habitat surrounded by forces and determinants that can affect its well-being (Barton & Grant, 2006; Whitehead & Dahlgren, 1991). These determinants are influenced and affected by different aspects, including biodiversity, climate change, and communities, as well as economic, political, and cultural systems (see Figure 3).

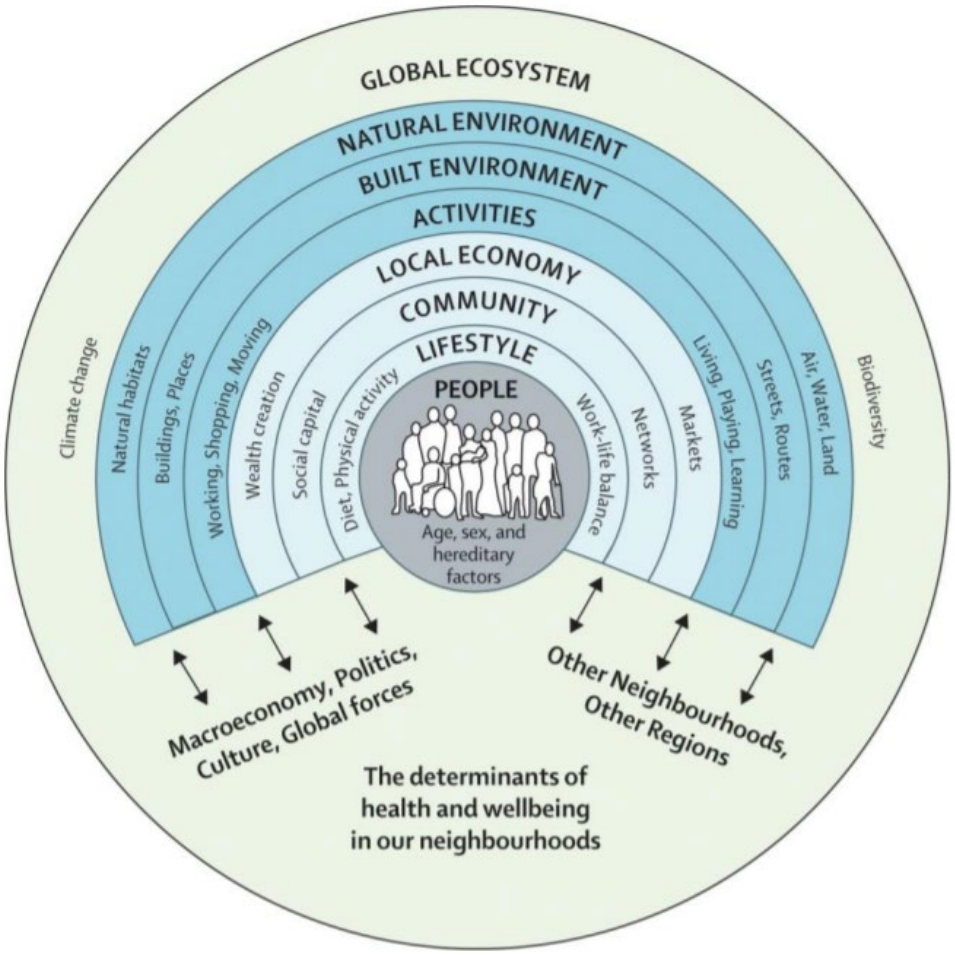

Figure 3: Determinants of Health Model further developed by Barton and Grant (Barton & Grant, 2006)

This model can be used to complement the One Health approach by considering the contexts in which humans live. It implies connections to the environment as well as animals by referring to 'biodiversity' and 'natural environments', which can be used to enhance the understanding of human–animal–environment interactions. Further, socio-political considerations can illuminate power relations as well as local and national realities, they can account for effects of globalisation and provide an understanding of the vulnerability of different populations (Craddock & Hinchliffe, 2015). The Quadripartite (at that time a Tripartite) also highlights the importance of considering the determinants of health as a key model in understanding the conditions and factors of daily life. Considering gender, involving social scientists, engaging communities, minorities, and indigenous populations is encouraged to be included as a practice to strengthen the development of One Health activities and policies (FAO et al., 2019).

In line with these considerations, ***The Lancet*** **One Health Commission** has recognised the interrelated nature of One Health that is influenced by the prevailing political, cultural, social, and economic contexts (see outer ring in Figure 4). Similar to the Determinants of Health Model, it integrates different layers of potential health impacts (Amuasi et al., 2020). While Barton and Grant (2006) outline environmental influences in detail,

connecting them with climate change and biodiversity, *The Lancet* One Health Commission emphasised our shared environment with companion animals, wildlife, and animals in agriculture (see Figure 4). Considering both models will be beneficial when establishing interdisciplinary collaboration, communication, and coordination from local to global levels. It can inform the implementation of activities and policies that are based on sound socio-economic, political, as well as ethical considerations, and it can protect and promote the health of humans, animals, and environments.

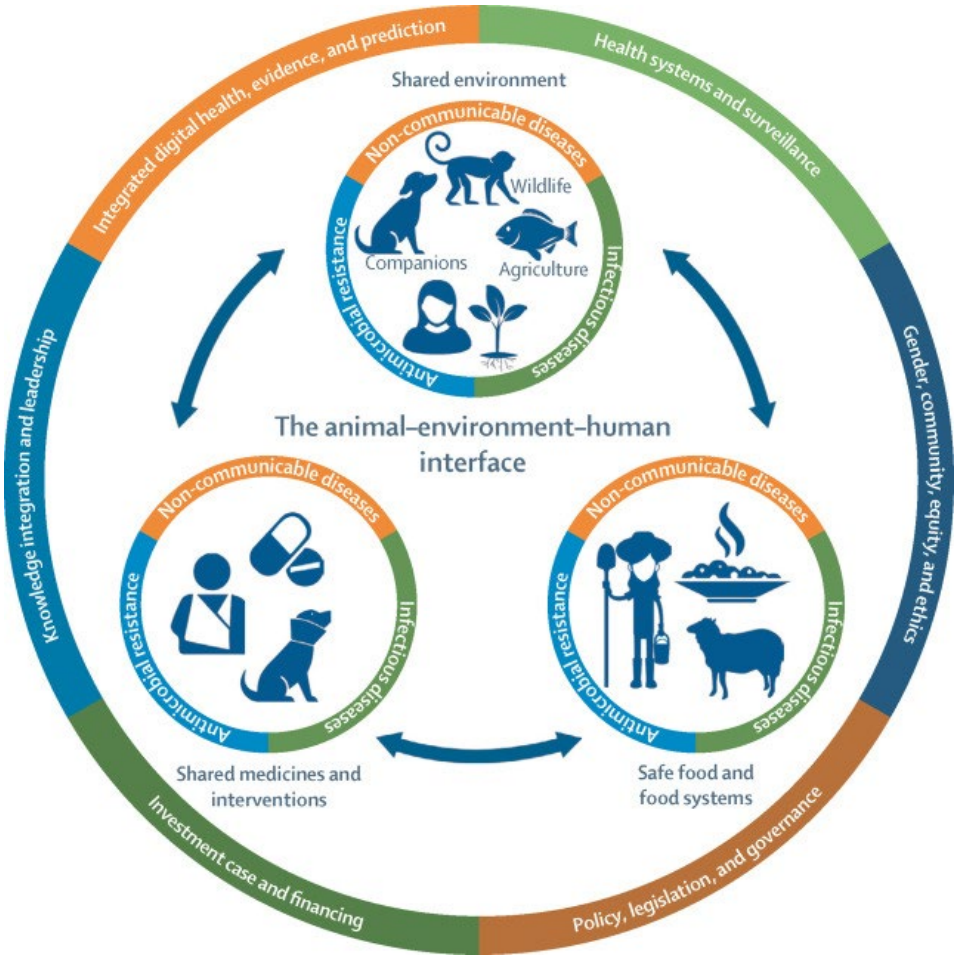

Figure 4: One Health approach integrating broader socio-political perspectives (Amuasi et al., 2020)

2. Links and summaries of papers

This section summarises the papers included in the dissertation. Table 1 provides an overview of the papers, their status, and it specifies their inclusion in the dissertation. The full-length version of Papers I–VI are presented in PART II of the dissertation. The declarations of co-authorship for co-authored articles are also located in PART II (see Appendix 4). The first six papers in Table 1 are listed in the chronological order of their writing. Papers VII–IX are the three papers that are not included in the dissertation but were published during

the course of the PhD project. Their exclusion is based on thematic differences. While Paper VII does address the One Health approach, it does so by investigating the inclusion of One Health measures in National Action Plans on AMR. This deviates from the aim of this dissertation by exclusively focusing on AMR policies and strategies. Papers VIII and IX both thematically address the Environmental Impact Assessment tool and its human health considerations. While the papers cover some broader One Health topics, such as environmental health, they do not focus on animal health. Hence, the papers were not included in the dissertation. The next sections provide the summaries of the papers that are included in the dissertation, followed by a description of how they are linked.

Table 1: Summary and status of papers developed during the PhD process

	ARTICLES	STATUS	IN KAPPE
I	Scientific article: Humboldt-Dachroeden, S., Rubin, O., & Sylvester Frid-Nielsen, S. (2020). The state of One Health research across disciplines and sectors – a bibliometric analysis. *One Health*, *10*, 100146. https://doi.org/10.1016/j.onehlt.2020.100146	• Published • Co-authored	Yes
II	Scientific article: Humboldt-Dachroeden, S. (2021). One Health practices across key agencies in Sweden – Uncovering barriers to cooperation, communication and coordination. *Scandinavian Journal of Public Health*. https://doi.org/10.1177/14034948211024483	• Published • Single-authored	Yes
III	Scientific article: Humboldt-Dachroeden, S., & Mantovani, A. (2021). Assessing environmental factors within the One Health Approach. *Medicina*, *57*(3), 240. https://doi.org/10.3390/medicina57030240	• Published • Co-authored	Yes
IV	Chapter: Humboldt-Dachroeden, S., & Degeling, C. (2023). Joint action against AMR with a One Health perspective. In O. Rubin, E. Bækkeskov & L. Munkholm (Eds.), Steering against Superbugs: The Global Governance of Antimicrobial Resistance. *Oxford University Press*. 10.1093/oso/9780192899477.003.0013	• Published • Co-authored	Yes
V	Scientific article: Humboldt-Dachroeden, S. (2023). Translating One Health knowledge across different institutional and political contexts in Europe. *One Health Outlook*, *5*(1). https://doi.org/10.1186/s42522-022-00074-x	• Published • Single-authored	Yes
VI	Scientific article: Humboldt-Dachroeden, S. (2022). A governance and coordination perspective – Sweden's and Italy's approaches to implementing One Health. *SSM - Qualitative Research in Health*, *2*(100198). https://doi.org/10.1016/j.ssmqr.2022.100198	• Published • Single-authored	Yes
VII	Scientific article: Munkholm, L., Rubin, O., Bækkeskov, E., & Humboldt-Dachroeden, S. (2021). Attention to the Tripartite's one health measures in	• Published • Co-authored	No

	national action plans on antimicrobial resistance. *Journal of Public Health Policy*, *42*(2), 236-248. https://doi.org/10.1057/s41271-021-00277-y		
VIII	Scientific article: Cave, B., Pyper, R., Fischer-Bonde, B., Humboldt-Dachroeden, S., & Martin-Olmedo, P. (2021). Lessons from an International Initiative to set and share good practice on human health in environmental impact assessment. *International Journal of Environmental Research and Public Health*, *18*(4), 4. https://doi.org/10.3390/ijerph18041392	• Published • Co-authored	No
IX	Scientific article: Humboldt-Dachroeden, S., Fischer-Bonde, B., & Gulis, G. (2019). Analysis of health in environmental assessments—A Literature review and survey with a focus on Denmark. *International Journal of Environmental Research and Public Health*, *16*(22), 22. https://doi.org/10.3390/ijerph16224570	• Published • Co-authored	No

2.1. Paper I

The state of One Health research across disciplines and sectors – a bibliometric analysis
Humboldt-Dachroeden, S., Rubin, O., & Sylvester Frid-Nielsen, S.

Using a bibliometric analysis, the paper explores the state of One Health in academic literature to visualise the characteristics and trends within the field, conducting a network analysis of citation patterns and bibliographic links. The article provides an overview of the academic features and dynamics together with the strengths and shortcomings characterising the scientific field of One Health. The network analysis illustrates connections and relations between researchers, research disciplines, and the publishing patterns of journals, and it contributes to an understanding of current One Health research. The study reveals a general increase in One Health publications. The increase in the use of the One Health approach is mainly linked to the sectors of human and veterinary medicine by the co-citation network of journals. This is represented by the majority of co-citation links in natural science journals. However, there are some (albeit few) social science contributions indicated by the presence of journals welcoming such contributions. The co-citation network of authors reflects how the One Health approach is mostly picked up by the WHO and authors with a veterinary background. Finally, the co-occurrence of keywords represents the themes, methods, and research techniques present in the analysed articles, which reflects how medical-related keywords play a central role in the One Health approach, while those connected to social and political sciences remain less central. The study contributes to an understanding of how the One Health approach is used in the academic literature and research, and it provides insight into the networks in which scientists and other actors are located.

2.2. Paper II

One Health practices across key agencies in Sweden – Uncovering barriers to cooperation, communication and coordination

Humboldt-Dachroeden, S.

Based on thirteen interviews with Swedish experts from the National Public Health Agency, the National Food Agency, the National Veterinary Agency, and the Swedish Environmental Protection Agency, the article examines the challenges and opportunities for integrating One Health practices in Swedish agencies. To investigate issues relating to cooperation, communication and coordination, the concept of knowledge translation is used to understand the challenges for translating scientific knowledge across disciplines and to politicians. The multiple streams approach aids an understanding of the factors necessary to develop the political agenda, especially in cases of disease outbreaks. The study provides specific insights into three challenges for the implementation of the One Health approach. The lack of a One Health strategy in Swedish agencies entails uncertainty in terms of the meaning of the One Health approach. This is connected to the issue of the lack of engagement of the environmental sector, which often does not participate in One Health research projects. Further, different mandates entailing the different agency priorities are perceived as a challenge to approach One Health issues. However, some opportunities are uncovered. The effective collaboration across the agencies (with the exception of the Swedish Environmental Protection Agency) has led to fruitful collaboration. Tools such as glossaries facilitate the communication across sectors. Outbreak management provides opportunity in terms of using effective procedures for the day-to-day work. Lastly, emphasis is placed on the importance and benefit of sharing knowledge, such as the lessons learned One Health projects. Hence, the study contributes practically by describing institutional processes for implementing the One Health approach. It provides a concrete example by referring to the Swedish agencies, which sheds light on institutional politics in relation to cross-sector health topics. Theoretically, the study provides insight into some aspects of agenda setting by expanding the use of the multiple streams approach to the practical example of One Health policy processes in Sweden.

2.3. Paper III

Assessing environmental factors within the One Health approach

Humboldt-Dachroeden, S., & Mantovani, A.

The article investigates the engagement of the environment sector in One Health activities based on two cases: the Danish Integrated Antimicrobial Resistance Monitoring and Research Programme (DANMAP) and the Italian handling of the occurrence of aflatoxin M1, a toxic metabolite produced by fungi that contaminates food and feed products. Both cases clearly show that animals and humans are affected, and the environment is an important indicator and component in facilitating the spread. The DANMAP is a comprehensive tool that assesses detailed information about animal and human health, including food

products and some environmental aspects. The study reveals how the DANMAP must elaborate environmental aspects, as demonstrated by environmental paths like water or manure, which facilitate the spread of resistant microbes. The Italian case of aflatoxin M1 shows that environmental considerations are crucial, as the occurrence of the fungi is highly dependent on climate changes. The Italian authorities have acknowledged the importance of considering all three components that impact and are affected by aflatoxin M1. A contingency plan has been developed to protect consumers and animals regarding the potential contamination of food and feed, taking into account extreme climatic conditions. Hence, this article clarifies the value of the environment sector for One Health issues and provides practical examples for the involvement of environmental scientists.

2.4. Paper IV

Joint action against AMR with a One Health perspective

Humboldt-Dachroeden, S., & Degeling, C

The chapter is part of the book *Steering against Superbugs: The Global Governance of Antimicrobial Resistance*. It addresses the global health threat AMR and investigates One Health initiatives aimed at tackling it. The chapter is based on survey data and policy analyses, with a focus on Europe. It describes the important role of the EU, their actions, as well as international surveillance activities, such as those driven by the WHO (e.g., the Global Action Plan on AMR or the Global Antimicrobial Resistance and Use Surveillance System). Some challenges for initiating and maintaining joint action against AMR are identified, including the need for a broad engagement of actors who do not neglect the environmental, social and political sciences. This, as well as supporting existing international initiatives (e.g., international surveillance and data-sharing initiatives by institutions such as the ECDC or WHO), are found to facilitate a better understanding of contextual factors. Furthermore, the chapter indicates the need for strong leadership to achieve political awareness as well as attention, and potentially policy change in relation to One Health. The issue of translating information across sectors is found to be crucial, especially among scientists and policymakers or when involving the public. Lastly, the consideration of adopting already existing legal frameworks is emphasised to advance the fight against AMR. The chapter provides specific insights into AMR-focused networks and initiatives. By doing so, it contributes to an understanding of political, institutional, and legal challenges for those networks to tackle AMR collaboratively with a One Health approach.

2.5. Paper V

Translating One Health knowledge across different institutional and political contexts in Europe
Humboldt-Dachroeden, S

The study investigates knowledge translation challenges across national institutes and within the political context. It is based on an online survey about the governance of the One Health approach. It involved 104 scientists, experts, and policy actors from the fields of public health, veterinary science, environmental science, and food safety. The study revealed unique insights into challenges of One Health implementation through perceptions of experts within Europe at national research institutes, ministries, EU agencies, and NGOs like the WHO and WOAH. The survey results demonstrated that leaders must establish a clear scope for the One Health activities and strong connections within networks. It indicated that knowledge must be translated to reach obtain political attention, which can be improved via learning from successful activities like AMR. The study pointed towards national and international actors with the ability to push One Health policies forward, such as government agencies, the Quadripartite organisations, and EU agencies. Additionally, influencing factors that affected One Health implementation were the lack of considering contexts and the lack of a common language among scientists and policymakers. This revealed how One Health often remained an abstract concept, which called for establishing a clear meaning of the One Health approach in relation to the context in which it is being implemented; for example, by way of engaging social and political scientists, who can provide their expertise to comprehend societal and political contexts. The study theoretically contributes to discussions of philosophical foundations for the One Health approach. It adds to the knowledge-translation field by expanding its use to the One Health approach, addressing the sharing of knowledge within and across sectors. It provides insight into political processes in terms of political attention and agenda setting, and it contributes to an understanding of the leadership characteristics needed for the One Health approach.

2.6. Paper VI

A governance and coordination perspective - Sweden's and Italy's approaches to implementing One Health
Humboldt-Dachroeden, S

Based on a comparative case study, this article examines 31 interviews of experts working for Swedish and Italian public health, veterinary, environment and food institutes. The investigation into the Italian and Swedish cases aims to understand how institutional and political contexts influence the implementation of One Health activities. The study identifies differences and similarities in relation to governance and coordination practices. Different governance practices demonstrate that excessively fragmented government agencies affect the ability to collaborate across sectors. Further, institutes can have different responsibilities and interests (e.g., economic versus public health interests). Or different tasks based on

whether they are national or regional/local institutes. Key similarities reveal how institutional and project-specific One Health strategies promote collaboration, as the mapping of actors in the design stage of One Health activities enables an inclusive process where common goals are established and different interests are accounted for. The article indicates that leaders who are able to broker between different sectors and promote knowledge translation can establish inclusive approaches. Further, One Health education is found to facilitate an understanding of the One Health approach and willingness to collaborate across sectors. This article is the first to provide a practical example of how two European countries approached the institutionalisation of the One Health approach. It contributes practical knowledge regarding government-institute relationships that affect One Health implementation and highlights the value of strategies for the One Health approach. Lastly, the study provides insight into the concepts of problem brokering and knowledge translation by transferring them to One Health networks and activities.

2.7. Links between the papers

The papers comprising this dissertation follow a logic in terms of how they build on each other and the methods used. Figure 5 illustrates this by indicating the methods used in the papers and how they are connected by two pathways that show how the knowledge produced complements the next paper.

Pathway 1: Paper I gives practical insight into the scientific field of One Health and provides knowledge on institutional and research-related challenges together with the thematic issues of the approach. Papers II and VI are both based on interview studies. The knowledge in Paper I regarding institutional challenges is picked up in both articles. Paper II focuses on the case of Swedish public health, veterinary, food and environment agencies and how they institutionalise One Health. Paper VI builds further on the same and expands on the coordination and government structures in Swedish and Italian agencies. Papers II and VI informed the survey study, which led to the investigation of more underlying political structures within the individual institutes (Paper V).

Pathway 2: Paper III provides insights into thematic issues by specifically addressing a single sector in the human–animal–environment interface: the environment sector. This paper highlights the importance of the environment sector by investigating AMR and other environmental conditions that impact health. Both the bibliometric analysis (Paper I) and the literature review (Paper III) indicate challenges for the environment sector and the governance of the One Health approach. This informed the survey study, which elaborates on the role of governance, agenda setting, and policymaking, which was the basis for Papers IV and V. Paper IV picks up the topic of One Health governance in relation to AMR, while Paper V addresses national institutional and political aspects that impact the implementation of the One Health approach.

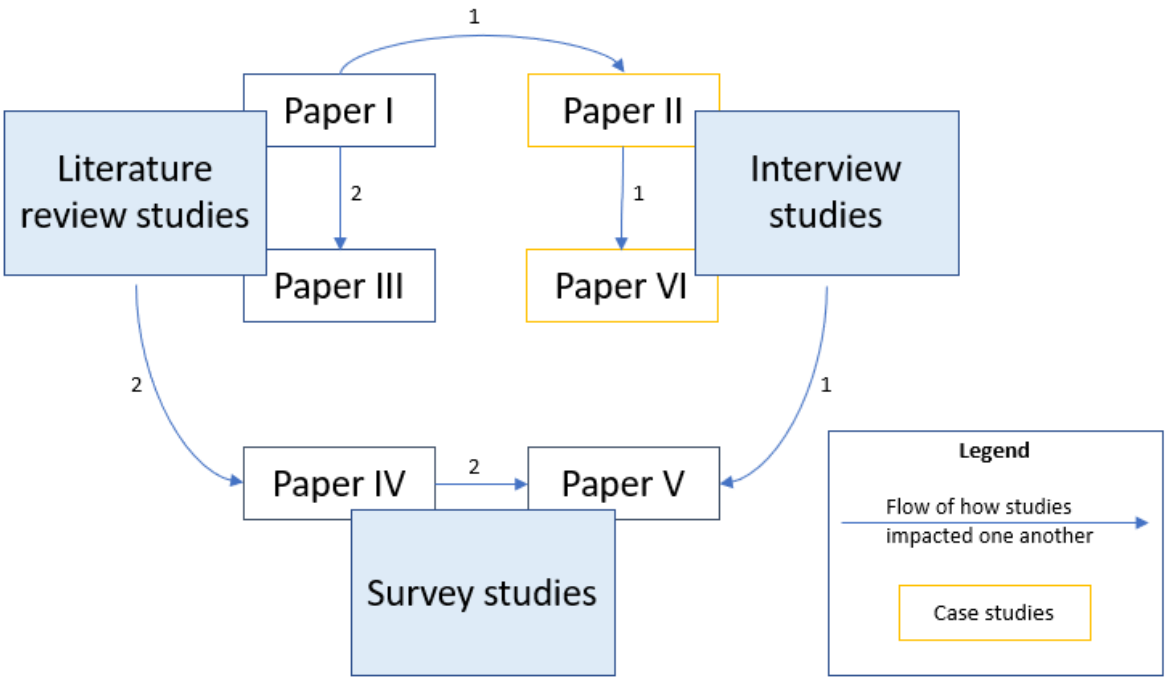

Figure 5: Pathways 1 and 2 displaying how papers are connected via methods

3. Theoretical approaches to One Health

This chapter provides insight into the application of some theories and concepts to the One Health approach. The six papers comprising the dissertation (Chapter 2) inform theories and concepts in relation to One Health. Each paper stands on its own in terms of its theoretical standpoint. They are, however, connected through the One Health theme, which is investigated from different perspectives. This chapter will present theories as well as concepts and depict the connectedness across the papers and how they speak to certain theoretical positions. There is no single, main theory that can be applied to all of the studies; rather, concepts drawn from theories are used to help categorise and theoretically contextualise One Health. The research is placed in the social and political sciences, but due to the nature of the One Health approach, it addresses many disciplines within public and veterinary health, as well as environmental sciences. The abductive approach reflects an iterative process, which allowed for theoretical and conceptual choices that generated a more appropriate understanding based on the empirical data (Blaikie, 2007).

The papers refer directly or indirectly to some of the theories, which often could not be discussed in detail due to the journal word limits. Hence, this chapter is used to introduce some political and social science theories and concepts to the field of One Health. By doing so, the research addresses a theoretical gap concerning the One Health approach in general, and specifically in terms of One Health institutionalisation

and agenda setting. The dissertation contributes to existing theories and concepts by expanding on their uses for the One Health approach. The aim is to inform those theories and concepts on their ability to provide a foundation for studying institutional and policy processes of the One Health approach.

The chapter starts with a brief ontological discussion of the One Health approach and proceeds to present the multiple streams approach in connection with policy entrepreneurs, problem brokers, and networks that inform the One Health policymaking process. It goes on to describe knowledge translation to explain aspects that affect how scientific findings reach (or not reach) decision- and policymakers. While the multiple streams approach and knowledge translation are not directly applied, they are used in some papers to inform theoretical aspects important for the One Health approach. In so doing, this thesis will address challenges and opportunities for the institutionalisation of the One Health approach.

3.1. The theory of One Health

The current literature does not particularly address theoretical considerations of the One Health approach. Some of the little-discussed aspects pertain to ontology. When focusing on specific diseases or health threats, One Health is often eyed in objective, positivist terms (see, e.g., two quantitative One Health-related studies, based on sampling and laboratory analyses, one in relation to AMR and one in relation to mycotoxins; see Paper III for an explanation of mycotoxins) (Viegas et al., 2020; Zaheer et al., 2020). However, an exclusive positivist approach is critiqued, as what we know is not captured by a merely objective view. Including subjective perspectives can provide beneficial input about circumstances and context within social and natural environments (Craddock & Hinchliffe, 2015; Friese & Nuyts, 2017). Ongoing discussions around acknowledging local realities in relation to the social constructs of One Health remain (Conrad et al., 2013; Wolf, 2015). Acknowledging local realities entails epistemological orientations, including the use of a broader range of methods to be able to assess cultural or behavioural considerations (Harrison et al., 2019). Papers I and III both discuss these aspects, recognising the benefits of using not only quantitative but also qualitative studies, methods, and data to approach complex One Health issues comprehensively. Papers I, II, IV, and V provide the perspective to involve experts from social, political, and economic sciences to strengthen the assessment of contexts ranging from specific to broad and from local to global.

3.2. Problems and windows

The multiple streams approach aims to provide insight into the dynamics of governmental agendas and policy processes (Kingdon, 2014). John Kingdon developed this approach, describing agenda-setting processes and the process by which policy windows that represent agenda-setting opportunities open. He explains how, when the three streams (problem stream, policy stream, and politics stream) meet, a policy window emerges

and policy change can occur (Kingdon, 2014). In the following, the three streams are described together with the insertion of the papers' conceptions.

The **problem stream** relates to a specific issue or public matter, which is framed as an attention-requiring problem. In the context of this research, the specific issue relates to a One Health topic. Disease outbreaks such as COVID-19, Campylobacteriosis, and Salmonellosis are used as examples in Paper II. In particular, these problems refer to the difficulties experienced when trying to coordinate the outbreak surveillance activities, or challenges for decisionmaking caused by institutional challenges, such as silo work (Ryu et al., 2017). The public can emphasise such problems as issues in need of attention, or they arise from national or international data on specific topics, such as disease outbreaks captured by surveillance activities. A crisis – as the COVID-19 pandemic was labelled – can amplify the policymakers' attention and awareness (Kingdon, 2014).

Problems such as those described above are discussed in the **policy stream** within specific communities of scientists, government staff, or interest groups. Policy communities discuss ideas and proposals, as they must be technical feasible, which means that the idea has to be worked out, the mechanisms for implementing the idea must be explained, and there must be plans for the practical use of the idea. Proposals must also be accepted regarding their values, (e.g., equity, efficiency, and justice). Additionally, the policy community will examine potential future constraints, such as budgetary concerns and public acceptability (Cairney & Zahariadis, 2016). In the Swedish case (Paper II), the problem of disease outbreaks was discussed to find solutions in terms of enhancing surveillance activities, preparedness, and response plans. There are individuals called **policy entrepreneurs**, who advocate for a proposal and are involved in linking solutions to problems. Such policy entrepreneurs create and use networks (Mintrom, 2019). They influence decisionmaking and policy formulation to promote a particular idea or proposal (Kingdon, 2014; Stone, 2019). These actors use resources such as time, energy, reputation, or money to influence the decisionmakers. Policy entrepreneurs can be academics, lobbyists, lawyers, or bureaucrats, and they may advocate for an idea or proposal to promote personal interests or values and to shape public policy (Kingdon, 2014). Policy entrepreneurs can operate in NGOs, academic or research institutes, but they usually work within governments or government agencies (Stone, 2019). Paper II uses the policy entrepreneur concept to advance its value in the discussion of One Health issues on a political level. On an institutional level, it is valuable to identify policy entrepreneurs so that they can use the momentum of a disease outbreak and advocate for action, potentially pushing One Health onto the political agenda. The Swedish case demonstrates the value of individuals who take the lead and promote One Health topics to raise awareness among policymakers (Paper II). In addition to the policy entrepreneur, the project also explores another agent

capable of driving One Health institutionalisation: the **problem broker,** as introduced by Åsa Knaggård (2015). These individuals strategically frame conditions as political problems but do not connect them to the policy stream. Hence, problem brokers aim to make a problem understandable in the political world. Framing a problem and conveying it to policymakers will affect how policymakers and the general public understand the issue. Paper V describes the value of the problem broker's ability to comprehend the technicalities related to different sectors, understand impacts within science and industry, and consider institutional capabilities. Paper IV exemplifies the problem broker and its skills to frame AMR as a problem. AMR is a health threat, and scientists have gone so far as to label AMR as 'a leading cause of death around the world' (Murray et al., 2022, p. 1). Nevertheless, the issue often remains neglected or secondary in policymaking. Paper IV suggests problem brokering as a tool to connect related AMR issues from different sectors on the human–animal–environment interface and to transform them into something comprehensible for policymakers; in other words, breaking down this multi-faceted, complex, and technical issue into something tangible.

Lastly, the **politics stream** is characterised by public mood, interest groups, political parties, and election results. Policymakers' beliefs can be modified when responding to the 'national mood' or to interest groups. Interest groups can pressure policymakers, as they inform the public and stimulate discussions around specific problems (Kingdon, 2014). Considering disease outbreaks discussed in Paper II (COVID-19, Campylobacteriosis, and Salmonellosis), such interest groups include the industry or health groups campaigning for the issue. Especially in the case of the COVID-19 outbreak, public awareness was heightened and likely had an impact on how politicians perceived the problem (Di Baldassarre et al., 2021). International awareness and pressure also influence the dynamics of this stream. This is exemplified in Paper II by the COVID-19 outbreak, which spread across the globe and triggered international awareness, and by Salmonellosis and Campylobacteriosis outbreaks, due to the potential of importing or exporting contaminated food, which can affect other countries.

According to Kingdon (2014), when the initially separate problem, policy, and politics streams overlap at the same time, a policy window opens and presents an opportunity for policy change to occur. Paper II describes the politicisation of disease outbreaks in Sweden and how the policy streams align. The opening of the policy window did affect some aspects of public policy and triggered structural changes. The COVID-19, Salmonellosis, and Campylobacteriosis outbreaks resulted in different outcomes after their respective policy windows opened. In the cases of Salmonellosis and Campylobacteriosis, they had an impact on surveillance programmes and enhanced certain policies. For COVID-19, surveillance activities were adjusted and veterinary laboratories became involved in the testing of human samples. In addition, public policies were adapted and modified to contain the spread of the virus (Paper II).

3.3. Problem brokers and policy entrepreneurs within networks

Although the roles of policy entrepreneurs and problem brokers can overlap, the difference is that the former actively link problems with policies to set the political agenda and formulate policies (Capano & Galanti, 2021; Kingdon, 2014), whereas the latter investigate a problem individually, making them understandable to inform policies (Gluckman et al., 2021). As Åsa Knaggård (2015, p. 453) formulates, problem brokers suggest 'that something needs to be done'. Figure 6 illustrates the respective tasks and aims of policy entrepreneurs and problem brokers.

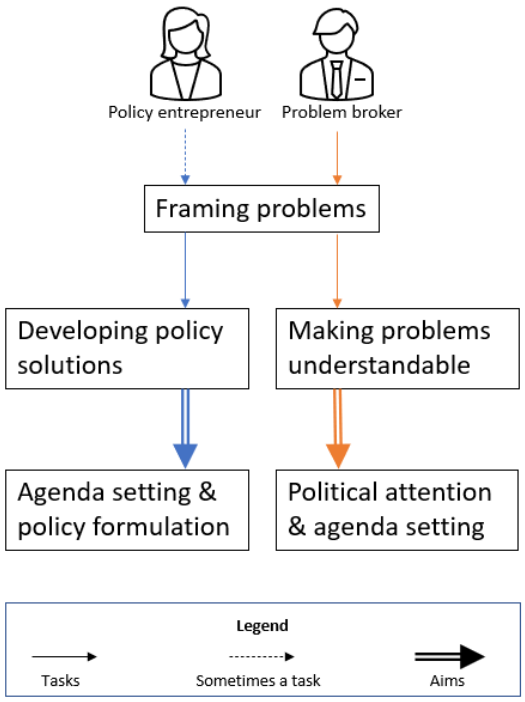

Figure 6: Policy entrepreneur and problem broker – tasks and aims

A policy entrepreneur can have different strategies to reach their aim. Four strategies that can illustrate the unique characteristics and competencies of the policy entrepreneur were outlined by the Overseas Development Institute (2004), a British think tank, and picked up by Diane Stone (2019): The storyteller, the engineer, the networker, and the fixer. The **storyteller** is able to create powerful narratives, translating complex topics into comprehensible, clear stories to inform policy communities. The **engineer**'s strategy is to become involved with street-level bureaucrats who are public service employees implementing policies, to test the technical feasibility of policies, and to generate practical policy recommendations. The **networker** is part of a network, has personal as well as political connections and the ability to make use of them. Lastly, the **fixer** has political savvy, understanding actors and their competencies, and is able to use their savvy to make the pitch for policy change or implementation to the right person. While this dissertation does not evaluate the different strategies, it can be useful to understand the manifold characteristics of policy

entrepreneurs. The different strategies that policy entrepreneurs use can facilitate their aim to frame a problem and convey policy solutions.

The problem broker also employs tools – knowledge, values, and emotions – to achieve their goals (Knaggård, 2015). Here, **knowledge** refers to knowledge of the problem based on scientific research or personal and practical experience. Knowledge based on scientific research can be more authoritative, but knowledge from personal and practical experience can also be valuable. Such knowledge can come from professionals and laypeople, and it can provide useful information for policies or alternative understandings of the problem (Zohlnhöfer & Rüb, 2016). **Emotions** can be a tool for problem brokers to influence policymakers; they can be negative, like anger and fear, or positive, like happiness and compassion. They can be used to influence the perceived urgency of a matter (Knaggård, 2015). Lastly, **values** describe why the problem is important and why action is required. Åsa Knaggård (2015, p. 457) argues that defining values helps 'to motivate political action'. Problem brokers who are political actors might feel more comfortable in demonstrating what is at stake. Scientists, on the other hand, are more likely to avoid this. This stems from the norms and scientific traditions in academia. The aim is often neutrality and objectivity together with a separation of science and politics. This understanding might be somewhat paradoxical, but it is engrained in the scientific culture and can thus impede scientists from moving into the policy stream (Zohlnhöfer & Rüb, 2016). This is also why this dissertation uses the problem broker concept rather than that of the knowledge broker. The concepts are similar, the difference being that the knowledge broker usually comes from education, academic, or research institutions, and knowledge is often specific to scientific findings that must be brokered. Using scientific knowledge restricts the framing of a problem (Knaggård, 2015; Rycroft-Smith, 2022). The problem broker builds on the knowledge broker, using not only scientific knowledge but also the tools described within this paragraph. Furthermore, problem brokers are not only from education or academic backgrounds; like the policy entrepreneur, they can also be found closer to policy- and decisionmakers within governments and government agencies (Dobbins et al., 2009; Knaggård, 2015).

Policy entrepreneurs and problem brokers often operate within networks. For One Health, networks are a valuable tool as the approach ideally brings together different actors (e.g., from academic institutes, research institutes, government agencies, governments) from different sectors (e.g., public health, veterinary, environment, food, agriculture). Within those networks, One Health topics are discussed, ideas formulated and shared, collaborations established, and knowledge disseminated (Khan et al., 2018). To enhance the understanding of One Health networks, it is valuable to investigate existing theories and concepts relating to networks.

From the 1970s, a growing body of literature was published relating to the necessity of viewing the political system as an interconnected web with 'subgovernments', 'subsystems', as well as different 'policy communities' and 'issue networks' (Enroth, 2011). The field continues to develop. Generally, networks are defined as the coming together of government, state, and societal actors. They might not have shared interests, but they are linked or share a dependence and interact on the grounds of their 'beliefs and interests in public policymaking and implementation' (Rhodes, 2017, p. 3). Navigating networks requires acknowledging the different interests, priorities, and levels of power (Hunter, 2016; Rushmer et al., 2019). In relation to interests, policy networks can be seen as places where interests are mediated between actors to push policies and, moving forward, how to implement them. Policy decisions (and their implementation) can form when political actors come together to interact and exchange information and resources. Such actors can come from the government as well as other influential institutions. Government and influential actors need each other; the government to meet policy objectives, and the influential actors to push their subjects forward. Rhodes (2008) states that this transcends the simple lobbyist–politician relationship; rather, it can form a collegial like relationship. This relation becomes a policy network, which can involve either closer or looser relationships (Rhodes, 2008). The 'policy community', describes the stable and close relationship of a selected group consisting of interest groups, governmental bureaucrats, and politicians with more or less shared interests for a policy issue (Thatcher, 1998). 'Issue networks' are complex networks with looser relationships that also include professional experts and academics. Hugh Heclo (1978) describes this group as larger and more fluctuating with some agreement among them but also unequal power relations.

Tasselli et al. (2015) write on how individuals shape the networks in which they find themselves and, at the same time, how networks and the manner in which they are built regarding regulations and routines form people. There are multiple relationships and a constant exchange of resources within the networks. The actors share dependencies and rely on the exchange of resources to achieve their goals. For successful exchanges, regulations and a relationship of trust are necessary (Enroth, 2011; Goodin et al., 2006). Trust can be enhanced through good leadership (Marion & Uhl-Bien, 2001). Leadership in relation to networks is discussed briefly in the following, as leaders are key actors due to their decisionmaking authority, their ability to establish trust as well as meaning, and to provide guidance for collaborations (Rogers, 2003; Stokols et al., 2008). The literature on leadership is extensive (see, e.g., leadership in connection with education: Guthrie & Jenkins, 2018; psychology: Haslam et al., 2020; organisations: Marion & Uhl-Bien, 2001). While this dissertation will not go into detail about the various disciplines dealing with leadership, a broad definition of leadership is important to consider in relation to the One Health approach. Here, leadership is addressed in the realm of research (e.g., leading scientific projects and networks) and as a practical skill. Leaders contribute to networks by advising and sharing their knowledge (Tasselli et al., 2015). Leaders are

decisionmakers who possess expertise and established trust, who can influence people and can consequently facilitate innovations (Rogers, 2003). Paper V describes the importance of distributing roles and responsibilities and establishing leadership. It draws on notions of the policy entrepreneur who employs the networker strategy and on issue networks that include experts who intend to use their relationships to capture political attention and to achieve their goals. Papers IV and VI contribute to this discussion by debating the role of leaders within One Health networks. For example, Paper VI discusses leaders who are not only able to advise and share their knowledge among peers, but who are able to broker knowledge and information across sectors. In some instances, policy entrepreneurs and problem brokers can have leadership positions (Capano & Galanti, 2021). Whether they are leaders or not, they use their brokerage skills to create networks, use knowledge within those networks to frame problems, and the policy entrepreneur then also aims to find and present solutions to policymakers (Mintrom, 2019).

When examining networks, there are relations or ties between different actors (Rhodes, 2008; Tasselli et al., 2015). Paper I describes this using the example of scientific networks, specifically co-citation networks of authors that illustrate the relations between authors in the form of their citation patterns. The strong-tie theory argues that similar people tend to bond and cluster. This is in line with homophily, a concept that portrays the tendency of actors to group together with other actors with whom they are familiar or who work with familiar topics (McPherson et al., 2001). As less effort is required to interact with those who are familiar or share common understandings, homophilous communication is argued to be more effective (Ertug et al., 2022). However, strong ties or homophily can lead to fewer innovations, for example in terms of designing One Health projects and sharing information about methodological and analytical approaches. Accordingly, weak ties, where individuals meet others who are not usually connected, can provide different perspectives, produce new information, and link otherwise disconnected actors (Ertug et al., 2022; McPherson et al., 2001). This is in line with heterophily (the opposite of homophily), which occurs when individuals group together with those who are different; for example, in relation to the topic they work on. Heterophilous communication can provide new knowledge that can facilitate innovations. Papers I and VI place the homophily concept within the realm of networks, which contributes to discussions of the phenomenon among scientists and their networks.

3.4. Knowledge translation

The literature on knowledge translation covers several disciplines and is hosted under multiple other theories, such as Organisational Theory, Social Network Theory, and Implementation Theory. There is no single overarching knowledge translation theory, but rather multiple approaches to adapting and integrating the notion of translating knowledge into different theoretical discussions (Estabrooks et al., 2006; Rushmer et al., 2019).

Many definitions for the term knowledge translation exist, as well as related terms like knowledge transfer, knowledge exchange, dissemination, diffusion, and more (Graham et al., 2006). The WHO defines knowledge translation as 'the synthesis, exchange and application of knowledge by relevant stakeholders to accelerate the benefits of global and local innovation in strengthening health systems and improving people's health' (WHO, 2005, p. 2). This definition provides a good starting point, although it can be adapted to the context of the dissertation by adding the aims to strengthen ecosystems and improving the health of animals and the environment.

Knowledge translation involves the process of transferring knowledge between different actors: The 'evidence producers' who share the knowledge (source) and the 'evidence users' who receive it (receiver) (Liyanage et al., 2009). Evidence producers can be scientists working at universities and national institutes, like public health, medical, veterinary, food or environment institutes. The industry also plays a role, as for example the food-producing industry provides practical input and data, and they can be both evidence producers and users. At the international level, organisations and agencies play a role in advising and recommending (e.g., WHO, FAO, WOAH), and in the context of the EU there are agencies such as the ECDC, the European Food Safety Authority (EFSA), and the European Medicines Agency. The receivers are institutes and organisations themselves in relation to cross-sector knowledge translation and transfer, and policymakers in national governments or EU-level decisionmakers; European Parliament (representatives of the citizens) and Council of the European Union (government ministers from EU countries), who approve or reject legislation (Wallace et al., 2020). For the One Health approach, knowledge translation occurs from scientists to political actors and to the public. However, the process also occurs across sectors, among scientists on the human–animal–environment interface, as ideally, findings or knowledge are compared, disparities and commonalities found, and then knowledge from other fields is assimilated and transformed into a tangible form (Grimshaw et al., 2012).

Liyanage et al. (2009) describe five steps for source–receiver knowledge transfer leading to knowledge translation: awareness, acquisition, transformation, association, and application. These five steps occur through networking and can be influenced by different factors. Influencing factors can include person-, political-, or organisation-related characteristics (e.g., political ambitions, election cycle), or cultural and socio-economic circumstances (Grimshaw et al., 2012; Liyanage et al., 2009). The five knowledge-transfer steps can be summarised as follows: Relevant knowledge must exist, there must be **awareness** of it, and willingness to share it (Liyanage et al., 2009). Knowledge **acquisition** depends on the identification and ability to obtain the knowledge from external sources. Next, knowledge must be **transformed** by modifying or adapting information, which 'can be accomplished by simply adding or deleting knowledge' (Liyanage et al.,

2009, p. 127). Transformed knowledge must be **associated** to the receiver's (e.g., political actors) needs, priorities, and abilities. Intermediaries like policy entrepreneurs (e.g., with competencies in storytelling) or problem brokers aid to interact and establish dialogue, as they can facilitate the exchange of knowledge from a scientific and technical language to a language that is more readily understood (Knaggård, 2015). The last step is knowledge **application**, where new knowledge is employed and put to use. Influencing factors like the local context must be taken into account to enable knowledge association and implementation (Liyanage et al., 2009; Rushmer et al., 2019). Source–receiver interactions facilitate the knowledge transfer process by engaging stakeholders and creating awareness about potential influences. For this, networks provide a platform for knowledge translation processes, including communication and collaboration (Liyanage et al., 2009).

Papers I, IV, V, and VI cover different aspects directly or indirectly in relation to the knowledge translation process. Paper I, presenting the bibliometric analysis of the One Health literature, provides insight into the challenges for knowledge translation due to the persistent silos across sectors that hinder collaboration and interdisciplinary scientific outputs. Challenges are the acquisition of knowledge, such as data on health-related issues from different sectors, which is essential for the One Health approach. Similarly, Papers IV–VI pick up the challenge of obtaining, sharing, and communicating scientific knowledge across sectors. Paper V examines the transformation, association, and application steps, taking the influencing factors into account together with the source and receiver networks.

The papers contribute to the knowledge translation concept by providing insight into applying it within the context of the One Health approach and presenting specific examples of the knowledge transfer process, networks, and influencing factors.

3.5. Overview and synthesis

In summary, the dissertation includes theories and concepts of the multiple streams approach, knowledge translation, networks, homophily, and intermediaries such as problem brokers, policy entrepreneurs, and leaders. While the number of theories and concepts appears generous, each provides their piece of the puzzle, which helps to grasp different aspects of the One Health approach. The theories and concepts provide insight into the institutional and political notions that constitute the One Health approach. Figure 7 illustrates how the theories and concepts come together. Within a network are different actors: policy entrepreneurs, problem brokers, or leaders; scientists and experts; and policy- and decisionmakers. There is knowledge exchange between and among the actors. The policy entrepreneur, problem broker, and leader utilise their knowledge translation and networking skills to make use of individuals and knowledge within networks and to engage with actors. The policy entrepreneur discusses ideas and proposals to solve problems. The problem

broker focuses on framing conditions as political problems. This highlights the role of the intermediaries in terms of connecting and transferring knowledge within networks (Glegg et al., 2019). There are impacts on the network, such as influencing factors like institutional mechanisms, governmental regulations, agendas, and priorities. The composition of the network (i.e., whether it is homo- or heterophilous) also impacts the topics discussed within the network. The policy entrepreneur, problem broker, and leader operate in networks on local, national, and international levels. The output of the actors' network interactions is the knowledge that can then be applied in political or scientific contexts.

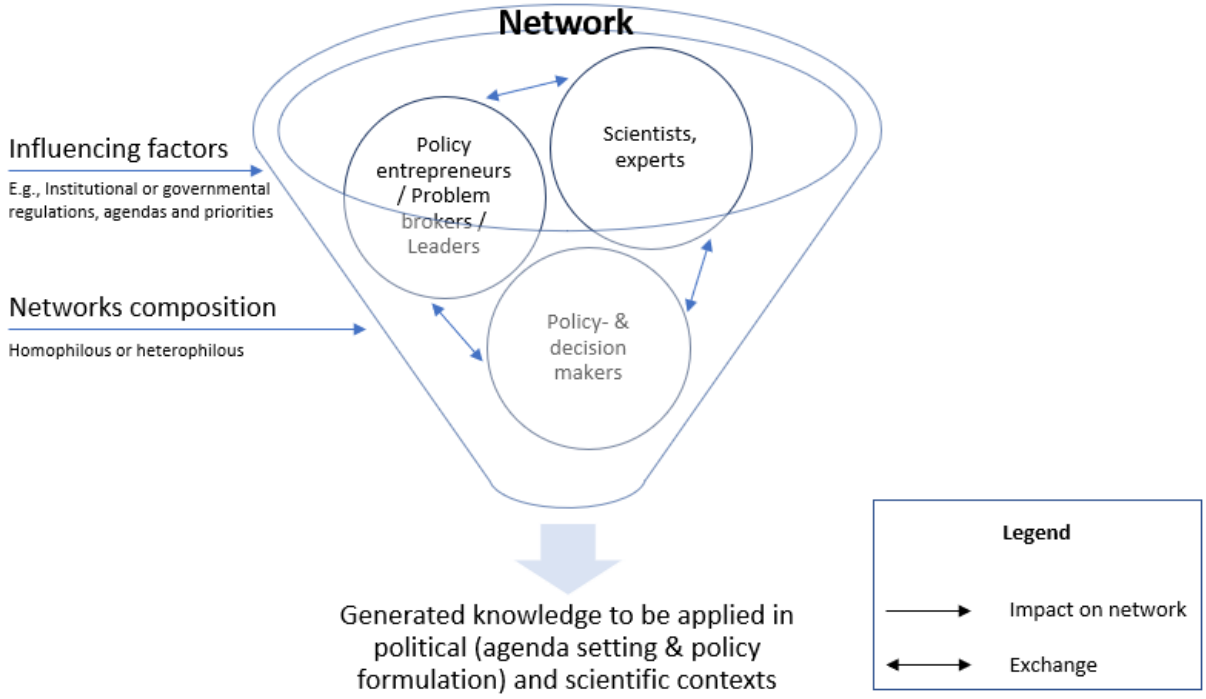

Figure 7: Theoretical and conceptual synthesis

4. Methods

The previous chapter described how not one settled theory was used to explore the contexts; rather, a set of theories and concepts was used to aid the explanation of the findings and the relationships between the different studies. Similarly, this chapter will proceed to describe the use of various methods to achieve a comprehensive understanding of different aspects of One Health institutionalisation and policy processes. The chapter begins with reflections on the research process and continues by presenting the research design, including ethical and methodological discussions. Following that, the different methods and their analytical approaches will be described.

4.1. Reflections on research process

Beginning in early summer 2019 and ending in late summer 2023, the process resulting in this PhD project is best described as a journey. There were bumps on the road along the way, and the project took some unplanned twists and turns. In the following, I will reflect on the research process.

When planning the research for the PhD project, the main topic – One Health institutionalisation – was already outlined by the One Health European Joint Programme (OHEJP) and Roskilde University. The OHEJP was a set of projects and activities involving research institutes across 22 EU states. The programme established a network across 44 research institutes and stakeholders from food, public health, veterinary, agriculture, and environment disciplines. The OHEJP aimed to approach issues like food-borne zoonoses, AMR, and emerging health threats in the human–animal–environment interface in an interdisciplinary manner (One Health EJP, 2021). Although the overarching topic of the PhD project was outlined, there was plenty of room to influence the project regarding the research design, case choice, methodology, and theoretical approaches. The research design was constructed and included plans for case-based research using qualitative and quantitative methods, including observation, interview, and survey studies.

Just five months into the PhD project, while I was occupied with the literature review and planning of the PhD project, rumours concerning the outbreak of a new disease began to surface. On 11 February 2020, the WHO announced 'COVID-19' as the name of this disease, and it was labelled a pandemic in March. Lockdowns around the world followed soon thereafter; also in Denmark, where this research was conducted, and in the country cases Sweden and Italy (Hu et al., 2020). This necessitated substantial revisions to the methodological approach and my PhD schedule. Several planned initiatives had to be cancelled or postponed. The observation study planned for 2020 that was supposed to be conducted at OHEJP stakeholder meetings had to be cancelled. These observations were intended to produce insight into practicalities and processes related to implementing One Health. The lockdowns led to the cancellation of some meetings, others being held online. The general confusion in the midst of the pandemic hampered access to meetings.

However, I was adamant to keep the interview and survey studies as part of the research design. The Swedish interviews were all carried out online, as they were conducted in spring 2020 in the midst of lockdowns and travel restrictions. Some of the Italian interviews were held online while others were conducted on-site. They were conducted in autumn 2021, when there were fewer restrictions. It was initially difficult to contact experts during the COVID-19 pandemic, as public health experts were occupied with pandemic-related work. Experts at the veterinary and food agencies were involved in the coordination of aid to the public health agency, providing laboratory support or examining the potential impact of COVID-19 on farm animals, pets, food, and feed. However, some persistent emails and encouragements from key gatekeepers helped the

interview process. Gatekeepers facilitate access to the field to collect data, either through their position or network (Bengry, 2018). In this context, access to the field meant access to potential interviewees and survey respondents. The gatekeepers were my co-supervisor, Ann Lindberg, Director General at the National Veterinary Institute in Sweden, and Alberto Mantovani, research director at the Istituto Superiore di Sanità, the national public health institute, who opened the doors for the PhD project to enter Italy. Conducting the interviews online did not seem to compromise the content or the extent of discussions. The pandemic even opened up possibilities of adding questions about COVID-19 in relation to the One Health approach. By the time the Italian interviews were conducted, video calls had become part of the day-to-day routine in the public health institute, and the interviewees had grown accustomed to online meetings.

Two research stays were planned: a three-month stay in Sweden at the national veterinary institute and a three-month stay in Italy at the public health institute. The Swedish research stay was reduced to a one-week stay in autumn 2019, planned as an introductory meeting. While only a small fraction of the originally intended time, it nonetheless provided some useful contacts and insights into the institute structures. However, the full three-month research stay in Sweden would likely have provided opportunities that might have led to different and possibly deeper impressions, collaborations, and a better understanding of the government agency itself. In Italy, a one-month research stay was accomplished at the Istituto Superiore di Sanità in autumn 2020. This period was productive in terms of conducting interviews and networking. However, strict COVID-19 regulations rendered it impossible to participate in ongoing meetings or other activities that might have provided in-depth insight into the institute processes and structures. One more month of fieldwork was conducted in Italy in autumn 2021, at which time I visited experts at regional veterinary institutes. While this deviated from the originally planned three-month research stay, the changes provided plenty of opportunity to network and conduct fieldwork. All in all, more interviews (both in Sweden and Italy) were conducted than initially planned, which demonstrates the flexibility of conducting online interviews.

The online survey also remained part of the research design. Here, being part of a large, EU-funded Horizon 2020 project provided invaluable access to stakeholders from different countries, sectors, and disciplines. Further, the OHEJP shared the survey invitations through their internal email lists. The Horizon 2020 project offered many opportunities for courses and networking, but also entailed an extensive amount of reporting. While extensive and time-consuming, these reporting procedures were a valuable contribution for the PhD project, as they taught among other things techniques to disseminate research findings. This was done (by sometimes venturing out of the personal comfort zone) continuously through conferences and engagement via social networking sites (e.g., LinkedIn, Twitter).

For theoretical discussions, the Roskilde University Globalization and Europeanization Research Group provided valuable input. Discussions in this forum contributed to the consideration of the theories chosen to inform the research. Conferences also provided opportunity to reflect on the theoretical and methodological approaches used in the PhD project. Due to the pandemic, most conferences were moved online. While this hampered the opportunities to network and discuss research choices in greater detail, the conferences provided opportunity to disseminate findings and learn about other ongoing research. The few in-person conferences (OHEJP Annual Scientific Meeting, 2021, Roskilde Academic Conference – Grasp, 2021, One Health Sweden meeting, 2022) led to fruitful discussions and provided opportunity to engage in conference organisation, where I facilitated a One Health quiz (OHEJP Annual Scientific Meeting, 2021). Throughout the PhD journey, I actively sought out and found opportunities to write and co-author articles. Some of the papers were (in some form) planned (Papers II, IV–VI). Papers I and III resulted from meetings with new colleagues and brainstorming on One Health issues, which led to the ideas for the manuscripts.

4.2. Research design

The One Health approach is more commonly known within the natural sciences, especially the veterinary sciences, than in the social or political sciences (Paper I). Hence, from a social science perspective, the One Health approach has yet to be studied extensively, which provided opportunity for this explorative study to investigate some institutional and political aspects of the One Health approach (Lapinski et al., 2015; Stebbins, 2001). The research process mirrors abductive reasoning through the entangled process of choosing methods, theories, and concepts under the influence of the empirical data that was gathered (Blaikie, 2007). The explorative study was based on mixed methods, where data was triangulated and several methodological approaches fed into each other. This enabled the identification of patterns within the data and revealed complementary traits that allowed generalisations to be drawn (Heale & Forbes, 2013).

Qualitative and quantitative approaches were used to gain insight into the One Health approach. Data was gathered sequentially, meaning that it was collected in successive periods (Schoonenboom & Johnson, 2017). Initially, a literature review on the One Health approach was conducted to gain an overview of the current state of academic and practical knowledge. The literature search extended to a bibliometric analysis of the current state of One Health research. Two cases were then selected to investigate national-level One Health institutionalisation. The cases describe Swedish and Italian One Health practices and represent experts from national agencies and institutes who unveil institutional structures that promote or inhibit the implementation of the One Health approach. Experts are individuals who have knowledge that others do not, including specialised knowledge and skills in a particular area gathered through their occupation and experience (Meuser & Nagel, 2009). The interviewees included scientific and administrative experts, which made it possible to analyse and compare One Health institutionalisation across agencies and countries in-

depth. A survey was subsequently launched, addressed to scientific and administrative experts in EU agencies, NGOs and national institutes within some EU countries together with Norway, Switzerland, and the United Kingdom. In the dissertation, research pertaining to 'Europe' usually refers to the countries included in the survey: the 23 EU member states plus Norway, Switzerland, and the United Kingdom (see Table 4 for a complete list of countries). Data was gathered on science-led policy processes to identify One Health policy processes, networks, and agenda setting. The triangulation of the methods aided to enhance the validity of the data, and the mixed method approach allowed the use of information gathered through one method to inform another. This approach provided a multifaceted view by employing methods that examined different national and international perspectives (Schoonenboom & Johnson, 2017). Combined, each method contributed to answering the research question by providing insights from different perspectives, such as institutional and governmental processes, individual actors, their roles, and networks.

4.2.1. Ethical considerations

The project was confronted with different ethical reflections in terms of data gathering, handling, and storage regarding the interview and survey studies. To fulfil the general ethical requirements, a clear methodological approach was established to obtain reliable research results. Here, data triangulation helped to promote validity and reliability, as information from different sources increased the precision of the information supported to answer the research question.

Data from the interview and survey studies were handled confidentially and respectfully. No sensitive or personal information (e.g., ethnicity, gender, religion, or sexual orientation) were gathered. Privacy and confidentiality were ensured throughout the entire process of the PhD and for all involved parties by storing data securely and anonymising participants. Participation in the interviews and the survey studies was voluntary, and participants were informed beforehand regarding the objective of the study and the use of the data. Informed consent was obtained prior to the beginning of the studies. Relevant Danish and European laws were considered to ensure data protection (Danish Code of Conduct for Research Integrity (Danish Ministry of Higher Education and Science, 2014); Roskilde University rules about good scientific practice (Roskilde University, 2020); and General Data Protection Regulation (Regulation (EU) 2016/679, 2018)).

The expert interviews and survey responses were used in three papers via quoted statements. Anonymity was ensured, albeit treated slightly differently in the papers. A numbering system was used, connecting each survey and interview participant to a number, followed by their workplace (Papers II & V), or their workplace and country (Paper VI); see the three following examples:

- Paper II: (9, Veterinary Agency)
- Paper VI: (16, Public Health Institute, Italy)

- Paper V: (P15 – University) [3]

Papers II and VI used the COREQ [4] checklist, which is a list for reporting qualitative research based on interviews and focus groups (Tong et al., 2007). Following the list allowed for reflection and thorough reporting, spanning the three domains 'research team and reflexivity', 'research design', and 'analysis and findings'. The checklists can be found on the respective journal websites (Chapter 2 provides the links) in the supplementary material.

Further, the analysis of qualitative data raises additional ethical considerations. Qualitative data from the interview studies and the open-ended answers from the survey study were interpreted. Subjectivity is inevitably interwoven into the interpretation of the data, which raises questions regarding the replicability and generalisability of the research (Auerbach & Silverstein, 2003). To strengthen generalisability and enable replication, the analytical approaches were made as transparent as possible by checking codes, piloting questionnaires, using the COREQ checklist, and describing the coding processes (for more detail, see sections 4.5.2 and 4.6.2, as well as the method sections of Papers I–VI).

The PhD project was funded in part by Roskilde University and the EU Horizon 2020 project OHEJP. The broader topic of the PhD project had already been outlined from the outset, but free choice was left regarding research design, methodology, and theoretical approaches. To support the project in terms of data gathering and the dissemination of survey invitations, the OHEJP provided access to partner institutes and stakeholders for the interview and survey studies. The stakeholder contact data was handled confidentially.

4.2.2. Methodology

The study was informed by critical realist ontology, which is positioned at the intersection between positivism, which represents objectivity in the form of analytical rigour and statistical data, and interpretivism, representing subjectivity and giving room for options and perspectives. It can encounter natural and social science domains (Bhaskar, 2008). This provided opportunity to study the One Health approach, which is on the one hand deeply embedded in the natural sciences due to the need to understand the physiology of animals and humans, molecular and cellular aspects, as well as other medical, biological, chemical, environmental and epidemiological characteristics. On the other hand, there are social science aspects in terms of institutional structures and political processes that form the One Health approach. Accordingly, critical realism recognises the use of different methods (Sayer, 2000). Hence, for this study,

[3] P stands for participant.
[4] COREQ stands for consolidated criteria for reporting qualitative research.

mixed methods using both qualitative and quantitative approaches allowed the study of a complex issue (One Health) and to learn about specific aspects (institutional and political processes).

Case studies, which are a central tool in critical realism, contributed to understanding 'the operation of a mechanism', that mechanism being the One Health approach (Vincent & Wapshott, 2014). Throughout the research process, particular kinds of data develop. Data obtained through one method, such as interviews, can reveal and inform other aspects or methods. In this study, the interviews informed the development of a survey questionnaire in terms of conceptual and contextual understanding and specific question development. The critical realist notion supports the idea that different kinds of methods or knowledge speak to each other and can be complementary (Hurrell, 2014). There is an understanding that science is not infallible and knowledge is only valid at the time and context it was created. For the PhD project, this means that the knowledge has been valid when the research was conducted, but also for the time that the One Health approach is deemed relevant and implemented. As reality is depicted as unstable and highly dependent on the changes in conditions and contexts, this ontology acknowledges the complexity inherent to the One Health approach (Dean et al., 2006).

4.3. Analysis of the literature

The dissertation and papers are based on scientific and grey literature. Hence, both systematic and semi-systematic reviews of the literature were conducted (Snyder, 2019). For the semi-systematic literature reviews, platforms such as Web of Science, PubMed, Google Scholar and web searches were used. Google searches were usually employed to detect grey literature (e.g., EU reports, national and international surveillance reports, and other non-peer-reviewed publications). The aim was to identify and synthesise research to obtain an overview and deeper understanding of a topic.

For the systematic review, the literature was searched more methodically, using only peer-reviewed articles from the Web of Science and PubMed platforms together with pre-formulated inclusion and exclusion criteria. Search terms were formulated and, after the initial search, the literature was screened to remove duplicates or other literature not suiting the criteria. A more detailed description of the literature review process is presented in Paper III.

Additionally, a bibliometric analysis was conducted to quantitatively link and visualise data produced by researchers revealing specific patterns and characteristics in terms of collaborations, networks as well as citations (Zupic & Čater, 2015). The analysis of academic features concentrated on publication trends, a co-citation network of scientific journals, co-citation network of authors, and co-occurrence of keywords. The bibliometric analysis contributed to an overview as well as describing and evaluating the published research.

The statistical analysis was conducted with the bibliometrix package for the R programming language. For a detailed description, see Paper I.

4.4. Case selection

The main focus of the study was Europe, specifically the EU, its member states, plus Norway, Switzerland, and the United Kingdom. The region provides a network of unique countries all facing health issues on the human–animal–environment interface. Those health issues can be similar, as for example how AMR concerns all countries. But they can also be distinct; for example, due to cooler northern or warmer southern climates. One Health-related challenges can be zoonotic diseases, AMR, food safety issues, climate change, environmental contamination, and many more (Garcia & Gostin, 2012). On the EU level, there are agencies tasked with tackling One Health challenges. The EFSA, EMA, ECDC, and European Environment Agency (EEA) are some of those agencies (Bronzwaer et al., 2022). Within European countries, there are usually specific national research institutes and government agencies involved in preventing and combating health threats, such as public health, veterinary, food and environment agencies (Mazet et al., 2014). European countries and the EU as a whole provide a comprehensive set of institutes, agencies and networks that coordinate interdisciplinary activities, such as outbreak management and surveillance activities (Belfroid et al., 2020; Bronzwaer et al., 2022; Jordana & Triviño-Salazar, 2020). In addition to the institutional and organisational aspects, the advising capacity of national and EU agencies to policymakers provided insight into One Health decision- and policymaking processes (Chatzopoulou, 2018).

To gain more specific insight, two countries, Sweden and Italy, were selected to serve as examples of how they tackled One Health issues. These two country cases allowed the investigation of a phenomenon, here the One Health approach, in different contexts and situations. They enabled the utilisation of knowledge that existed within the two cases (Yin, 2014). Each country case provided insights into specific institutional and political structures of their public health, veterinary, environment and food institutes. In Sweden and Italy, the terms ‘institutes’ and ‘agencies’ are both used to refer to the respective governmental services. These words are used interchangeably in the dissertation.

Cases were selected based on convenience sampling strategy. The non-random sampling was used as the cases were easily accessible due to gatekeepers who facilitated access to the institutes under investigation in the countries. The sampling strategy is based on the judgement of the researcher and struggles with selection bias, meaning that other important cases may not be detected or excluded (Schreier, 2018). To avoid the unintentional exclusion of cases, the semi-systematic analysis of the literature provided information on the state and usage of the One Health approach within European countries. Additionally, the grey literature provided an overview of One Health-related policy and pandemic surveillance documents. The

literature highlighted research activities (or the lack thereof) in Sweden and Italy relating to the One Health approach. Further, the assessment of the cases was based on a mapping of the 44 OHEJP partner agencies situated in the 22 EU member states (One Health EJP, 2021). This ensured that the institutes within the selected countries related their work to the One Health approach. One obvious limitation is the lack of an eastern European country case. Eastern European countries could have provided valuable knowledge on One Health institutionalisation, as the lack of literature relating to One Health in those countries indicates some of the challenges related to the implementation of the approach (Humboldt-Dachroeden et al., 2020). An eastern European country case could have provided lessons learned regarding challenges in implementing the One Health approach and could have potentially revealed how to prevent and overcome them.

The literature pointed towards different structural aspects that were taken into account for the case selection. The countries showed different governmental and institutional structures covering different thematic areas (as described in sections 4.4.1 and 4.4.2 below). This is due to their belonging to different ministries and their respective mandates and administrative tasks. The thematic areas are determined by the countries' priorities and the issues with which they have had to deal. This can be linked to the environmental, cultural, or political conditions from which different health-related scenarios can emerge (Verhoest et al., 2012). The political handling of water offers a good example: Water is a complex topic and can be connected to environmental politics (e.g., different water sources (sea, lake, river), different types of water (waste water, fresh water, salt water)), and to food politics (e.g., food production, drinking water), or to veterinary and public health politics (e.g., water-borne diseases) (Garcia & Gostin, 2012). The topic often involves competing interests. Hence, it can be found on multiple agendas and mandates within different ministries and government agencies (Whaley, 2022). Structural differences become clearer when considering such an example, and they expose the heterogeneous Italian and Swedish organisational structures and political landscapes. The institutes were compared in terms of the thematic areas resulting from their belonging to a respective ministry; not however, regarding the internal distributions of power and their operationalisation. In examining the One Health approach, this provided an overview of two cases encountering both similar and distinct challenges and which provided unique means to resolve them.

Differences in government structures and their services were also considered. The literature suggested that the One Health approach in Sweden plays a major role on political, institutional and research-related levels (e.g., One Health in policies (Eriksen et al., 2021); One Health in education (Haxton et al., 2015); and One Health in disease surveillance (Ståhl, 2021)). For the Italian case, the literature review yielded fewer results in terms of institutional approaches but more regarding the implementation of the One Health approach in a scientific manner via research projects (e.g., Canali et al., 2020; Lorusso et al., 2020; Paternoster et al.,

2017). Other important aspects for selecting the two EU countries were the geographic and climatic differences and similarities between the countries, as these aspects defined their respective One Health issues. The geographic and climatic differences provide grounds for different human lifestyles animal habitats, which lead to the emergence of different diseases and health issues. In Italy, for example, West Nile virus is a major concern, while it does not play a role in Sweden. West Nile Virus is a mosquito-borne disease, usually prevalent in warmer regions, and can be transmitted to humans and animals (Habarugira et al., 2020). Conversely, the zoonotic disease tulameria, while rare, occurs more often in Sweden than in Italy. It is a zoonotic disease that can survive in cooler environments, is often prevalent in rural areas, typically affecting rabbits or rodents, but humans can also be infected, usually through tick bites (ECDC, 2021). Appendix 1 provides a more detailed list of such considerations regarding geographic, climatic, but also political and demographic aspects.

Hence, the selection of the cases, Sweden and Italy, was based on the different organisational structures of government agencies, climate-related differences, and the countries' respective efforts to implement the One Health approach, which was demonstrated by their surveillance activities of zoonotic diseases, their national action plans for AMR and their cross-sector collaboration activities (e.g., Ministry of Health, 2020; Swedish Veterinary Agency, 2023). The combination of the synthesised knowledge of the literature review and the access to the OHEJP partner agencies ensured a consistent sampling method, which strengthened reliability. While the Swedish and Italian cases do not represent all European countries, as there are many factors that differ across the two countries and compared to other European countries, they do represent northern Europe and southern Europe to some extent, for example in terms of climate-related aspects (see Appendix 1). The critical cases provided in-depth insight into the two countries, their governments as well as government agencies, and some findings may generalise to other contexts (Flyvbjerg, 2006).

4.4.1. Ministries and services – Sweden

The government of Sweden addresses about 10.3 million inhabitants living in the country, which has a size of about 450,000 km² (as of 2019) (Eurydice, 2022b). The Swedish agencies cover the areas of veterinary science (Swedish National Veterinary Institute), public health (the Swedish Public Health Agency), food (Swedish National Food Agency), and the environment (Swedish Environmental Protection Agency). They are all governmental institutions steered by three different ministries: Public Health Agency by the Ministry of Health and Social Affairs, Veterinary and Food Agencies by the Ministry of Enterprise and Innovation, and Environmental Protection Agency by the Ministry of Environment (see Figure 8). The Food Agency covered the drinking-water issue, while the Environmental Protection Agency covered other water-related issues. There are 21 regions in Sweden dealing with public health, veterinary and environmental authorities on

regional and local levels that are regulated by national laws (Burström & Sagan, 2018; Swedish Environmental Protection Agency, 2017).

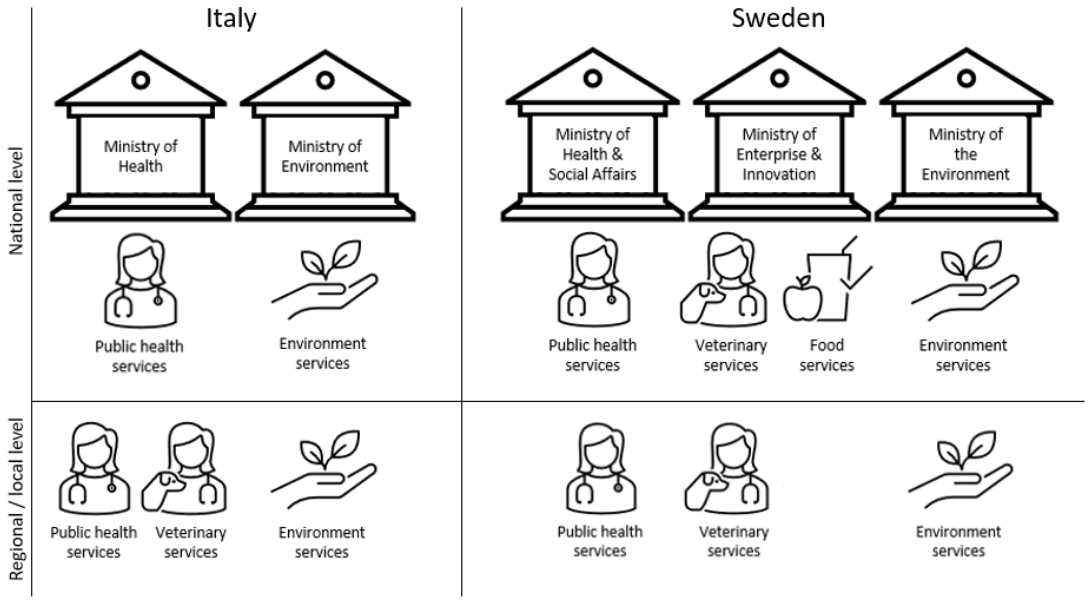

Figure 8: Italian and Swedish ministries and their One Health-related services on national, regional, and local levels (Humboldt-Dachroeden, 2022)

4.4.2. Ministries and services – Italy

The Italian government provides services to approximately 60.2 million people within a country encompassing roughly 302,000 km² (as of 2020) (Eurydice, 2022a). The institutes involved in Italy were in the area of public health (National Institute of Health), veterinary science (veterinary institutes), and environmental science (National Institute for Environmental Protection and Research). Italy has 20 regions, one (Trentino-Alto Adige) of which is split into two autonomous provinces, there are 21 decentralised public health and environmental agencies. The agencies are independent and have their own jurisdictions (AGENAS, 2022; Poscia et al., 2018). There is no national veterinary institute; rather, as part of the national health service, there are 10 regional veterinary agencies for the 21 regions in the country (ISPRA, 2022; Poscia et al., 2018). The national institutes are all governmental institutes, steered by two different ministries: Public Health and Veterinary institutes under the Ministry of Health, and the Environmental Protection and Research Institute under the Ministry of Environment (see Figure 8). The National Institute of Health had several human health-related departments, as well as veterinary, environment, and food-safety departments. The veterinary agencies also deal with food safety topics. There is no national food institute, and the water issue is covered by the environment services.

4.5. Interviews

The interviews were designed to examine the institutional structures, practices, and networks within public health, veterinary, food, and environment institutes via a case-based qualitative analysis. The study was

based on semi-structured, open-ended interviews. Thirteen interviews were conducted for the Swedish case, 19 for the Italian case. The interviewee profiles included experts from the public health, veterinary, food, and environment sectors, who were engaged in national and international projects concerning One Health topics (see Table 2). Expert interviews were utilised, as they provided an effective tool for gathering technical and specific information (Bogner et al., 2009). Approximately three months were invested in collecting data for each case, six months total. Thirty-two interviews were conducted, which unveiled unique insight into One Health practices and outbreak-related operations. Variations in agency sizes and the availability of experts led to an uneven distribution of interviewees.

Table 2: Workplace and background of Swedish and Italian interviewees

SWEDEN			ITALY	
PUBLIC HEALTH AGENCY [N = 4]				NATIONAL INSTITUTE OF HEALTH [N = 11]
1	Microbiology		1	Veterinarian
2	Epidemiology		2	Biology
3	Epidemiology		3	Chemistry
4	Epidemiology		4	Veterinary epidemiology
			5	Natural Science
			6	Human medicine
			7	Public health
			8	Veterinary medicine
			9	Molecular biology
			10	Molecular biology
			11	Veterinary medicine
NATIONAL VETERINARY INSTITUTE [N = 6]				REGIONAL VETERINARY INSTITUTES [N = 6]
5	Finance		12	Veterinarian
6	Veterinary pathology		13	Biology
7	Veterinary epidemiology		14	Veterinary medicine
8	Epidemiology		15	Veterinary medicine
9	Research coordination		16	Veterinary epidemiology
10	Parasitology		17	Veterinary medicine
ENVIRONMENTAL PROTECTION AGENCY [N = 1]				NATIONAL INSTITUTE FOR ENVIRONMENTAL PROTECTION AND RESEARCH [N = 1]
11	Biology		18	Environmental Science
NATIONAL FOOD AGENCY [N = 1]				NOT APPLICABLE
12	Microbiology			
13	Microbiology			
NO INTERVIEWS CONDUCTED [N = 0]				MINISTRY OF HEALTH [N = 1]
			19	Veterinary medicine
	Total Swedish interviews: 13			Total Italian interviews: 19
	Total interviews: 32			

A purposive sampling strategy was employed, which is a non-random sampling based on pre-existing knowledge of the cases (Schreier, 2018). Sampling was based on the best available knowledge, which was developed in the course of research stays in Sweden and Italy that enabled networking and exchange; through OHEJP-provided data regarding the consortium members in the two countries that specified their roles; and through web searches that identified additional experts in the public health, veterinary, food, and environment sectors. Access to experts beyond the OHEJP consortium members was needed, including to experts in regional veterinary institutes in Italy or to experts in environment institutes in Italy and Sweden. Hence, the snowball sampling strategy, where participants helped to identify other potential subjects among their acquaintances, was employed and the participants provided a useful source for contacts (Vallgårda & Koch, 2008). These strategies strengthened the reliability and limited the unintentional exclusion of interviewees. This method proved useful, as it made it possible to approach people who were knowledgeable about specific issues relevant for the study.

The interviews were held in English, an acquired language for all of the interviewees and the interviewer alike. To counter the risk of misunderstandings, participants were chosen based on their work on international research projects (e.g., OHEJP). No language-related issues occurred other than a few participants having to pause on occasion to find words or phrases. One interviewee brought along a colleague to avoid any misunderstandings.

The interviews were initially set to take place face-to-face in Sweden and Italy. Due to the COVID-19 travel restrictions, however, the Swedish interviews were conducted online via Microsoft Teams or Skype for Business. The Italian interviews were conducted partly online and face-to-face. The latter were conducted in Rome with experts from the National Public Health Institute, and at the regional veterinary institutes in Brescia, Padova, Bologna, and Teramo.

4.5.1. Interview design

The semi-structured approach of the interview guide was aimed at gathering systematic information about a set of central topics while also allowing the exploration of new, emerging issues or topics. This structure allowed the number and order of predefined questions to be more flexible. To be able to delve into further detail, open-ended questions were formulated that aided spontaneous answers, opened up new themes, and allowed to follow up on some specific issues based on their response (Doody & Noonan, 2013). The interview guide consisted of 23 core questions (see Appendix 2), which were set to take approximately 60 minutes.

The guide was divided into three parts: the introduction, containing questions about the interviewee and their occupation; the main part, containing questions addressing political and structural processes within the

respective institutes and around the One Health topic; and the final part, containing questions about COVID-19 and a concluding question. Some questions were adapted to the interviewee's particular job and the context of their work (i.e., the agency or institute in which they were employed), as it entails different work areas and tasks.

The interview guide was reviewed by a social science expert and subsequently tested on five different occasions. The first two tests were conducted with colleagues, which primarily helped to refine the questions. The interviews were then pilot-tested with three experts to inspect the validity of the interview guide. The experts interviewed for the pilot test all worked in Denmark at the National Food Institute and the Public Health Institute, and they were involved with the OHEJP to ensure knowledge of the topic. Measuring the validity in this manner ensured that the interview questions were able to capture the responses that they were intended to measure. The interview guide was updated throughout the entire interview processes in Sweden and Italy, as the interviews revealed question requiring specification, adaptation, and/or adjustment.

4.5.2. Analytical approach

The interview recordings were transcribed, applying intelligent verbatim transcription. This means that filling words were not included in the transcriptions and grammar was corrected. The transcripts were then examined using the software NVivo Pro (version 12) via content analysis. Assarroudi et al. (2018) define content analysis as a systematic coding and categorising approach, suitable for larger data sets. This approach was used to determine trends and patterns among the words used, their relationships and structures, as well as discourses of communication. The NVivo software supported the process of coding and categorising themes.

Coding is a process whereby data are labelled and categorised by assigning different categories or themes to it. Open coding was applied to categorise key themes and identify patterns. Codes were assigned based on the interpretation of the data in the transcripts, sometimes assigning different codes to the same sentence. By categorising the codes, themes were established. This enabled an in-depth understanding of participants' perceptions and motivations. Papers II and VI describe the coding processes including the themes that were established in more detail (see Publications in Part II).

4.6. Survey

An online survey entitled 'One Health governance survey' was conducted to provide data for a study of the institutionalisation of the One Health approach among different epistemological communities, both cross-country and cross-sector. The survey examined the political drivers and constraints for the integration of the One Health approach across Europe. Specifically, it aimed to illuminate how One Health principles are included in the policy- and decisionmaking processes of political actors and networks.

The survey target group consisted of policy actors from public health, veterinary, food, and environment institutes, and government agencies; ministries; NGOs; and EU agencies. Represented NGOs were, for example, the WHO and WOAH. The EU agencies included the EFSA, EMA, and EEA (see Table 3).

Table 3: Workplaces of survey respondents

WORKPLACE				[N]
Veterinary institute				18
Public health institute				17
University				12
Food institute				12
Ministry (Ministries of Agriculture; Health; Education & Research)				7
NGO (WHO, WOAH, ICARS*)				5
Interdisciplinary research institutes:				
Veterinary	Food	Environment	Agriculture	
x	x			4
	x	x	x	4
x	x	x		4**
x	x	x	x	3
x			x	2
Agriculture institute				2
EU agency (EFSA, EMA, EEA***)				4
Funding institute				1
Museum (natural history)				1
N/A				8
Total:				104

Source: Adapted from Humboldt-Dachroeden (2023)
* ICARS: International Centre for Antimicrobial Resistance Solutions
**One research institute also includes public health services
*** EMA: European Medicines Agency; EEA: European Environment Agency

A purposive sampling strategy was applied to target these experts. To avoid selection bias, the population was defined to include experts and policy actors in the public health, veterinary, food, and environment sectors, employed in institutes, government agencies, and organisations in Europe. Here, the OHEJP provided a network of experts from 44 different government agencies, ministries, EU agencies, and NGOs. Via internal mailing lists, the survey was distributed to the OHEJP network members. Own searches for participants were also conducted, targeting experts working within relevant areas and sectors. Four rounds of follow-up emails were sent out, addressed to non-responders, which engaged more participants each time. The survey sample size concluded with 104 participants from four regions (western Europe, Nordic countries, southern Europe, and eastern Europe), from 20 EU and three non-EU, European countries (Norway, Switzerland, United Kingdom) (see Table 4). Among the regions, eastern European countries are least represented, with only one or two individuals participating per country. This is due to fewer contacts and lack of responses from eastern European respondents. With a confidence level of 95% and a margin of error of 5%, the desired sample size

would be 141 respondents. Nevertheless, the survey sample provides a good overview of different countries, experiences, and expertise.

Table 4: List of countries of survey respondents' residences

	COUNTRIES	[N]
Western Europe	United Kingdom	10
	Germany	9
	France	8
	The Netherlands	7
	Belgium	5
	Austria	4
	Switzerland	3
	Ireland	2
Nordic countries	Sweden	10
	Denmark	8
	Norway	3
	Finland	3
Southern Europe	Italy	9
	Portugal	6
	Spain	1
Eastern Europe	Hungary	2
	Lithuania	2
	Bulgaria	1
	Czech Republic	1
	Estonia	1
	Latvia	1
	Poland	1
	Romania	1
	N/A	6
	Total Countries: 23 EU countries: 20 European countries: 3	104

Source: Adapted from Humboldt-Dachroeden (2023)

4.6.1. Survey design

The survey was created using SurveyExact, a programme developed by Rambøll Management Consulting. The most current version at the time of use, Version 12.9, was utilised. The interviews conducted prior to the survey informed the development of the questionnaire. They helped to identify the general sections of the survey as well as some topics (e.g., the topic of political attention under the category Science to Policy, or the topic of AMR governance under Coordination of antimicrobial resistance). The questionnaire consists of 21 main questions categorised under the sections Demographics, Experience with One Health, Science to Policy, Coordination of One Health, Coordination of antimicrobial resistance activities, and End (see

Appendix 3). The questionnaire produced both quantitative and qualitative data through closed- and open-ended questions. The types of questions included multiple- and single-choice, Likert-scale, open-ended, and ranking questions. This allowed an in-depth analysis of the relationships between the public health, veterinary, environment, and food sectors, as well as an analysis of implications of One Health institutionalisation on institutional, national, and international levels. The questionnaire was in English.

Four colleagues screened the questionnaire prior to initiating the survey. With their social policy, social science, and veterinary expertise, they contributed to optimising the survey in terms of understanding, language, and structure. Subsequently, a pilot study was conducted involving 21 researchers working with public health, veterinary science, environmental science, and food safety. The pilot study was performed over a 10-day period (8–17 March 2021). The pilot study was evaluated regarding coherence, objectiveness, and relevance to the subject. This contributed to the refining of the demographic questions, the main part regarding some explanatory and technical aspects, together with some clarifications of content and structure. This strengthened the construct validity, which represents an accurate examination of what the research question aims to answer (Yin, 2014). After the pilot study, the survey was launched on 23 March 2021. It ran for two months, and the survey response rate was 46.8%.

4.6.2. Analytical approach

The survey respondents represented experts who provided their subjective perspective and expertise to the questions, based on their work environment, the topics they work with, and their experience with the One Health approach. This offered general information about their countries, as the questionnaire contained specific questions relating to their country of residence. While the respondents indirectly and directly depict their workplaces, their perspectives are not restricted to the workplace, as they might also draw on their experiences within networks, memberships, collaborations, and other activities.

The survey analysis was divided into two parts; first, the qualitative and quantitative analyses are described. The former contained the analysis of the open-ended questions relating to comments and elaborations made by the respondents. Demographics and answers to the open-ended questions were entered into NVivo Pro (version 12) to conduct a thematic content analysis. Separate analyses were conducted, depending on the aim of the papers. The coding process established relevant themes, which were subsequently reviewed to ensure the consistent and appropriate categorisation of codes into the themes. A more detailed description of the analysis can be found in the respective papers and their supplementary materials (see Papers IV & V).

The quantitative analysis was conducted using IBM SPSS Software (version 27). The general response rate and response rates for sub-populations of survey respondents from different European regions were calculated. The closed-ended questions were fed into the software to analyse descriptive statistics of

respondents' characteristics in terms of countries, workplace, and areas of work. This included some measures of central tendencies (see Papers IV & V). Independent t-tests were used to determine potential significant differences between the means of sub-groups of the survey population (see Paper V).

The analyses focused on the governance of One Health within and across agencies, ministries, and organisations, as well as on the knowledge transfer between scientists and policy actors. One Health-related issues were assessed to identify the facilitators and barriers of networks, their efficacy, and to investigate the relations and influences between scientists and policymakers. These analyses provided evidence indicative of the main barriers and opportunities of One Health institutionalisation on a broader perspective (country and European levels), as well as on a more specific perspective (institutional level).

5. Discussion

The research for this dissertation explored the implementation of the One Health approach in institutional settings. To do so, the following research question was established:

> **What are the key institutional drivers and constraints on the effective implementation of the One Health approach?**

The dissertation is based on five articles and one chapter, which address the research question from different angles, allowing for different theoretical, methodological, and empirical perspectives. The individual findings of the papers are presented coherently by linking overlapping and connected topics. The papers address institutional and political aspects in relation to the One Health approach. Institutional aspects are structures and procedures of government and research institutes. Political aspects relate to the science–policy interface, including governance, political attention, agenda setting, and policymaking. The studies contribute to the literature by adding knowledge about the implementation of the One Health approach on an institutional level, and they give insight into agenda setting and knowledge translation processes. The dissertation provides some practical implications, such as lessons learned via the case study, which are relevant for institutions and agencies that (aim to) implement the One Health approach.

The findings of the dissertation stretch from practical research-related to organisational and political aspects, making the findings interesting for scientists, policy actors, and individuals within national government agencies as well as national and international institutes and organisations working with the One Health approach. Concretely, the dissertation contributes to the fundamental understanding of the One Health approach, knowledge translation processes, and institutional as well as political decisionmaking practices. The challenges and opportunities of One Health institutionalisation that were revealed through the research

project can contribute to enhancing existing and future One Health activities. The findings can impact local communities by engaging them and establishing contextual conditions for the One Health approach. Practically, One Health communication and education in schools, universities, and among scientists can further strengthen the understanding of cross-cutting health threats.

In the following, the general findings of the papers and their connections are discussed under four sub-headings. Under the first, One Health-related sectors and disciplines as well as governments, government agencies, and how their set-up affects collaboration are discussed. The second sub-chapter addresses knowledge translation among scientists, between scientists and policymakers, and between scientists and the public. It provides some insight into the concepts of the policy entrepreneur and problem broker together with potential avenues for translating scientific findings. The third sub-chapter focuses on managing One Health in relation to leadership, relationships, and networks. The last sub-chapter ends with a discussion of the limitations and reflections on theoretical and methodological choices, and implications as well as possibilities for future research.

5.1. Institutional silos, sectors, and disciplines

5.1.1. About the sectors of One Health

In the scientific context, the One Health approach is mostly known and used among veterinary scientists, and something of a monopole has been established (Paper I). On the other hand, the environmental sciences are not as engaged, both due to a lack of initiation and invitation. This two-sided challenge represents on the one hand scientists at the public health, veterinary, and food agencies, who find it difficult to engage with scientists from environment institutes due to lack of knowledge on who to involve, and not perceiving a need to connect. On the other hand, scientists at the environment institutes do not find thematic overlaps and, if common themes do exist, they lack information on who to contact (Papers I–III). However, environmental aspects and conditions have been described in the literature as important for tackling many health-related issues (Jones et al., 2008; Redford et al., 2021; Zinsstag et al., 2018). Environmental conditions can help to predict stress as well as risks, and the environment affects humans and animals through a variety of pathways. They can be directly related to beneficial or adverse effects for humans, animals, the ecosystem, and its biodiversity (Paper III). This also includes plant health, which has received little attention in One Health projects and activities thus far (Andrivon et al., 2021).

The public health disciplines are frequently represented and engaged within One Health activities (Papers I–VI). This includes public health professionals but does not always expand to medical professionals working in hospitals (Paper VI). Relations among veterinary and public health institutes exist, and they are often good (Papers II & VI). Agriculture, food, and climate are often categorised under the public health, veterinary, and

environment sectors. An example of categorising sectors is illustrated in Figure 9, where disciplines are displayed within their circle. Each circle displays a sector. The listed disciplines are not conclusive, as there are other topics that could be added or recognised as part of already established categories (e.g., biostatistics, behavioural medicine, toxicology). The sectors overlap with one another (see explanation of sectors in section 1.2). One Health is displayed in the middle to illustrate its connection to all sectors.

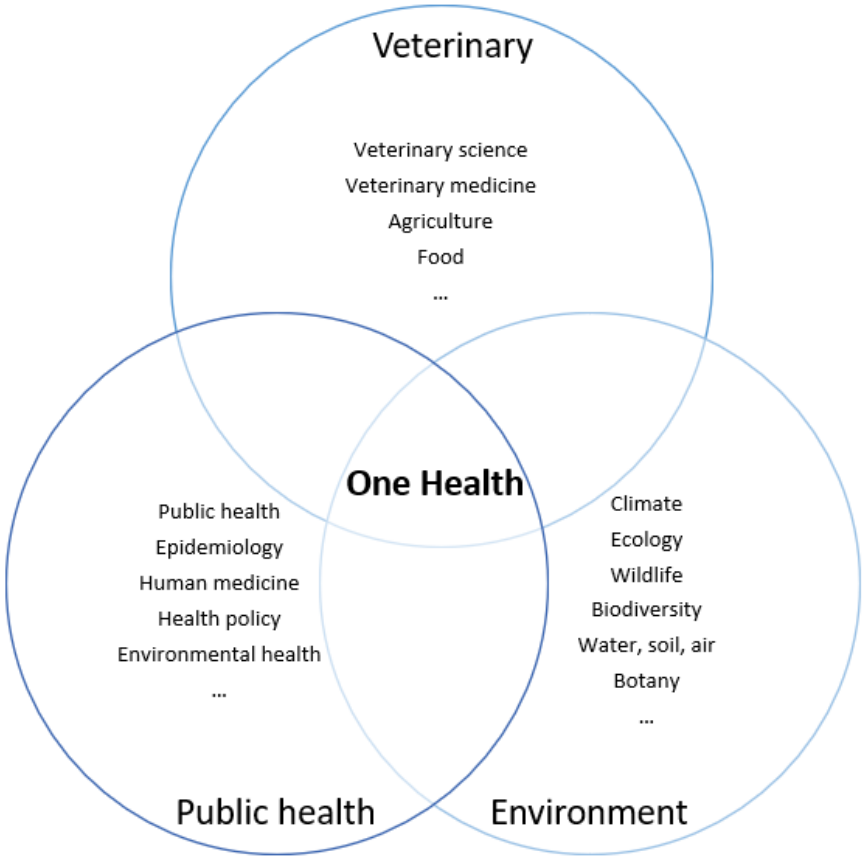

Figure 9: Public health, veterinary, as well as environment sectors and their disciplines of the One Health approach

In addition to the public health, veterinary, and environment sectors, there is another sector that directly and indirectly affects all other sectors and their disciplines: the social sciences. Within the One Health approach, a stronger social science presence could possibly provide tools and techniques to assess and appreciate contextual factors that aid in the creation of projects and activities (Papers I & V). The sector is crucial, as it can contribute to an understanding of societal contexts, economic, and behavioural aspects, and it can be used to understand policymaking processes, institutions, and networks (Papers I–V). Figure 10 includes the social science sector and its disciplines, surrounding the public health, veterinary, and environment sectors. This aims to illustrate the potential disciplines with which the social sciences can contribute, as well as the cross-cutting nature of this sector.

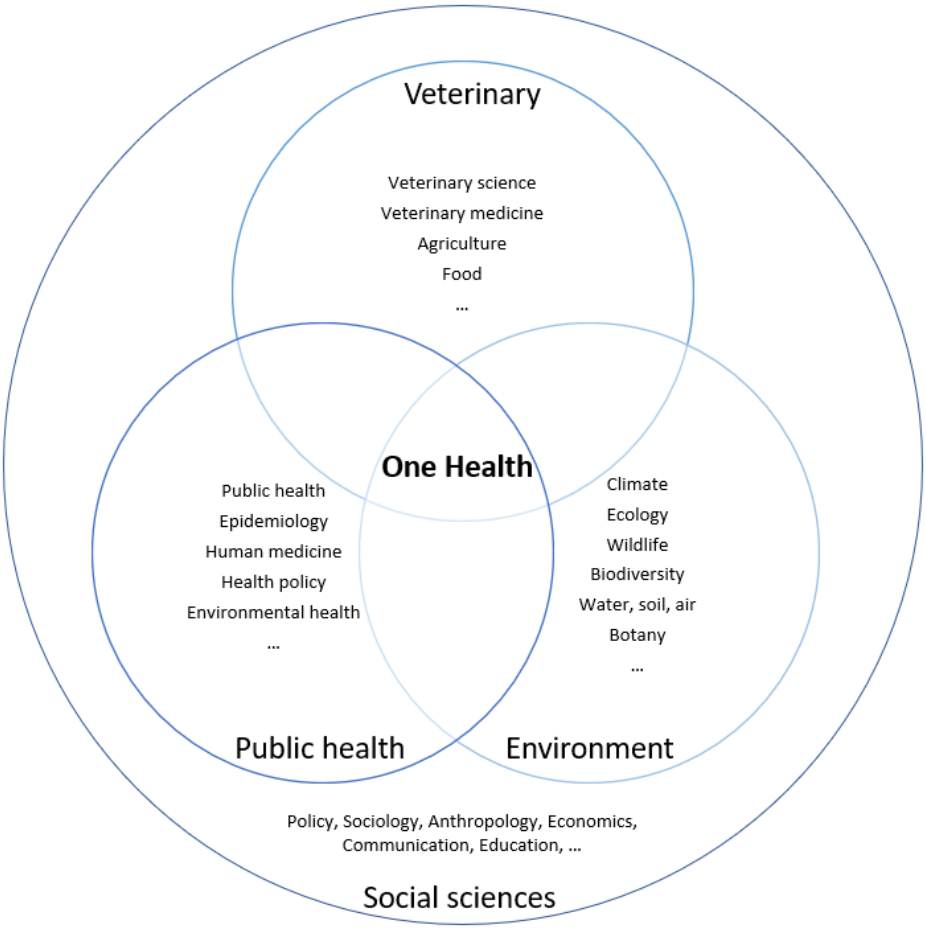

Figure 10: Public health, veterinary, environment and social science sectors and their disciplines of the One Health approach

Including different perspectives and tools of the social sciences can benefit One Health activities and shine some light into the black box of One Health policymaking (Degeling et al., 2015; Lapinski et al., 2015; Michalon, 2020). For One Health policymaking, the social sciences can assist in mediating and brokering between scientists and politicians by providing insight into policy processes and political institutions (Papers IV–VI). Further, the social science sector can reveal contextual as well as behavioural aspects underlying to One Health issues. Contributing to clarifying contextual aspects is to define the One Health approach in the beginning – as a fundament – of projects or activities. Because how the approach is defined depends on the context of where the One Health approach is implemented (Papers II & V). Clarifying and defining the approach can prevent the word 'One Health' from merely becoming a trend or 'buzzword' [5] (Paper V). It can facilitate the implementation and institutionalisation of the One Health approach by establishing the frame, scope, context, and capabilities.

[5] From One Health governance survey 2021. Respondent's workplace: Research institute in areas of agriculture, environment, and food.

5.1.2. Governments and government agencies

On the local and national levels, the sectors on the human–animal–environment interface are usually represented by government agencies, such as public health, veterinary, food, and environment agencies; by universities; and by other research institutes. The government agencies are mandated by legislation which defines their agendas and priorities. Within a government agency, there is often a fruitful environment that allows for the exchange of information and performance of interdisciplinary activities (Paper II). Engaging in activities across agencies can, however, be a challenge. The clash of interests due to different agendas and priorities, data security issues, competition, or lack of resources can impede cross-sector collaboration and communication (Papers II–VI). This is why the sectors are often referred to as silos. The coordination of activities, collaboration, and communication are easier within a silo, as there are clear common objectives and themes. Bridging to another silo entails more complex coordination, as potentially distinct interests and objectives must be addressed. Obviously, connecting three or even more sectors presents an even more complex web of agendas, interests, and priorities, all of which must be accommodated. Nevertheless, it is important to have those sectors with their respective focus and perspective. They provide specific knowledge that can be and is used for political decisionmaking (van Thiel et al., 2012). However, a mindful division of the topics within the sectors together with a cautious establishment of additional sectors is crucial (Paper VI). Being mindful and cautious helps to identify connections and complementary knowledge that can be important for decision- and policymaking (van Thiel et al., 2012). The case study provides two examples of how two topics are categorised differently among government agencies: In Italy, the National Institute of Health deals with food safety, but the veterinary institutes also work with certain food safety issues. In Sweden, in contrast, food safety is handled by the National Food Agency, a stand-alone agency. Further, water-related issues are categorised within the Institute for Environmental Protection and Research in Italy, whereas matters related to drinking-water are dealt with by the National Food Agency in Sweden, the Environmental Protection Agency taking care of other water-related topics (see Table 5) (Paper VI).

Table 5: Italian and Swedish agencies responsible for food safety and water-related issues

	GOVERNMENT AGENCIES	FOOD SAFETY	WATER
Italy	National Institute of Health	✓	✗
	Veterinary institutes	✓	✗
	Institute for Environmental Protection and Research	✗	✓
Sweden	Public Health Agency	✗	✗
	National Veterinary Institute	✗	✗
	Environmental Protection Agency	✗	✓
	National Food Agency	✓	✓

This depicts an example of two distinct government approaches to categorising food safety and water-related issues in different sectors. Of course, the categorisation is not static and can change in the future with the election of new governments that transform agendas, ministries, and agencies. Hence, the categorisation of the sectors can vary as disciplines might be combined or split under different ministries and institutes, affecting the mandates and tasks of the agencies or institutes. This also affects collaboration and funding opportunities. The effects on governance must be taken into account when establishing services, agendas, and distributing responsibilities to enable multifaceted partnerships, cross-fertilisation, and sustainable approaches.

Different countries obviously have different arrangements of government structures and divisions of services under the ministries. Some European countries (e.g., Germany, Belgium) have federal systems where the central government does not hold all the power, instead sharing it with the regional authorities (Papers IV & V). Along with increased bureaucracy, this can lead to disconnected governing approaches of national, regional, and local authorities (Paper VI). The different government systems – as well as under which ministry the public services are mandated – can have implications for the resources available, the power or influence of the institute, and how they operate and respond (Azfar et al., 2004). For example, the research in Paper V points towards some well-working arrangements of government agencies to tackle AMR (e.g., DANMAP in Denmark). Paper IV however, presents remaining challenges that the fight against AMR still faces. The challenges might be due to the lack of perceived urgency, judging AMR as a creeping crisis (Engström, 2021; Munkholm et al., 2021). Additionally, Paper IV describes how intricate institutional contexts cause issues, where multiple ministries and government agencies work on different aspects of AMR on the national level. The institutions do not always align their work (e.g., through similar analytical approaches and data harmonisation to make data comparable), which adds to the information complexity that compromises cross-sector collaboration and communication. To prevent information complexity, national governments must consider interconnections when creating government agencies. For this, governments must establish criteria that account for the needs of those agencies to allow for transparency and manageability (Paper VI) (van Thiel et al., 2012).

5.1.3. Geographical silos

In addition to the challenges that can arise with establishing agencies and the distribution of topics, there are geographic distinctions that can impact agency productivity. For example, the geographic proximity of agencies within a country can facilitate collaboration (Paper II). Across countries, it can be more difficult to maintain such collaboration, as effort and funding is required (Papers V & VI). For instance, there are few co-

citations and One Health-related publications of authors from eastern European countries, indicating little interaction (Paper I). Western (and especially Nordic) countries seem more inclined to implement the One Health approach than eastern European countries (Paper V). There can be many reasons for this, and the process can change as the One Health approach gains popularity and more international research funds support projects with a One Health perspective (Paper I). The scarcity of eastern European countries within interdisciplinary research projects and the lack of data from those countries for international surveillance activities is a challenge for the One Health approach, as it leads to a fragmented picture, making data comparisons, disease prevention, and tracing measures more difficult (Boqvist et al., 2018). The eastern European countries and the countries working together with them would benefit from collaborations in terms of cross-fertilisation, knowledge creation, and sharing. To establish a comprehensive One Health approach, these disparities and differences should be evaluated and approached within institutes as well as by decision- and policymakers (Papers IV–VI). Policy entrepreneurs and problem brokers are actors who can be employed to tackle this disconnect, as they can use their skills to create networks and establish connections (Paper VI). Education promoting the One Health approach throughout the working lives of scientists can contribute to the dismantling of (geographical) silos by emphasising the cross-sector and cross-country connectedness of One Health-related topics (Paper II).

5.1.4. Bridging silos during outbreaks

Working together across disciplines and sectors can be particularly effective during 'war times'[6]; that is, periods when there is a disease outbreak (Paper II). During such war times, which can involve food-borne disease outbreaks like Salmonellosis or Campylobacteriosis (Paper II) or infectious diseases like COVID-19 (Papers II & VI), funds are more rapidly allocated to tackle outbreaks, and cross-sector coordination is facilitated. During one food-borne disease outbreak[7] in Sweden, however, the National Food Agency and Public Health Agency clashed over different agendas and priorities: the National Food Agency with interest for the food industry and economy; the Public Health Agency with interest for public health (Papers II & VI). Such conflicting agendas and priorities must be considered when establishing One Health surveillance and response activities. At the same time, different orientations can also be complementary and result in strong, knowledge-sharing networks (Papers II & V).

Additionally, in Sweden and Italy, the tackling of disease outbreaks revealed different perspectives between the medical, veterinary, and public health sectors; where the medical perspective usually focuses on the individual, the veterinary and public health perspectives can include both individual and population-wide

[6] From interview study 2020. Respondent's workplace: Veterinary institute, Sweden.

[7] Mentioned during interviews with Swedish experts (2020).

perspectives. These differing perspectives can become a point of contention regarding the respective importance among practitioners and scientists (Paper VI). During the COVID-19 pandemic, Swedish and Italian scientists highlighted the value of both perspectives. In these two countries, the veterinary agencies have demonstrated their significant contributions to tackling the pandemic. Public health laboratories and hospitals usually have less capacity, processing smaller numbers of samples. Conversely, veterinary laboratories are used to test multitudes of samples, applying a herd or population approach (Papers II & VI). In addition to the laboratory capacity, combining the expertise of public health and veterinary scientists on SARS viruses, which is a subject studied in both fields, has contributed to improving practices regarding diagnosis, therapies, and the treatment of COVID-19-related maladies (Paper VI) (Fenollar et al., 2021). The environment institutes also contributed to investigating the spread of COVID-19; in Italy, for example, studies were conducted to determine the presence of the virus in sewage (Paper III) (La Rosa et al., 2021). Hence, all sectors related to the human–animal–environment interface were utilised in some manner to contain the spread of COVID-19 or to inform about it. A One Health approach was institutionalised as the countries invested effort in developing cross-sector activities and processes – whether intentionally or unintentionally *One Health*. The urgency of the outbreak facilitated the allocation of funds that were helpful to link sectors, work together, and share knowledge. The Italian case, however, displayed some persisting difficulties across sectors (Paper VI). The veterinary agencies responsible for analysing the swabs for COVID-19 experienced challenges when working with medical doctors in hospitals. The main claim that was voiced concerned the lack of knowledge of medical doctors about the work and expertise of veterinarians. Unfortunately, within the PhD project, medical doctors working in hospitals were not interviewed and could therefore not provide their perspective, which would have been worthwhile. The reason for the difficulties among veterinarians and medical doctors might be rooted in different values and hierarchical thinking, which should be addressed to enable a levelled and fruitful environment for future collaboration (Huth et al., 2019). This can be approached via training and the education of scientists, explaining the meaning and actors involved in tackling multifaceted health issues (Papers II & VI).

The Swedish and Italian cases provide examples of the lessons learned in terms of how veterinary, public health, food (and sometimes environment) institutes communicate, collaborate, and coordinate One Health-related activities (Papers II & VI). Concretely, lessons can be learned about cross-sector meetings concerning outbreaks, One Health networks, and collaborative approaches to tackle disease outbreaks (e.g., Salmonellosis, Campylobacteriosis, and COVID-19) (Papers II & VI).

5.2. Learning new languages

Language and the translation of knowledge plays a tremendous role for the One Health approach, and it can address different actors and sectors (Papers II, IV, V, & VI). In this context, knowledge translation can

contribute to the learning of new languages, 'languages' in the sense of different terminologies and the specialist jargon with which research, operations, methods, analytical approaches, and other specific issues are communicated. This provides opportunity for different actors to get to know and contribute to the One Health approach. Some actors were identified within the papers and will be presented in three different dimensions that depict knowledge translation among scientists, between scientists and policymakers, and between scientists and the public. Each of these dimensions provides potential ways to overcome translation issues, which can have practical implications for implementing the One Health approach.

5.2.1. Knowledge translation among scientists

The first dimension addresses knowledge translation **among scientists** within different disciplines and sectors. Communication, data sharing, and understanding one another are key aspects of knowledge translation. The public health, veterinary, food, and environment sectors all have their own terminologies, methods, and analytical approaches, and while they overlap, they do not always align (Papers II, IV, & V) (Mateus et al., 2022). Different technologies and analytical methods can produce results that are difficult and sometimes impossible to compare (Paper II). This provides challenges, both on national and international levels, when working together on cross-sector health issues, research projects, and when carrying out disease surveillance activities. Such difficulties can be in the form of fundamental communication-related issues when scientists talk with one another about the same issue from their respective sector-related perspectives, the difficulties being due to different terminologies. Methods and analytical approaches used in different sectors also reflect their own language, because using different methods and analytical approaches for the same issue (e.g., Salmonellosis surveillance) can lead to different interpretations and difficulties when comparing findings. Hence, harmonising data can at least to some extent facilitate the comparison of data, which is crucial when investigating health threats that are able to cross borders (Papers II–IV). It can also enhance the efficient use of data, as similar samples or data are often gathered across the different sectors. Streamlining and communicating data can prevent the unnecessary duplication of efforts (Paper VI). Establishing cross-sector networks supported by strong and open-minded leadership can save resources by facilitating the exchange and brokering of knowledge across sectors (Papers IV & VI). Tools such as glossaries should be shared within networks, and they can help to clarify the terms and terminologies used in other sectors (Papers II & V).

A One Health strategy on an institutional level that problematises and defines each specific One Health topic will further help to clarify roles, responsibilities, and the expectations held to one another (Papers I, V, & VI). This can especially have positive implications for the environment sector as their role and potential contributions become clear, which could motivate future collaborations (Papers II, V, & VI). Further, capacity building in terms of scientist training and education can facilitate the learning of new languages and jargon,

by promoting the understanding of One Health surveillance techniques and more generally by specifying the One Health approach in practice. Capacity building constitutes an important aspect of the One Health approach, as reflected in the high number of One Health networks reporting on it (Khan et al., 2018). Capacity building refers to individual development in terms of equipping scientists with skills and access to information, knowledge, and training. Ideally, this will lead to personal development and enable performance as well as adaption to new knowledge and contexts (Boyko et al., 2012). Paper V identifies the influencing factor 'lack of context' that typically hampers the knowledge translation process. Engagement with social, political, and economic scientists will prove fruitful, as their contributions can address this issue by using tools and expertise to unravel contextual and cultural aspects. While natural scientists might be somewhat accustomed to the One Health approach, this is a novel notion for many social scientists (Papers I & VI). Building bridges across the sectors and tackling homophily will facilitate knowledge sharing and learning. This can contribute to an enhanced understanding of the world as an interconnected web while acknowledging local, societal, and political realities (Papers I & VI) (Craddock & Hinchliffe, 2015; Lapinski et al., 2015). Figure 11 summarises knowledge translation actions that can be taken among scientists, as well as their potential implications.

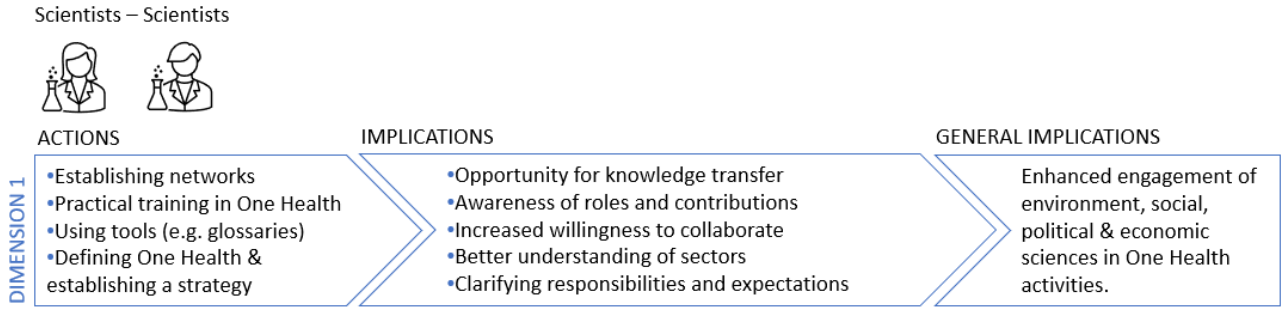

Figure 11: Knowledge translation between scientists – the implications for the One Health approach

5.2.2. Knowledge translation between scientists and policymakers

The second dimension addresses issues of knowledge translation **among scientists and policymakers** (e.g., bureaucrats, politicians). 'Lack of common language among scientists and policymakers' is an influencing factor interfering with the knowledge translation process (Paper V). Scientists who want to share their knowledge (scientific findings) are often faced with difficulties in their interactions with policymakers (Mateus et al., 2022). Or even one step before this: When seeking to catch their attention (Paper V). Policymakers often lack a background in the natural sciences and, in the same way, scientists do not necessarily have any training in the dissemination of science to non-scientists. The inability to break down complex scientific information and to create a 'compelling narrative'[8] can lead to misunderstandings and

[8] From One Health governance survey 2021. Respondent's workplace: World Health Organization.

render it impossible to convey the importance of a specific issue (Paper V). The fact that One Health issues often span several disciplines and sectors contributes to the difficulty of expressing an issue coherently and making it readily understandable. Education and training in research communication can better equip scientists with the tools necessary to disseminate their research findings. Confident and eloquent expressions when sharing scientific findings within policy communities can help scientists to advocate and lobby for their topic and increase the likelihood of catching political attention (Papers IV & V). By doing so, they can become policy entrepreneurs, using their scientific expertise and storytelling competencies to translate knowledge (Paper II) (Stone, 2019). Problem brokers can also be research communicators and help to frame scientific findings comprehensibly, as they are able to understand and speak the scientific and political languages (Rushmer et al., 2019).

Considering the One Health approach generally, many problems are already clearly outlined and solutions have been proposed, such as conceptual frameworks, guides, or references to support One Health research, policies and implementation (e.g., Coker et al., 2011; FAO et al., 2008; Lebov et al., 2017; Rüegg et al., 2018) (Papers I, II, IV, & V). However, political awareness is scarce and policy communities often struggle to generate interest (Connolly, 2017) (Papers II & V). This indicates areas where policy entrepreneurs and problem brokers can be employed to facilitate the contact between scientific and bureaucratic knowledge and to communicate successfully with politicians (Papers II & IV). Here, policy entrepreneurs who employ the networker strategy and know how to exploit networks can use their connections to inform policymakers of problems (Stone, 2019). The problems that require attention fuel the problem stream; and when the policy and politics windows also align, it can stimulate innovation in terms of methodologies, technologies, and analytical approaches (Kingdon, 2014; Rogers, 2003). Capturing political attention can have implications for scientists working with the One Health approach, potentially resulting in policy change and increased funding for One Health-related research. Increased awareness of the One Health approach and the issues it addresses can entail a more widespread use of the One Health term in strategic reports (Paper I); for example, the European Commission adopted the 'European One Health Action Plan against Antimicrobial Resistance' (European Commission, 2017). Mentioning One Health in the title and body of the document sends a clear signal to the EU member states, demonstrating the EU's initiative and encouraging the use of the One Health approach.

Paper V has presented processes that can lead to policy change, including the roles and abilities of different actors. International actors such as those coming from EU agencies (the ECDC, EFSA and the European Medicines Agency) were perceived as important to pushing One Health policies forward, and they can also act as policy entrepreneurs (Papers IV & V). Interestingly, based on the lack of co-citation networks of

authors, there does not seem to be much scientific One Health-related exchange among these agencies (Paper I). The EFSA and ECDC have a memorandum of understanding to cooperate on common issues, explicitly mentioning the One Health approach (EFSA & ECDC, 2021). The bibliometric analysis indicates how greater effort should be invested in using each other's knowledge via co-authoring collaborations or by referencing one another (Paper I). Such increased mutual cross-fertilisation can influence policies relating to One Health issues, as they in fact advise and hence indirectly influence decisions made by the European Commission (Chatzopoulou, 2018; Wood, 2018). Establishing transdisciplinary One Health Research and Innovation governance, as suggested by Bronzwaer et al. (2022), could possibly aid the translation of knowledge between the agencies and set a research agenda that facilitates cross-sector collaboration. The Quadripartite were also perceived as important actors, especially due to the potentials lying in the organisations' combined forces and because of their prestige (Paper V). Building on this, the Quadripartite should identify policy entrepreneurs and problem brokers within their organisations who utilise their storytelling ability to translate knowledge, creating powerful and compelling narratives to inform policymakers (Stone, 2019). Above all, national agencies were recognised to be the most important actors to push One Health policies forward, which is plausible as the government agencies (evidence producers) are indirectly involved in government policymaking (evidence users) (Papers IV & V). Figure 12 summarises the potential actions that can be taken to foster knowledge translation among scientists and policymakers, as well as the implications this might have for the One Health approach.

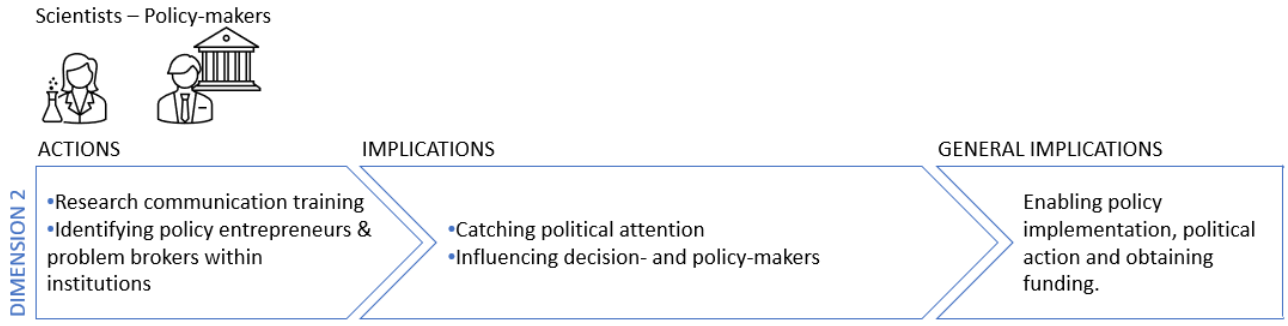

Figure 12: Knowledge translation between scientists and policymakers – the implications for the One Health approach

5.2.3. Knowledge translation between scientists and the public

Lastly, the third dimension examines knowledge translation between **scientists and the public**. The public impacts and is affected by their environment, their own health, as well as the health of animals and ecosystems. The characteristics of different communities – of how society is built and governed – are crucial for preventing, mitigating, and combating health threats. This has been emphasised in the definition of the One Health approach by the One Health High-Level Expert Panel (WHO, 2022a). However, there is often a disconnect between scientists and those communities and societies. The determinants of health address

some of these connections, focusing especially on the people, societies, as well as the communities and the environment in which they live (Barton & Grant, 2006). The Determinants of Health Model (see Figure 3) lacks a specific ecosystem perspective, including animals. Yet the model provides a valuable knowledge base for the One Health approach in relation to the interconnectedness of individuals, communities, and their socioeconomic, cultural, and environmental conditions (Barton & Grant, 2006).

To disseminate knowledge, researchers mostly publish their findings in scientific journals that rarely reach the public. However, the communication to the public can be important to move from theory to practise (Senabre Hidalgo et al., 2021). It can activate the politics stream, in which the public mood is a crucial element for setting agendas (Kingdon, 2014). Disseminating scientific findings to the public can make them aware of an issue, stimulate discussion, and can pressure policymakers (Paper II). Similar to communication issues among scientists and policymakers, breaking down complex One Health topics remains an obstacle in communications with the public (Mateus et al., 2022). Training in research communication or employing research communicators and problem brokers can facilitate the translation of knowledge and popularise science. Scientists can engage with the public via their research projects, engaging, welcoming, and encouraging the public to take part if the project allows. Public participation, such as citizen science or the co-creation of science, can intrigue the public, make them more aware of the One Health approach, and reveal the societal and contextual determinants of health (Paper IV) (Senabre Hidalgo et al., 2021). Including the public in One Health-related research can lead to more local One Health activities and projects (Paper VI). If public participation is not possible, scientists can engage with the public in other ways, such as research fairs and festivals, social media, TV news, radio, and newspaper articles (Ross-Hellauer et al., 2020). A broad audience can be reached in this manner, enhancing knowledge about specific One Health topics and the whole approach in general (Paper IV). An enhanced understanding of the One Health approach among the general public can trigger discussions and initiate action on the political level (Papers II & VI) (Haxton et al., 2015).

The One Health approach can also be brought to the public by implementing it in school education. This can give children the chance to become familiar with the approach already from a young age, which can enhance their knowledge about One Health, possibly even shaping their future education decisions (Paper II). A study of sustainability education showed that children who learn about topics relating to sustainability in school have an impact on their parents and their consumer habits (Walker, 2017). As Figure 13 illustrates, knowledge translation between scientists and the public can have positive implications in terms of generally raising knowledge about specific One Health topics relevant for a specific area or context and by shaping public opinion and attracting political attention to those issues.

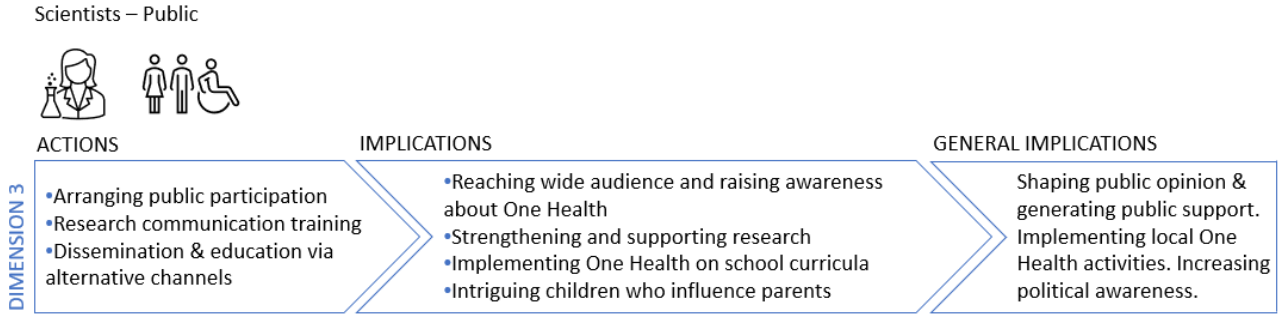

Figure 13: Knowledge translation between scientists and the public – the implications for the One Health approach

5.3. Managing One Health

Individuals and groups of people who inspire and lead are important drivers for the One Health approach. They must have the ability to steer through complex national and international systems, being conscious of needs, interests, priorities of states, governments, institutes, and organisations (Stephen & Stemshorn, 2016). This chapter scrutinises the opportunities available to leadership and leaders to drive the One Health approach forward. It examines the role and importance of relationships, including the nature of close relationships, their opportunities, and pitfalls for the One Health approach, and the potential to form relationships with new, previously unknown connections.

5.3.1. The role of leadership

In the context of this dissertation, leaders are individuals who lead scientific projects and networks. They can be policy entrepreneurs and problem brokers. However, policy entrepreneurs, problem brokers, and leaders are not interchangeable terms. Problem brokers have limited functions with respect to agenda setting. They usually operate in the preceding steps, framing a problem and making an issue understandable (Knaggård, 2015). Similarly, policy entrepreneurs work towards framing a problem and go further to suggest policy changes. Some of the skills of leaders go even further than that, as they possess more resources to make policy innovations (Capano & Galanti, 2021).

To establish and maintain collaborations within networks and scientific projects, there is a need for leaders with decisionmaking skills who guide, enable innovations, and are trustworthy (Papers IV–VI) (Rogers, 2003; Stokols et al., 2008). A leader must be able to problematise and define specific One Health issues to establish clear goals and objectives (Paper V). In the following, problematising specific One Health issues and the opportunities they entail will be described using the AMR example. Paper III outlined how Denmark demonstrated collaborative processes that problematise AMR. The DANMAP report includes information, data, and knowledge from different sectors and has explicitly mentioned how implementing cross-sector monitoring and surveillance and engaging different sectors is based on motivated leadership (Papers III & V). However, while One Health approaches such as the Danish approach to AMR surveillance provide a good

example, they cannot always be easily translated to other contexts, such as to countries or regions like the EU (Papers IV & V). Projects, programmes, activities, interventions, and measures that work on a local level might not be translatable to other local or global contexts – and vice versa. Activities must be adapted to specific circumstances, preferably already in the planning stages (Papers IV–VI). For example, implementing AMR stewardship programmes must consider the many actors who are affected and involved who have different aims and priorities. Additionally, microbes can easily cross state borders, meaning that AMR should not only be treated within countries but also – and ideally – in partnerships, collaborations, and networks with other countries (Paper IV). Apart from national actors, there are also multiple EU agencies and NGOs working with different aspects of AMR. Hence, leaders should facilitate among sectors and create inclusive networks to connect and create One Health activities that include all relevant actors (Paper V). The knowledge produced within such networks must be exploited to foster cooperation and communication (Papers IV & V). The aims and priorities of different actors must be accounted for and addressed to avoid miscommunication and shortcomings regarding mitigation and preventing the spread of diseases (Papers II & IV). Some international approaches, like the Joint Programming Initiative on Antimicrobial Resistance, which is a global funding coordinator, have successfully provided resources to collaborate on tackling AMR (Papers IV & V). Interdisciplinary projects like this facilitate cross-sector collaboration. Such projects can foster an understanding (and appreciation) of the counterpart's work (Papers II & VI).

However, combating AMR on an international level remains a challenge (Paper IV). This might be due to challenges in associating knowledge, which means conveying scientific information to the policymakers they find plausible and relatable (Papers IV & V). To tackle such challenges, engaging experts from the social, political, and economic sciences can aid in associating knowledge by using their methodological and analytical tools to assess circumstances and contexts. They can provide knowledge on contexts and policy processes from the local to the global levels, which can complement knowledge from the medical and natural sciences (Paper IV). Hence, engaging social, political, and economic experts can potentially induce innovation, as it allows for tailored, sustainable approaches (Papers IV–VI). Here, leaders must connect experts from the social, political, and natural sciences within networks to enable knowledge sharing. Based on this knowledge, leaders can then problematise issues and broker between sectors to establish relationships among the scientific and political sectors and to convey the scientific information comprehensibly to policymakers (Papers V & VI) (Rogers, 2003; Tasselli et al., 2015). This is the setting for problem brokers and policy entrepreneurs, who can use their skills to promote, convince, and even persuade policy- and decisionmakers (Papers II, IV, & VI). The focus should also be on using already existing stewardship programmes and frameworks for implementing as well as evaluating AMR (and other One Health) activities, and learning from studies that describe specific country cases (e.g., Jani et al., 2021; Lebov et al., 2017; Paternoster et al., 2017;

Rüegg et al., 2018) in terms of their experiences with implementing the One Health approach (Papers I, II, & IV).

5.3.2. Close and distant relationships

Relationships, personal relationships in particular, are essential for the One Health approach, as they facilitate communication and make collaboration easier (Papers V & VI). Relationships promote the implementation and effectiveness of activities, as shown by the collaborations among Swedish agencies on One Health-related topics as well as the collaboration of Danish institutes and industry on AMR (Papers II & III). Here, trust is necessary to carry out One Health activities and seems to ensure reliability subjectively (Papers IV & V). However, relationships are often confined to the borders of ones one epistemic culture and work environment. There are usually strong ties among actors, as they invest time and emotion in establishing the relationship (Rogers, 2003). This can lead to homophily and entail the exclusion of relevant actors and perspectives (Papers I & VI). Homophily describes the phenomenon whereby similar individuals (e.g., in terms of age, gender, work topic, education, values, believes, etc.) group together (McPherson et al., 2001). To combat homophily, establishing a One Health strategy within institutes that define the scope of activities and projects can help to determine relevant perspectives and actors who must come together (Paper VI). Leaders should clarify objectives as well as scope, ensuring the mapping of stakeholders in the design stage of the One Health activity (Paper VI) (Bordier et al., 2021; Mazet et al., 2014). In so doing, leaders can facilitate cross-sector connections and promote heterophily. This would encourage actors to engage with individuals with whom they have no prior relations (creating weak ties), which can facilitate new connections, information sharing, and innovation (Paper VI) (Rogers, 2003). Papers II and VI highlighted how seeking weak ties requires the availability and knowledge of where to find contact information. Institutions (e.g., government agencies, research institutes) should provide easy access to contact information. This will help to address collaboration shortcomings and avoid the exclusion of relevant actors, such as the oft-neglected actors from the environment sector (Papers I–III). It will also facilitate the inclusion of actors from the social and political sectors (Papers I, IV, V, & VI). Another possibility that can strengthen the collaboration of stakeholders from different sectors is to establish environments that facilitate knowledge sharing, such as interdisciplinary conferences, meetings, workshops, or summer schools (Papers I, II, & VI). Policy entrepreneurs and the problem brokers who are in such network environments can use or expand the networks to go from knowledge sharing to translation. The intermediaries can be used as brokers to connect sectors and actors. Additionally, there is already existing literature, guidance, and advice on establishing comprehensive One Health projects and activities as well as cross-sector and interdisciplinary collaborations, which can be used and adapted (Papers I & IV).

5.4. Futures of the One Health approach

This section addresses some of the limitations of this dissertation, pointing towards potential future research avenues for One Health research together with the presentation of some practical implications. It also points out some unanswered questions and unaddressed notions, which can also contribute to future research.

5.4.1. Theoretical and methodological reflections

Methodologically, the research conducted for the PhD project is based on data gathered through a search of the literature, interview, and survey studies. For the interview and survey studies, the sample sizes were 32 and 104 respondents, respectively. For both studies, the respondents included experts with specialised knowledge of their field and, in particular, the One Health approach. The approach continues to evolve, and it has yet to be established within all research institutes and governments (Paper I). The number of individuals familiar with One Health and knowledgeable about the institutional processes connected therefore remains limited. For the survey and interview studies, the number of interviewees was thus deemed sufficient, and participants provided an adequate overview of One Health institutionalisation. Nevertheless, to counter any of the potential biases that a small sample size can entail, interview, and survey questionnaires were piloted, coding choices were always reviewed, and research findings continuously discussed in scientific contexts. The triangulation of research methods (interview, survey, and literature review studies) also solidified credibility and validity when discussing and connecting the research findings of the papers. For future research, studies with different methodological orientations involving bigger sample sizes can offer some additional insights and facilitate the attainment of statistically generalisable outputs (Schreier, 2018).

Another methodological consideration was the mixture of conducting online and face-to-face interviews. The literature notes that the answers given during online interviews can be shorter and possibly lack context (L. Davies et al., 2020). A similar range of topics was covered with both methods in the interviews with Swedish and Italian experts. Further, the video option in online interviews made it possible to capture and react to verbal and non-verbal expressions. The possibility of conducting interviews online effectively facilitated the connection to the experts who were involved in COVID-19 task forces, as the scheduling (and re-scheduling) of meetings provided flexibility.

One limitation of the case selection and the survey study was the lack of engagement from eastern European countries. For the case study, an eastern European country could have provided valuable knowledge of the country's context pertaining to One Health institutionalisation. There is a lack of literature relating to One Health in connection with eastern European countries, which indicates challenges regarding the implementing the approach (Humboldt-Dachroeden et al., 2020). Investigating an eastern European country could have provided lessons learned in terms of the challenges, and potentially given insight into how to

prevent and overcome them. Unfortunately, such opportunities did not arise due to a lack of contacts to eastern European countries. For the survey study, the reasons for the scarcity of eastern European participants were fewer contacts and a lack of response from the individuals contacted. The resources and timeframe of the PhD project did not allow for a more in-depth stakeholder investigation and engagement process. Additionally, Papers I and V found that there were generally fewer intra- and intercountry One Health activities in eastern European countries. Focusing on those countries could provide valuable insight into problem framing and agenda setting for the One Health approach tailored to the specific national context. Other country cases also could have provided interesting examples of One Health institutionalisation. Especially interesting would have been to investigate lower- and higher-income countries or countries with federal systems. There are many different angles and perspectives that One Health institutionalisation can be investigated through, which provides plenty of work for future research.

Another opportunity for research is to select cases based on specific health threats (e.g., AMR, Salmonellosis, or less prevalent diseases like tulameria) and investigate them in relation to problem framing, political attention, and agenda setting. Problematising a health threat in relation to One Health can aid in establishing scope and objectives. It can provide guidance for adapting other cross-sector health issues to catch political attention and reach the political agenda (Paper V). The case-based approach can cast light on the black box of policymaking for multifaceted health issues. Lessons that can be learned must always be adapted to research innovations and advances, as well as the specific circumstances within a country (Papers IV–VI).

The dissertation also focused on knowledge translation by drawing parallels between One Health networks and the knowledge transfer model by Liyanage et al. (2009). Using knowledge translation provided opportunities for understanding One Health communication and terminologies. It pointed out the benefits of further investigating these and other aspects within the knowledge transfer model. The research focused mainly on the steps involving the transformation, association, and application of the knowledge transfer model (Paper VI). More in-depth investigations of different steps (or all steps simultaneously) of the knowledge transfer model could help understand ways to enhance coordination, communication, management, and the use of resources. For example, investigating awareness and the acquisition of knowledge can help to determine processes and benchmarks that identify ‘appropriate or valuable knowledge’, and to discover the ability of receivers to acquire the knowledge (Liyanage et al., 2009, p. 126). Further research should also elucidate the receivers’ abilities to absorb new information by investigating how knowledge becomes useful. This could produce practical implications that can guide new One Health-related contributions to existing knowledge bases and establish the means to effective problem brokering. Further, evaluating knowledge transfer processes within and across institutions could help reveal problems that

hinder the conveyance of information and data. This will help to work on challenges and embrace opportunities to strengthen and maintain knowledge translation within the One Health approach.

5.4.2. Capacities of the environment and social science sectors

One Health projects are needed, not least because it is estimated that there will be more disease outbreaks, often connected to a loss of biodiversity and climate change (Wannous, 2020). Environmental factors play a tremendous role in predicting, preventing, and mitigating outbreaks (Paper III). While Paper III highlighted the importance of the environment sector within the One Health approach, Paper VI indicated the difficulties of connecting this sector to the veterinary and public health sectors. Within networks and when forming new One Health projects, future efforts should focus on including scientists from the environmental sciences. One way of intriguing and engaging environmental scientists can be to use well-established terms like 'sustainability', 'biodiversity', and 'climate change', which are relevant for the One Health project (Paper VI). Importantly, including the environmental sector means to include the discipline of botany, as plant health is crucial within horticulture, food and feed production, biodiversity, and climate change (Papers III & IV) (Andrivon et al., 2021). Plant health is also specified by the latest definition of the One Health approach, recognising its interconnectedness to humans, animals, and the environment (OHHLEP et al., 2022). Hence, future research activities should focus on engaging environmental scientists, as their perspectives can provide complementary knowledge that contributes to a more sustainable One Health approach.

While drawing on a broad range of literatures, the dissertation not only contributes to the knowledge base and One Health literature by taking social and political science perspectives, it also demonstrates the value of these perspectives for understanding the One Health approach. However, the empirical analyses highlight a lack of specifically that: integrating social and political perspectives into One Health approaches, rather than 'just' the natural science perspectives. While the natural sciences are obviously crucial for investigating One Health issues, they should be complemented with social, political, and economic perspectives to establish strong arguments and foundations for One Health activities (Papers I, IV, V, & VI). The social, political, and economic sciences provide tools to base research on qualitative methods. This can complement quantitative studies, which are more commonly used within the natural sciences (Papers I & III). The studies presented as part of this dissertation have provided some suggestions regarding the potential entry points for the social and political sciences. Practically, the studies pointed towards including gender-based perspectives and indigenous knowledge, as they could contribute to One Health projects by providing guidance and specific context-dependent information (Papers V & VI). Additional entry points could be to explore connections of the One Health approach to the Determinants of Health Model or investigating the different dimensions (e.g., 'knowledge integration and leadership', 'gender, community, equity, and ethics', or 'policy, legislation, and governance') proposed by *The Lancet* One Health Commission's animal–

environment–human interface (Section 1.3.2). Disease surveillance must also take economic aspects into account, such as in relation to the food and feed industry (Paper VI). There are opportunities for future social, political, and economic science studies to analyse the role of agriculture institutes that often deal with economic development and the performance of agriculture and horticulture for the One Health approach (Putsenteilo et al., 2020). This could add other viewpoints that explain social behaviours, relationships, farming culture, industry and consumers, together with political structures, processes, and policy decisions in relation to the health of humans, animals, and the environment. These viewpoints can facilitate the understanding of needed and effective measures for surveillance (Paper IV) and should be increasingly included when studying One Health issues. Hence, building comprehensive One Health surveillance must include relevant actors, safeguard economic and social interests, and establish secure cross-sector knowledge-sharing opportunities.

5.4.3. Practical implications and learned lessons

Preventing, preparing, and surveying outbreaks are crucial elements in health protection, and as became apparent during the COVID-19 pandemic, also for economic stability, social cohesion, and well-being (Paper II). A One Health perspective for disease outbreaks and climate change can enable a more comprehensive view on factors, drivers, and indicators that can help to prevent and mitigate (re-)emerging outbreaks on the human–animal–environment interface (Wannous, 2020). Practically, developing and maintaining comprehensive One Health surveillance systems can help to achieve just that. This obviously requires extensive resources, workforce, willingness, and motivation (Bordier et al., 2020). Paper II presented an example of joint surveillance of food-borne disease outbreaks, involving different sectors and providing data from the public health, veterinary, and food sectors. Similarly, the Danish AMR surveillance and monitoring programme brought together different sectors for joint activities (Paper III). These examples should be picked up to learn from encountered challenges and opportunities.

The dissertation also finds practical opportunities for One Health capacity building, including education and training. Early education starting in schools can help to internalise the One Health approach as a term just like ‘climate change’ and ‘biodiversity’. This would help to increase awareness among children and the public more generally regarding the connectedness of health-related issues. There are already some approaches (e.g., in Swedish schools (Haxton et al., 2015), or internationally through One Health Lessons, an approach to bring One Health into classrooms around the world (Thomson, 2022)). Nevertheless, efforts and research should increasingly focus on developing school and university curricula that account for the One Health approach (Paper II). Additionally, continuous education and training should be provided by institutes and agencies for scientists, policy actors, as well as actors within the industry who work with the One Health approach. The focus could be on understanding One Health, its actors, and processes for implementing the

approach, facilitating cross-sector collaboration, and on employing specific One Health strategies that identify objectives, agendas, and priorities (Papers V & VI). Enhancing One Health capacity building can lead to broader public familiarity with the One Health approach, it can fuel discussions, and thereby increase the awareness among decision- and policymakers.

Imperative and a prerequisite for understanding the One Health approach itself is understanding its philosophy and meaning. The philosophical considerations of the One Health approach have yet to be explored extensively (see section 3.1). Commencing with philosophical discussions for One Health will aid in developing hypotheses and inform choices pertaining to methodology and method. Philosophical discussions are needed and relevant to address how to develop and create knowledge and to tackle subjective assumptions. Research into this will elucidate the strengths and weaknesses of the approach and inform decisions regarding research design. It will fuel discussions about the meaning(s) of One Health and can provide purpose for establishing complex and comprehensive projects and activities (Paper V).

6. Conclusion

This final section summarises three main points of the dissertation in connection to the research question and reflects on their implications for the One Health approach. The dissertation set out to answer:

> **What are the key institutional drivers and constraints on the effective implementation of the One Health approach?**

Six papers were produced that inform this question, focusing on the EU, some of its member states, plus Norway, Switzerland, and the United Kingdom as well as the two cases (Sweden and Italy). The research is based on literature, interview, and survey studies gathering the perceptions of scientific and administrative experts. The papers deal with the use of the One Health approach in research institutions, One Health networks, and between individual scientists, as well as the abilities of policy actors to address multifaceted health issues, institutional boundaries, and political agenda-setting challenges. The intention of the research was to shed light on institutional and policymaking processes relating to the One Health approach. Knowledge about these processes is relevant for (institutionally and politically) enhancing One Health approaches and designing future ones.

The findings of the papers identified three overarching constraints for the implementation of the One Health approach. The constraints listed in Table 6 are followed by drivers that were yielded by the analysis of the studies.

Table 6: Institutional drivers and constraints for the implementation of the One Health approach

CONSTRAINTS	DRIVERS
INSTITUTIONAL BARRIERS OF THE ONE HEALTH APPROACH	
Fragmented governments	• Define criteria when establishing government agencies
Differing agendas	• Develop One Health strategies • Incorporate problem definitions when designing One Health projects
KNOWLEDGE TRANSLATION CHALLENGES	
Knowledge translation challenges among scientists	• Use tools such as glossaries for terminology clarification • Institutions to provide easily accessible contact information • Harmonise analytical approaches and data • Collaborate with scientists beyond the usual colleagues and networks • Leaders to enable cross-sector coordination
Knowledge translation challenges between scientists and policymakers	• Identify and use policy entrepreneurs to find solutions and convey them to policymakers • Identify and use problem brokers to use their problem framing skills
INSUFFICIENT UNDERSTANDING OF THE ONE HEALTH APPROACH	
Lack of philosophical One Health discussions	• Carry out philosophical groundwork
Lack of understanding what the One Health approach means	• Introduce One Health into school curricula • Engage public via, e.g., citizen science projects • Capacity building for experts and scientists • Engage social scientists

In the following, the three constrains along with the drivers are summarised: First, **key barriers that challenge the institutionalisation of the One Health approach** were identified. The barriers represent the challenges facing government agency set-ups and different agendas. The papers comprising this dissertation show how the barriers inhibit coordination, collaboration, communication, and policymaking processes in relation to the One Health approach on the national and EU levels. The set-up of government agencies affects the topics dealt with within the individual country. It is therefore crucial to determine clear criteria when establishing ministries and government agencies to be able to account for the topics while considering a country's context. This can lead to more informed decisions, less fragmentation of government agencies, and potentially easier cross-sector collaboration. It can also determine funding opportunities that agencies can realise, such as based on whether they are national or regional agencies. Ministries provide legislations and mandates to their respective government agencies, which reflect their objectives, agendas, and priorities. For example, different agendas can lead to different orientations in terms of health, economic, and industry-

related interests. Coordinating the different objectives, agendas, and priorities across sectors (or across one's epistemological silos) is a challenge. The dissertation provides insight into institutional processes (e.g., (cross-sector) collaboration, data sharing, agendas, and priorities), which help to highlight opportunities for improving coordination, collaboration, and communication. In particular, the findings of the dissertation suggest that establishing institutional One Health strategies and incorporating specific problem definitions when designing One Health projects and activities can be a way to enhance institutional processes. Practically, this will promote the ability of scientists to recognise what expertise (apart from their own) is needed and increase the awareness of the need for cross-sector collaboration to address multifaceted health issues. Possibilities present themselves to open policy windows, especially in relation to urgent issues – as highlighted by the COVID-19 outbreak. Lessons can be learned about the mechanisms that enabled the opening of such policy windows, which can be adapted and applied to other circumstances.

Second, there are **knowledge translation challenges among scientists and between scientists and policymakers**. Among scientists, being aware of sector-related languages and terminologies is crucial for establishing efficient and successful One Health activities. Existing resources such as glossaries should be identified and used. Knowledge about who to contact – of roles and the responsibilities of actors – is requisite to initiate communication. In practice, institutions can facilitate this by making contact information easily accessible. Harmonising analytical approaches and data is another factor and will help to compare data (this is important for cross-sector and international disease surveillance activities) and avoid redundant work among scientists. It facilitates collaboration and the efficiency of data sharing across sectors. Investigating knowledge translation processes for One Health indicated that understanding networks and their actors can facilitate communication and collaboration practices. In relation to networks, knowledge translation boundaries were emphasised by homophily, which highlighted institutional silo work and the lack of cross-fertilisation when groups consist of the same or similar people. Scientists must challenge themselves to commit to collaborations involving scientists and experts beyond the usual suspects in their familiar networks – thereby creating heterophily. It also pointed towards the importance of leaders and their capacity to enable cross-sector coordination. This will provide cooperation opportunities for actors from the usually lesser involved sectors, such as the environment, social, and political science sectors. To overcome knowledge translation challenges between scientists and policymakers, the strategic use of policy entrepreneurs who can facilitate the development of networks and use the knowledge within to find solutions to problems and convey them to policymakers is important. Similarly, problem brokers must be employed to use their skills in framing problems, making them understandable to policymakers. The intermediaries must be identified within institutions.

Lastly, the studies indicate that there is an **insufficient understanding of the One Health approach.** Efforts must be put into understanding the One Health approach and what it means generally for institutes and scientific projects. Philosophical groundwork for the One Health approach must be strengthened. This groundwork will in turn facilitate the development of One Health projects and enhance their implementation by means of ascertaining meaning, as well as determining and strengthening research designs. Further, in order to understand the One Health approach more generally, it should already be introduced in school education, as children are susceptible to multifaceted issues. This can broaden their knowledge and awareness, potentially leading them to career paths dealing with One Health or One Health-related topics. To further an understanding of the One Health approach in the general public, scientists can engage with citizens in discussions about One Health and include them in research (e.g., via citizen science projects). Capacity building involving opportunities for continuous training and education for experts and scientist can contribute to strengthening the One Health approach by keeping up to date about the approach, its tools, and implementation opportunities. When creating a One Health activity, social and political scientists must be engaged, as they can contribute their tools, techniques, and expertise to assess factors that provide an understanding of the context in which the activity is implemented.

As the use of the One Health approach is likely to become more widespread, it is imperative that the social sciences as well as further theoretical (and philosophical) exploration will inform the design, implementation and evaluation of the approach. The One Health approach is a well-intended tool. To maintain these good intentions, scientists and policymakers must account for how to engage with the approach, implying sensitivity for local communities, practices, traditions, and beliefs. The One Health approach can then be regarded as more than a technical concept, but as a tool for scientific as well as policy enhancement and implementation. Scholars will need to take further initiative to explore the different perspectives of the approach. Politicians must integrate One Health notions into policies to enable the consolidation of the approach among the general public and policymakers, appreciating the health and sustainable development of humans, animals, and the environment in our shared ecosystem.

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PART II

Publications

PAPER I

Humboldt-Dachroeden, S., Rubin, O., & Sylvester Frid-Nielsen, S. (2020). The state of One Health research across disciplines and sectors – a bibliometric analysis. *One Health, 10*, 100146. https://doi.org/10.1016/j.onehlt.2020.100146

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The state of One Health research across disciplines and sectors – a bibliometric analysis

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ABSTRACT

There is a growing interest in One Health, reflected by the rising number of publications relating to One Health literature, but also through zoonotic disease outbreaks becoming more frequent, such as Ebola, Zika virus and COVID-19.

This paper uses bibliometric analysis to explore the state of One Health in academic literature, to visualise the characteristics and trends within the field through a network analysis of citation patterns and bibliographic links. The analysis focuses on publication trends, co-citation network of scientific journals, co-citation network of authors, and co-occurrence of keywords.

The bibliometric analysis showed an increasing interest for One Health in academic research. However, it revealed some thematic and disciplinary shortcomings, in particular with respect to the inclusion of environmental themes and social science insights pertaining to the implementation of One Health policies. The analysis indicated that there is a need for more applicable approaches to strengthen intersectoral collaboration and knowledge sharing. Silos between the disciplines of human medicine, veterinary medicine and environment still persist. Engaging researchers with different expertise and disciplinary backgrounds will facilitate a more comprehensive perspective where the human-animal-environment interface is not researched as separate entities but as a coherent whole. Further, journals dedicated to One Health or interdisciplinary research provide scholars the possibility to publish multifaceted research. These journals are uniquely positioned to bridge between fields, strengthen interdisciplinary research and create room for social science approaches alongside of medical and natural sciences.

1. Introduction

One Health joins the three interdependent sectors – animal health, human health, and ecosystems – with the goal to holistically address health issues such as zoonotic diseases, antimicrobial resistance, foodborne diseases and environmental conditions [1]. In 2010, the Food and Agriculture Organization (FAO), the World Organization for Animal Health (OIE) and the World Health Organization (WHO) engaged in a tripartite collaboration to ensure a multisectoral perspective to effectively manage and coordinate a One Health approach. One Health is defined as.

> *"an approach to address a health threat at the human-animal-environment interface based on collaboration, communication, and coordination across all relevant sectors and disciplines, with the ultimate goal of achieving optimal health outcomes for both people and animals; a One Health approach is applicable at the subnational, national, regional, and global level"* [2].

This paper uses bibliometric analysis to explore the state of One Health in academic literature, to visualise the characteristics and trends within the field through a network analysis of citation patterns and bibliographic links. A bibliometric analysis is a quantitative method to capture, in this case, the networks of journals, authors and occurrences of keywords. By investigating these citation indices, it is possible to get an overview of the academic features and dynamics, the strengths and the shortcomings, that characterise a particular scientific field [3]. Previous bibliometric studies have investigated the use of One Health documents, examining journals over time, tracking the increase of public health research involving animals, or investigating the issue of citation indices in relation to veterinary medicine and One Health publications [4–6]. This paper is the first to use bibliometric analysis to explore One Health contributions across disciplines and sectors.

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2. Methodology

The data for the bibliometric analysis is drawn from the Web of Science (WoS). The WoS is arguably one of the largest academic multidisciplinary databases, and it contains more than 66.9 million contributions from the natural sciences (Science Citation Index Expanded), social sciences (Social Sciences Citation Index) and humanities (Arts & Humanities Citation Index) [7]. The broad scope of the database aligns well with the One Health concept's cross-disciplinary approach. The analytical period is demarcated by the first One Health publication included in the WoS in 1998 and it ends in December 2019. The search term "One Health" was applied to compile the first crude sample of articles that mention the concept of One Health in their title, keywords or abstract. This search, however, excluded articles that thematically address One Health, but do not label it as such, as well as articles that refer to the human-animal-environment interface before the term of One Health first appeared in 2004 [8]. With the applied method, some articles might have been excluded that address One Health. However, the analysis focused on the use of the One Health concept. Hence, articles that did not mention One Health but thematically address its inherent topics were not intended to be included. For the literature search, the basic assumption was that articles conducting One Health research (whether conceptually, methodologically and/or empirically) would as a minimum have mentioned "One Health" in the abstract, title or keywords. The literature search resulted in 2004 English articles, see flow chart in Fig. 1. However, this sample also included a sizable group of articles that just made use of "one health" in a sentence such as "one health district" or "one health professional". To restrict the sample to contributions only pertaining to the *concept* of One Health, two subsequent screening measures were taken. First, 587 contributions which used One Health as a keyword were automatically included in the sample. Second, the abstract of the remaining contributions (1417) were manually screened to determine whether One Health was included as a concept or was just a generic syntax. This screening exercise led to 937 contributions being discarded. The final sample consisted of 1067 contributions pertaining to the *concept* of One Health.

The bibliometric analysis was conducted with the bibliometrix package for the R programming language. The analysis focuses on: 1) publication trends, 2) co-citation network of scientific journals, 3) co-citation network of authors, and 4) co-occurrence of keywords.

The publication trend is outlined using both absolute and relative number of One Health publications. The co-citation networks of scientific journals provide information on the disciplinary structure of the field of One Health while the co-citation network of authors disaggregates further to the citation patterns of individual authors. The co-citation network of journals shows the relation between the publications within the outlets. For example, when a publication within journal A cites publications within journals B and C, it indicates that journals B and C share similar characteristics. The more journals citing both B and C, the stronger their similarity. To minimise popularity bias among frequently cited journals, co-citation patterns are normalised through the Jaccard Index. The Jaccard Index measures the similarity between journals B and C as the intersection of journals citing both B and C, divided by the total number of journals that cited B and C individually [9,10]. Like the co-citation network of journals, the co-citation network for authors measures the similarity of authors in terms of how often they are cited by other authors, also normalised through the Jaccard Index. When author A cites both authors B and C, it signifies that B and C share similar characteristics.

The study also investigates the co-occurrence of keywords to identify the content of One Health publications. Here, co-occurrence measures the similarity of keywords based on the number of times they occur together in different articles. It provides information on the main other topical keywords linked to One Health and can thus be used to gauge the knowledge structure of the field. Here, the articles Keywords Plus are the unit of analysis. WoS automatically generates Keywords Plus based on the words or phrases appearing most frequently in an articles bibliography. Keywords Plus are more fruitful for bibliometric analyses than author keywords, as they convey more general themes, methods and research techniques [11].

Disciplinary clusters within the networks, illustrated by the colours in Figs. 3 to 5, are identified empirically applying the Louvain clustering algorithm [12]. Louvain is a hierarchical clustering algorithm that attempts to maximise modularity, measured by the density of edges between nodes within communities and sparsity between nodes across communities. The nodes represent the aggregated citations of the academic journals and the edges, the line between two nodes, display the relation between the journals. The shorter the path between the nodes the stronger their relation. Node size indicates "betweenness centrality" in the network, which is a measure of the number of shortest paths passing through each node [13]. Betweenness centrality estimates the importance of a node on the flow of information through the network,

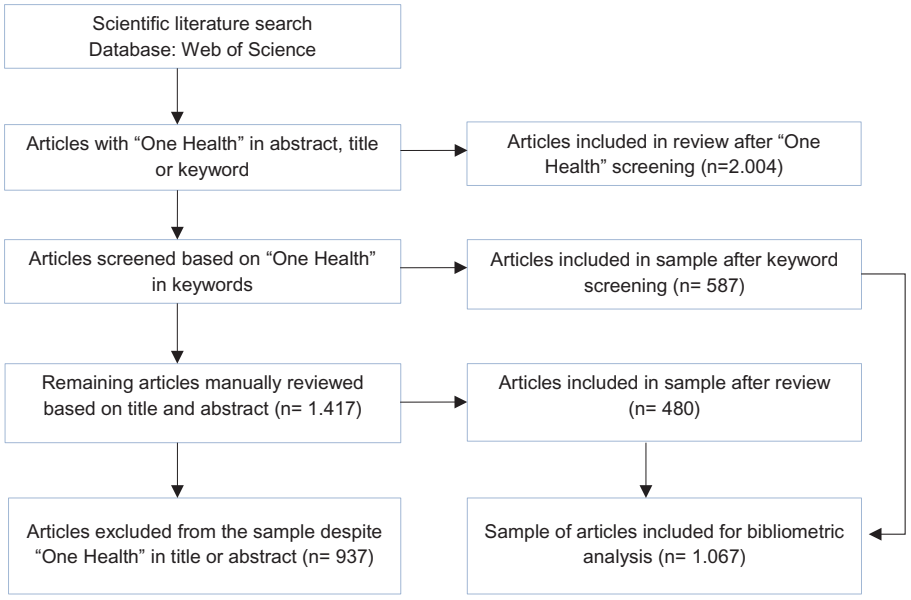

Fig. 1. Flow chart of literature search in the Web of Science database.

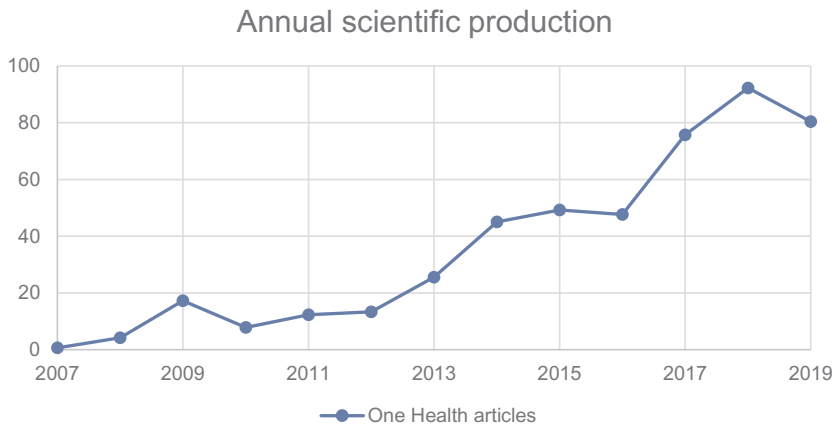

Fig. 2. Ratio of annual scientific production of One Health articles.

based on the assumption that information generally flows through the most direct communicative pathways.

3. Results

3.1. One Health publication trends

In the period from 1998 to 2019, One Health publications have increased in both absolute and relative terms. The absolute number of publications referring to the concept of One Health has risen from one publication in the 1990s, to 39 in the 2000s, to 1027 in the 2010s. Especially in the 2010s, the annual number of publications rose steadily, passing 100 publications in 2015 and 200 in 2018. The relative number of publications, where we control for the general increase in academic publications in the WoS, reveals a similar pattern of increasing academic attention to the concept (Fig. 2). For every million publications in the three main WoS citation indices, 80 publications in 2019 mentioned the concept of One Health in their title, keywords or abstract. The annual scientific production has steadily increased after the initiation of the FAO/OiE/WHO collaboration in 2010 [14]. After 2016 in particular, the publications appear to have bourgeoned, which is consistent with the timelines of the Ebola and Zika virus outbreaks [15,16]. For example, the One Health publications in our sample relating to Ebola have more than tripled after 2016. One might, therefore, expect to observe a similar spike in One Health publications that study the COVID-19 outbreak in 2020.

3.2. Co-citation network of scientific journals

While the use of the One Health concept has increased, the co-citation network shows that the increase is mostly driven by the sectors of human and veterinary medicine, evidenced by their centrality in terms of information flows within the network.

Fig. 3 visualises the co-citation network of journals, demonstrating four colour coded clusters. The clusters display journals which are most similar in terms of their co-citation patterns, which indicates specific disciplinary traits in the network. Since the clusters emerge inductively through the use of the Louvain algorithm, the meaning of the clusters was investigated qualitatively to allocate categories based on their shared characteristics. As a result, four main disciplinary groupings were identified (green: microbiology; blue: parasitology; purple: infectious diseases; red: general sciences). Most journals are in the field of infectious diseases, with *Plos One* and *Emerging Infectious Disease* as the most central outlets. The nodes *Plos One* and *Emerging Infectious Disease* have a high betweenness centrality which indicates a high level of influences on the flow of information throughout the network. The journals are heavily co-cited and connect to outlets covering all four areas. The cluster of the general sciences shows many co-citations links, especially within the same area, for example *Preventive Veterinary Medicine, The Lancet, Nature, Science* and the *Proceedings of the National Academy of Sciences of the United States of America.* However, there are also co-cited journals in the field of the general sciences, which indicate more social science contributions of One Health topics, including the journals *Social Science & Medicine* and *EcoHealth.* These journals allow for broader social and political science perspectives. The journals also show similar characteristics, as they are both co-cited with *The Lancet* and *Preventive Veterinary Medicine*. In the field of microbiology, the network shows strong interrelations between journals within the cluster and only modest relations to other clusters. The area of parasitology is also mostly co-cited in its own area. Here, most aggregated citations are rooted in the journal *PLOS Neglected Tropical Diseases*. In these last two clusters, microbiology and parasitology, the journals cover topics mainly exclusively pertaining to medical or biological sciences.

3.3. Co-citation network of authors

The most active One Health scholars, publishing more than ten articles over the last 12 years, are from the field of veterinary research. Of the top six researchers, five have a veterinary background (Jakob Zinsstag, Jonathan Rushton, Esther Schelling, Barbara Häsler and Bassirou Bonfoh). While Degeling is the only researcher of the top six with an education in the social sciences, the remaining five veterinarian scholars do touch upon social science themes within their publications, relating to systemic or conceptual approaches, sociopolitical dimensions and knowledge integration (e.g. Zinsstag and Schelling [17]; Häsler [18]; Rushton [19]. Five of the six most productive researchers work in Europe and three of them are associated with the same institute, namely the Swiss Tropical and Public Health Institute (Zinsstag, Schelling and Bonfoh) [20].There has been some cooperation across institutes and department as evidence by the co-authorships of Zinsstag and Häsler, Häsler and Rushton, Rushton and Zinsstag (e.g. [21–23]).

Fig. 4 illustrates the co-citation network of authors. Four clusters of authors emerged in the network (green: zoonoses and epidemiology; blue: biodiversity and ecohealth; purple: animal health, public health; red: policy-related disciplines). Academic scholars are mainly found in the green, blue and purple clusters, whereas the authors of the red clusters are mainly represented by organisations such as the WHO, CDC, FAO, OiE, and the World Bank. Generally, the network shows that the field is dominated by the WHO and Zinsstag (red and purple cluster), these clusters are also the most central to the flow of information in the network. Scholars within the biodiversity and ecohealth cluster are less connected with the other clusters but especially scholars in the green cluster are more isolated from the other clusters. More specific, the network shows that, Degeling and Steve Hinchliffe

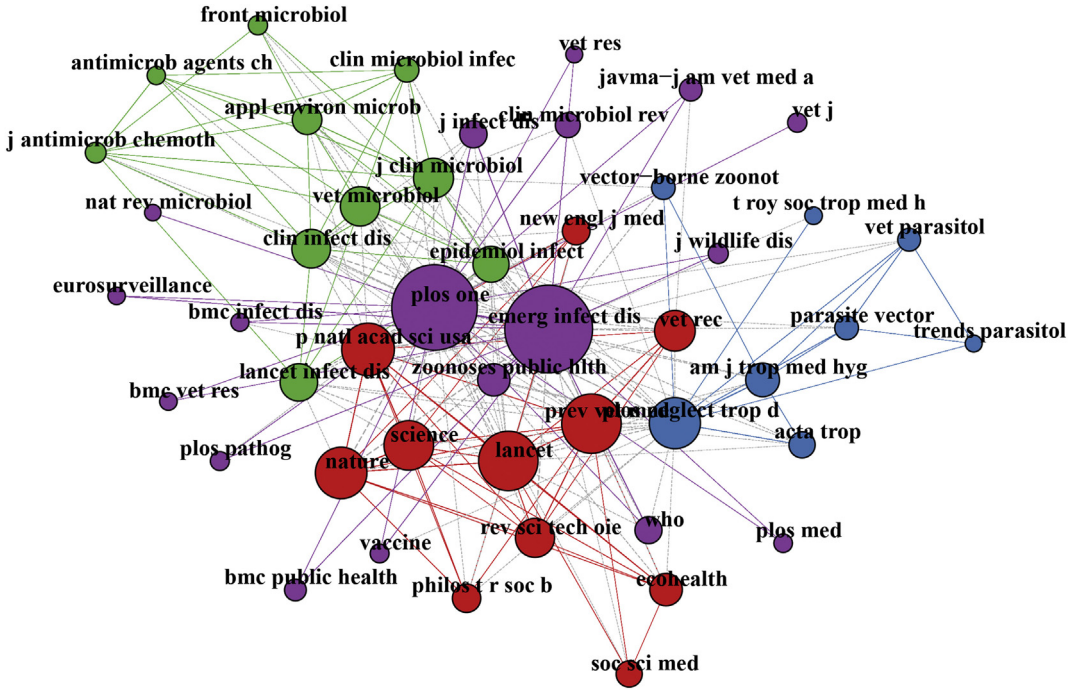

Fig. 3. Co-citation network of scientific journals for One Health.

are often cited together with Zinsstag by other authors, indicating similar characteristics in their research. The network also shows that Zinsstag is often cited with the Schelling and Roth, which again signifies that the authors share similar properties. The organisations in the network are also co-cited by each other. Especially the WHO was co-cited heavily within the network. Notably, the European Centre for Disease Prevention and Control (ECDC) is not cited together with the American counterpart, the CDC. The European Food Safety Authority (EFSA) is an agency funded by the European Union that provides independent scientific advice on food safety, such as for animal and plant health, which embedded the One Health approach in its mission statement [24]. EFSA shows no direct connection to the ECDC or any other organisations. It indicates that the two European institutions are not commonly cited together in scientific publications despite covering similar One Health topics. However, EFSA and ECDC do collaborate, which for example results in the annual European Union reports on zoonoses and antimicrobial resistance [25,26].

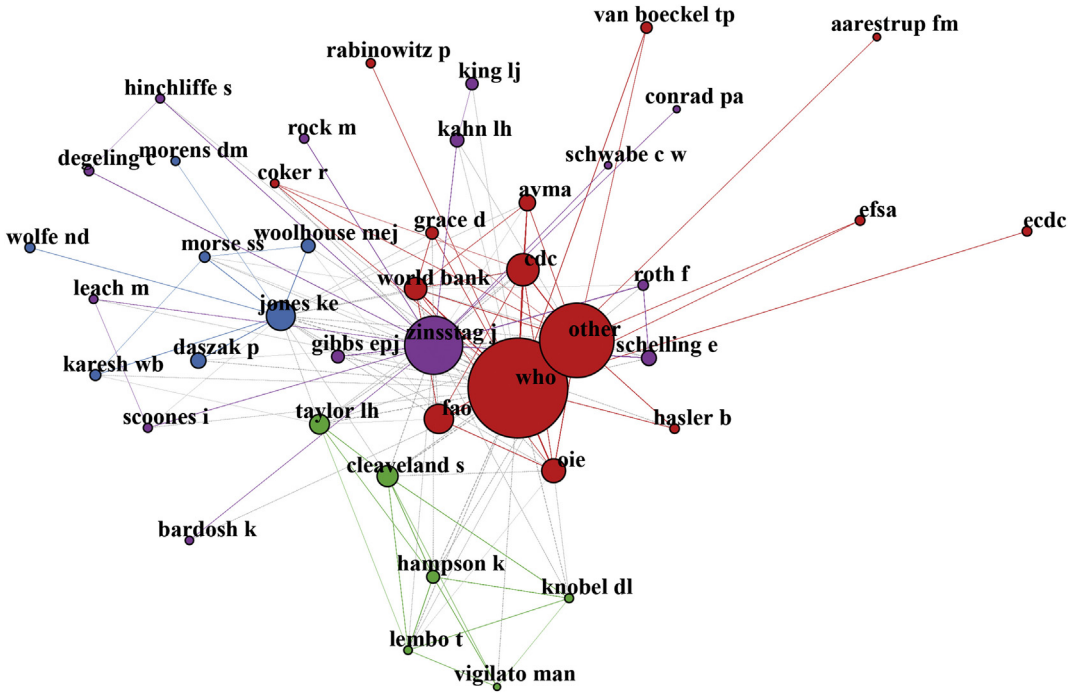

Fig. 4. Co-citation network of authors working on One Health topics. The node “other” represents any publication without a specific author, which could be grey literature such as reports.

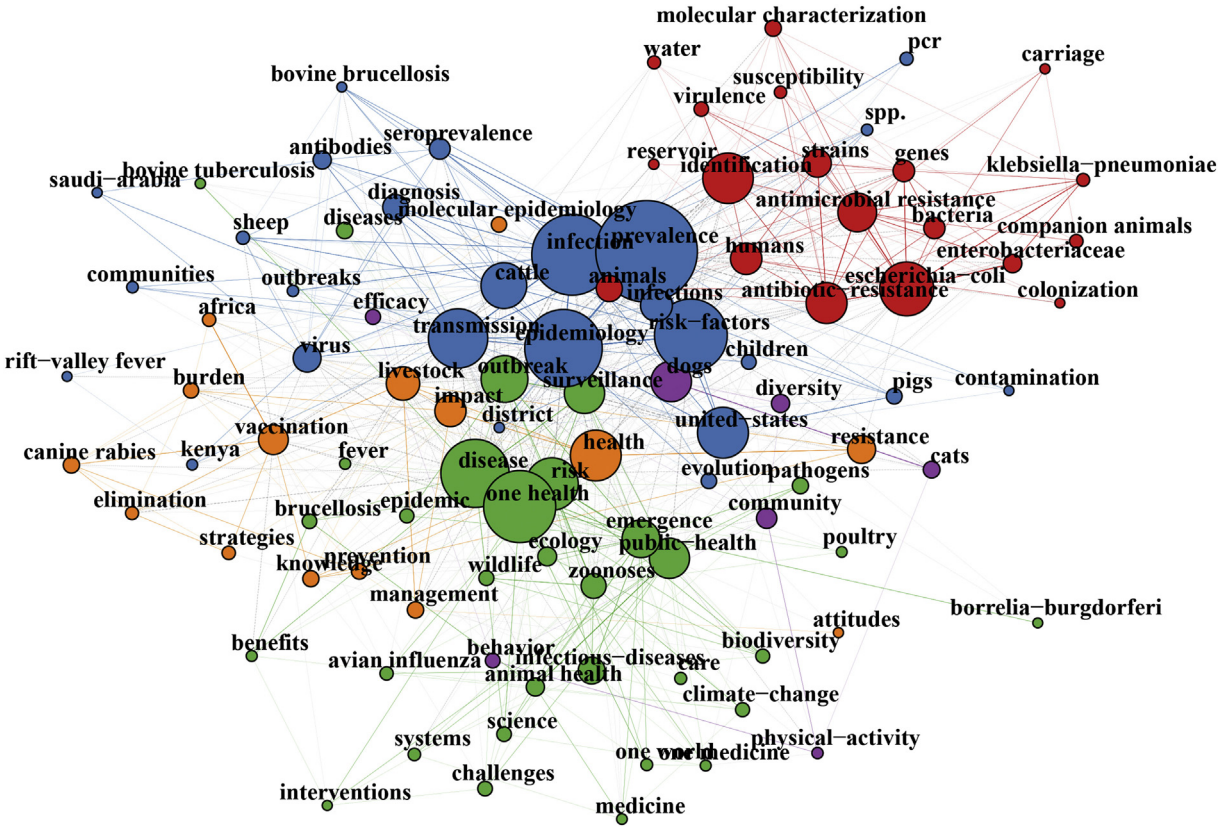

Fig. 5. Co-occurrence of keywords within articles pertaining to One Health.

3.4. Co-occurrences of keywords

Within the bibliometric analysis, the co-occurrence of Keywords Plus in the reviewed articles is analysed to reveal topics and concepts that are the most mentioned and interconnected. The clustering algorithm produces five distinct thematic clusters within the network (red: microbiology; blue: medical science; green: veterinary and ecological science; orange: public health management; purple: anthropology). Fig. 5 illustrates that the blue 'medical science'-cluster is very central, connecting to all other disciplines and showing strong relations within and outside the cluster. Most central keywords are prevalence, epidemiology, infection, risk factors and disease. The green cluster of veterinary and ecological science is also central in the network with many and strong links to the other clusters. The microbiology cluster is also a prominent cluster in the network, although it is primarily a self-referential cluster with limited keyword links to other thematic clusters. The public health management and anthropology clusters are the least prominent clusters. In the anthropology cluster, there are only seven nodes, which are sparsely distributed with distant connections and no central nodes. The orange cluster is more central but key concepts such as strategies, knowledge, management and attitudes play a peripheral role.

4. Discussion

There has been a steady increase of One Health articles, in particular in the wake of the FAO/OiE/WHO collaboration in 2010. External pressures primarily in the form of disease outbreaks such as Ebola and Zika virus also appear to have facilitated further research into One Health. In short, more and more scholars appear to display an interest in the holistic approach of One Health. While this is indeed a welcome development, the bibliometric analysis reveals certain shortcomings in the academic field of One Health that can be structured around three important dimensions: 1) diversity of sectors and disciplines; 2) themes and interfaces addressed; 3) scholars and institutions involved.

4.1. Sectors and disciplines

The citation network of journals showed that One Health is heavily researched in the sciences, particularly in the fields of microbiology, parasitology, infectious diseases and general sciences. The mostly cited journals for One Health themes are the epidemiological journal *Emerging Infectious Diseases* and the science journal *PLOS One*. This is certainly merited, as many One Health issues directly concern humans and animals, such as infectious diseases, foodborne illnesses and antimicrobial resistance. Comprehensive research in these areas is crucial to combat health challenges within a One Health approach. However, One Health is also a tool to inform policy-makers, to manage infectious disease outbreaks, to implement strategies and to enhance institutionalisation [14]. The current COIVID-19 pandemic has made it painstakingly clear that attention to these broader sets of socio-economic issues are essential in public health responses. Scholars have long expressed concern of silo research in One Health, advocating for more interdisciplinary research to include diverse perspectives (e.g. social, political, anthropological) [17,27–30]. The network analysis indicates that there is a general lack of journals for the type of interdisciplinary research that is promoted by the One Health approach. The network analysis does identify some interdisciplinary journals well-positioned to capture broader socio-economic and management perspectives such as *Social Science & Medicine* and *Ecohealth*. Interestingly, the bibliometric analysis did not reveal One Health research in monodisciplinary social science outlets such as political science, global governance or public administration. Neither did it reveal dedicated One Health outlets. There are a few established One Health journals such as *One Health Outlook* published by BioMed Central and the present *One Health* outlet published by Elsevier for the International Federation for Tropical

Medicine. However, these journals are recently established and *One Health Outlook* has not yet made it into the WoS. Stronger cross-sectoral and interdisciplinary One Health research can be promoted by either expanding the thematic areas in existing journals or by increasing the engagement of other types of journals such as those dedicated to One Health or interdisciplinary journals. One Health journals can provide a platform that encourages holistic research from multiple angles, combining quantitative and qualitative research that investigates One Health issues not only as medical and biological themes, but as political as well as socio-cultural themes. Social and political contributions can foster One Health institutionalisation and facilitate policy dialogue. However, the journal network reveals few journals that bridge not just disciplines but whole research traditions, most notably between the medical and social sciences. Hence, interdisciplinary work should be encouraged, as it can promote collaboration, communication as well as knowledge sharing across scientific traditions, disciplines and sectors. One Health and broader public health outlets can facilitate the understanding of complex problems and promote the development of innovations also in the fields of implementation, management, strategy or institutionalisation. Interestingly, absent in our bibliometric analysis were many of the top-tier medical and public health journals, which suggests that One Health research is mainly being published outside the most prestigious international outlets. Indeed, of the 44,063 pieces that have been published in the top ten medical journals in the WoS during the last five years (e.g. *Lancet*, *New England Journal of Medicine*, *British Medical Journal* and *PLOS Medicine*), only six referred to the One Health concept in the title, abstract or keywords. Even among the top ten ranked journals in public, environmental and occupational health (e.g. *Lancet Global Health*, *Lancet Public Health*, *Bulletin of the World Health Organization* and *Annual Review of Public Health*), only seven contributions referred to the One Health concept out a total of 7819 contributions. This modest attention to One Health from the top-tier public health and medical outlets contrasts with the relevance placed on the concept from health practitioners and agencies. The weak academic infrastructure for One Health research risks reproducing a vicious cycle that disincentives new research into One Health due to the more moderate impact factor options available as well as limits the reach and influence of published One Health research.

4.2. Themes and interfaces

One of the defining features of a One Health approach is the attention paid to the nexus between human, animal and environment. However, the field of environment is often disregarded in much One Health research. The colour coding of the co-citation networks of journals and authors reveal that environmental perspectives are dwarfed in comparison to epidemiological, microbiological and public health perspectives. Additionally, the co-occurrence of keywords shows that keywords relating to environment, ecology and biodiversity are scarce. These finding are in line with Khan et al. and Lebov et al. who both found that perspectives from the environmental and ecological sector have been neglected within One Health research [30,31]. Further, the co-occurrence network of keywords illustrated that research into One Health is mainly undertaken in the medical science cluster with the most connections to the other clusters. This indicates that a majority of articles is constructed around medical themes, and that there is most interdisciplinary research across areas in the medical science cluster. However, few keywords indicate research into administrative or anthropological approaches to examine the management of One Health. Making these thematic perspectives more central to the network could strengthen the One Health approach regarding implementation and institutionalisation. One Health initiatives and projects that specifically promote mixed methods studies and engage researchers with various expertise could facilitate implementing comprehensive initiatives. Here, a gap in the One Health research could be addressed, facilitating not only quantitative but a qualitative research to comprehensively approach the multifaceted issues implied in One Health topics [32].

There is no shortage of existing outlets, frameworks and approaches that promote interdisciplinary research. Already in 2008, a strategic framework was developed by the tripartite collaborators, as well as the UN System Influenza Coordination, UNICEF and the World Bank, outlining approaches for collaboration, to prevent crises, to govern disease control and surveillance programmes [8]. Rüegg et al. developed a handbook to adapt, improve and optimise One Health activities could also provide some guidance on how to strengthen future One Health activities and evaluate already ongoing One Health initiatives [21]. Coker et al. produced a conceptual framework for One Health, which can be used to develop a strong research strategy to inform policy-making [19]. Lebov et al. have also devised concrete planning guidelines for One Health researchers on how to construct an interdisciplinary and holistic study design that covers all three health domains [30]. Further, guidance documents such as the 2019 published tripartite guide should be considered when implementing One Health activities [2].

4.3. Scholars and institutions

The study reveals a high degree of author proximity within and across departments and universities. The physical and academic closeness of the most active scholars might indicate the presence of homophily. Homophily is the tendency of individuals to associate and interact with other individuals similar to them [33]. The proximity might increase effectiveness and create synergies, but risks resulting in a lack of diversity in approaches and themes [34]. Some of these themes might be the environmental issues or social science perspectives.

The citation network also illustrates the centrality of organisations such as the WHO, FAO, CDC, OiE and the World Bank. These organisations appear to have a key role in scientific communication. The organisations have been working together, sharing information, which pushed forward the One Health approach and contributed to the recognition of the approach. This is illustrated by the increase in publications of One Health articles after their engagement in 2010. Especially the WHO is co-cited heavily by various authors and institutes, which is reflective of the institute's engagement with research and guidance on One Health related topics. However, these international organisations appear to completely dominate the policy-cluster at the expense of academic scholars. Thus, there is clearly an opportunity for academic scholars to engage more with the policy field of management, implementation, strategies and policy collaboration in the context of One Health. Furthermore, to facilitate interdisciplinary collaboration and to strengthen the engagement of the environment field into One Health, the FAO/OiE/WHO collaboration could involve the environmental sector. For example, the United Nations Environment Programme could be engaged to push forward and connect human and animal health to the environment. Maybe the tripartite could evolve to a quadripartite agreement? The co-citation network for the ECDC, EFSA and CDC indicates that although they all contribute to similar research areas, only limited connections between them could be traced in their research. Additionally to the analysis of co-citation networks, an investigation into co-authorship could have further shed light on interactions of authors. Another reason for the limited connections between ECDC, EFSA and CDC is that within scientific articles, authors prefer to quote peer-reviewed scientific articles rather than reports. Nevertheless, the lack of co-citations indicates a potential barrier for cooperation beyond the limits of the own organisation. The organisations share core principles of the One Health approach but appear to work in epistemological and/or institutional silos, as evidenced by limited cross-citations between organisations. To facilitate cross-institutional collaboration on One Health research, more focus could be on activities that not only promote interdisciplinarity but cross-institutional engagements such as hosting One Health workshops with

broad participation, establishing cross-organisational research groups and encouraging co-authored research projects. Additionally, more flexible research regulations within sectors and improved coordination of engagement of different actors can strengthen work within and across disciplines [35].

5. Conclusion

It is essential to take advantage of the current momentum to advance the One Health approach. The momentum is not only reflected by the rising number of publications relating to One Health literature, but also through zoonotic disease outbreaks becoming more frequent, such as Ebola, Zika virus and the current case of COVID-19. The bibliometric analysis showed the potential and increasing interest for One Health. However, it also revealed little engagement with the environmental sector. It indicated that there is a need for more applicable approaches to strengthen intersectoral collaboration and knowledge sharing. Engaging researchers with different expertise and disciplinary backgrounds will facilitate a more comprehensive perspective where One Health is researched in an interdisciplinary way that conceives of the human-animal-environment interface not as separate entities but as a coherent whole. Existing frameworks and guidelines should be used to promote One Health activities. Further, journals dedicated to One Health or interdisciplinary research provide scholars the possibility to publish multifaceted research. Journals, such as *One Health* and *One Health Outlook*, are uniquely positioned to bridge between fields and strengthen interdisciplinary research. With case studies of One Health implementation and themes of governance as well as interdisciplinary collaboration, the journals can also create room for social science approaches alongside of medical and natural sciences.

Despite the success of One Health, there is a need to pay attention to the persistent challenges of integrating social science disciplines, the environmental sector and researchers from diverse disciplines. Nevertheless, the One Health approach has the potential to be established as a comprehensive research field, engaging multifaceted expertise across disciplines.

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Declaration of Competing Interest

The authors report no conflicts of interest.

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PAPER II

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ORIGINAL ARTICLE

One Health practices across key agencies in Sweden – Uncovering barriers to cooperation, communication and coordination

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Abstract

Aim: This study examined the barriers and opportunities in Sweden for integrating One Health practices. Sweden's long tradition of working with One Health was used as a case to analyse persistent barriers as well as opportunities. *Method:* Thirteen semi-structured interviews with experts from the Swedish Veterinary Agency, Food Agency, Public Health Agency, and Environmental Protection Agency were carried out. A thematic content analysis was conducted on the interviews using inductive coding in NVivo. *Results:* The study revealed that while collaboration is the general aspiration across the Swedish agencies, barriers persist regarding the understanding of One Health, the integration of the environment sector and awareness of the different terminologies employed within the disciplines. There are legislative challenges and barriers to science to policy translation. Disease outbreak was identified as an opportunity for One Health integration. ***Conclusions:*** **A One Health strategy needs to be developed at agency level to define One Health and clarify the roles and responsibilities. To overcome practical challenges, experts need to be aware of different terminologies and practices when collaborating. Further prospects for One Health integration include employing policy entrepreneurs to push One Health onto the political agenda. Preparations for disease outbreaks need to focus on reducing barriers to effectively integrate One Health. Experiences of One Health projects must be disseminated, and to raise awareness, education programmes must integrate One Health into curricula.**

Keywords: *One Health, Swedish practice, veterinarians, public health, food, environment, zoonoses, disease outbreaks, qualitative research*

Introduction

Worldwide, emerging and re-emerging infectious diseases are increasing due to globalisation and global warming [1]. It is estimated that more than 60% of infectious diseases are zoonotic, meaning that the diseases can be transmitted between animals and humans. In Europe, *Campylobacter spp*. and *Salmonella spp*. are the most commonly reported zoonotic bacteria [2]. The Covid-19 pandemic has highlighted the threats and risks at local, national and international levels associated with the emergence of an infectious disease that can spread quickly within and across species [3]. Such disease outbreaks pose challenges to public and animal health and highlight the relevance of sharing solutions to tackle infectious diseases already in their origin and with a One Health approach in mind [1].

The One Health approach refers to establishing coordination, communication and collaboration to achieve optimal health outcomes for humans, animals and the environment [4]. Previous studies have emphasised the need for interdisciplinary research and One Health projects [5,6]. The importance of bridging the silos of the sectors working on One Health themes has been pointed out [7,8]. This is the first study to investigate Swedish One Health practices by gathering the experiences of researchers

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working with One Health. Sweden can demonstrate a long tradition of working with One Health [9]. The One Health practices referred to in this study are comprehensive surveillance and control measures for infectious and zoonotic diseases as well as the effort of working together across agencies in general. Through thirteen qualitative interviews, the study aimed to identify barriers and opportunities of One Health cooperation, communication and coordination practices, to provide examples for integrating and optimising One Health practices in Swedish agencies as well as in other countries and agencies. The focus was on cooperation, communication and coordination, as these are three aspects that are crucial for successful One Health activities [10,11]. The research was based on the concepts of knowledge translation and transfer as well as agenda setting. Hitziger et al. and Conrad et al. provided the starting point by suggesting how networks can create a basis for knowledge translation and facilitate learning from existing examples and practices [10,12]. The view on agenda setting emphasised science to policy translation, as well as the narrative of pushing topics, in this case One Health, onto the political agenda [13,14].

Methods

Interviews with Swedish experts

Qualitative interviews were conducted from March to October of 2020. To identify relevant interviewees, a convenience sampling strategy was employed to take advantage of the facilitated access to interviewees [15]. All but one interviewee were part of the One Health European Joint Programme (OHEJP). OHEJP is a European Union-funded project, involving 44 institutes to enable interdisciplinary research projects on One Health topics such as zoonoses and antimicrobial resistance [16]. Targeting OHEJP participants ensured that interviewees had experience with One Health activities. The focus was on national experiences and practices to unveil unique insights into One Health practices and outbreak-related operations relating to One Health. Thirteen interviews with experts were conducted: four from the Public Health Agency, two from the National Food Agency, six from the National Veterinary Agency, and one from the Swedish Environmental Protection Agency. Supplemental Material 1 presents the interviewees who are in administrative and research positions, information about their workplace as well as their general background and work area. Each interviewee was assigned a number to be able to link them to their background and work area when quoted in the Result section. The limited number of interviewees from the National Food Agency and the Swedish Environmental Protection Agency was due to the lack of contacts and responses from experts in those agencies.

Data collection method and analysis

An interview guide was constructed on topics emphasised in the literature as well as themes arising regarding the Covid-19 pandemic (see Supplemental Material 2). The interview guide was reviewed by a social science and a veterinary expert. Subsequently, five pilot tests were conducted, the first with a PhD student to test the clarity and coherence of the questions as well as the approximate duration of the interview. The remaining four pilot tests were conducted with experts from the Danish National Food Institute and Public Health Institute to refine the questions, examine the duration and enhance the validity of the interview guide. Expert interviews were conducted to gather both technical and context-specific information pertaining to One Health practices within and across institutes [17]. Informed consent was obtained and the reasons for undertaking the research were explained before the start of each interview. The interviewees were contacted via email and interviews were held online via Microsoft Teams or Skype for Business where audio and video were recorded. The interviews were semi-structured and lasted between 40 and 60 min.

The files were transcribed applying intelligent verbatim transcription. This means that filler words were removed and there was light editing of grammar to facilitate the analysis and to reflect the accurate meaning when interviewees were quoted. After the transcription, all files were once again reviewed. NVivo software (NVivo Pro, version 12) was used for the thematic content analysis. The software supported the process of establishing codes. Based on the interview guide and informed by scientific literature on One Health implementation and institutionalisation, seven themes were deductively formulated. Each theme has several sub-themes under which the codes were categorised. The themes 'communication', 'coordination' and 'collaboration' pertained to One Health-related activities within and across sectors. The One Health 'perspective' theme captured interviewees' opinions and perceptions of One Health and its implementation in the Swedish agencies. The theme 'current pandemic' included topics that emerged through talks about Covid-19 disease surveillance and their experiences with the pandemic, as many interviewees were involved in Covid-19 outbreak-related tasks. Lastly, the One Health 'projects' and 'characteristics' themes referred to job functions, experiences and tasks generally and within OHEJP. The sub-themes were established to capture how

some codes showed patterns, fitting the theme but indicating a specific dimension (see Supplemental Material 3). After establishing the themes, everything was reviewed again to ensure consistent and appropriate categorisation. This paper focuses on the themes that occurred regularly in the interviews or themes that were linked to supporting literature. The COREQ checklist for reporting qualitative research (see Supplemental Material 4) was used to report the findings [18].

Results

To showcase the findings of the interviews, the Results section is split into two, listing the main barriers and opportunities relating to One Health practices in Sweden. For this study, a barrier was defined as an obstacle to successfully integrating the One Health approach in practice within and across the agencies. An opportunity was described as a scenario identified by the interviewee that allowed One Health to be implemented or enhanced.

Barriers

The content analysis identified three barriers to effective One Health practise:

1) Ambiguity of what One Health entails in practice

None of the four Swedish agencies had implemented a strategy for One Health and for many researchers the term remains intangible. This could impair potential collaborations and the sharing of knowledge, data and openness to different perspectives [19]. While the interviewees generally expressed support for the One Health approach, there was some confusion about how to translate the abstract approach into concrete practices. One of the interviewees, for example, working in the area of disease surveillance, emphasised the challenges of applying the concept of One Health, 'So then I realised that all of us are talking about One Health surveillance but none of us really knew what it was and that it was just this abstract concept' (9, Veterinary Agency).

2) Lack of engagement of the environment sector

Certain collaboration structures have been established between the Environmental Protection Agency and the Veterinary Agency in terms of wildlife, and with the Public Health Agency regarding outdoor recreation and access to green areas for schoolchildren, however, these collaborations are limited and case-specific. The analysis revealed no connections between the Environmental Protection Agency and the Food Agency, although an obvious avenue would be through their mutual topic of water management, 'as nature-based solutions can contribute to clean drinking water' (13, Environmental Protection Agency). Interviewees were uncertain about the role, contribution and engagement of the environment sector. The absence of environment in One Health projects was explained as the result of holding different priorities and focuses. Although One Health is not a work area of the Environmental Protection Agency, the interviewee referred to their personal advocacy for One Health:

> I have been trying to develop these contacts, but the interest hasn't been really great from the agency, from my agency, to develop a work area on this (13, Environmental Protection Agency).

3) Legislative differences

In Sweden, ministries steer the agencies, dictating the legislation and mandates that authorise the agencies to carry out policies [20]. Some interviewees lamented that legislation is not always straightforward, which leaves scope for interpretation. This can therefore influence the selection and method used to sample health-related data and how it is analysed, which can affect the comparability of the results. It can also pose problems in terms of identifying who is responsible for implementing and performing tasks. Further, agencies have different mandates, which has an impact on the prioritisation of different areas. In an outbreak situation, for example, this can lead to different aims and procedures within sectors. Interviewees from the Public Health Agency and the Food Agency noted that there have been different approaches in foodborne outbreaks. Staff at the Public Health Agency argued that they wanted to find the source of the outbreak and take measures 'to stop the food getting into the market that we know is contaminated' (4, Public Health Agency). An interviewee from the Food Agency also experienced this conflict and explained,

> 'I guess something that sometimes becomes obvious is that different agencies will have their different focus and sometimes that can collide quite often, if you compare public health and food. [For] [t]he public health [agency], [it] is really clear that it is the public health that is their focus. And for the food sector, we also have the companies, the food producers . . ., it is in our mission to support them. And that can become a source of irritation perhaps' (5, Food Agency).

Opportunities

The analysis identified four opportunities for improving One Health practise:

1) Well-established collaboration between the Veterinary, Public Health, and Food Agency

Interviewees described how the barriers to reaching out to colleagues at different institutes are low. Communication across sectors take place regularly, such as in meetings for disease surveillance and outbreak investigations, like the Zoonotic Council meeting once a month 'where they have more strategic discussions around zoonotic issues. That has also been going on for more than 10 years' (5, Food Agency). Further, the report *Surveillance of Infectious Diseases in Animals and Humans in Sweden* is published yearly in collaboration with the Veterinary Agency, the Public Health Agency, the Food Agency and the Swedish Board of Agriculture. Since 2009, the agencies 'have created routines to share the results before writing the chapters. Instead of being three agencies writing pieces of texts that then get collected together, now the writing of the paper is a One Health initiative' (9, Veterinary Agency). Another initiative is called One Health Sweden, which is a network of researchers and governmental organisations who work with zoonotic diseases and antimicrobial resistance [21]. The initiative was created to build a platform to share experiences and interact and it 'tried to influence in different ways, so that the politicians in Sweden become aware about what One Health is' (11, Veterinary Agency). It was emphasised that collaboration is well-received nationally, within and between Swedish agencies and internationally. To engage the environment sector, agencies should 'invite[d] [them] to the forums where the One Health problems are discussed' (12, Veterinary Agency).

2) Potential for different terminologies and methods

An interviewee emphasised the importance of acknowledging differences across disciplines, especially 'being modest about that you only understand parts of the other sectors data' (1, Public Health Agency). To understand terminologies used in different sectors, a cross-disciplinary glossary was mentioned. The glossary established by OHEJP was cited by some interviewees as an example of bridging between the disciplines (Table I).

Discussing methods, analytical approaches and data is crucial to comprehend the research of other disciplines. Different approaches can complement One Health implementation, as methods 'that you use within the veterinary science can be applied to humans. . . . So we can learn from each other although we have different backgrounds' (2, Public Health Agency).

3) Opportunity from disease outbreaks

During an outbreak, there is increased collaboration and communication, and policy decisions are more promptly implemented. Examples were the zoonoses Covid-19, salmonellosis and campylobacteriosis. The latter two are recognised as primary causes of foodborne diseases [2]. Covid-19 presents as a zoonotic disease, as it was likely to have been transmitted from an animal to a human, it spreads from humans to some animals and in the case of the Danish mink farms, back to humans [3,22].

An outbreak brings together multiple actors, such as the World Health Organization and national institutes like healthcare providers, medical professionals and research institutes [23]. For campylobacter or salmonella, additional actors are slaughterhouse operators, farmers, consumers and others that put pressure on the authorities [24]. An outbreak can help to 'try the systems, both nationally and internationally and understand the limits' (1, Public Health Agency). During a salmonella outbreak, an interviewee observed that this was the time 'when you can build something together' (9, Veterinary Agency). This was also apparent for the Covid-19 outbreak, as laboratory testing for Covid-19 was supported by the Veterinary Agency, which would not have been possible before the pandemic due to data safety restrictions. Nevertheless, to be able to assist in an outbreak situation, plans and strategies need to be already in place before the outbreak, as one interviewee put it,

> If you don't establish how this collaboration should work in peace time, in war time it would almost take more time to establish the collaboration than the time is safes [*sic*] by having that help (9, Veterinary Agency).

4) Disseminating experiences and knowledge

Learning from each other is key to aid other countries or institutes to build on existing knowledge. Experiences could describe ways to overcoming potential technical-, resource- or person-related challenges. Dissemination of examples of One Health projects was suggested, to share 'what they are doing well, why and how this can be put in practice, what has been done and how it was done' (9, Veterinary Agency).

Table I. Main themes followed by actions and experiences highlighted by interviewees.

	Topics	Actions
Barriers	Meaning of One Health	• One Health strategy to define One Health, to facilitate interdisciplinary involvement and coordinated actions
	Engagement of the environment	• Expanding connections to environment sector and initiate joint One Health activities
	Legislative differences	• Detailing descriptions of legislations to clarify roles and responsibilities, facilitate procedures and enhance efficacy of One Health activities
Opportunities	Collaboration	• Maintaining and developing good collaboration
	Outbreaks as opportunity	• Integrating One Health into disease preparedness, surveillance and response plans • Agencies to identify policy entrepreneurs to promote One Health issues to policymakers • Enhancing knowledge transfer between science and policy
	Aligning terminology and methods	• Raising awareness about different terminologies • Using and developing cross-disciplinary glossaries, e.g. the One Health glossary by OHEJP (https://foodrisklabs.bfr.bund.de/ohejp-glossary/)
	Disseminating experiences and knowledge	• Disseminating experiences and knowledge of One Health projects • Providing One Health summer schools for undergraduates and graduates • Integrating One Health into the school curriculum • Sharing knowledge at teacher conferences

Another way to promote One Health is education and to foster 'knowledge building about the relationship that our life depends on nature and biodiversity' (13, Environmental Protection Agency). Interviewees cited One Health summer schools and one interviewee shared their experience at a schoolteacher conference, presenting the One Health approach, suggesting that education about One Health should begin in schools.

Table I summarises the topics related to the barriers and opportunities that were identified by the interviewees. It goes further to present actions that were based on the interviewees' suggestions or concluded from the literature. The actions were based on the Swedish case, however, they could be adapted to other agencies or countries.

Discussion

The analysis focused on practices and demonstrated that there were barriers and opportunities that need to be addressed for successful One Health institutionalisation and implementation.

In Sweden, the Public Health Agency, the Veterinary Agency, the Food Agency and the Environmental Protection Agency are all in close proximity to one another. The geographical closeness of the agencies might facilitate collaboration across agencies. However, there were only few interviewees from the Food Agency and the Environmental Protection Agency. This was a limitation of the convenience sampling strategy and indicates that the results cannot be generalised. However, the opinions of the interviewees relate to their work experiences and were interpreted in consideration of their respective contexts. Although the contexts of other countries might vary, Sweden could be used as an exemplar, showing that successful collaboration stems from regular exchange, from cooperation on reports and surveillance activities as well as from initiatives like One Health Sweden [9].

These established routines and cross-disciplinary meetings facilitate collaboration between the agencies and on an institutional level. However, practically, some challenges for the integration of One Health into everyday life still persist. Implementing a One Health strategy could clarify the meaning of the approach, facilitate interdisciplinary activities and foster the transformation of One Health into coordinated actions. A One Health strategy could be a basis for existing collaborations and encourage the engagement of the environment sector as well as its involvement in One Health networks and activities [25]. For meaningful cooperation between the Environmental Protection Agency and the other agencies, existing collaboration could be expanded by engaging in communication on common themes.

Disease outbreaks such as salmonella, campylobacter and Covid-19 can inspire the development and implementation of legislation. Some interviewees described the opportunities to shape the political agenda and to accelerate policy implementation in an outbreak situation. There can be opportunities for the political agenda to be set and for policies to be implemented when a policy window opens. The policy window opens when the problem, policy and politics streams align [13,26]. In this case, the problem stream refers to a disease outbreak, and the policy stream to proposed solutions, such as surveillance, preparedness and response plans. The politics stream refers to interest groups advocating for the issue and to the capacity and preparednessf politicians to acknowledge the problem. The rapid response to the Covid-19, campylobacter or salmonella outbreaks was due

to several interest groups that came from various sectors, and due to public awareness of the urgency. In addition, there can be international pressure if an outbreak in one country spills over into a neighbouring country, or into many parts of the world, as was the case with Covid-19 [3]. This pressure forces governments to make rapid decisions. Consequently, scientific development in outbreak situations is quicker and the science to policy connection is closer [27]. The Covid-19, campylobacter and salmonella outbreaks opened policy windows that led to policy change. For example, campylobacter policies and the salmonella control programme implemented in Sweden enhanced surveillance and control measures and led to a decrease in cases [9]. For Covid-19, surveillance, preparedness and response plans were rapidly adapted and new strategies were developed [28]. The veterinary laboratory tested human samples for Covid-19, which would not have been possible before the pandemic due to data security issues. Other Covid-19 policies concerning the public sector were quickly released and subsequently adapted where necessary, such as restrictions on travel and public gatherings [28].

Interviewees who were involved in outbreak management remarked that during an outbreak, or in 'war times', outputs are generated faster to provide emergency responses. After the 'war', it is important to learn from the close collaboration and coordinated responses. In 'peace time', meaning routine work environments after (or before) an outbreak, there is an entry point for One Health considerations to be integrated into preparedness, surveillance and response plans. Consequently, effective collaboration across sectors could be maintained and awareness for One Health on institutional and political levels raised. Every outbreak is an opportunity for One Health to get through the policy window and onto the political agenda. To facilitate this, advocates or policy entrepreneurs who promote these issues to decision makers are needed. Policy entrepreneurs must be able to translate scientific findings for policymakers. Agencies need to identify their advocates to push One Health onto the political agenda. These policy items must be described well as the outcome may have implications for both human and animal lives. A clear stewardship of the respective ministries aids researchers in determining the roles, responsibilities and processes for the implementation of legislation.

Recognising the complexity of translating knowledge from various disciplines is important. It is unlikely to create a common terminology across all disciplines, but it is possible to be aware of the differences and to acknowledge them. A cross-disciplinary glossary could highlight sector-specific terminology and terms that share the same meaning across sectors. Using and developing the glossary could also strengthen cross-disciplinary research. It could foster knowledge translation and enable researchers and potentially policymakers to comprehend the work of various disciplines [14,29]. Simultaneously, researchers need to communicate effectively to reveal differences in terminologies, methods and analytical techniques. Establishing opportunities to discuss scientific themes across sectors would facilitate a comprehensive understanding of different contexts [11,30,31].

Further, One Health education via One Health summer schools and school-based education fosters knowledge building. Schoolchildren, for instance, are receptive to topics like sustainability and climate change and have influence on sustainable purchasing behaviour [32]. Education leads to more awareness of issues like sustainability and climate change, and teaching children about One Health could have the same effect, increasing the general awareness of those interconnected topics. Education could also be useful in promoting the topic within and beyond the commonly involved institutes (public health, veterinary, food and environment) and include other actors that could benefit from being aware of and acknowledging the benefits of One Health, such as hospitals, health insurances companies, pharmaceutical companies, economic stakeholders and many more.

Conclusion

This study has illustrated that while collaboration within and across veterinary, public health and food agencies is good, the environment agency still needs to be engaged. Further, there are some challenges to practically integrating One Health into the everyday work of researchers. A One Health strategy on an agency level could help to define One Health, and clarify roles and responsibilities. Experts need to be aware of the different terminologies and practices when collaborating. Further prospects for One Health integration include exploiting disease outbreak situations, implementing interdisciplinary approaches and advocating to policymakers. Agencies need to identify and employ policy entrepreneurs to push One Health onto the political agenda. The dissemination of One Health experiences and the integration of One Health into the school curriculum will raise awareness of the approach. Understanding the barriers and opportunities will be beneficial when integrating One Health considerations in the Swedish context and more widely. For a successful implementation of the One Health approach, more research should be conducted to enhance understanding of institutional contexts, cross-agency cooperation, and the needs and perceptions of researchers.

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PAPER III

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Review

Assessing Environmental Factors within the One Health Approach

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Abstract: *Background:* One Health is a comprehensive and multisectoral approach to assess and examine the health of animals, humans and the environment. However, while the One Health approach gains increasing momentum, its practical application meets hindrances. This paper investigates the environmental pillar of the One Health approach, using two case studies to highlight the integration of environmental considerations. The first case study pertains to the Danish monitoring and surveillance programme for antimicrobial resistance, DANMAP. The second case illustrates the occurrence of aflatoxin M1 (AFM1) in milk in dairy-producing ruminants in Italian regions. *Method:* A scientific literature search was conducted in PubMed and Web of Science to locate articles informing the two cases. Grey literature was gathered to describe the cases as well as their contexts. *Results:* 19 articles and 10 reports were reviewed and informed the two cases. The cases show how the environmental component influences the apparent impacts for human and animal health. The DANMAP highlights the two approaches One Health and farm to fork. The literature provides information on the comprehensiveness of the DANMAP, but highlights some shortcomings in terms of environmental considerations. The AFM1 case, the milk metabolite of the carcinogenic mycotoxin aflatoxin B1, shows that dairy products are heavily impacted by changes of the climate as well as by economic drivers. *Conclusions:* The two cases show that environmental conditions directly influence the onset and diffusion of hazardous factors. Climate change, treatment of soils, water and standards in slaughterhouses as well as farms can have a great impact on the health of animals, humans and the environment. Hence, it is important to include environmental considerations, for example, via engaging environmental experts and sharing data. Further case studies will help to better define the roles of environment in One Health scenarios.

Keywords: one health; environment; antimicrobial resistance; DANMAP; mycotoxins; risk analysis; food safety; farm to fork

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1. Introduction

One Health is a concept that has gained popularity during the last years, especially since the Tripartite engagement of the World Health Organization (WHO), the Food and Agriculture Organization (FAO) and the World Organization for Animal Health (OiE) in 2010 [1]. The Tripartite defines One Health as:

> "An approach to address a health threat at the human-animal-environment interface based on collaboration, communication, and coordination across all relevant sectors and disciplines, with the ultimate goal of achieving optimal health outcomes for both people and animals; a One Health approach is applicable at the subnational, national, regional, and global level" [2].

Infectious zoonotic diseases are a main One Health issue, as these diseases transmit from animals to humans and vice versa. The environment, where humans interact with farm animals, pets or wild animals, plays an important role for disease transmission. The

ecosystem and how it is shaped by human activities like agriculture, is an important determinant for the risk assessment of zoonoses transmitted by wildlife [3]. Climate change represents a crucial example of an environmental factor severely impacting wild and domestic animal populations, food chains and human health [4–6]. Changes of the climate like altering temperatures can play a considerable role in the spread of diseases. It can affect the migration and adaptation of infectious pathogens like bacteria, viruses, parasites and fungi. Through climate change, infectious pathogens may find new habitats, which can cause diseases in new and previously unaffected geographical regions [7]. Mycotoxin-producing fungi are an example of plant pathogens, whose incidence is modified by climate changes. Among mycotoxins, aflatoxins are especially poisonous and these naturally occurring toxins may contaminate feed and food and adversely affect animal and human health [8]. Further, the carry-over of pollutants from farm animals to human food is influenced by the environment as well as by the animal metabolism, and it is associated to health risks for humans consuming foods of animal origin and also for animals [9].

Antimicrobial resistance (AMR) is another topic that points out the connectedness of animals, humans and the environment. It is a global concern as it threatens the ability to treat infections in humans, animals and plants. AMR occurs when microbes such as bacteria, fungi, viruses or parasites change so that conventional treatments fail. Factors that increase the selective pressure toward resistant pathogenic strains are misuse and overuse of antimicrobial drugs in humans and livestock; inadequately tested antimicrobial pesticides for plants; inadequately enforced agricultural regulations; as well as insufficient awareness. AMR can spread between humans and animals and circulate through the environment; for example, via food products [10]. The presence of toxic metals in the environment, such as arsenic or copper, can also enhance AMR by eliciting bacterial co-resistance or cross-resistance mechanisms [11].

The increasing threat of zoonoses and AMR highlight the importance of a One Health approach able to cope with complex, multifaceted problems. While the One Health approach evolved especially since the Tripartite engagement of the WHO, FAO and OiE in 2010, similar approaches like farm to fork have been introduced, too [1]. The farm-to-fork strategy was implemented by the European Union to guarantee food safety, integrating sustainable food systems [12]. In particular, the strategy calls for a One Health perspective applied to scientific opinions and intends to support an up-to-date regulatory framework: the risks to human health are considered alongside the health of food-producing organisms and the potential impact of food chain components on the environment, such as substances used in animal feed [13].–In recognition of the need to effectively tackle complex problems, the One Health approach is now widely appreciated for interdisciplinary research and is integrated with the farm-to-fork strategy, currently considered in high-level strategic documents [12,14]. For example, the report by the European Commission, "A European One Health Action Plan against Antimicrobial Resistance", is based on the One Health approach, mentioning the importance of considering the human–animal–environment interface [15]. The farm-to-fork approach is implemented as a strategy for the European Green Deal, a plan developed in 2020 to make Europe climate neutral by 2050. The plan also promotes One Health in the context of AMR and sustainable food production [12].

However, while the One Health approach gains increasing momentum because of its multifaceted aspects and due to the Covid-19 pandemic, its practical application meets hindrances [16]. One Health implementation calls for identifying priority areas for added value of joint activities, and for the effective knowledge elicitation of experts from different and relevant disciplines. Accordingly, One Health may call for updated models for establishing and maintaining effective and timely collaboration and communication across and within disciplines. The establishment of One Health approaches and networks can be of high value for countries that aim to establish or improve their One Health activities, for instance to support science-based regulations in the fields of health, food and environment [2,17].

In the evolving One Health field, there are gaps, open questions and challenges about meaningful integration and institutionalisation of the approach [18]. Zoonoses have been the cradle of One Health; therefore, human–animal relationships have had an ample impact as the first two pillars of the One Health approach [4]. Much thought and actions are needed to optimise the role of environment as the third pillar. Main challenges include how environmental datasets and factors can strengthen the One Health approach for issues such as AMR, as well as how to assess environmental and health issues such as toxic pollutants [17,19].

One Health and the Environment

When reviewing One Health activities, veterinary as well as medical themes prevail and the environment is often neglected [20]. Nevertheless, the environment is all around us, it depends on and affects human and animal health in many ways. For example, healthy soils and clean water can prevent the spread of diseases, and clean environments in slaughterhouses, preservation of natural habitats of animals and biodiversity can contribute to fewer disease infections in animals and humans [21–24]. Climate change is another perspective demonstrating ecological changes affecting environmental, animal and human health. Zinsstag et al. displayed how One Health considerations can aid in solving issues resulting from climate change, such as livestock farming, food security, food safety and sanitation. Integrating public health concerns as well as animal and environmental health perspectives can contribute to enhanced and more contextual problem solving [25]. Yet, beyond the recognition of the importance of the environmental pillar, in what scenarios can it be integrated?

In the following and displayed in Table 1, we propose two partly overlapping scenarios, describing different environmental impacts that highlight the importance of the environment within the One Health approach:

(I) *Environmental changes modulating risk factors for health*

A good example for environmental changes is provided by climate change. Events driven by climate changes may increase the availability of toxicants for food-producing organisms: erosion of soils from flooding, heavy rainfall, thawing of frozen soil and forest fires release mercury from "trapping" environments into the ecosystem [26]. Factors such as temperature and humidity affect the availability of toxic pollutants like lead, causing adverse health effects in animals and humans [27]. It can also aid the distribution of some zoonotic vectors, which in turn affect disease epidemiology. Climatic changes may affect some regions and some populations more than others. More data are needed for a thorough risk assessment, since drivers of vector populations show specific patterns according to vector species and regions [7]. The ongoing and developing scenario of the Covid-19 pandemic highlights how the health impact of an infectious disease can be modulated by a number of diverse, environment-related factors, including meteorological conditions, air pollutants, sewage and wastewater management and even by industrial chemicals, which are widespread, persistent and immunotoxic [28–31].

(II) *Anthropogenic activities as a source of One Health risk factors through the environment*

Anthropogenic activities are main drivers that shape the environment [32,33]. Environment-modifying human activities include improper disposal of toxic waste, impacts of industrial emissions, utilisation of polluted wastewater or manure on pastures and crops used as animal feed. The presence of zoonotic agents in manure is a recognised problem, and methods for anaerobic digestion and manure storage are envisaged to reduce the potential risks [34]. Some pollutants may bioaccumulate in farm animals, and the human exposure is mediated and modified through the animal metabolism and ecology. An example of the industrial impact of exposure to pollutants is the persistent and bioaccumulating β-hexachlorocyclohexane, a by-product of the insecticide lindane. In an instance in Italy, the insecticide accumulated in industrial waste was found in animals, feed and humans [35]. Lifestyle choices and food habits were important predictors

of human exposure to the insecticide, which highlights the importance of a One Health perspective [36]. Concerning pesticides, the European Food Safety Authority (EFSA) has recommended approaches beyond the characterisation of hazards and towards the risk assessment of different ecosystems through the integration of datasets coming from disciplines like ecology, biology and toxicology [37]. Intriguingly, the intensive use of herbicides such as glyphosate and glufosinate is suggested to increase the selective pressure towards antibiotic resistance in environmental bacterial communities, indicating yet another link between chemical pollution and a typical One Health issue such as AMR [38].

Table 1. Examples of environmental scenarios of One Health relevance.

Scenario	Example of Risk Factors	Implications
Environmental changes modulating risk factors for health Climate change contributes to the distribution of insect vectors of zoonotic agents and to the increased amount of bioavailable toxicants in the environment. These toxicants accumulate in food-producing organisms (plants, animals).	• Zoonotic vectors living in warmer areas; • Occurrence of toxic metals; • Meteorological conditions, air pollutants, sewage, wastewater and industrial chemicals.	• Through insect migrations, arthropod-borne zoonoses can spread to colder world area [7]; • Toxic metals like lead cause adverse health effects for animals and humans, in particular affecting the nervous system [27]; • Infectious diseases (like Covid-19) modulated by environmental factors, including immunotoxic chemicals [28–31].
Anthropogenic activities as a source of One Health risk factors through the environment Farming activities may release noxious emissions, waste and by-products into the environment, which affect ecosystem quality, animal and human health. Industrial and other environment-modifying human activities affect food-producing organisms, thereby causing human exposure to hazardous agents.	• Agricultural waste and by-products; • Industrial emissions; • Polluted wastewater or manure; • Persistent, bioaccumulating substances (e.g., the by-product β-hexachloro-cyclohexane); • Herbicides (e.g., glyphosate and glufosinate).	• Agricultural waste and by-products can affect ecosystems, animal and human health, either directly or indirectly by contributing to climate changes [34]; • Bioaccumulation of pollutants and by-products exposes farm animals and subsequently humans to toxic substances [35]; • Increase of selective pressure towards antibiotic resistance of bacteria [38].

As highlighted above, it appears that the environmental pillar of One Health is evident, yet, case studies are needed to assess and exploit the environmental component in a One Health-based risk analysis.

This study presents two cases to portray the importance of environmental considerations in the One Health interface. The abovementioned scenarios are used as an orientation under which the cases are arranged. The two cases describe the Danish Integrated Antimicrobial Resistance Monitoring and Research Programme (DANMAP) and the environment-driven impact of the mycotoxin aflatoxin M1 on dairy farming in Italy.

2. Methods

Two cases were identified to exemplify One Health approaches with environmental considerations. The first case describes the DANMAP. A scientific and grey literature review was conducted to locate relevant articles and documents to describe the case. For this purpose, the database Web of Science was searched. The literature search included relevant articles in English from 1995, the year in which DANMAP was implemented, until January 2021. Keywords used for the search for the DANMAP case included the terms "DANMAP", "AMR", "Antimicrobial resistance", "from farm to fork", "One Health". Included were English articles that mentioned DANMAP or articles containing themes

pertaining to antimicrobial resistance in Denmark. Disregarded were articles that presented research on specific pathogens or scientific methods.

The grey literature search gathered DANMAP reports and additional information on the Danish and European antimicrobial resistance approach. The grey literature was located through a web search via Google. DANMAP reports were found on the website created for the programme (https://www.danmap.org/ (accessed on 27 January 2021)). The reports are mainly in English, but the report from 1997 written in Danish was also included. Additional sources were either found through references in the reports or internet searches.

For Aflatoxin M1, a literature search was performed in PubMed using the search term "Aflatoxin M1" and ("dairy" or "cheese" or "milk"). From this search, two subsets were extracted, using as search terms "climate" and "Italy". The search included English articles published from the early 2000s, when the first aflatoxin case in Italy occurred, until January 2021.

Datasets from an EFSA opinion on aflatoxins and by the Italian Food Safety National Committee were also used [39,40]. Grey literature pertaining to aflatoxin-related issues were obtained by an internet search.

3. Results

The literature search revealed scientific articles and reports that aided the analysis of the two case studies. The search identified 294 articles, of which 28 articles were included into the analysis; see Figure 1. In total, 266 articles were excluded based on a screening of title and abstract and a subsequent full-text screening of the remaining articles. Additionally, ten reports were found and included in the analysis. The articles were used to explain the cases and their backgrounds. The reports were used for a more general understanding of European and international One Health perspectives, as well as in-depth analysis of DANMAP reports.

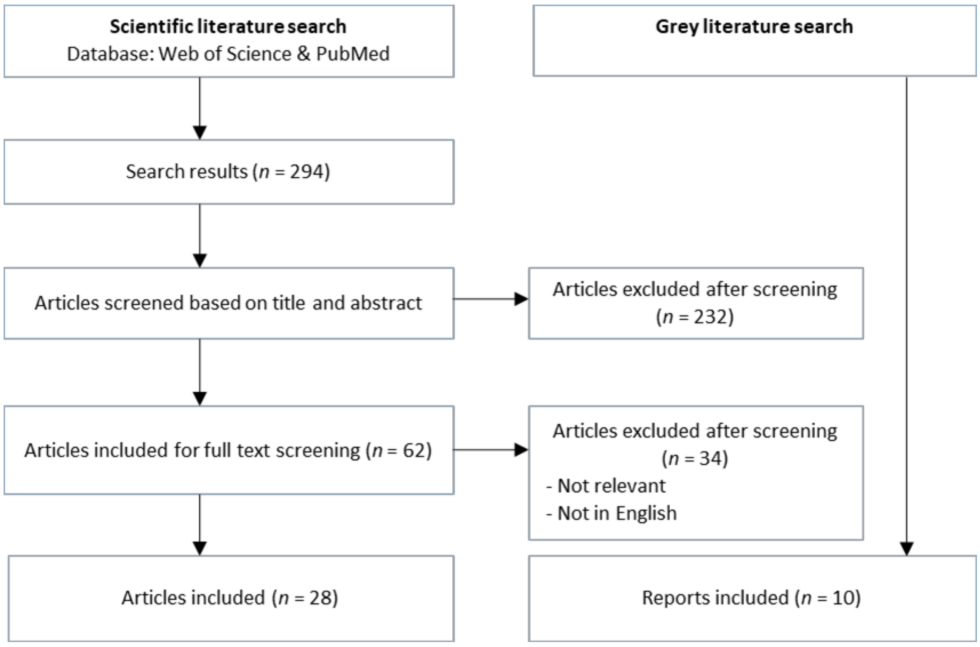

Figure 1. Screening process of literature from the databases Web of Science and PubMed.

3.1. The Danish AMR Monitoring Programme

Denmark implemented the AMR monitoring programme DANMAP to tackle the challenges of AMR in 1995, and it was the first country to do so [41]. The programme was initiated by the Danish Ministry of Food, Agriculture and Fisheries and the Danish Ministry of Health. DANMAP is funded by the Ministry of Health and the Ministry of Environment and Food and is performed by the Public Health Institute (Statens Serum

Institut), responsible for human health aspects and the National Food Institute, responsible for food and veterinary sections. In 2004, the Danish Veterinary Institute was fused with the National Food Institute, which might be the reason that the National Food Institute covers veterinary themes [42]. The DANMAP presents four objectives: the first two relate to (1) monitoring presence of antimicrobial residues in food and feed as well as (2) the occurrences of AMR in bacteria. The latter two concern association with (3) antimicrobial consumption, transmission routes and (4) potential further research areas [43].

The DANMAP has since produced scientific knowledge on AMR and it focuses on the collaboration between the human, food and veterinary sectors, but also includes other stakeholders like farmers, slaughterhouses and pharmacies [44]. Since the initiation of the programme, Denmark has successfully reduced the prevalence of AMR [10]. Most of the attention within DANMAP is provided by the public health and veterinary health sectors; nevertheless, the environment was included. For DANMAP, the environment includes the areas where humans and animals meet, shelters of animals and places that are susceptible for infection [44]. Already in the first report of 1996, food and environmental laboratories were involved in analysing food samples from animal and non-animal origin, such as fruits and vegetables [45]. The surveillance results of bacteria in 1996 found resistance of antimicrobials in the environment [45,46]. In the 1997 report, the occurrence of resistance among *Escherichia coli* from fruit and vegetables was also found for eight antibiotics. No further specifications of actions or implications were mentioned in the report. While in the 1996 and 1997 reports, fruit and vegetable sampling was mentioned, it was not mentioned in the DANMAP reports after 1997.

For most of the years from 1997, the DANMAP reports have mentioned the approach from farm to fork and it was integrated into the AMR surveillance activities [47,48]. The strategy is utilised to monitor the entire food chain and further, as they state: "from farm to fork to patient" [44].

Since 2010, the One Health approach has been incorporated in the reports and emphasised as a fundamental principle when monitoring and researching AMR [49]. Although the One Health concept is mentioned, the reports often fail to explicitly mention the environment sector. Nevertheless, DANMAP acknowledges that the environment can be the source of infection, as exemplified by showing environmental transmission routes of different bacteria in the 2019 report [49]. Additionally, the environment is acknowledged as a source of exposure to antimicrobials and to AMR-carrying bacteria for both animals and humans. Hygiene and biosecurity measures are therefore endorsed in immediate environments of farms and hospitals [44]. To accompany the DANMAP reports, the Danish government published a One Health strategy to tackle antibiotic resistance in 2017. It contains five goals of which at least three are relevant for environmental considerations within antibiotic resistance. The first goal, "A prudent use of antibiotics to reduce the incidence of resistance", emphasises that the environment can be a reservoir for microbes and can transmit microbes to animals and humans. Through the second goal, "Greater efforts to prevent infections and to facilitate antibiotic alternatives", the immediate environment of humans and animals such as surfaces is also mentioned. Here, it is emphasised to execute thorough hygiene measures to prevent the spread of AMR from the environment. The third goal, "Enhanced knowledge to improve targeted measures", admits the need to promote knowledge building on the impacts of the environment [50]. In the report, the European Union action plan is highlighted, which integrates a One Health approach to tackle AMR. In the report, the role of the environment is emphasised as an area in need of engagement. The environmental role for transmission, potential tools and methods will be considered as well as data from environmental monitoring programmes [15,50].

3.2. Aflatoxin M1 in Italy as a One Health Issue

Several aflatoxin "crises" have occurred in northern Italy, the first and most severe in 2003 and the last happened from 2015 to 2017. These events were characterised by highly increased levels of Aflatoxin B1 (AFB1) in corn used for feed, and of Aflatoxin M1 (AFM1)

in milk and dairy products. This happened in relation with environmental conditions featuring high temperatures, drought and enhanced insect damage of the crop [51–53].

Aflatoxins rank prominently among mycotoxins because of their genotoxic potential. AFB1 can cause hepatocellular carcinomas in humans, a type of liver cancer, with a higher risk for people infected with the hepatitis B or hepatitis C virus. EFSA considers that current levels of exposure to aflatoxins in foods may represent a health concern, in particular for younger age groups. In Europe, the food categories "liquid milk" and "fermented milk products" have been identified as the main contributors to overall AFM1 exposure throughout all age groups, infants being most exposed. Legal limits of foods and feeds and official monitoring programs are in place to prevent the risks for human and animal health due to aflatoxins. In the European Union, the legal limit for AFM1 in dairy products is 0.05 microgram per kilogram [54]. Aflatoxin production by fungi are common in hot and humid climate conditions, and can take place pre- and post-harvest [40]. In Serbia, a study showed that changes in temperature and moisture, resulting in the alternation of drought and flooding, enhance aflatoxin production. Hence, climate change may increase the health risks due to aflatoxin contamination of food [55].

AFB1 affects mainly grains and nuts, which are also the main sources of human exposure. However, the contamination of crops, such as corn used as animal feed, lead to the intake and digestion by farm animals. Dairy-producing ruminants transform AFB1 into AFM1, which is also a public health hazard, because it is genotoxic and carcinogen in vivo, even though it is less potent than AFB1 with respect to liver carcinogenicity. The toxic metabolite resulting from feed contamination is found in dairy products of ruminants like cattle, sheep, goats and buffaloes [40,51]. Dairy products are an important component of the diet in Italy [56]. AFM1 binds with proteins in milk and therefore, concentrates in cheese and other dairy products with a high protein content, such as the whey-based ricotta [57]. The National Reference Centre for the quality of bovine milk recommends that control of cheeses are postponed as compared to milk in consideration of the maturing periods of cheeses [53].

The area with the highest milk production is the Po Valley in northern Italy, and it is among the foremost agriculture intensive areas in Europe. The different environmental farming conditions of low- and high-yield dairy cows have an impact on AFM1 contamination. In low-yield cows, the carry-over of AFM1 to milk is in the 0.1–0.5% range of the AFB1 intake, but it is 1% to up to 6% in high-yield cows [57–59]. The environmental and agricultural scenario in Italy makes the area with the highest dairy production the most vulnerable to AFM1 contamination. The climatic conditions are characterised by high humidity rates, averaging at about 80%. Climate changes lead to greater stress on the crops due to temperature increase alternating between drought and heavy rainfall. This leaves the crops vulnerable to aflatoxin-producing fungi [55,60]. In Italy, almost 95% of total milk production, 13.3 million tonnes in 2019, is provided by cattle [61]. The milk production shows a seasonal trend, being higher from March to May.

The latest data provided by the National Reference Centre for the quality of bovine milk showed that the climatic trend in late spring and early summer is the critical factor influencing the extent of AFB1 contamination in cereal and corn crops [54]. This trend has been confirmed by the data analysis since 2012. Hence, climate trends influence the extent of the contamination in feed, flour and silage entering the animal feed circuit during the summer and for the following twelve months. Thanks to prevention and control measures, the latest data do not indicate health concerns, as the samples collected in 2019 show a sharp decrease of AFM1 concentrations compared to samples found in the period from 2012 to 2016. This is clearly reflected by the percentage of samples above the legal limit: while from 2012 to 2016, the average of samples above the legal limit was 2.50% with a peak of 5.06% in 2016, in 2019 the non-compliant samples have been a mere 0.34% [54].

In southern Italy, the climate affects aflatoxin occurrence as well, although concentrations in milk are generally low in this area due to lower humidity, less intensive farming and lower milk yield per animal. However, AFM1 contamination was significantly higher

in cold season, particularly in autumn, than in the warmer season of spring. In this scenario, the non-compliance with the legal limit was just 0.1% [56].

The crisis of 2003 has prompted the Italian Ministry of Health to issue a contingency plan for the prevention and risk management of aflatoxins contamination in the dairy chain and in the production of corn for human and animal consumption in extreme climatic condition [51]. Besides this, the regular monitoring of raw milk and feed, more intensive in vulnerable months, allows timely advice given to the dairy farms to launch corrective measures [52,53].

4. Discussion

The two case studies illustrate how the environment interacts with the health of humans and animals, making up an essential pillar of One Health. Indeed, environment-related factors can play multiple roles that need proper characterisation to manage the complexity inherent to One Health issues. In the following, the two cases will be categorised under the established scenarios (Table 1) to highlight the integral part of the environment within the cases.

4.1. Climate Change Modulating Risk Factors for Health

The Italian aflatoxin case illustrates well how toxic pollutants fit into the One Health context, bringing together human health, animal health and their products as well as the environment [9]. Aflatoxins are carcinogens, thus human exposure has major health implications [40]. While the main aflatoxin, AFB1, is a contaminant of foods of vegetable origins, dairy-producing ruminants transform it into the toxic metabolite AFM1, which is excreted in milk, representing an additional route of human exposure [51]. The environment has a crucial role, shaping the exposure scenarios and the consequent human risk: Climate influences the contamination of crops used for feed by aflatoxigenic fungi, as the AFM1 presence in milk is closely related to yearly climate patterns as well as to seasonality [54–56,60]. Further, the farming environment is important, with intensively bred, high-yield herds showing a greater carry-over of AFM1, even at comparable feed contamination levels [56–59].

The AFM1 case study highlights some noticeable implications. A number of economic drivers orient a large part of the dairy production of the Po Valley toward high-quality products like the made-in-Italy cheeses Parmigiano and Grana. These meet high demand from national and international markets, but require high-yield cows and high costs to maintain the technologically developed intensive farming [51]. This economic trend makes the dairy farming system of the Po Valley more vulnerable to climate changes and associated risks such as AFM1 outbreaks.

This case study exemplifies the far-reaching impact of the environment in which feed is grown, from a One Health perspective. Although the current data indicate a low or very low carcinogenic risk from AFM1 in Italian dairy products, changes in the climate, as well as potential health hazards, justify continuous monitoring, crisis preparedness and regular updates of the exposure assessment [52]. In particular, modelling climate trends can aid to detect potential risks for aflatoxin occurrences, as a rise of AFM1 in milk is expected to occur from August to November due to the presence of AFB1 in feed materials in spring to early summer. Consequently, the sampling plan of feed and milk has to concentrate on this critical period [53]. In the face of a changing climatic scenario and potential following crises, the AFM1 issue has been efficiently managed through a food chain approach by the Italian Ministry of Health. This resulted in progressive reduction of the chance of consumer exposure [52,53].

4.2. The Anthropogenic Environment as a Source of One Health Risk Factors

Anthropogenic activities have led to new challenges for the environment [19]. Hence, complex issues like AMR must be handled in a coordinated manner. In the latest DANMAP report of 2019, the need to "supporting decision making in the prevention and control of

resistant bacterial infections" was highlighted [44]. This requires an integrated approach tackling the complexity of AMR. Accordingly, the programme involves researchers from different disciplines, holding regular meetings between the Statens Serum Institut and the National Food Institute. Involved are veterinarians and public health professionals, such as physicians and epidemiologists but also microbiologists, which contributes to the farm-to-fork and One Health approach [48]. By including various disciplines, a wide range of expertise comes together, which can constantly improve the DANMAP. Additionally, researchers, political actors (Danish Ministry of Environment and Food and Ministry of Health) and private stakeholders from relevant sectors (e.g., pharmaceutical industries, meat chain enterprises, as well as farmers, retail, feed mills, pharmacies, etc.) are also continuously involved. For example, private stakeholders are engaged, as data are obtained from feed mills, slaughterhouses and via samples from food for human consumption [44]. This strengthens trust between the parties and has likely facilitated the large amount of voluntary data that is produced by the industry. To improve transparency, the DANMAP reports or website can provide additional information on the engagement of the public, consumers and the media.

The involvement of researchers from different disciplines and the cooperation among veterinary, food, human and environmental laboratories in terms of data sharing and common technological platforms are proficient ways to integrate the environment sector into AMR surveillance [44,48]. Additionally, the Danish One Health strategy to tackle antibiotic resistance and European approaches for AMR and One Health are good bases for establishing a connection to the environment and strengthening environment-related research for these topics [12,15]. For DANMAP, strengthening environmental research can facilitate the integration of environmental considerations into its analysis. These can encompass areas such as antibiotic use in plants, pesticides, manure and wastewater.

For instance, plant agriculture frequently uses antibiotics to enhance crop yields. This means that fruits and vegetables can be a source for AMR [62,63]. Pesticides may be a pathway for AMR, as some chemical substances may exert a selective pressure favouring antibiotic resistant bacteria [19]. In the Danish agricultural practice, the use of highly toxic and persistent substances is severely restricted. For instance, the insecticide lindane was been banned in Denmark since 1994. While the ban of high-concern pesticides is beneficial to humans, animals and ecosystems, these substances may leave environmental "legacies". In the case of lindane, the by-product β-hexachlorocyclohexane can still be found in soils and wastewater, as it resists not only germs but also biodegradation, posing risks to human health [64]. Most important, there are indications that pesticides, their residues and by-products may increase the presence of AMR in the environment [65]. Some herbicides like glyphosate and glufosinate represent telling examples of widespread chemicals with the potential to increase the environmental AMR burden [38]. The overall use of substances in both animal and plant farming, including the overuse and misuse of antimicrobials as well as some pesticides can therefore act in an additive way [19,65]. Another environmental factor to be considered is the contribution to AMR by toxic metals, which can derive from soil composition, industrial emission or, in the case of copper, also from its use as feed additive [11,66].

However, more data are needed to conduct a meaningful risk assessment that comprehensively considers these environmental factors and weighs their possible contributions. Continuous monitoring and assessments must be maintained to prevent AMR and toxic by-products entering the ecosystem. Readopting sampling and screening measures within DANMAP for fruits and vegetables can aid in determining the current role of AMR and pesticides.

Further, monitoring manure used on soils is essential to screen AMR and infectious agents to prevent the spread into the food chain [34,67]. In connection with manure, wastewater is an important variable in the distribution of AMR and resistant pathogens. While the DANMAP reports acknowledge water as a source for resistant pathogens, more effort can be put into implementing water monitoring, as resistant pathogens can spread

through use of wastewater, consumption of water and contamination of food or kitchen utensils [34,62]. AMR can persist for a long time in wastewater of plant and animal agriculture, and intensive animal farming may lead to a greater environmental enrichment of AMR [67,68]. The surveillance of soil and wastewater in water treatment plants, which turn wastewater into drinking water, is crucial to mitigate risks of infection or AMR [22]. For a comprehensive understanding of AMR, it is important to identify overuse misuse as well as critical pathways, and to recognise the connections between soil, manure and water to gauge the anthropogenic impact. One of DANMAP's objectives is to explore further research areas and this could include investigations into plants, soil and water. These investigations can aid in determining any inadequate use of antimicrobials in agricultural settings and fuel the search of alternatives to bioaccumulating toxins and pesticides. This can support a surveillance approach that is holistic and foster research and development of environmental effects on AMR.

In the case of DANMAP, the farm-to-fork approach and the One Health strategy are integrated into the programme. The reoccurring emphasis of the One Health approach can strengthen the inclusion of all disciplines. Nevertheless, it is important to consider that this does not necessary entail that all disciplines must be represented equally in each scenario. Transmission routes for AMR-carrying microbes occur more often through contacts between animals, their products and humans rather than through the environment [69,70]. Hence, the veterinary and public health disciplines have a paramount role in this field. Nevertheless, environmental factors doubtlessly modulate AMR transmission as, for instance, AMR-carrying bacteria from animal farms persist for a long time in water, even after going through wastewater treatment plants [67]. The DANMAP reports consistently refer to the need of complying, upholding and improving current surveillance and prevention measures for infections through resistant bacteria [44]. Hence, it is crucial to foster the engagement of the environment to a necessary degree to characterise the environmental transmission of AMR in a qualitative as well as quantitative way, and to establish preventive measures.

4.3. Way Forward for the Environment and One Health

The two case studies show that the assessment of environmental risk factors is relevant to One Health surveillance. The accumulation of toxins from fungi, pesticides, manure or other sources in the environment can have downstream effects on human and animal health. Food as well as feed safety and surveillance are important to detect foodborne diseases and harmful accumulated chemicals. A structured analysis based on the identification of points of particular attention can support surveillance activities. Under this respect, Lombardo et al. have proposed a scheme for the analysis of environment-related factors in the animal farming scenarios with a One Health view. The proposed system considers the area (geo-climatic factors, waste disposal sites, land usage, main crops, water sources) and farm characteristics (size and conditions, biosecurity, use and disposal of biocide and drugs, feed quality and origin) [71]. In addition, available information such as routine controls and previous alerts should be exploited and integrated in the scheme.

The surveillance of terrestrial and aquatic ecosystems are of increasing interest and relevance in the One Health approach, as knowledge of the ecology of organisms can help to model and predict recurrent threats. Examples include, but are not limited to, blooms of toxic algae and outbreaks of infections spilling out from wildlife like bats, to humans [72,73]. In these examples, the environmental expertise can support the epidemiological modelling by identifying relevant modulating factors, such as pollution and land use for algal blooms, and bat-borne infection, respectively.

The environment can encompass water or soil, but it can also cover less obvious areas such as slaughterhouses or other areas where food is produced and processed, as it was exemplified by the DANMAP and the AFM1 cases. Through these different environments, humans and animals are in some ways always connected, which highlights the importance of finding ways to integrate environmental perspectives via engaging experts, employing

techniques to assess environment-related factors and sharing data. The One Health approach provides an essential tool to link various disciplines, and to investigate the specifics and added values of each field. Not missing out on the environmental pillar will benefit the One Health approach through opportunities for environmental research that aid to better understand links between humans, animals and the ecosystem. Additionally, the Covid-19 pandemic points out that the health impact of an infection can be significantly modulated by a number of environmental factors [28–31]. The view of Covid-19 as "syndemic" recognises the need to interpret and assess the complex interplay between an infectious agent and concurrent determinants related to the physical and social environment, which is consistent with the One Health approach [74].

5. Conclusions

One Health is an approach to assess and manage complex public health issues that are cross-cutting and require the cross-fertilisation and integration of different expertise [1,2]. Therefore, One Health links the environment, humans, animals, including the food and feed chain. One Health approaches can be modulated in a case-specific way, as not all sectors need always be involved to the same degree.

International engagements like the Tripartite or European approaches must continue to refer to One Health, while also emphasising the importance of the environment pillar of the One Health approach.

In the AFM1 case study, environmental components are represented mainly by climate patterns and by the more or less intensive dairy farming scenarios in different Italian areas. These determinants are directly influencing the extent of contamination of feed by AFB1 and of milk by AFM1, and thus are directly linked to the AFM1-associated risk to human health [51–53,55,56].

In the AMR case study, the environment is not the main area of focus of the DANMAP, but nonetheless important, as anthropogenic activities contribute to the flow of bacteria-carrying AMR from sources like hospitals and farms. Potential overuse and misuse of AMR contribute to the occurrence of AMR in the environment, in particular soil and water, which are reservoirs for animals and humans [62,63,67].

One Health is a developing, multifaceted web of feedbacks and interactions among its components. The goal is not to drown in complexity, but to manage complexity. Further work is needed to better define the roles of environment in One Health scenarios. The characterisation of environmental factors is paramount to model the risks for animal and human health. One Health should be implemented as an institutional tool in public health, especially fit for evidence-based priority setting and to support decision-making [4,20]. More case studies are needed to showcase the role of the environment, highlighting the benefits of environmental expertise in connection to human and animal health.

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PAPER IV

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PAPER V

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One Health Outlook

RESEARCH

Open Access

Translating One Health knowledge across different institutional and political contexts in Europe

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Abstract

Background Implementing a One Health approach is complex. It demands engaging different sectors and actors in the promotion and protection of human, animal and environmental health. A key challenge for successfully implementing the One Health approach are knowledge translation processes among scientists and policy-makers.

Methods An online survey reached 104 experts from 23 European countries, working at national agencies or institutes, universities, ministries, non-governmental organisations (World Health Organization, World Organisation for Animal Health), and European Union (EU) agencies. Qualitative and quantitative analyses were conducted to describe experts' perceptions.

Results This study indicated a lack of networks among scientists and between scientists and policy-makers. Relations of scientists and policy-makers were perceived as challenging due to different interests and priorities, leading to difficulties in reaching political attention for One Health topics. It also highlighted a favoured attention to some One Health topics (e.g. antimicrobial resistance) as opposed to others (e.g. environmental issues). Important international actors to push One Health policies forward were the Quadripartite organisations and EU agencies. National actors (government agencies, national research institutes, universities) were on average perceived to be more important than international actors due to their roles and influences. Factors influencing the knowledge translation process were the different languages spoken by scientists as well as politicians, and an equivocal understanding of the One Health approach.

Conclusion The study shows the importance of leadership to establish interdisciplinary networks and to problematise One Health issues with clear scope and targets. This will help to link knowledge to needs and capabilities of policy-makers. Establishing strong relationships among national and international actors can encourage networks and raise awareness of the One Health approach to policy-makers. Lastly, promoting research communication skills of scientists can provide a valuable tool to reach policy-makers to enhance attention to One Health topics.

Keywords One health, Knowledge translation, Networks, Leadership, Political attention, Research communication

Background

One Health is an approach that connects public health, veterinary and environmental sectors. It aims to tackle societal issues, such as threats to ecosystems, zoonotic diseases, which are diseases that spread from animals to humans and vice versa, or antimicrobial resistance (AMR), which happens when microorganisms develop and become resistant to conventional treatments that are

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used to treat infectious diseases (among other treatments this includes antibiotics). To achieve this, the approach is based on collaborations, communication and coordination across the sectors and relevant actors [1]. Collaboration is a key aspect for the integration of different disciplines and expertise to enable knowledge sharing [2]. Implementing a One Health approach can lead to enhanced disease control, biosecurity procedures, and can identify opportunities for health promotion and risk mitigation on the human-animal-environment interface [3, 4]. It is a multifaceted approach entailing the integration of different sectors (e.g. public health, medical, animal health, environment, food safety) and actors (e.g. bureaucrats, politicians, scientists, health care providers, industry, public) who follow their own agendas and priorities [5]. The implementation of One Health activities broadens the scope of study designs due to the engagement of multiple sectors, and the different types of knowledge from various sources, such as scientific evidence from scientists of different disciplines [3, 6].

However, the literature describes silos between the sectors and how they present a challenge for implementing One Health activities [2, 7, 8]. Often the silos arise due to difficulties in collaborating, communicating and translating information across sectors, disciplines as well as outside one's own epistemic community [7]. This may lead to a lack of political awareness and hence, resources and funding of One Health initiatives [2]. A key premise for enabling the implementation of the One Health approach is the translation of knowledge across research disciplines, and from scientists to policy-makers [8, 9]. However, little is known about the knowledge translation processes among scientists and policy-makers, such as bureaucrats and politicians. Knowledge translation processes take part among different actors and sectors, they can facilitate the coordination of One Health activities, connect actors promoting collaboration and access of data [10]. Investigating the knowledge translation process for the One Health approach among scientists and policy-makers can give insight into obstacles for implementing the One Health approach.

The aim of this study is therefore to comprehend institutional and political structures that enable the knowledge translation process for the One Health approach. This is one of the few studies that examines some of the knowledge translation challenges that impede the implementation of the One Health approach by including experts' perceptions of institutional and political challenges.

The theoretical basis of the study is the knowledge transfer model to shed light on the translation of knowledge (scientific evidence) from the source (scientists) to the receiver (policy-makers) [11]. This study will especially investigate networks and relations of the source and receiver in terms of transforming, associating, and applying knowledge, and provides insight into some influencing factors. Transforming knowledge is the process of making knowledge useful for the receiver, and associating it entails linking it to policy-makers' needs and capabilities. Transformed and associated knowledge can then be applied by the receiver to create value [11]. Influencing factors are elements that can affect networks, actors, their relations and thus they can affect the process of transferring knowledge either positively, enhancing the process, or negatively, impeding the process [11, 12]. This paper limits itself to the influencing factors of capabilities and skills to assess potential avenues that enhance positive and avoid negative influences for the knowledge transfer process. The dimensions (networks, relations and influencing factors) will structure the analysis and provide an insight into the knowledge translation processes between scientists and policy-makers.

This study is based on an online survey about the governance of One Health. It involved 104 scientists, experts and policy-makers from the sectors of public and veterinary health, environment and food. The paper finds that there are some unsatisfied opportunities and identifies three areas in which to improve the knowledge translation process of One Health activities: Networks, relations of scientists and policy-makers, and influencing factors. The results indicate that the uptake of the One Health approach within European agencies and institutes is insufficient, impeding comprehensive and cross-sectoral considerations of health on the human-animal-environment interface. This study demonstrates some of the constrains that can be used as lessons learned and inspire future planning, designing and implementing of One Health activities.

Methods

The study employed a mix of quantitative and qualitative data from the survey to inform the three dimensions: networks, relations and influencing factors.

Online survey

An online survey was created with version 12.9 of SurveyExact by Rambøll Management Consulting. The questionnaire contains 17 questions categorised under the sections Demographics, Experience with One Health, Science to Policy, Coordination of One Health, End (see Additional file 1). The survey was anonymous and no sensitive nor personal information was gathered.

Prior to launching the survey, the questionnaire was examined by four colleagues from the fields of social and veterinary sciences, which optimised the understanding, language and structure of the questions. Subsequently,

a pilot study was conducted with 21 scientists in the fields of public health, veterinary, food and environmental sectors. The pilot study was performed over ten days in March 2021 and was evaluated for coherence, objectiveness and relevance. This led to refine demographic questions, explanatory and technical aspects, and clarifications of content and structure, which strengthened construct validity of the survey. The survey was open from March to July 2021 and completed by 104 experts from 23 European countries, see Table 1. Survey respondents were selected based on a purposive sampling strategy. The study was part of the (European Union) EU Horizon 2020 project One Health European Joint Programme (OHEJP), which contains projects working on One Health topics. The OHEJP provided access to experts in the areas of medicine, public health,

Table 1 Characteristics of respondents

	Countries	**[n]**	**Workplace**				**[n]**	**Areas[d]**	**[n]**
Western Europe	United Kingdom	10	Veterinary institute				18	Zoonotic diseases	73
	Germany	9	Public health institute				17	Antimicrobial resistance	63
	France	8	University				12	Food safety	58
	The Netherlands	7	Food institute				12	Disease surveillance	56
	Belgium	8	Ministry (Ministries of Agriculture; Health; Education and Research)				7	Disease prevention & preparedness	56
	Austria	4	NGO (WHO, WOAH, ICARS[a])				5	Food security	24
	Switzerland	3	Interdisciplinary research institutes:					Environmental contamination	23
			Vet	Food	Env	Agri			
			x	x			4		
				x	x	x	4		
			x	x	x		4[b]		
			x	x	x	x	3		
			x			x	2		
						x	2		
	Ireland	2	EU agency (EFSA, EMA, EEA[c])				4	Climate change	17
Nordic Countries	Sweden	10	Funding institute				1	Biodiversity	13
	Denmark	8	Museum (Natural history)				1	Other	19
	Norway	3	N/A				8		
	Finland	3							
Southern Europe	Italy	9							
	Portugal	6							
	Spain	1							
Eastern Europe	Hungary	2							
	Lithuania	2							
	Bulgaria	1							
	Czech Republic	1							
	Estonia	1							
	Latvia	1							
	Poland	1							
	Romania	1							
	N/A	3							
	Total	104					104		402
	Countries: 23								
	EU countries: 20								
	European countries: 3								

[a] *WHO* World Health Organization, *WOAH* World Organisation for Animal Health, *ICARS* International Centre for Antimicrobial Resistance Solutions

[b] One research institute also includes public health services

[c] *EFSA* European Food Safety Authority, *EMA* European Medicines Agency, *EEA* European Environment Agency

[d] Areas respondents work with – multiple responses were possible

veterinary, environment and food sciences in 22 EU countries. The survey was distributed via mailing lists to OHEJP members. Additional own searches located more survey respondents working in relevant sectors. The response rate of the survey was 46.8%.

The survey respondents specified their workplaces and areas of work (Table 1). The survey included 68 natural and 13 social scientists (plus 23 respondents who did not specify their background). Respondents with a background in veterinary sciences ($n=45$), biology ($n=13$), agriculture ($n=5$), physics ($n=2$), environmental science ($n=2$), and medicine ($n=1$) were categorised into the natural sciences, while respondents with a background in public health ($n=6$), law ($n=3$), social science ($n=2$) and public administration ($n=2$) were categorised into the social sciences. The responses represented the respondents' subjective perspective that they obtained through their work and the country they live in.

Analytical approach

The analysis of the open-ended questions was conducted via the software NVivo Pro (version 12). A content analysis was conducted, and seven themes were established: Attention; Government & governance structures; Networks & activities; Roles; Influences; Interests & priorities; Scientific language. This followed inductive reasoning, finding patterns within the respondents' statements that allowed for the above-mentioned categorisation into the themes, which were then related to concepts (networks, relations, influencing factors) of the knowledge transfer model. These themes were reviewed to ensure consistent and appropriate categorisation of codes into the themes. The following three sub-chapters in the result section encompass these themes. Each of the 104 respondents were assigned a number, which allowed to connect them to their statements and survey choices. These numbers identify the participants (P) and their workplace when quoted in the Results section (e.g. (P15 – University).

The closed questions allowed for a quantitative analysis that was conducted via the IBM SPSS Software (version 27). Descriptive statistics of respondents' characteristics in terms of respondents' countries, workplace and areas of work were examined. Some measures of central tendencies were conducted in relation to respondents' perception of challenges for the implementation of One Health; respondents' categorisation of communication, attention and translation issues between scientists and policy-makers; and respondents' ranking of importance of international and national actors.

Two independent t-tests were conducted to compare means across sub-groups of the population to investigate whether (1) coming from Nordic countries, western, southern and eastern Europe (see Table 1 for categorisation); or (2) having a background in social or natural sciences showed differences from one another. The categorisation of educational backgrounds into natural and social sciences is broad and limits itself in presenting the variability of the disciplines, including their unique ways in addressing and approaching issues. Nevertheless, this categorisation allows the comparison of two groups that have fundamentally different educations but both work with One Health.

Results

Networks – (dis-)connections between ministries

Establishing networks, for example across ministries can be challenging due to increased compartmentalisation [13]. This was also perceived by ministries dealing with the One Health approach, as one survey respondent put it: "Policy-makers are sitting in different ministries. Much depends [on] how good the communication and collaboration between the ministries [is] in reaching the common understanding" (P15 – University). Especially the collaboration across ministries, which deal with topics on the human-animal-environment interface was perceived to be more challenging and indicates disciplinary silos and a lack of networks, see Table 2.

The main challenge identified by the respondents was a lack of funding, followed by structural and organisational issues, like the lack of collaboration across ministries, the lack of political awareness and the lack of governance/leadership, which were all among the top four challenges

Table 2 Respondents' perception of challenges for the implementation of One Health[a]

	Number of respondents (n)	Answers (%)[b]
Lack of funding	53	20
Lack of collaboration between ministries	49	18
Lack of political awareness	43	16
Inadequate governance/leadership	36	13
Lack of education and training	20	7
Lack of communication between institutes	16	6
Lack of collaboration between institutes	16	6
Lack of willingness	8	3
Confusing legislation	8	3
Lack of guidance	4	1
Other	18	7
Total: *Total number of responses*	100 271	

[a] Question refers to the respondents' respective country

[b] Max. three choices

perceived by the survey respondents (Table 2). The organisation of networks on a ministerial level can provide a way in which information can be shared across sectors to ensure a more comprehensive perspective. To increase political awareness of the One Health issues, it was suggested to involve actors from the "[…] economy, [and] social sector[s]" (P42 – Research institute (Agriculture & Veterinary)) additional to actors on the human-animal-environment interface to get together in "[…] forums where scientists and policy-makers sit together to discuss the challenges they are facing" (P1 – University). This was also represented by the survey results, where none of the 104 respondents stated that communication between scientists and policy-makers on One Health issues is very easy, whereas 48% stated it to be difficult or very difficult (see Table 3). No statistically significant differences across regions (Nordic countries ($n=23$), western ($n=48$), southern ($n=16$), eastern Europe ($n=11$)) were detected [$F(3, 72=0.569)$, $P=0.637$].

AMR networks were exemplified by respondents as networks that work well. Mentioned were for example the Danish AMR surveillance programme (DANMAP) and the Joint Programming Initiative on Antimicrobial Resistance (JPIAMR). The JPIAMR is a "global collaborative organisation and platform", and one of the respondents pointed out that "[t]here is a close connection between researchers and policy-makers in this field" (P91 – Funding institute) [14].

A factor that affects networks in each country uniquely are the established ministries and services under a country's government. These may vary in number and types. For example, the Ministry of Health in Italy covers human and animal health, and the Ministry of Health and Social Affairs in Sweden covers human health – and not animal health – simultaneously to social welfare topics. Further, respondents pointed out that some countries like Belgium and Germany have a federal government structure, where powers are shared by the national and regional governments.

Additional to the structural aspects was a geographic perspective. Survey respondents from the 23 European countries represented on average fewer respondents from eastern European countries (1,25 respondents from 8 countries) with only one or two individuals representing their country (Table 1). On average, there were six respondents from four countries in the Nordic countries, six respondents from eight countries in western Europe and 5,3 respondents from three countries in southern Europe. Further, the response rate (RR) to the survey was lowest from the eastern European region ($RR_{\text{Eastern Europe}}= 22.2\%$; as compared to $RR_{\text{Western Europe}}= 55.4\%$, $RR_{\text{Nordic countries}} = 53.3\%$, $RR_{\text{Southern Europe}} = 43.2\%$).

Relations of scientists and policy-makers

Respondents perception of whether One Health receives adequate attention from policy-makers in their respective country was more equally distributed with 40% of respondents strongly disagreeing or disagreeing, and 35% agreeing or strongly agreeing, see Table 3. No statistically significant differences across regions (Nordic countries, western, southern, eastern Europe) [$F(3,72=0.569)$, $P=0.637$] or educational backgrounds (social ($n=13$) and natural sciences ($n=68$)) [$t(79)=0.342$, $P=0.733$] were detected. The issue of receiving attention, as a respondent working with environmental themes at the WHO described, is that "One Health requires a long-term strategic approach and policy-makers generally take a short-term view" (P47 – WHO). To drive One Health policies forward, the interests and priorities of research institutes must align with those of politicians, as research institutes are "dependent on the willingness of politics" (P28 – ICARS). Many respondents emphasised that priorities of politicians might change after the end of an election cycle. Further, interest or priorities of policy-makers may have an incomplete focus. For example, a respondent lamented that the European Commission focuses "[…] too much on AMR in a One Health perspective" and misses "[…] the broader scope" (P31 – University).

In terms of relations between the source and receiver, perceptions of respondents on leadership for One Health highlighted challenges for associating knowledge. Respondents expressed the need for stronger leaders to bring together different sectors, push forward the One Health approach and implement governance structures. In the specific case of AMR, this appeared to be perceived as more successful. Many respondents mentioned established networks and initiatives for AMR (e.g.

Table 3 Respondents' categorisation of communication and attention issues between scientists and policy-makers

	Very difficult & difficult	**Neither**	**Easy & very easy**
Communication between scientists and policy-makers on One Health issues	50 (48%)	40 (38%)	14 (13%)
	Strongly disagree & disagree	**Neither**	**Agree & strongly agree**
One Health receives adequate attention from policy-makers in my country	42 (40%)	26 (25%)	36 (35%)

JPIAMR, DANMAP, EU action plan against AMR) and reasoned that policy-making for AMR works well.

Leaders can be identified within national and international institutions that were ranked in the survey according to the respondents' perceived importance for driving One Health policies forward, see Table 4. Both on international and national level, the main explanations for the ranking by the respondents were the actors' roles and influences. Internationally, the WHO, the Food and Agriculture Organization of the United Nations (FAO) and the WOAH were ranked to be within the five most important actors. The United Nations Environment Programme (UNEP) was not included in the ranking but highlighted by many respondents as important, because the UNEP is engaged with the WHO, the FAO and the WOAH, forming the Quadripartite who aim to tackle One Health issues. The respondents perceived their roles and influence as strong, describing the organisations as "trendsetters" (P33 – Ministry) who "take a lead globally" (P76 – Research institute (veterinary & food)).

The EFSA and the European Centre for Disease Prevention and Control (ECDC) were placed on second and third place respectively, indicating their important roles. A Swedish respondent explained: "European One Health policies must be driven by the European institutions dealing with these matters together with the member states and their research institutions" (P19 – Veterinary institute). The ranking did not include the European Medicines Agency (EMA), but respondents emphasised the agency as an important actor. The only European agency that was deemed unimportant was the EEA. Another actor that was not listed in the ranking but mentioned by respondents was the European Commission. It was suggested that the Commission as a "central player", could appoint a "[…] secretariat or commissioner" (P8 – Museum) to focus on One Health topics.

Nationally, the actors that ranked from highest to lowest importance were government agencies, national research institutes, universities, regional, local research institutes. The ranking did not take into account potential structural differences across countries, like federal structures in Austria, Belgium, Germany and Switzerland; or the lack of local and regional agencies, such as in France and Czech Republic.

In comparison to the international actors, the national actors were on average perceived to be more important for driving One Health policies forward (see average importance in Table 4). The respondents argued for the national actors' importance by pointing out the role of research institutes and universities as influencing policy-making, and the role of government agencies as policy-makers. This was explained by two respondents who stated that government agencies "have the power to implement policies based on science and technical support from national research institutes" (P1 – University), and they "[…] can have direct input into national policy definition" (P25 – Research institute (Food & Agriculture)). Universities as well as local and regional agencies were seen to have some influence through their scientific and advisory contributions. One respondent emphasised the role of universities in the ranking, explaining that the education of the One Health approach potentially has future impact for One Health policies.

Table 4 Respondents' ranking of importance of international and national actors

Ranked international actors	Average importance[a] (in descending order)	Ranked national actors	Average importance[b] (in descending order)
1. WHO	3.95	1. Government agencies	1.54
2. EFSA	4.26	2. National research institutes	2.12
3. ECDC	4.27	3. Universities	2.98
4. WOAH	4.94	4. Regional research institutes	3.90
5. FAO	5.57	5. Local research institutes	4.46

[a] 11 levels of importance. Other actors were: Med-Vet-Net Association (6.63); One Health Commission (6.78); One Health Initiative (6.96); International research institutes (7.34); One Health Platform (7.56); European Environmental Agency (EEA) (7.74)

[b] 5 levels of importance

Influencing factors

This section comprises influencing factors that can affect the knowledge translation process through different actors and aspects. An influencing factor that presented a challenge for implementing the One Health approach was identified in the survey as the different "languages" spoken in science and politics. Respondents labelled the scientific language as "technical", "complex", "detailed", and "inferred" (P44 – Research institute (Veterinary, Environment & Food)); P7 – Food institute; P50 – N/A; P84 – Public health institute). On the other hand, the political language was described according to policy-makers needs of "simple statements that can be easily understood", "concrete messages about what can be done", and that policy-makers are "more interested in the bottom line and want straight forward answers" (P7 – food institute; P28 – ICARS; P50 – N/A). Accordingly, respondents identified the lack of training to communicate scientific findings to politicians, including the absence of a "compelling narrative" (P70 – WHO) as factors impairing to motivate One Health actions.

An additional challenge to the different "languages" across sectors were the different understandings of the One Health approach. 98% of respondents agreed or strongly agreed that they completely understand what One Health means. Yet, throughout the survey, respondents highlighted the "different meanings of One Health" (P53 – Public health institute). The capability of establishing a common understanding of the One Health approach remains a challenge. One respondent acknowledged that "there is no clear view of One Health" (P57 – Food institute), inhibiting translation to politics, supported by another statement that there is "limited understanding of the One Health approach by policy-makers" (P52 – WHO). Blamed for this was for example the complexity of the One Health approach with its intertwined relationships on the human-animal-environment interface (P56 – Public health institute). Further, there were concerns that One Health "has lost most of its meaning" (P96 – Ministry) and that it "is becoming a buzzword!" (P58 – Research institute (Agriculture, Environment & Food)), which might diminish importance and significance of the One Health approach.

Discussion

The One Health approach is a global paradigm. However, the survey was geographically limited to Europe and perspectives of experts working within European institutes and agencies. Further, the lack of access to respondents from the social sciences, ecology, and economic sectors causes a narrower view on One Health that neglects environmental (including plant and ecological), societal and community efforts and issues. Main One Health topics addressed were zoonoses, AMR and food safety. It is important to highlight the manifold issues that One Health can address (e.g. behaviours [15], climate change [16], non-communicable diseases [17]), as they are essential for a comprehensive understanding of One Health.

Nevertheless, the study demonstrated the importance of connecting knowledge from scientists to policy-makers. The survey identified several challenges for knowledge association of One Health in terms of institutional barriers, and challenges of communicating scientific information to policy-makers. The challenges were structured in three sub-headings: (1) Leadership; (2) Political attention; (3) Languages and meanings. Table 5 shows the three dimensions (networks, relations and influencing factors), the corresponding challenges for the knowledge translation process, and potential solutions identified within the study.

Leadership

Within networks, information can be shared about multifaceted One Health-related topics. However, survey respondents lamented the sparse collaboration across ministries, which indicates a lack of formal or informal networks. Good leadership is a way to establish and maintain networks that bridge across ministries, sectors and countries. The employment of One Health leaders is mentioned in the literature, referring to abilities of performing strategic analysis, finding solutions, organising, and employing flexible and transparent approaches [18, 19]. However, in relation to the complexity of One Health activities, more concrete characteristics of leaders must be discussed. The One Health approach is often implemented in scientific or administrative settings, where project managers or principal investigators are responsible for conducting projects and leading interdisciplinary teams. Literature on leadership often refers to leadership in organisations. Some aspects of this can apply or be adapted to the scientific context like research projects, and administrative contexts for coordinating interdisciplinary activities. Marion and Uhl-Bien [20] suggest that leaders must strengthen networks while being aware of their interdependencies and dynamics, as

Table 5 Dimensions of the knowledge translation process, challenges and potential solutions

	Challenges	Potential solutions
Networks	Lack of leadership	• Approach One Health issue individually (like AMR); • Engage eastern European experts into One Health networks; • Problematising to establish scope and target.
Relations	Lack of political attention	• Identify appropriate, valuable and tangible information for policy-makers; • Establishing strong relations with national actors; • Learning from successful activities (e.g. AMR); • Select leaders from NGOs and EU agencies.
Influencing factors	Lack of context	• Engage social, political and economic actors; • Determine meaning of One Health for each activity.
	No common language among scientists and policy-makers	• Glossary; • Communication training; • Employing communication experts.

well as encourage them by facilitating communication. In the survey, communication between scientists and policy-makers was perceived as rather difficult across all regions. Interestingly, the response rate of the survey was lowest from the eastern European region. The limited participation of eastern European experts suggests less communication and fewer networks within those countries. Fewer One Health-related publications and a lack of co-citations of authors from eastern European countries also indicates sparse discussion of One Health on a political level and across scientists [21, 22]. Engaging eastern European experts into One Health networks can facilitate communication among scientists and between scientists and policy-makers. The notion of facilitating the role of networks is crucial as actors within those networks have "information about what the different government organizations with which they interact are doing" [23]. Combining this information can clarify the usefulness of activities, link it to needs and capacities, and enable cross-ministerial policy coordination [12]. Hence, within networks leaders can facilitate knowledge translation, and foster communication, collaboration and the sharing of information.

To make each One Health issue manageable, it is desirable to approach them individually, and clearly formulate tasks and scope of the project or activity [20]. For example, the latest report on the Danish AMR surveillance described that DANMAP was only made possible through some active scientists, advocating and taking the lead to establish the national surveillance and monitoring system [24]. However, other, less well-defined One Health issues must first be problematised to assess specific challenges within and across the sectors. While the DANMAP is comprehensive, acknowledging public and animal health issues, as well as some environmental aspects, it is important to note the lack of engagement of the environment sector [24, 25]. This underlines the importance of leadership able to problematise AMR, push it forward and implement it. On EU level, AMR is also a priority. This was exemplified by the European Commission's support of the JPIAMR, which problematises the issue of AMR by defining key areas that need to be addressed, and providing leadership through coordination, guidance as well as resources. This has resulted in over hundred research projects and activities. Of course, the JPIAMR has a specific focus on AMR, with a stronger emphasis on issues from the medical, epidemiological and biological disciplines [14]. Nevertheless, examining those processes, from problematising AMR to developing policies, will provide lessons learned that can be applied to other One Health topics. The contextualisation of One Health issues for the receiver (e.g. actors within ministries) enables an understanding of the implications, as it establishes the usefulness of the activity via outlining tasks, roles and responsibilities.

Political attention

Problematising One Health issues can also help to catch political attention. The survey displayed that many respondents disagreed that there is political attention on One Health due to politician's periods in office that entail short-term agendas, as opposed to long-term approaches needed for successful One Health activities. The respondents' perception of missing political attention was not statistically significant across regions or educational backgrounds (social or natural sciences). However, there were fewer respondents with social science backgrounds. This can indicate a lack of social scientists within One Health networks, highlighting the need to engage and involve those actors into the One Health approach. Social scientists can aid in catching or facilitating political attention by using social, economic or political arguments that can help to associate One Health issues with current politics [15, 26].

Capturing political attention can result in policy development as well as the allocation of funding [27]. The lack of funding for One Health-related activities was mentioned by the majority of respondents as a challenge for implementing the One Health approach and also corresponds with the literature [2]. However, an underlying challenge to the lack of funding is the translation of knowledge on an institutional and political level. Translation of knowledge across sectors, through collaboration, networks and good relations might be as, or even more important for implementing the One Health approach, as it is the prerequisite for receiving funding. To raise the attention of politicians regarding any One Health issue, it is crucial to associating knowledge by identifying valuable information that policy-makers can relate to and find tangible.

Productive relations between the source and receiver are crucial for knowledge translation, and are affected by the work environment, which ideally should be an environment of trust and openness to discussion [20]. Discussions become crucial to address different agendas, roles, priorities and interests among the actors, and how to align them [28]. National actors were perceived as very important for pushing One Health policies forward, especially government agencies and national research institutes. Establishing strong relations within those networks, as a fundament to translate, problematise and associate knowledge will facilitate the implementation of One Health activities.

There is no one-fit-for-all solution for catching political attention, as the allocation of services under ministries is different across states, and different government systems

(like federal systems) affect how powers are distributed within a state [19]. Considering a governments structure is important for national One Health approaches, as it can facilitate but also impede the establishment of networks.

International actors, identified by the survey respondents who can catch political attention and drive One Health policies forward were the Quadripartite organisations. The Quadripartite did not conceive the One Health approach, but they adopted it as a cross-sector collaboration. Their aim has been to establish a coherent approach to tackle One Health issues [29, 30]. While the organisations approach is not perfect, for example due to little emphasise on plant health or engagement of society, the agencies are recognised as important actors, not least by the survey respondents [31, 32]. Among the Quadripartite organisations, the WHO was perceived as the most important actor to push One Health policies forward. This might reflect the WHO's role as a global actor in tackling a broad range of health-related topics, including environmental factors and interdisciplinary topics like outbreaks and pandemics [33]. The EFSA, ECDC and EMA were also identified as important agencies due to their advising role to the European Commission who has the ability to propose and influence new EU laws and policies. Hence, the Quadripartite, especially the WHO, and the EU agencies were perceived to have power and influence through their positions, which they can use for One Health-related policy- and decision-making. The EEA was the only EU agency that was not considered to be an important actor to push One Health policies forward. A factor might be that the role of the EEA differs from those of the EFSA, ECDC and EMA. The latter three agencies have regulatory functions, while EEA's function is consultative, focusing on networking and sharing information on practices as well as policies [34, 35]. The lack of perceived importance of the EEA on EU level can impede a comprehensive and interdisciplinary approach to One Health issues. Environmental and ecological considerations (including plants) are crucial for tackling One Health issues [25]. Regardless of the lack of regulatory functions, the EEA can promote the One Health approach by clarifying their role and being receptive or initiating to engage in collaboration for One Health activities.

Languages and meanings

The understanding of what the One Health approach is varies among sectors and actors, and some survey respondents feared that it might lose meaning by becoming a buzzword or label instead of becoming a concurred approach, utilising the philosophy behind it and the tools it can provide. Determining the meaning and philosophy is important for a One Health activity as it facilitates defining scope and tasks [36, 37]. Creating value and meaning is crucial to prevent the occurrence of buzzwords - or confusion by creating yet another term [38]. It entails carefully considering the research or activity, evaluating if it is in fact "One Health" or if it does not concern all items on the human-animal-environment interface. This might result in different meanings of the One Health approach in different contexts.

Contextualising One Health issues can help to design, implement and raise awareness of One Health activities. This means to understand decision-making processes and provide societal perspectives [39]. For this, actors with social, political and economic backgrounds are well equipped [26]. These actors are underrepresented within the One Health approach, as mentioned by survey respondents and in the literature [15, 21, 26, 40, 41]. The inclusion of social, economic and political scientists into One Health networks can accumulate new perspectives on how to tackle complex issues, for example the potential of gender-responsive perspectives to consider health disparities, glocal governance approaches, or by providing methods that allow gathering context dependent data or data relying on cultural knowledge [15, 42, 43]. This can help to illustrate and contextualise implications and provide insight into societal aspects that can benefit the creation of One Health activities [26, 40].

Further factors that influence knowledge translation were the capabilities and skills of scientists to construct and communicate a "compelling narrative" (P70 - WHO) for One Health issues to spark interests of other scientists to engage in collaboration, and to spark the interest of policy-makers. For knowledge translation among scientists of different disciplines, existing tools such as glossaries can facilitate a common language (e.g. https://foodrisklabs.bfr.bund.de/ohejp-glossary/ [44]). The interdisciplinary nature of the One Health approach makes it especially difficult to break down issues to an understandable and tangible form. It can be beneficial for scientists to have some communication background or training [45, 46]. Employing communication experts can be an option to promote knowledge translation from scientists to policy-makers, preventing misunderstandings or simply a disregard of the issue, and enhancing political attention and awareness of One Health topics.

Conclusion

Implementing One Health activities is complex and relies on the commitment of actors across disciplines and sectors. To implement those activities, it is crucial to understand different aspects of the knowledge translation process. This study provided insight into this process from a European perspective, which can help

to understand scientists and policy-makers' relations, networks and some influencing factors. It highlighted the importance of knowledge translation by pointing towards challenges relating to leadership, political attention, meanings and understanding of "languages" within the One Health approach.

The study showed a lack of leadership, which impairs networks engaged in One Health activities. Establishing leadership that facilitates networks, also with and within eastern European regions where there are fewer, is likely beneficial to promote the One Health approach generally. Challenges also regard the relations among different actors on national and international level, which can lead to a lack of political attention for the One Health approach. Further, the influencing factors highlight issues with different understandings of One Health and a lack of context when implementing One Health activities. More engagement of social, political and economic actors could counteract this. As there are many disciplines and actors involved, finding a common language, promoting research communication capabilities and skills of scientists can provide a valuable tool to reach policy-makers and facilitate more attention to One Health topics.

To strengthen the implementation of One Health activities, future research could illuminate the role of other steps within the knowledge transfer model, such as awareness and acquisition as prerequisite to transforming knowledge.

Abbreviations

AMR	Antimicrobial Resistance
DANMAP	Danish Integrated Antimicrobial Resistance Monitoring and Research Programme
ECDC	European Centre for Disease Prevention and Control
EEA	European Environment Agency
EFSA	European Food and Safety Authority
EMA	European Medicines Agency
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
ICARS	International Centre for Antimicrobial Resistance Solutions
JPIAMR	Joint Programming Initiative on Antimicrobial Resistance
OHEJP	One Health European Joint Programme
P	Participant
RR	Response rate
UNEP	United Nations Environment Programme
WHO	World Health Organization
WOAH	World Organisation for Animal Health (formerly known as OiE)

Supplementary Information

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Additional file 1. "One Health governance" online survey questionnaire.

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Authors' contributions
SHD conceptualised the manuscript, gathered and analysed data, wrote and edited all sections. The author(s) read and approved the final manuscript.

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Declarations

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PAPER VI

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A governance and coordination perspective - Sweden's and Italy's approaches to implementing One Health

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ABSTRACT

The aim of this study is to broaden the understanding of how different institutional and political contexts influence the successful implementation of One Health activities. To do this, a comparative case study of Italy and Sweden, based on qualitative interviews was conducted to get an inside perspective of the structural and operational factors that impacted the implementation of the One Health approach. Concretely, the study draws on thirty-one interviews of experts from Italian and Swedish public health, veterinary, food and environmental institutes that were conducted from 2020 to 2021.

The study identified important differences and similarities across the two countries with respect to governance and coordination practices. The different governance practices demonstrated that the creation and design of government agencies affected the ability to collaborate within and across sectors. Another distinction among the countries was their different approach to One Health-related procedures and meetings. Non-formalised and irregular approaches lead to challenges for collaboration and more fragmented One Health-related outputs. Similar coordination approaches in the two countries showed that institutional and project-specific One Health strategies enabled an inclusive process of designing the One Health activities. Leaders can contribute to implementing One Health projects and networks, by brokering to different sectors, enabling heterophilious collaborations and promoting knowledge translation.

Hence, the comparative analysis provided insights and lessons learned into understanding institutional and government set-ups influencing One Health implementation and can inform about processes and steps that are crucial when planning and designing One Health activities.

1. Introduction

The One Health approach is an approach that is embedded in the sectors of public health, veterinary and environmental sciences, and it acknowledges their interdependencies. It suggests a coordinated as well as collaborative approach to designing programmes, community-based activities and policies with the goal of achieving optimal health outcomes for humans, animals and ecosystems. The approach can be implemented on local, national and international levels, and emphasises the importance of coordination, collaboration as well as communication across sectors (OHHLEP et al., 2022). The One Health approach has been valued as a tool to comprehend the complexity behind health threats like zoonotic diseases, which are diseases that can spread between animals and humans, and antimicrobial resistance, which happens when microbes become resistant to antimicrobial drugs (Zinsstag et al., 2020). The COVID-19 pandemic has reinforced this notion, considering its potential animal origin and ability to spread between humans and animals like minks or pets (Mushi, 2020; Ruckert et al., 2020). Nevertheless, as highlighted by a systematic literature review, there have been some challenges for implementing the One Health approach in practice (dos S. Ribeiro et al., 2019). Dos S. Ribeiro et al. (2019) list challenges such as the issue of disciplinary silos, the lack of engagement of the environment sector, the lack of funding, and the lack of awareness and commitment of policy-makers.

One Health implementation has been addressed in the academic literature. Studies often focus on specific One Health topics such as arbovirus in Serbia, Tunisia and Georgia; West-Nile virus in Italy; or joint surveillance activities in Australia (Dente et al., 2019; Johnson et al., 2018; Paternoster et al., 2017)). The studies have found partly integrated One Health approaches across sectors. But issues of separated data collection and analysis, of communication, and of a lacking uniform understanding of One Health appear in most studies. Similar to dos S. Ribeiro (2019), the studies highlight shortcomings of funding, and of policy-maker's awareness as well as willingness to implement One Health

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activities (Johnson et al., 2018; Paternoster et al., 2017). In some non-European countries, there have been more elaborate approaches to explicitly investigate One Health implementation, such as in Nepal, Uganda, or Kenya (Acharya et al., 2019; Buregyeya et al., 2020; Munyua et al., 2019).The studies reported on the countries One Health ambitions, highlighting that they all established One Health-related networks. Among the issues they experienced were coordination and administrational challenges on regional and national levels. Investigating One Health implementation has been limited within a European context. One study has examined One Health practices across Swedish government agencies, which found that formulation of One Health strategies within agencies can clarify practical and procedural issues. The study indicated that support of policy entrepreneurs can facilitate to reach political awareness (Humboldt-Dachroeden, 2021). Altogether, the studies on One Health implementation coincide in issues of lack of funding, communication, and awareness among policy-makers (Acharya et al., 2019; Buregyeya et al., 2020; Dente et al., 2019; dos S. Ribeiro et al., 2019; Humboldt-Dachroeden, 2021; Johnson et al., 2018; Munyua et al., 2019; Paternoster et al., 2017). As these issues are reported frequently, this study investigates the more underlying issues to One Health implementation. Thus, the study contributes to knowledge on the implementation of the One Health approach in a European context, specifically by analysing and comparing governance as well as coordination practices in Sweden and Italy. This allows for a unique comparison of differences and similarities regarding structural and institutional settings.

Specifically, the study examines expert opinions and perceptions who work at Swedish and Italian public health, veterinary, environment and food institutes. The investigation into the two cases aims to broaden the understanding of the different institutional and political contexts in which One Health activities are implemented. It provides lessons learned and gives unique insights into Swedish and Italian coordination and governance practices of the One Health approach within institutions on the human-animal-environment interface.

1.1. Theoretical considerations

To comprehend institutional contexts of public health, veterinary, food and environmental institutes, this study drew on notions of network governance theory. This provided an understanding of the concepts of governance and coordination that were inductively established. Network governance theory refers to a set of theories that address decision-making processes of public policy outcomes (Powell, 1990; Rhodes, 1996).

Governance networks function as space for governments and other actors to make and implement policies (Skelcher et al., 2011). Governance within governments and governmental agencies refers to the government as a system, to processes and procedures that are in place to manage a country's affairs from national to local levels (Verhoest et al., 2012). The system, its processes and procedures impact decision-making and implementation of decisions, it can be challenged by boundaries of silos, in which ministries and government agencies are located (Egeberg et al., 2016). Further, different actors interact within governments and government agencies who have different agendas due to the mandates they receive from the ministry they are under (Rhodes, 1996, 2017).

In the context of this study, coordination describes the process of individuals working together, to guide others and build networks specific to One Health issues within and across government agencies and institutes of different sectors (Heclo, 1978; Rhodes, 2017). To coordinate (One Health) activities across sectors can be challenged by conflicting interests (Hitziger et al., 2018). However, coordination has been found to be crucial for actors to align actions and achieve common goals (Rhodes, 2017). Coordination relies on individuals, their relationships, information exchange, governance structures and their task as well as responsibility distribution (Gulati et al., 2012).

Network governance theory facilitated an understanding of governance that explained structural aspects of governments and governmental agencies, what actors as well as sectors can be involved, and how the system is built up (Rhodes, 2017; Skelcher et al., 2011). It allowed to examine coordination within and across agencies, by exploring strategies, networks, and their outputs (Heclo, 1978; Rhodes, 2017). Further, theoretical notions of knowledge translation processes were used to investigate underlying structures that facilitate coordination and governance. Coordinating One Health activities means to provide platforms where knowledge translation processes can take place (Hitziger et al., 2018). Knowledge translation is the process of transferring knowledge (e.g. scientific findings and data) between different actors (Liyanage et al., 2009). These processes are essential when multiple sectors are involved (Hitziger et al., 2018). Interactions of actors within networks can facilitate knowledge translation by setting out structures for coordinating cross–sectoral collaboration (Boyko et al., 2012; Liyanage et al., 2009). However, networks rely on relationships among actors (Gulati et al., 2012). Those relations are often homophilious, meaning that the ties between actors are formed between individuals that are similar to each other (McPherson et al., 2001). For example, actors working on the same topics or within the same institute. Once relations are established and complementary skills are recognised, people tend to persist in collaborating and maintaining relationships (Tasselli et al., 2015). Altogether, the theories and concepts are utilised to comprehend government agencies, their networks, how they govern and coordinate the One Health approach across sectors.

2. Methods

2.1. Case selection

A comparative case study of Swedish and Italian public health, veterinary, food and environmental institutes was conducted. Often, the One Health approach addresses the three sectors of human health, animal health and the environment. This study also included the food sector due to its inextricable link to and dependence on the other sectors (OHHLEP et al., 2022). Food plays a crucial role for the Swedish One Health approach, demonstrated by a stand-alone food agency (Burström & Sagan, 2018). Further, the topic of food is represented in all Swedish and Italian institutes (Burström & Sagan, 2018; ISPRA, 2022b; Naturvårdsverket, 2022; Poscia et al., 2018).

The case study provided a structured approach and enabled a more in-depth study of similarities and differences of operationalising the One Health approach across the two cases (Yin, 2014). Sweden and Italy were purposefully selected cases because both countries demonstrated efforts to implement the One Health approach (e.g. through their surveillance activities of zoonotic diseases, national action plans for antimicrobial resistance or establishment of cross-sector collaborations (Ministry of Health, 2020; SVA, 2022a)). Further, Sweden and Italy are critical cases as they provided relevant information on One Health implementation that can be helpful in other countries contexts. The cases were specifically selected due to their ability to demonstrate institutes and actors efforts of operationalising the One Health approach (Flyvbjerg, 2006). In particular, the cases provided insight into two differently built-up governments in terms of ministries and their respective services. The services that were included in the analysis were the National Veterinary Institute, the Public Health Agency, the Food Agency, and the Environmental Protection Agency in Sweden. The institutes in Italy were the National Public Health Institute, four regional Veterinary Institutes and the Institute for Environmental Protection and Research.

Italy has a centralised public health institute, a centralised environmental institute, and ten regional veterinary institutes that are spread across Italy and have a jurisdictional area for one to three regions (ISPRA, 2022a; Poscia et al., 2018). There are 21 decentralised public health and environmental agencies within Italy's 20 regions (Poscia et al., 2018). One region (Trentino-Alto Adige) is split into two autonomous provinces, making it 21 regional health-related authorities (AGENAS, 2022). There is no food institute. The institutes are mandated by the following ministries: Public health and veterinary institutes are under the Ministry of

Health; and the environmental protection and research institute is under the Ministry of Environment (see Fig. 1).

Sweden has centralised public health, veterinary, food and environmental protection agencies. The regional services within the 21 regions that are responsible for issues of public health, animal health and the environment must abide to national legislations (Burström & Sagan, 2018; Swedish Environmental Protection Agency, 2017). The national agencies are mandated by the following ministries: The public health agency is under the Ministry of Health and Social Affairs; the veterinary and food agencies are under the Ministry of Enterprise and Innovation; and the environmental protection agency is under the Ministry of the Environment (see Fig. 1).

Comparing the Swedish and Italian system opened up a vantage point into government set-ups of ministries and services. This revealed implications the set-ups can have on the implementation of the One Health approach. As described, the countries differ from one another in certain operational and structural aspects. The comparison shed light on effects and underlying factors that are favourable or unfavourable to achieve One Health implementation and outcomes.

2.2. Interviews with Swedish and Italian experts

Qualitative expert interviews were conducted from March 2020 to October 2021 to gather structural and context-specific information of One Health practices within and across institutes (Bogner et al., 2009). To identify relevant interviewees, a purposive sampling strategy was employed to choose a representative sample of experts from public health, veterinary, food and environmental institutes (Oliver C. Robinson, 2014). Some interviewees were part of the One Health European Joint Programme (OHEJP). The OHEJP is a European Union-funded project performing several One Health-related research projects (OHEJP, 2020). Locating interviewees who are in the OHEJP consortium ensured that interviewees had knowledge about the One Health approach. Additionally, the snowballing sampling strategy was used to reach experts from environmental and regional veterinary institutes. Before approaching interviewees, they were screened in terms of their expertise of One Health topics (e.g. via their research fields and outputs). Experts who did not seem to have worked with One Health were not considered as interviewees. While subjective and potentially excluding relevant interviewees, this screening ensured that the participants had knowledge about and worked with the One Health approach. In total, thirty-one interviews were conducted, see Appendix A. Each interviewee was assigned a number that links them to their background and work area when quoted in the result section. The limited number of interviewees from the Swedish food agency and the Swedish as well as Italian environmental institutes were due to the lack of contacts and responses of experts from those institutes.

2.3. Data collection method and analysis

The COREQ checklist for reporting qualitative research (see Appendix B) was used to report the findings (Tong et al., 2007). An interview guide was constructed (see Appendix C), which was reviewed by a social science and a veterinary expert. Five pilot tests were conducted with a PhD student as well as experts from the Danish National Food Institute and Public Health Institute. This enhanced the validity of the interview guide by clarifying and improving coherence of the questions. Informed consent was obtained, and interviews were held face-to-face, as well as online via Microsoft Teams or Skype for Business. For the face-to-face interviews, audio, and for the online interviews audio and video were recorded. The semi-structured interviews with the participants lasted between 40 and 70 min. Verbatim transcription was used, which means that grammar and syntax were lightly edited, and filling words removed. The thematic content analysis was inductively conducted via the NVivo software (NVivo Pro, version 12). It resulted in the formulation of six themes. The themes (1) 'Structural aspects and institutional politics in Italy' and (2) 'Structural aspects and institutional politics in Sweden' pertained to the set-up of governments and their services as well as the governance of One Health-related activities. In the following, this will be presented under the heading 'Governance'. The themes (3) 'One Health-related strategies within and across sectors' and (4) 'One Health-related networks' demonstrated coordinated efforts of operationalising the One Health approach. This will be addressed under the heading 'Coordination' in the result section. The themes (5) 'Impressions of current pandemic' and (6) 'Experiences within One Health projects' were also deduced from the codes. The former theme emerged through the often exemplified COVID-19 pandemic as well as related surveillance activities, and the latter referred to responsibilities, experiences and tasks

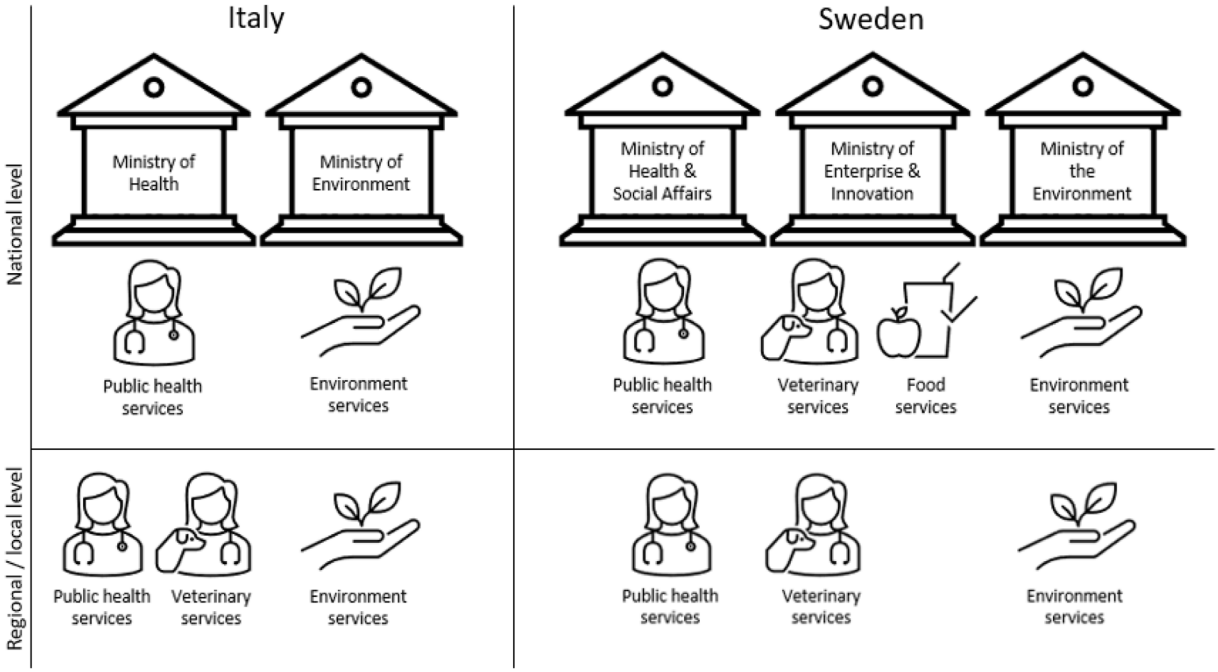

Fig. 1. Italy's and Sweden's distribution of national, regional and local One Health-related services under the ministries.

of interviewees. The themes were frequently mentioned by interviewees. This generated a pattern that highlighted structures and set-ups in Italian and Swedish public health, veterinary, environment and food institutes. It elucidated their strategies, networks and outputs. A limitation of the thematic content analysis is the subjectivity of perception and selection of themes (Guest et al., 2012). To minimise the thematic content analysis limitation of subjective perception and selection of themes, the themes were reviewed to ensure consistent and appropriate categorisation of the codes.

3. Results

The interviews indicated a general enthusiasm of the One Health approach among the Swedish and Italian interviewees. However, there are challenges and differences in the implementation and operationalisation of One Health activities. The focus was on the experts' experiences of national and institutional One Health practices to reveal unique insights into aspects that allow or inhibit the implementation of the One Health approach. The analysis of the interviews revealed issues that were categorised under the two following headings 'Governance' and 'Coordination'. Governance elucidates the structural aspects of governments and governmental agencies, while coordination refers to subjective perspectives of coordination within the agencies. This aided to explain the differences and similarities within Swedish and Italian institutes, as well as to contextualise the countries One Health approaches.

3.1. Governance

In the following are the experts' reflection on government structures and governance. First, Italian expert experiences of One Health governance within government institutes are described, followed by Swedish expert experiences. Fig. 2 illustrates the interviewees statements of which institutes are involved in One Health activities and how they operationalise One Health via their collaboration efforts and outputs.

3.1.1. Italy

The Italian public health institute is structured in many departments including a veterinary department and an environment department. One interviewee described the departments "going from environment, food safety, to infectious diseases to all communicable diseases to many, many other fields that seldom are all together represented and covered by public health institutes" (16, Public Health Institute, Italy). As the interviewee indicated, food safety is covered by the public health institute, but the veterinary institutes also deal with some aspects of food safety. There is no national veterinary institute, instead, there are ten regional veterinary institute. Although many respondents emphasised the well-established structures and network of the veterinary institutes, some interviewees revealed a disadvantage in regard to applying for grants. It was stated that instead of regional veterinary institutes, a national veterinary institute could be an advantage to "[…] apply to research projects or other activities […]" (26, Veterinary Institute, Italy). Another respondent from an Italian veterinary institute supported this, adding that being a regional authority with smaller administrative offices challenges the ability to apply for grants, especially elaborate ones from the European Union. The institute for environmental protection and research is the national authority covering the environment. There are connections to the public health institute's environment department, as well as close contacts with the regional environmental institutes and their laboratories.

The Italian national and regional authorities work together on specific projects or ongoing surveillance activities. However, concerns were raised regarding clashes among national and regional approaches (see Fig. 2, top box on the left). This was attributed to the independence of the Italian regions that have their own laws, as one interviewee lamented: "We have 21 regions, we have 21 different health systems, which is not good for a country" (14, Public Health Institute, Italy). To approach this issue, interviewees emphasised the need to facilitate dialogues between national and regional levels to understand their needs and simultaneously promote the One Health approach.

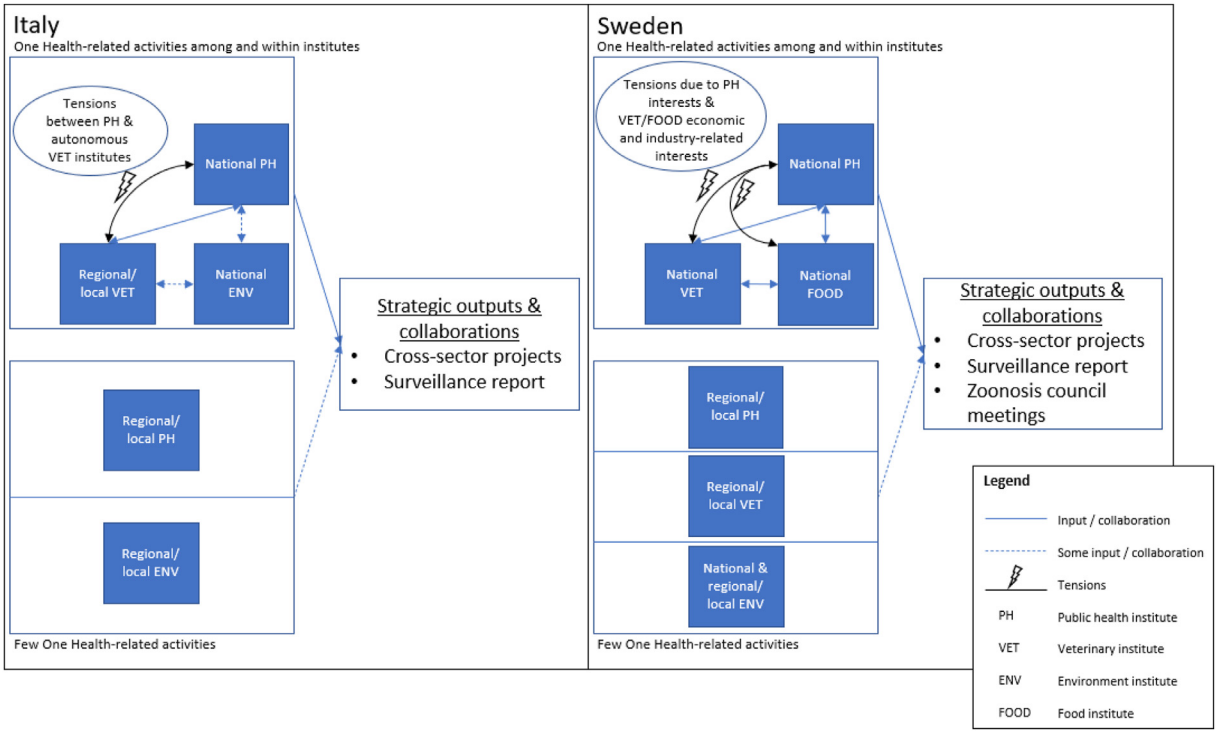

Fig. 2. One Health operationalisation in Italy (left) and Sweden (right). Main actors and activities according to interviewees.

3.1.2. Sweden

In Sweden, there are authorities on regional and local levels responsible for issues of public health, animal health and the environment, which are regulated through national legislations (Swedish Environmental Protection Agency, 2017). However, it was stated that the local municipalities "haven't worked with One Health at all" (17, Environmental Agency, Sweden). This might be related to Sweden's more national approach to One Health (see Fig. 2, top box on the right), as one interviewee stated: "We are a small country, just 10 million people. We do most things on national level." (14, Veterinary Agency, Sweden).

Both, the Swedish national public health and the veterinary agencies are expert authorities and provide scientific advice to their respective ministries. In contrast to Italy, Sweden has a stand-alone food agency. The food agency deals with water, especially drinking-water, which, as an interviewee explained is covered by environmental institutes in most other European countries. This categorisation can be a challenge for the food agency, as in Europe "no one wants to discuss drinking-water [with the food agency], because it is [categorised under] environment and not food" (10, Food Agency, Sweden). The Swedish environmental protection agency covers other water-related topics such as water use and wastewater. In general, the agency focuses on "compiling knowledge and documentation" and developing and implementing environmental policy and does not have own laboratory capacities (Naturvårdsverket, 2022).

The different mandates of the agencies and their resulting agendas and priorities can cause conflicts and clashing interests (see Fig. 2). The food agency must for example take into account the industry's ("the companies, the food producers") interests, as it is in their "mission to support them" (5, Food Agency, Sweden). The veterinary agency must consider "economic interests that sometimes [come] before [the] health of the animals" (11, Veterinary Agency, Sweden).

3.2. Coordination

Coordination was approached from different angles by the interviewees. In the following, the findings on coordination in relation to strategies and networks within and across agencies are outlined.

3.2.1. Strategies

Many interviewees emphasised the extensive coordination efforts needed to realise the One Health approach. Interestingly, to accomplish this, neither Swedish agencies nor Italian institutes employed a One Health strategy. Although no specific One Health strategy was employed, experts from both countries emphasised that there are approaches to "overcome the division within the different scientific fields" (15, Public Health Institute, Italy), to "meet […], to attend the different meetings [of] outbreak groups together with the different agencies", and that there is a "[…] One Health […] base in whatever we are doing" (11, Veterinary Agency, Sweden).

For example, in Italy, the One Health approach is realised through research activities of institutes. Italian interviewees did not indicate that national and regional institutes established formal frames for meeting to discuss One Health-related themes. However, interviewees described some informal approaches: "One Health is being taken as a paradigm or a conceptual reference for departments, different departments in our institute. And recently we started to talk to each other and to interact. We are now trying to launch an initiative gathering all of us" (16, Public Health Institute, Italy). The initiative was called the 'One Health group', and is confined to the public health institute, though including several departments to discuss interdisciplinary One Health issues. A follow up with interviewees revealed that the group has established itself informally in 2021, operating under the president of the Italian public health institute, with meetings approximately every two months. Further, the Ministry of Health has a One Health strategy for antimicrobial resistance (Ministry of Health, 2017). A key output is the national prevention plan, which "[f]or the first time, […] is urging the development of the One Health approach" (32, Environmental Institute, Italy). The report is issued every three to five years by the Ministry of Health, supported by the public health institute, including also environmental and veterinary perspectives (Ministry of Health, 2020).

In Sweden, there are several opportunities to discuss One Health-related issues, for instance in bi-monthly meetings, involving the veterinary, food, and public health agencies, as well as the Swedish Board of Agriculture. The Swedish Board of Agriculture is an expert authority, covering agriculture and horticulture, which also has a department for animal health and welfare (Jordbruksverket, 2021). Further, the Swedish Zoonosis Council, including the veterinary, food, and public health agencies, as well as the Swedish Board of Agriculture, Work Environment Authority, County Medical Officers, County Veterinary Officers, and representatives of the municipalities meet four times a year to discuss "strategic issues" relating to zoonoses (Ellis-Iversen et al., 2019). Another initiative is One Health Sweden, a platform for scientists working with zoonoses and antimicrobial resistance to network and connect (Hallstan, 2021). A Swedish One Health output is the joint report on zoonotic diseases. The report is created annually since 2000 in collaboration of the veterinary, food and public health agencies as well as the Swedish Board of Agriculture (SVA, 2022a). Sweden also develops an action plan to combat antimicrobial resistance, which emphasises and employs the One Health approach in terms of cross-sector collaboration including public health, veterinary, food and environment sectors (Wierup et al., 2021).

There was a dissonance between national and local One Health practices in both countries. Interviewees felt a lack of dialogue and communication that caused "the regions to take decisions that are completely different than those of the central government" (14, Public Health Institute, Italy). Putting strategies in place that "make it to a routine" (4, Public Health Agency, Sweden) to collaborate was indicated by both Swedish and Italian interviewees as beneficial for a harmonised One Health approach. Additional strategies to achieve multifaceted One Health activities were to involve "sociologists and lawyers" (23, Public Health Institute, Italy) and to consider "economical, social, cultural" aspects (11, Veterinary Agency, Sweden).

Interviewees also pointed towards another strategic approach that could encourage the use of the One Health approach, which was to put "[One Health] in a broader context, also with sustainability and climate change", as those approaches already include "ecological and social and economic" dimensions (6, Food Agency, Sweden). Or biodiversity, as "it has already sort of an institutional stamp in several documents" (32, Environmental Institute, Italy). The notion of increasingly connecting One Health to those environmental concepts was raised because within the environment sector, One Health "is not very much felt as an urgency", in contrast to the environmental concepts (32, Environmental Institute, Italy).

3.2.2. Networks

To coordinate One Health activities, the role of individuals as leaders can be especially beneficial for creating networks within and across institutes (Stephen & Stemshorn, 2016). For example, in Sweden, the notion of One Health is well known and there are already networks established in the form of regular cross-sector meetings for zoonoses and outbreaks, or the One Health Sweden network, connecting experts from different sectors. One interviewee emphasised that "in every One Health activity, you really need to have someone steering the process towards using the data together, sharing the data constantly, and using information from one side as an input for the other side" (15, Public Health Institute, Italy). This can also help to avoid doing the same work double across and within institutions, as a veterinary scientist emphasised: "We have different plans, but with the same task, within the same institutes. We lose money, we lose efforts. We don't put together our commitment in a way that we probably can reach much more results" (28, Veterinary Institute, Italy). Similarly, another interviewee expressed that "[t]here is a big risk of people doing the same work in different places at the same time if you don't coordinate and get to know each other" (7, Veterinary Agency, Sweden).

In both, Swedish agencies and Italian institutes, there are collaborations across disciplines that are perceived to be One Health. The collaborations felt valuable, as one interviewee put it: "It is a very enriching experience to see the different perspectives from each of the disciplines involved in One Health. And it makes me realise how small and narrow my own field is. And if you don't put it into perspective, you don't really understand the full impact" (8, Veterinary Agency, Sweden). However, there are limits for collaborations, as they happen more likely within institutes to different departments or between the public health and veterinary institutes. There are some connections to the environment sectors, but those have less routines. In Sweden, those connections did not seem to include three-way collaboration of the public health, veterinary and environmental agencies. Rather, the connections were two-way collaboration among the environment and public health agencies on specific topics, such as "outdoor recreation" and school children's "access to green areas", or among the environment and veterinary agencies on "wildlife welfare" (13, Environmental, Sweden). An interviewee from the Italian environmental institute stated that they "do not think there is a strict cooperation [with the public health and the veterinary institutes]", although it was mentioned that the COVID-19 pandemic provided a "chance to improve this cooperation" (32, Environmental Institute, Italy). Suggestions were that "[w]hen you have a problem for humans and for animals, you should also involve people interested in the environment, so you create such habits" (21, Public Health Institute, Italy), and to establish "[…] an institutional process of working together" (32, Environmental Institute, Italy). However, even if involved, the participation might be limited, as a scientist from the Swedish veterinary agency noticed: "I know [scientists from the environmental agency] have been invited for some areas of work but have not really participated so much" (3, Public Health Agency, Sweden). This was attributed by interviewees to the different tasks and agendas that the Ministry of Environment mandates to the environmental institutions, as compared to those for the veterinary and public health institutions, but also to limited personal contacts and willingness of the environment sector to engage. Further, across departments within an institute and across the borders of the institute, it was not always clear who to contact to establish collaboration. Connecting with scientists from the environment sector seemed especially challenging, as there are generally fewer research collaborations, and forums to meet, as one scientist stated: "I don't even think I understand who does that in my country. Who would we have to include? […] [T]he environment would require so many different agencies. You know there is weather, there are natural resources … I don't even know how we would go about it" (9, Veterinary Agency, Sweden). Interestingly, at the Italian veterinary institutes, there is more clarity regarding responsibilities and who to contact. The good structure and role allocation was generally well-known: "It is easy to work with the [veterinary institutes] especially if you are a vet, it is more difficult to collaborate with the human side, the public health colleagues, especially because […] it is not clear who is tasked with what" (17, Public Health Institute, Italy). However, at the Italian public health institute, the presence of the environment department and the veterinary department was seen by many interviewees as a helpful connecting entity to respective national and regional institutes.

Some conflicts were pointed out among veterinarians and medical doctors, relating to veterinarians experiencing "difficulties to interact with physicians" (30, Veterinary Institute, Italy). This was attributed to the issue of "more vets than human doctors that are participating" in One Health projects (5, Food Agency, Sweden), and the sentiment that medical doctors "[…] are much less interested in One Health" (24, Public Health Institute, Italy).

4. Discussion

The case study demonstrated examples of One Health governance and coordination in Italy and Sweden. This provided a foundation to investigate some of the challenges of implementing the One Health approach, comparing government and institutional structures as well as coordination practices. However, the small number of interviewees from the Swedish food institute and the environmental institutes in Sweden and Italy limits the research validity, as the perspective of the few interviewees is not representative. Nevertheless, the interviewees were included to gain general insight into the institutes and their structures, procedures and approaches to One Health. The findings of the study can inform about processes and steps that are crucial when planning to implement One Health activities. The knowledge translation perspective allowed to illuminate organisational structures and networks. In the following, the differences and similarities of the two cases are discussed.

4.1. Differences

4.1.1. Governance

The study showed that Swedish and Italian ministries and their services are differently structured, which affects the institutes agendas due to different mandates, interests and priorities. For example, while Sweden has a stand-alone food agency, in Italy food safety issues are dealt with by the public health and veterinary institutes. For the One Health approach, both setups can have advantages and disadvantages. While a stand-alone food agency can potentially result in a more focused conception of the topic, it can also lead to cementing another disciplinary silo (Manlove et al., 2016). Having food safety within public health and veterinary institutes can result in closer connections and collaborations on interdisciplinary issues like food-borne diseases, contamination, and animal welfare (Landford & Nunn, 2012). Similarly, the topic of drinking-water is categorised under the authority of the Swedish food agency, while some specific water-related topics are handled by the environmental agency. An interviewee highlighted that in Europe (as well as in Italy), water-related issues are usually dealt with by environmental institutions. Connecting the Swedish food agency with other countries' environmental institutes has shown to create challenges when dealing with water-related issues, as pointed out by an interviewee of the food agency. Categorising water under environmental institutes could not only facilitate a more coordinated approach, it can also provide an entry point for the institutes into One Health activities and projects that focus on issues like water-borne diseases. Hence, it is crucial to consider the collaboration potential and the topics that need to be dealt with before establishing a government agency (Rhodes, 2017; van Thiel et al., 2012). There are different ways in which governments can decide for the need of a government agency. Within the decision-making process, it is important to establish criteria that provide clarity on the agency's tasks and responsibilities. This can help to keep fragmentation of agencies limited, manageable and transparent (van Thiel et al., 2012). Developing criteria can support decisions for or against establishing national agencies. For example, the lack of a national veterinary institute in Italy has led to challenges in terms of acquiring funding for international projects. In contrast to the national institutes, regional veterinary institutes have small or no administrative departments with little resources that may assist in grant writing. This has led to fewer institutes able to apply for international funding opportunities. Evaluating this aspect could help to determine whether this is a challenge within all regional institutes. Establishing criteria (in the case of the Italian veterinary institutes it could be to acquire more funding or presence in international research projects) can identify the governments needs for the agency.

Another distinction is the different responsibilities of the institutes. Veterinary and food institutes have responsibilities for the industry and must take economic performance into account (van Herten & Meijboom, 2019). These responsibilities might clash with interests of, for example the public health institute, which rest primary on the health of the public. Establishing a One Health activity that in the design stage of the project considers the actors responsibilities, interests, and potential ways to align or adapt to them, can circumvent clashes (Rhodes, 2017). Further, it can facilitate knowledge translation across sectors, clarifying institutional boundaries as well as agendas, and promoting cross-fertilisation that

allows for aligning and adapting perspectives (Liyanage et al., 2009).

There are also differences in national and regional approaches. While in Sweden, most is coordinated on national level, leaving defined tasks to the regional and local authorities, in Italy, regions have more autonomy. This can lead to disparities in efforts to implement the One Health approach. In Sweden, a main issue between the national and local level was that the local levels rarely work with One Health. There is limited knowledge of the One Health approach and hence, One Health is sparsely integrated into local activities (Vestling, 2020). The lack of knowledge about One Health and the ensuing lack of implementation must be addressed, especially by national legislation and agencies as they direct the regional and local authorities' work. A way can be to involve regional actors into project design and planning stages to share knowledge and establish common goals, tasks as well as responsibilities (Gulati et al., 2012).

4.1.2. Coordination

Collaborations can result in complementary knowledge coming together and creating fruitful outcomes (Boyko et al., 2012). In Sweden, this can be seen by formalised procedures like regular meetings addressing outbreaks as well as investigations, and by outputs such as the report addressing antibiotic resistance or the yearly issued surveillance report. In Italy, One Health-related procedures and outputs are more fragmented and less formalised. This difference between Sweden and Italy might relate to the different sizes and structures within the countries. In terms of population, Sweden is much smaller and all four national agencies are in proximity (European Union, 2022; The Government Offices, 2014). In contrast, Italy has a much larger population, and while the public health and environmental institutes are both located in Rome, the veterinary institutes are spread across Italy (European Union, 2022; ISPRA, 2022a; ISS, 2022; Ministry of Health, n.d.). This posed as a challenge to find responsible individuals and set-up meetings. Italian interviewees did not mention regular, formalised meetings where outbreaks, zoonoses or other One Health-related topics were being discussed. However, the interviewees reported that a One Health group within the Italian public health institute was being formed. The One Health group can be a inception towards a more formalised process that may encourage interdisciplinary discussions (Skelcher et al., 2011). Italy's key One Health-related outputs are the action plan against antimicrobial resistance and the national prevention plan that address the One Health approach specifically, as well as many related topics (Ministry of Health, 2017, 2020). In comparison with the annually published Swedish surveillance report, the Italian national prevention plan is less frequently issued with three to five year intervals (Ministry of Health, 2020; SVA, 2022b). To establish more formalised networks (like the One Health group can become) and regular outputs (like the prevention plan), establishing a One Health strategy on institutional level can help to create One Health networks, projects and outcomes that are coordinated across sectors (Khan et al., 2018; Skelcher et al., 2011). It can establish stakeholder engagement procedures that facilitate the identification of responsible actors (Conrad et al., 2013). A strategy can further assist in connecting actors that previously might not have known one another. This can especially benefit the inclusion of actors from the environment, social and political sectors (Humboldt-Dachroeden, 2021; Khan et al., 2018).

4.2. Similarities

4.2.1. Governance

Similarities of the Swedish and Italian government and their governance practices were based on their democratic set-ups that allow for managing specific sectors within ministries. Further, the study showed that both governments and their agencies expressed their dedication to implementing the One Health approach. The countries main One Health-related functions and outputs, such as surveillance practices, reports, and networks were on a national level, while regional and local levels addressed more specific One Health themes. Recognising the similarities of the government set-up and governance practices highlighted the importance of establishing structures that enable cross-sector governance (van Thiel et al., 2012). Clear agency-related set-ups facilitate comprehensive surveillance activities and reports that integrate essential components from the public health, veterinary, environment and food sectors. Hence, enabling cross-sector coordination facilitates and fosters One Health-related collaborations and networks. These factors can become lessons learned for other countries, transferring them to their context in terms of designing agencies with low barriers for collaboration.

4.2.2. Coordination

Mapping and engaging actors should happen early in the stages of establishing One Health activities. However, who partakes in activities is often determined by personal connections and convenience. People within the same institute and within close proximity are more likely to engage into collaboration. This phenomenon is called homophily (McPherson et al., 2001). When mapping for scientists to engage into One Health collaboration, an emphasis must be put on finding relevant actors (Mazet et al., 2014). Those actors might not be in proximity, both in terms of topic and location. Networking and resource-related efforts must be made to find and reach out to actors. The actors might not be within the usual pool of colleagues (Errecaborde et al., 2019; Mazet et al., 2014). As described above, more collaboration (and therefore knowledge translation) happens among the public health and veterinary sectors and fewer with the environment sectors. A special emphasise must be put on finding actors from the often-neglected environment sector (Essack, 2018). Communication and knowledge translation to this sector will facilitate collaborations (Boyko et al., 2012). It can reveal similarities in topics, technologies, and methods. It can also counteract duplication, like the collection of assimilable data or performing similar surveillance activities (Gulati et al., 2012). Further, and if feasible for the One Health activity, using terms and notions of already established approaches within the environment sector, like 'sustainability', 'biodiversity' and 'climate change', might facilitate knowledge translation. It can encourage inclusion of actors from the environment sector who are familiar with these concepts, and contribute to connecting One Health to those approaches.

Homophily does not only happen on the human-animal-environment interface. This study also indicated a gap or distance to actors from the social and political sciences. The social and political science sectors are lacking collaborations (and consequently also knowledge translation) and are not fully integrated in One Health networks (Lapinski et al., 2015). While social and political science actors can contribute in various ways to the One Health approach, like agenda setting, policy-making, contextualising through analysis of local to global realities, contributions of gender-based or indigenous knowledge, and much more, social and political scientists rarely contribute to One Health projects (Craddock & Hinchliffe, 2015; Degeling et al., 2015; Garnier et al., 2020). The more 'common' One Health actors from the natural and medical sciences might have no connections or reference persons to social or political scientists. However, the strategic inclusion of experts with social and political science backgrounds is argued to be essential to establish One Health projects that are comprehensive and sustainable (e.g. (Craddock & Hinchliffe, 2015; Degeling et al., 2015; Garnier et al., 2020; Lapinski et al., 2015)). Establishing inclusive networks relies on the effort of people who design One Health activities. Here, leaders can foster cross-sector relations through their ability to broker knowledge, meaning to connect to, and communicate with different sectors (Tasselli et al., 2015).They can use their competencies to influence individuals to enable innovation in terms of linking formerly disconnected or rarely connected sectors, which promotes the designing of inclusive One Health activities (Heclo, 1978; Tasselli et al., 2015). This encourages heterophily of the hitherto lesser involved sectors, and facilitates knowledge translation (Rogers, 2003).

Networks rely on relations among people (Errecaborde et al., 2019). Interviewees with veterinary backgrounds experienced challenges with experts in the human health sector, specifically with medical doctors. This might be due to different perspectives within these sectors: the individual versus the population perspective. While veterinary health professionals can have an individual perspective, working at veterinary clinics, they can also have a population perspective and deal with public health or epidemiology, managing numerous animals, herds, or samples in laboratories. Medical doctors usually have an individual approach, focusing on diagnosing and treating persons (King, 2021). Individual and population perspectives are both important and inextricably linked through context, circumstances and the environment (Arah, 2009). When investigating health or disease (in humans and animals), it is important to consider both perspectives. However, bridging the individual and population perspectives can be challenging. There might be misunderstandings or a perceived unimportance of more comprehensive approaches that take time, resources, and only show results delayed. Brokering knowledge across the sectors can facilitate a One Health approach that benefits from both, individual- and population-based perspectives (Tasselli et al., 2015). That the perspectives can complement one another was exemplified by the COVID-19 pandemic. Specific (human and veterinary) medical knowledge was crucial for understanding the pathways and course of the disease, which is important for promoting and protecting human and animal health (Ferri & Lloyd-Evans, 2021). At the same time, the population approach enabled veterinary laboratories in Sweden and Italy to assist and take active roles in diagnosing human samples to support hospitals. This was possible, as veterinary laboratories are usually equipped to deal with large amounts of samples (Humboldt-Dachroeden, 2021). Educating and leading discussions on the importance of both, the population and the individual perspectives, their links to disease prevention and health protection, as well as the abilities and benefits of both professions will be valuable for establishing One Health-related collaborations.

5. Conclusion

As One Health gains momentum, it is important to understand institutional governance and coordination that challenges or facilitates the approaches implementation within institutes that deal with cross-sectoral health topics. Italy and Sweden provide good examples to understand institutional and government set-ups that influence One Health implementation. This is because both countries promote the One Health approach but operationalise it differently due to the institutional and structural set-up of their agencies.

This article highlights the importance of considering the need for specific agencies and distribution of tasks, already when establishing the agencies. Decreasing agency fragmentation regarding the Swedish food agency by integrating it into public health and veterinary agencies can be beneficial for enhanced coordination and reaching of common interdisciplinary One Health goals. This also facilitates the food and veterinary sectors' roles of accommodating the industry's economic interests. The result can be an increase in formalised activities that lead to more One Health-related outputs. To achieve this, the implementation of institutional One Health strategies that are carried out by leaders who are able to identify responsible actors and connect sectors is important. This fosters diversity of sectors within One Health networks and enhances collaborative outputs. Similarities of governance and coordination practices in the two countries demonstrate the importance of the design stage of a One Health activity that includes the mapping of actors. While accounting for different interests, common goals must be developed to ensure effective cross-sector collaboration. Institutes will benefit from educating or employing brokers who enable the connection of different sectors and promote knowledge translation. This facilitates heterophily by enabling the engagement of lesser represented but relevant actors into One Health activities, such as those from the environment, social and political sectors.

This study presents insights into institutional governance and coordination processes. The lessons learned of the cases provide valuable information that can be used to enhance the design and implementation of a country's One Health approach. Future research about One Health implementation can benefit from a more focused engagement of actors, for example those from the environment sector or those coming from countries where the One Health approach is in its infancies.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmqr.2022.100198.

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Appendix

Appendix 1: Case selection

Case selection – Considerations of different aspects of Sweden and Italy

Table A. 1: Case selection

	SWEDEN	ITALY
Form of government	Constitutional monarchy	Republic
Population	Ca. 10,327,589 (2019)	Ca. 60,244,639 (2020)
Area	Ca. 450,000 km^2	Ca. 302,068 km^2
Geography	- Part of the Scandinavian Peninsula - Forests cover half of the country - Over 100,000 lakes - Over 24,000 islands	- Peninsula - Alps and glacial lakes in the north - Mountains and hills stretch through country
Regions	21	20/21*
Climate	Varies from northern parts, where temperatures can go below –30°C to the southern milder parts. Winters are wet and snowy. Summers are mild.	Mediterranean climate but varies in different regions. Summers are usually hot and dry, winters cool and wet.
Government mandates	Ministry of Health and Social Affairs - Public Health Agency of Sweden (Folkhälsomyndigheten) Ministry of Enterprise and Innovation: - National Veterinary Institute (Statens veterinärmedicinska anstalt) - National Food Agency (Livsmedelsverket) Ministry of the Environment: - Environmental Protection Agency (Naturvårdsverket)	Ministry of Health: - National Institute of Health (Istituto Superiore di Sanità) - Veterinary institutes (Istituti Zooprofilattico Sperimentale) Ministry of Environment: - National Institute for Environmental Protection and Research (Istituto Superiore per la Protezione e la Ricerca Ambientale)

*20 geographical regions, 21 healthcare governed regions

Sources: (Eurydice, 2022a, 2022b; Nangeroni et al., 2022; Swedish Institute, 2021)

Appendix 2: Interview guide

Interview guide for interviews with experts from the Swedish Public Health Agency, National Veterinary Institute, National Food Agency, and Environmental Protection Agency.

And experts from the Italian National Institute of Health, regional veterinary institutes, Environmental Protection and Research Institute, and Ministry of Health.

Table A. 2: Interview guide

INTERVIEW QUESTIONS*
Introduction
Q.1 Can you please tell me what your position at the agency/institute is?
Q.2 Have you previously worked with One Health topics?
Q.3 Does your agency have a strategy to implement One Health?
Experiences
Q.4 How do you experience collaborating with other agencies/institutes?
Q.5 How do you experience collaborating on One Health projects?
Q.6 What are the challenges you faced while collaborating with other institutions?
Q.7 How do you exchange information with collaborating organisations within One Health projects?
Q.8 What are some of the most effective channels for communication?
Q.9 Since working on One Health projects, has communication and collaboration with other institutes changed?
Q.10 What challenges did you come across while executing One Health projects?
Q.11 What opportunities did you come across while executing One Health projects?
Q.12 Do you think your agency influences policymaking specific to One Health themes?
Way forward
Q.13 Do you think it is important to work with a One Health perspective?
Q.14 In your view, how does the OHEJP contribute to an institutionalisation of One Health?
Q.15 What can your institute do to strengthen One Health?
Q.16 What should be done to strengthen One Health institutionalisation within the European Union?
Q.17 Do you think it is important to work with a One Health perspective?
COVID-19
Q.18 How do you experience the COVID-19 outbreak in your institution?
Q.19 Do you see COVID-19 as a One Health issue?
Q.20 Do you support the public health agency/institute during the COVID-19 outbreak? / Have you been supported by other agencies/institutes (e.g., veterinary, food, environment agencies/institutes) during the COVID-19 outbreak?
Q.21 How do you think your government is handling the pandemic?
Q.22 How do you experience the COVID-19 outbreak in your institution?
End
Q.23 Is there any particular topic you would like to address regarding One Health institutionalisation and implementation?

*This was only used as a guide. During the interview, the order of the questions might therefore have varied. Further, additional and follow-up questions were frequently asked. They addressed specific statements and are not listed in the interview guide.

Appendix 3: Survey questionnaire

'One Health governance' survey questionnaire

Table A. 3: Survey questionnaire

<table>
<tr><th>SURVEY QUESTIONS</th><th>RESPONSE OPTIONS</th></tr>
<tr><td colspan="2">Demographics</td></tr>
<tr><td>1. What is your educational background?</td><td>Free text</td></tr>
<tr><td>2. What is your job title?</td><td>Free text</td></tr>
<tr><td>3. In what country do you mainly work?</td><td>Free text</td></tr>
<tr><td>4. What is your workplace?</td><td>Free text</td></tr>
<tr><td colspan="2">Experiences with One Health</td></tr>
<tr><td>5. On a scale from 1–5, how would you rate your understanding of the One Health approach?
1: I do not understand what One Health is.
5: I completely understand what One Health is.</td><td><table><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>❍</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td></tr></table></td></tr>
<tr><td>5.1. Please elaborate in a few words how you understand One Health.</td><td>Open ended</td></tr>
<tr><td>6. To what extent do you agree or disagree with the following statements?</td><td><table><tr><th></th><th>Strongly disagree</th><th>Disagree</th><th>Neither agree nor disagree</th><th>Agree</th><th>Strongly agree</th></tr><tr><td>COVID-19 is a One Health issue.</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td></tr><tr><td>Climate change is a One Health issue.</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td></tr><tr><td>Biodiversity is a One Health issue.</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td></tr><tr><td>Environmental contamination is a One Health issue.</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td></tr></table></td></tr>
<tr><td>7. Which area(s) do you work with?</td><td>❑ Zoonotic diseases
❑ Antimicrobial resistance
❑ Food safety
❑ Food security
❑ Disease prevention and preparedness
❑ Disease surveillance
❑ Climate change
❑ Environmental contamination
❑ Biodiversity
❑ Other, please specify</td></tr>
<tr><td>8. What sectors are you in contact with when</td><td>❑ Public health
❑ Human medicine</td></tr>
</table>

<table>
<tr><td>working with One Health issues?</td><td>❑ Veterinary science
❑ Environment
❑ Food
❑ Political sector
❑ I do not collaborate with any sectors
❑ Other, please specify</td></tr>
<tr><td colspan="2">Science to Policy</td></tr>
<tr><td>9. Who are the most important international actors when it comes to driving One Health policies forward? Please rank according to importance 1= Most important; 10 = Least importance</td><td>❍ World Health Organisation
❍ Food and Agriculture Organization
❍ World Organisation for Animal Health
❍ Med-Vet-Net Association
❍ One Health Commission
❍ One Health Initiative
❍ One Health Platform
❍ EFSA
❍ ECDC
❍ International research institutes
Text box: Other, please explain your reasoning</td></tr>
<tr><td>10. Who are the most important national actors when it comes to driving One Health policies forward? Please rank according to importance 1 = Most important; 5 = Least important</td><td>❍ Governmental agencies
❍ National research institutes
❍ Regional research institutes
❍ Local research institutes
❍ Universities
Text box: Other, please explain your reasoning</td></tr>
<tr><td>11. To what extent do you agree or disagree with the following statements?</td><td><table><tr><th></th><th>Strongly disagree</th><th>Disagree</th><th>Neither agree nor disagree</th><th>Agree</th><th>Strongly agree</th></tr><tr><td>One Health receives adequate attention from policymakers in my country.</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td></tr><tr><td>Science to policy translation for One Health issues is successful.</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td></tr></table></td></tr>
<tr><td>11.1. If you strongly agree or strongly disagree that science-to-policy translation for One Health issues is successful, please elaborate why.</td><td>Open ended</td></tr>
<tr><td>12. How would you categorise communication between scientists and policymakers on One Health issues?</td><td><table><tr><th>Very easy</th><th>Easy</th><th>Neither easy nor difficult</th><th>Difficult</th><th>Very difficult</th></tr><tr><td>❍</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td></tr></table></td></tr>
<tr><td>12.1. If difficult or very difficult: What are the main barriers for communication between</td><td>Open ended</td></tr>
</table>

scientists and policymakers?	
Coordination of One Health	
13. What initiatives, projects, or programmes are you aware of in your country that focus on One Health?	

	I am aware of, please provide an example	I am not aware of
Initiatives, projects, or programmes on national level	❍	❍
Initiatives, projects, or programmes on regional level	❍	❍
Initiatives, projects, or programmes on local level	❍	❍
Initiatives, projects, or programmes on international level	❍	❍

14. What are the three main challenges in your country for the implementation of One Health?	❑ Lack of communication between institutions ❑ Lack of collaboration between institutions ❑ Lack of collaboration between ministries ❑ Confusing legislations ❑ Lack of guidance ❑ Lack of education and training ❑ Lack of willingness ❑ Lack of funding ❑ Lack of political awareness ❑ Inadequate governance/leadership ❑ Other, please specify
15. How do you think the public should be informed about One Health? (Choose the three most important outlets)	❑ Social media ❑ Print media ❑ TV news ❑ Campaigns ❑ Public meetings ❑ Websites ❑ Radio ❑ Education ❑ Other, please specify
16. Do you think informing the public about One Health will lead to more discussions about One Health on a political level?	❍ Yes ❍ No ❍ Don't know
Coordination of antimicrobial resistance activities	
17. In your country, is there any overlap in responsibilities related to antimicrobial resistance surveillance between ministries?	❍ Yes, please specify which ministries ❍ No ❍ Don't know
18. In your country, is there any overlap in responsibilities related to	❍ Yes, please specify which institutes ❍ No ❍ Don't know

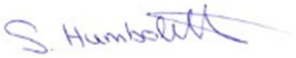
<table>
<tr><td>antimicrobial resistance surveillance between national institutions?</td><td></td></tr>
<tr><td>19. To what extent do you agree or disagree with the following statements?</td><td>
<table>
<tr><th></th><th>Strongly disagree</th><th>Disagree</th><th>Neither agree nor disagree</th><th>Agree</th><th>Strongly agree</th></tr>
<tr><td>Information regarding antimicrobial resistance is often presented in a comprehensible format.</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td></tr>
<tr><td>The volume of existing research on AMR makes it difficult to find the information I am looking for.</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td></tr>
<tr><td>Researchers need to advocate more for the awareness of antimicrobial resistance.</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td></tr>
<tr><td>There is a need for a multi-stakeholder engagement to combat antimicrobial resistance.</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td><td>❍</td></tr>
</table>
</td></tr>
<tr><td>20. Do you think that a multi-stakeholder engagement for antimicrobial resistance is realistic?</td><td>❍ Yes, please elaborate in a few words why you feel this way
❍ No, please elaborate in a few words why you feel this way
❍ Don’t know</td></tr>
<tr><td colspan="2">End</td></tr>
<tr><td>21.Thank you very much for participating in the survey!
Do you have any additional comments regarding the coordination and implementation of One Health?</td><td>Free text</td></tr>
</table>

Declaration of co-authorship – Paper I

1. Declaration by	
Name of PhD student	Sarah Humboldt-Dachroeden
E-mail	sarahhd@ruc.dk
Name of principal supervisor	Olivier Rubin
Title of the PhD thesis	Understanding policy processes for the institutionalisation of the One Health approach across Europe

2. The declaration applies to the following article	
Title of article	The state of One Health research across disciplines and sectors – a bibliometric analysis
Article status	
Published ☒ Date: June 2020	Accepted for publication ☒ Date: June 2020
If the article is published or accepted for publication, please state the name of journal, year, volume, page, and DOI (if you have the information).	Humboldt-Dachroeden, S., Rubin, O., & Frid-Nielsen, S. S. (2020). The state of one health research across disciplines and sectors–a bibliometric analysis. One Health, 100146. doi.org/10.1016/j.onehlt.2020.100146

3. Declaration of the individual elements Co-authors should fulfil the requirements of the Vancouver rules[1] The extent of the contribution to the article is assessed on the following scale: **A**. Has contributed to the work (0–33 %) **B**. Has made a substantial contribution (34-66 %) **C**. Did the majority of the work (67–100 %)	**Author 1** **(A, B, C)**	**Author 2** **(A, B, C)**	**Author 3** **(A, B, C)**
1. Formulation in the concept phase of the basic scientific problem on the basis of theoretical questions which require clarification, including a summary of the general questions which it is assumed will be answered via analyses or actual experiments/investigations	C	C	A
2. Planning of experiments/analyses and formulation of investigative methodology in such a way that the questions asked under (1) can be expected to be answered, including choice of method and independent methodological development	B	B	A
3. Involvement in the analysis or the actual experiments/investigation	C	A	C
4. Presentation, interpretation, and discussion of the results obtained in the form of an article or manuscript	C	B	A

Signatures		
Date	**Name**	**Signature**
05.05.2021	Sarah Humboldt-Dachroeden	
06.05.2021	Olivier Rubin	
06.05.2021	Snorre S. Frid-Nielsen	

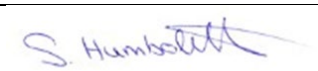
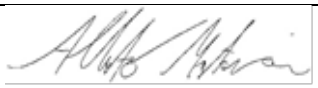
[1]"All persons named as authors must satisfy the authorship requirement. The order of names must be a joint decision taken by all authors. The individual author must have participated in the work to a sufficient degree to be able to accept public liability for the content of the scientific work. Authorship can only be based n substantial contribution with regard to: 1) conception and design or analysis and interpretation of data, 2) drafting the article or revising it critically for important intellectual content, and 3) final approval of the version to be published. Involvement based only on obtaining funding for the work or collecting data does not qualify for authorship, neither does general supervision of the research group in itself qualify as authorship. If the authorship is collective, key persons who are responsible for the article must be identified. The editors of the scientific periodical may ask authors to account for their part in the authorship."

Declaration of co-authorship – Paper III

1. Declaration by	
Name of PhD student	Sarah Humboldt-Dachroeden
E-mail	sarahhd@ruc.dk
Name of principal supervisor	Olivier Rubin
Title of the PhD thesis	Understanding policy processes for the institutionalisation of the One Health approach across Europe

2. The declaration applies to the following article	
Title of article	Assessing environmental factors within the One Health approach
Article status	
Published ☒ Date: 05.03.2021	Accepted for publication ☒ Date: 28.02.2021
If the article is published or accepted for publication, please state the name of journal, year, volume, page, and DOI (if you have the information).	Humboldt-Dachroeden, S., & Mantovani, A. (2021). Assessing Environmental Factors within the One Health Approach. *Medicina*, *57*(3), 240. doi.org/10.3390/medicina57030240

3. Declaration of the individual elements Co-authors should fulfil the requirements of the Vancouver rules[1] The extent of the contribution to the article is assessed on the following scale: **A**. Has contributed to the work (0–33 %) **B**. Has made a substantial contribution (34–66 %) **C**. Did the majority of the work (67–100 %)	**Author 1** **(A, B, C)**	**Author 2** **(A, B, C)**
1. Formulation in the concept phase of the basic scientific problem on the basis of theoretical questions which require clarification, including a summary of the general questions which it is assumed will be answered via analyses or actual experiments/investigations	B	B
2. Planning of experiments/analyses and formulation of investigative methodology in such a way that the questions asked under (1) can be expected to be answered, including choice of method and independent methodological development	C	A
3. Involvement in the analysis or the actual experiments/investigation	B	B
4. Presentation, interpretation, and discussion of the results obtained in the form of an article or manuscript	C	B

Signatures		
Date	**Name**	**Signature**
05.05.2021	Sarah Humboldt-Dachroeden	
05.05.2021	Alberto Mantovani	

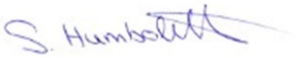
[1]"All persons named as authors must satisfy the authorship requirement. The order of names must be a joint decision taken by all authors. The individual author must have participated in the work to a sufficient degree to be able to accept public liability for the content of the scientific work. Authorship can only be based n substantial contribution with regard to: 1) conception and design or analysis and interpretation of data, 2) drafting the article or revising it critically for important intellectual content, and 3) final approval of the version to be published. Involvement based only on obtaining funding for the work or collecting data does not qualify for authorship, neither does general supervision of the research group in itself qualify as authorship. If the authorship is collective, key persons who are responsible for the article must be identified. The editors of the scientific periodical may ask authors to account for their part in the authorship."

Declaration of co-authorship – Paper IV

1. Declaration by	
Name of PhD student	Sarah Humboldt-Dachroeden
E-mail	sarahhd@ruc.dk
Name of principal supervisor	Olivier Rubin
Title of the PhD thesis	Understanding policy processes for the institutionalisation of the One Health approach across Europe

2. The declaration applies to the following article	
Title of chapter (In book)	Joint action against AMR with a One Health perspective (In *Steering against Superbugs – The Global Governance of Antimicrobial Resistance*)
Article status	
Published ☐	Accepted for publication ☒ Date: June 2022
If the chapter is published or accepted for publication, please state the name of journal, year, volume, page and DOI (if you have the information).	Humboldt-Dachroeden, S., & Degeling, C. (2023). Joint action against AMR with a One Health perspective. In O. Rubin, E. Bækkeskov & L. Munkholm (Eds.), Steering against Superbugs: The Global Governance of Antimicrobial Resistance. Oxford University Press. 10.1093/oso/9780192899477.003.0013

3. Declaration of the individual elements Co-authors should fulfil the requirements of the Vancouver rules[1] The extent of the contribution to the article is assessed on the following scale: **A**. Has contributed to the work (0–33 %) **B**. Has made a substantial contribution (34–66 %) **C**. Did the majority of the work (67–100 %)	**Author 1** **(A, B, C)**	**Author 2** **(A, B, C)**
1. Formulation in the concept phase of the basic scientific problem on the basis of theoretical questions which require clarification, including a summary of the general questions which it is assumed will be answered via analyses or actual experiments/investigations	C	B
2. Planning of experiments/analyses and formulation of investigative methodology in such a way that the questions asked under (1) can be expected to be answered, including choice of method and independent methodological development	C	A
3. Involvement in the analysis or the actual experiments/investigation	C	A
4. Presentation, interpretation and discussion of the results obtained in the form of an article or manuscript	C	B

Signatures		
Date	**Name**	**Signature**
03.04.2023	Sarah Humboldt-Dachroeden	
04.04.2023	Chris Degeling	

[1]"All persons named as authors must satisfy the authorship requirement. The order of names must be a joint decision taken by all authors. The individual author must have participated in the work to a sufficient degree to be able to accept public liability for the content of the scientific work. Authorship can only be based n substantial contribution with regard to: 1) conception and design or analysis and interpretation of data, 2) drafting the article or revising it critically for important intellectual content, and 3) final approval of the version to be published. Involvement based only on obtaining funding for the work or collecting data does not qualify for authorship, neither does general supervision of the research group in itself qualify as authorship. If the authorship is collective, key persons who are responsible for the article must be identified. The editors of the scientific periodical may ask authors to account for their part in the authorship."

ABSTRACT

The One Health approach aims to protect and promote health by acknowledging the interconnection between humans, animals, plants, and the environment. To do so, facilitating cross-sector coordination, collaboration and communication is crucial to tackle health challenges like zoonotic disease outbreaks, antimicrobial resistance, food safety hazards, and threats to the ecosystem. Collaborative approaches between the public health, veterinary, and environment sectors lead to enhanced outbreak surveillance, including pandemic detection, preparedness, and responses on local, national, and international levels.

This dissertation sheds light on the drivers and constraints of the implementation of the One Health approach by investigating international non-governmental organisations, European Union (EU) agencies and some EU countries, plus Norway, Switzerland, and the United Kingdom. Additionally, the two country cases, Sweden and Italy, are included to provide concrete examples of One Health institutionalisation by demonstrating agenda setting as well as knowledge translation processes, and the work carried out in government agencies and networks within and across the agencies.