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Critical Public Health

ISSN: 0958-1596 (Print) 1469-3682 (Online) Journal homepage: http://www.tandfonline.com/loi/ccph20

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To cite this article: Carrie Friese & Nathalie Nuyts (2017) Posthumanist critique and human health: how nonhumans (could) figure in public health research, Critical Public Health, 27:3, 303-313, DOI: 10.1080/09581596.2017.1294246

To link to this article: http://dx.doi.org/10.1080/09581596.2017.1294246

CRITICAL PUBLIC HEALTH, 2017
VOL. 27, NO. 3, 303–313
http://dx.doi.org/10.1080/09581596.2017.1294246

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RESEARCH PAPER

Posthumanist critique and human health: how nonhumans (could) figure in public health research

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ABSTRACT

This paper uses bibliometric analysis and critical discourse analysis to explore the rise in research involving nonhumans in public health, and the potential contribution of posthumanist social theory to this growing body of public health scholarship. There has been a sudden and rather marked increase in research and writing on animals, zoonoses and/or the 'One-health' paradigm within public health journals since 2006. Indeed 'One-health' rather than 'posthumanism' holds together research involving nonhumans of various kinds – from viruses to animals – within the discipline. Advocates of the 'One-health' paradigm argue that human and animal health must be integrated through joining the research, training and care practices of human and animal medicine. By mapping the terrain of public health research involving non-human species, we consider how and where posthumanist theory could be productively drawn upon to contribute to both critical and applied research involving nonhumans within public health. We specifically ask how the posthumanist insight to 'follow the nonhumans' would raise new questions and analytics for this research area.

ARTICLE HISTORY
Received 4 April 2016
Accepted 7 February 2017

KEYWORDS
Posthumanism; nonhumans; animals; One-health; bibliometric analysis

Introduction

There is a growing literature in the social sciences and humanities that explores the salience of nonhumans of various kinds for social life, as this special issue on posthumanism attests to. Posthumanism is a broad and even conflicting area of social theory that seeks to understand how humans are made in tandem with nonhumans of varying kinds, such that separating out humans from the world is problematized. However, public health research has not engaged with the posthumanist scholarship to date. We conducted a search of the terms 'posthuman' and 'public health' in Web of Science, and found only two entries; both articles were published in *Critical Public Health* and were written by the same lead author (Rock, 2013; Rock, Degeling, & Blue, 2014). As a point of comparison, a search in Web of Science for 'posthuman' within the social sciences and humanities resulted in 587 articles published between 2010 and 2014. That said public health *is* researching the ways in which non-human animals and other kinds of non-human agents (such as microbes or viruses) are embroiled in human health. So there is at least some overlap between posthumanism in the social sciences and humanities, and public health research concerned with nonhumans. To consider these spaces of shared interest and the potential for productive dialogue, this article starts with reviewing the literature at the intersection of non-human species and public health using bibliometric analysis and critical discourse analysis. We ask where and how nonhumans figure within public health research today and historically. The aim of this review is to

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Supplemental data for this article can be accessed http://dx.doi.org/10.1080/09581596.2017.1294246.

provide an overview to the themes or topics addressed within the public health literature focused on nonhumans. Based on this analysis we consider how posthumanist theory could productively contribute to these areas of public health research into the future.

This paper builds directly upon Rock et al.'s (2014) argument that posthumanist theory is relevant for public health. Towards that end, Rock, Degeling and Blue have provided a synthetic review of the posthumanist literature, tracing it through post-structuralism generally and science and technology studies (STS) in particular. Their goal is to introduce public health to this theory, as they argue it is relevant to research regarding zoonotic infectious diseases, toxins and other environmental contaminants as well as the healthy and unhealthy consequences of pet populations.

The goal of this paper is the inverse. We map how nonhumans currently figure within public health research. Through this mapping we ask if, where and how posthumanist theory could productively contribute to existing research agendas within public health. We start with a brief review of the posthumanist literature as it relates to this article. We then discuss our use of bibliometric analysis in combination with critical discourse analysis, and present our findings based upon this analysis. We demonstrate that the 'One-health' paradigm is providing the theoretical basis for research involving nonhumans in public health research today. One-health is a term that is used to reorganize the relationships between human medicine and animal veterinary medicine, so that these two medical fields speak more to one another in both knowledge and practice. We conclude by considering why public health is turning to One-health, and what posthumanist theory could contribute in this context. We argue that the posthumanist injunction to 'follow the nonhumans around' would raise new questions and analytics for this research area. In particular, this could be productively entwined with existing practices in both critical public health that explores power relationships and social epidemiology that explores relationalities between humans and things, such that posthumanism could extend not only critique in public health, but also more applied practices.

Background to posthumanism

Rock et al. (2014) have provided an excellent discussion of the posthumanist literature for a public health audience. They note that humanism posited an intrinsic value for human life, and a universal capacity amongst people to be moral and rational. Humanism is therefore an important achievement in many respects. But Rock, Degeling and Blue contend that our imbrication with technologies, in particular, has required critiquing some aspects of humanism today, which they do through post-structuralism specifically. Rock, Degeling and Blue contend that Pierre Bourdieu was a post-structuralist who revitalized humanism, while Michel Foucault was a post-structuralist who showed how the notion of the human is itself historically contingent. Rock, Degeling and Blue then trace how post-structuralism has been taken up in some uniquely posthumanist ways since. This includes non-representational theories in geography, which allow us to understand meaning-making in ways that take a more-than-human and more-than-textual world seriously. This also includes actor network theory in STS, which has (in)famously argued that nonhumans must also be understood as agentic. Rock, Degeling and Blue then provide an introduction to other concepts from these fields which may be useful to public health researchers. This includes the idea that purportedly natural things like diseases need to be socially and materially 'enacted' (Mol, 2002) and that agency is relationally distributed across humans and nonhumans through 'meshwork' (Ingold, 2011). Rock, Degeling and Blue conclude that there is space for productive dialogue between public health and anthrozoology, which focuses on the interactions between humans and nonhumans through primatology and ethological perspectives.

Building upon the review of posthumanism offered by Rock, Degeling and Blue, the background section of this article has more modest goals. It is meant to provide necessary context for understanding how and why we selected the search terms that we did in conducting our bibliometric analysis, and what is left out as a consequence of these choices. This background also allows us to discuss the specifics of how posthumanism could contribute to existing public health research agendas in the Conclusion, which is based on our analysis of how nonhumans are currently situated in public health research.

The term 'posthumanism' carries some rather different and even conflicting meanings, informed by various strands of thought including post-structuralism, humanism and cybernetics (Wolfe, 2010). On the one hand, posthumanist thought argues that we need to look at the ways in which humans are embroiled, and thereby develop, or 'become' (Haraway, 2008), with other species as well as other non-human things. For example, physical anthropologists are contributing to posthumanist thought by showing that domestication is not something that we humans simply do to other species; humans also show all the physical traits used to demarcate domesticated species, and so we humans have also changed through our interactions with other animal species over time (Cassidy & Mullin, 2007; Leach, 2003). As such, posthumanist critique is, to some extent, part of the 'materialist turn' in the social sciences and humanities, in that it seeks to recoup the animality of humans as embodied and embedded (Wolfe, 2010, p. xv). This strand of posthumanist thought argues that humanism is a discourse that needs to be troubled, despite the important ways in which it has facilitated rights for various oppressed groups of people (Wolfe, 2010). Specifically, it is argued that humanism is based upon an inadequate division between humans and nonhumans (Cubukcu, in press), one that we need to problematize in order to appreciate human interactions with animals, plants and all the other things that we live with on this planet (Wolfe, 2010). It is a divide that we also need to challenge because, in being based on a hierarchy, humanism risks perpetuating rather than ameliorating differences between humans that can in turn perpetuate rather than ameliorate oppression (Cubukcu, in press). Posthumanism has thus sought to intervene in the anthropocentrism of the social sciences and humanities by emphasizing how we as humans socialize with a variety of nonhumans, including other animal species, plants and inanimate objects. We believe that this strand of posthumanist thought has the most relevance to public health.

But there is a different use of the term posthuman, seen particularly within bioethics but also sociology. Here 'posthumanism' or 'transhumanism' is used as part of an argument that humans can and should develop and use biotechnologies in order to improve human bodies (Fuller, 2011; Savulescu & Bostrom, 2009). There is a glorification of science, choice and consumption here that has been consistently silent on issues of power, refusing to consider how fantasies of biological control risk reproducing hierarchies, including gender, sexuality, race, ethnicity, class, nation, citizenship, age and (dis)ability. This version of posthumanism has therefore been critiqued as an extension of humanism (Wolfe, 2010). Largely developing in bioethics, these posthumanists tend to take, as their counter-argument, those who see biotechnologies as eroding an a priori, unified and fundamental human essence, such as Jurgen Habermas (2003) or Francis Fukuyama (2002). We do not believe that this more speculative and futurist area of thought is particularly relevant to public health at present, or to the goals of critique.

Given that there were only two references to 'posthuman' and 'public health' while also knowing that public health research is considering the implications of human–non-human species relations for health, we decided to search for specific topics in public health research where a posthumanist insight could be relevant. This included zoonotic diseases, animals generally and the 'One-health' paradigm. We asked how research in public health is organized, which is topically compatible with posthumanism but that does not reference to this term. We were also interested in considering the relationship, if any, between these areas of research. The animality of humans is therefore our focus in this paper, and we do not engage in the more cybernetic aspects of posthumanism.

Methods

This paper combines bibliometric methods with critical discourse analysis. To start, bibliometric methods have been adopted in this paper to review the public health literature that addresses non-human species in order to provide insights into what main topics are addressed, and how those topics are addressed. The particular method used in this paper – bibliographic coupling in combination with clustering – has been found to be a valid tool for identifying research themes within a large field (Jarneving, 2007).

The bibliometric data for this paper were gathered from the Web of Science Core Collection database. Within the titles, abstracts and keywords of the publications indexed in this database, a search was executed to select out all articles between 1995 and 2014 that used the terms 'zoonosis' OR 'zoonotic'

OR 'animal' OR 'one health' AND 'public health'. The search criterion 'one health' selected articles that fit within the 'One-health' paradigm as well as publications discussing, for example, 'one health care practice'. Therefore, all the publications selected through this criterion were manually cleaned, keeping only those publications that dealt with the 'One-health' paradigm specifically. In total, the search resulted in 7294 publications, which were analysed by means of bibliographic coupling and cluster analysis.

Bibliographic coupling was used to build a visual map based on the overlap in the references cited by the publications. In other words, distance on this map represents the amount of overlap between the references in the bibliographies of the publications. The more similar the topics of texts are, the closer the articles are located in relationship to one another on the map. The analysis was executed in VoS-viewer, a programme developed for the construction and visualization of bibliometric networks, which uses a mapping technique closely related to multidimensional scaling (van Eck, Waltman, Dekker, & van den Berg, 2010). After the bibliographic coupling, the publications were further assigned to exactly one cluster, or a set of closely related nodes (Waltman, van Eck, & Noyons, 2010). Within clusters, co-citation analysis of the bibliographic references shows the most frequently shared texts. These documents are the foundational references for the topical area. Foundational texts were analysed using critical discourse analysis (Jager & Maier, 2009; Wodak & Meyer, 2009).

Based on the bibliographic analysis, we then conducted a closer analysis of the most frequently cited texts in one key cluster using critical discourse analysis (Jager & Maier, 2009; Wodak & Meyer, 2009). The One-health cluster bridges the different substantive areas of focus in the map, and so we wanted to better understand how nonhumans were discussed in these texts. The question we asked when reading these texts was: how are non-human species represented generally and in relationship to public health specifically in this document? In addition, we also conducted a close reading and critical discourse analysis of the other article published in *Critical Public Health* that addresses non-human species but that does not reference posthumanism. We selected this text because the only references to posthumanism and public health within our sample were published in *Critical Public Health*. The question we asked when reading this text was: how might posthumanism provide a different theoretical insight? Combining bibliometric analysis with critical discourse analysis in this way allowed us to ask where and how there are synergies between posthumanist theory and public health research.

Findings

The spread of the 7294 articles published in the past 20 years on zoonosis, animals or 'One-health' within the public health literature is unevenly distributed over time (see Supplementary Material, Graph 1). In the first 10 years – between 1995 and 2005 – a small but steady rise is visible. From 2006 onwards, the number of publications per year increases rapidly.

The rise in research regarding zoonosis, animals and/or 'One-health' within the public health literature can be compared with the rise in the general public health literature. Graph 2 (see Supplementary Material) plots the growth of this research and compares it to the growth of the general public health literature. In this graph, the number of publications in 1995 is taken as the baseline. For each year it calculates how much the number of articles has risen in comparison to 1995. For example, a growth of two would mean that the number of publications in that year is double the number of publications in 1995. In Graph 2, we see that the two literatures are increasing at a similar rate from 1995 to 2005. However, research on zoonotic diseases, animals or 'One-health' begins to escalate rapidly relative to the general public health research in 2006. In other words, the research on zoonotic diseases, animals or 'One-health' has become a greater proportion of the total public health research since 2006.

The 7294 publications within the subset of public health, used in this paper, come from 1777 different journals. The top ten journals, in which most articles are published, are shown in Table 2 (see Supplementary Material). Based on the titles of the most occurring journals, it appears that public health research involving non-human animals is primarily applied research that is focused on zoonotic diseases. *Zoonoses and Public Health* publishes the majority of this research by far. Also both the second (*Revue Scientifique et Technique-Office International des Epizooties*) and the tenth journal (*Vector-borne*

and Zoonotic Diseases) in our sample focus explicitly on zoonotic diseases. The other journals are either medical (e.g. *Plos One*, *Epidemiology and Infection*, *Emerging Infectious Diseases* and *Plos Neglected Tropical Diseases*) or veterinary (e.g. *Veterinary Parasitology*, *Preventive Veterinary Medicine* and *Veterinary Microbiology*) journals.

To further investigate the content of our sample, and consider where posthumanist critique could contribute, the publications were mapped by means of bibliographic coupling and then divided into clusters. The analysis comprises 6986 of the 7294 documents. Three hundred and eight documents were excluded from the analysis because they were unconnected to any other document (i.e. they either did not share any bibliographic references or there was not any information about the references available). In total, 39 clusters were found, ranging in size from two to 1125 publications. The discussion of the results that follows only addresses the 10 largest clusters, which comprises 72% of the articles in the sample. Table 1 shows the number of publications for the 10 largest clusters in our dataset.

To interpret the clusters, a word analysis of the titles, keywords and abstracts of the articles was executed for each cluster. After removing stop words (such as 'the', 'is', 'at', 'which' and 'on') and punctuation, and transforming all upper case letters to lower case letters, the words were 'stemmed'. This refers to an automated process, which reduces the inflectional forms of a word to a common base form. An example is reducing 'humans' to 'human'. After completing these automated preparations, the frequencies of each word were counted. Since the clusters are homogeneous subsets within the sample, the main topic of the publications in a cluster can be derived by examining the most frequently used words.

The biggest cluster, with 1125 publications, addresses food-borne bacterial infections such as *Salmonella*, *Escherichia coli* and *Campylobacter jejuni*. The second cluster focuses on nutrition-related public health problems, such as obesity and diabetes. Many of the publications in this cluster used non-human animals as models for human disease. We note this because one of the frequently used words in this cluster is 'model' (mentioned 548 times in this cluster), and was used in specific reference to animal models. The third largest cluster comprises of more critical and reflective publications within public health, dealing for instance with policy and health protection programmes. It is within this cluster that a large number of publications can be found that conceptually reflect upon or empirically apply the 'One-health' paradigm. The two publications that explicitly use the terminology of posthumanism can also be found in this cluster (Rock, 2013; Rock et al., 2014).

Clusters four, five and six in Table 1 focus on specific zoonotic diseases: diseases brought forward by helminths such as *Echinococcosis*, vector-borne diseases (for example through ticks or mosquitos) and influenza/viral pandemics (for example avian influenza H5N1). In addition, the final three clusters in Table 1 (clusters eight, nine and ten) also deal with zoonotic diseases. Specifically, these clusters focus on rabies, water-borne parasites (such as *Cryptosporidium* and *Giardia lamblia*) and toxoplasmosis. Finally, the seventh cluster addresses environmental pollution and toxicology. Non-human animals are present in this cluster in two different ways: as experimental models for human diseases and as a site for assessing the exposure of both humans and animals to environmental pollution.

Figure 1 (see Supplementary Material) shows the bibliographic coupling map, in which publications are spatially positioned depending upon the amount of overlap in the references that the publications

Table 1. Overview of clusters with corresponding number of publications.

Cluster	Size
Foodborne infections	1125
Obesity and diabetes	665
One-Health and general	591
Helminths	457
Vector-borne diseases	450
Influenza and viral pandemics	444
Environmental pollution and toxicology	411
Rabies	337
Waterborne parasites	309
Toxoplasmosis	206

cite. Publications positioned close together will have a larger amount of overlap in their bibliographies than publications positioned further away from each other. The colours on the map show the different clusters. The ten main clusters discussed above are marked with the corresponding labels on the map.

On the left hand side, we find the clusters that are focused on zoonotic diseases, or the ways in which human and animal health is interconnected. On the right hand side of the figure, two clusters are found: Environmental pollution and toxicology as well as Obesity and diabetes. These two clusters are spatially rather separate from the other clusters, and differ in content from the other clusters. These two areas of research tend to use animals as models of human disease, or in the case of environmental pollution as co-sufferers. The 'One-health/general' cluster sits right in the middle of our map. This cluster links the public health literature that addresses zoonotic diseases with the research that uses animals as models of human diseases.

Due to the central location of the 'One-health' cluster, we see it as the point of departure for asking if and how posthumanist theory could contribute to public health. 'One-health' is a call for interdisciplinary research and practice regarding the global and interspecies aspects of health and illness in the context of travel as well as declining habitats for non-human, non-domesticated animal species (Craddock & Hinchliffe, 2015; Wolf, 2015); it is embedded in the history of comparative medicine. The most frequently shared references in this cluster (see Supplementary Material, Table 3) gives insight into the key publications within this paradigm and highlight its orientation towards medical science (that includes veterinary medicine). The results presented in Table 3 (see Supplementary Material) are based on a subset of the whole dataset which only includes the 591 publications of cluster 3. From these publications, the most commonly shared publications are listed, which were determined through co-citation analysis. The first column of Supplementary Material Table 3 indicates how many of the 591 publications cite the publication. The first two most frequently cited texts are general public health publications. However, the subsequent publications all focus on the link between human and animal health, and human and animal medicine. The articles were published in medical and veterinary journals in the early years of the 2000s. An exception is the seventh publication, the 1984 book by Calvin Schwabe entitled *Veterinary medicine and human health*. The concept 'one medicine' was coined in this book, which has been further developed and extended into the 'One-health' paradigm in more recent years. We also see from Supplementary Material Table 3 just how important the work of Jakob Zinsstag has been for this cluster, as he is a co-author on three of the ten articles. Further, Zinsstag's work has played a crucial role in raising the importance of Calvin Schwabe's book. The centrality of Schwabe's book could be seen as a critical juncture in the development of One-health, informing its distinctly medical approach today.[1]

Table 4 (see Supplementary Material) shows the publications found within the 'One-health' cluster that have been most cited. We conducted a closer analysis of these articles using critical discourse analysis as these texts have been taken up by other scholars and used in other research programmes the most extensively. These texts are primarily focused on the consequences of non-human agents for human health, such as the species of zoonotic pathogens most likely to be associated with emerging diseases in humans (Taylor, Latham, & Woolhouse, 2001), the factors associated with emerging infectious disease outbreaks in humans (Jones et al., 2008), the problem of antibiotic resistant microbes for human health (Spellberg et al., 2008) and the distribution of ticks and Lyme disease risk (Nicholson & Mather, 1996). One article viewed animals as surrogates for humans in assessing the health effects of chemicals in the environment, in a manner that extends the use of animal models to include animals as sentinels (van der Schalie et al., 1999). The discourse analysis thus mapped onto the bibliometric analysis, wherein One-health links public health research on zoonotic diseases with research using animal models. The former set of articles could be subdivided in terms of focus, where characterizing and classifying pathogens was the goal of some (Cleaveland, Laurenson, & Taylor, 2001; Taylor et al., 2001), understanding the transmission of diseases and its contexts the focus of others (Epstein, 2001; Jones et al., 2008; Mangili & Gendreau, 2005; Nicholson & Mather, 1996), while a third subset of articles were more programmatic or calls to action (Jackson, 2003; Spellberg et al., 2008; Zinsstag, Schelling, Waltner-Toews, & Tanner, 2011).

Non-human species were largely represented as objects for analysis in these texts. There were, however, some instances wherein non-human species were discussed in more agentic terms. For example, microbes were represented as having 'incredible power' that requires 'respect' given their ability to 'inhabit literally every possible climate and environment on the planet' such that 'human beings are nothing more than walking microbial planets' (Spellberg et al., 2008, p. 156). The agency of microbes makes the metaphor of 'war' absurd according to the authors, as it is one that humans could never win. Indeed the authors credit microbes with 'inventing' the primary 'weapon' that humans have in fighting microbes; microbes 'invented' antibiotics over two billion years ago while humans simply 'discovered' antibiotics in the first half of the twentieth century (Spellberg et al., 2008, p. 157). Antimicrobial effectiveness is thus considered a precious resource, one that requires constant stewardship and renewal on the part of humans in order to keep pace with microbial adaptions.

In turn, humans in general and human health specifically were the predominant subjects of these texts. In general, the bifurcation of subjects/objects, culture/nature and human/non-human was implicitly sustained, in a manner that stands in contradiction to posthumanism. However, the animality of humans was nonetheless also at times expressed with statements like: 'Modern society is increasingly aware that humans and culture are components of the natural environment' (Jackson, 2003, p. 191). And the animality of humans presumably makes possible the 'inextricable interconnection of humans, pet animals, livestock and wildlife' that undergirds calls to integrate the medicine and health of humans and animals through One-health (Zinsstag et al., 2011, p. 148). Interestingly, Zinsstag et al. contend that public health has been particularly slow to collaborate and cooperate in addressing zoonotic diseases through a One-health programme because of its focus on human subjects (Zinsstag et al., 2011, p. 151).

To better understand how posthumanism might be integrated into public health research, we looked at the one article in our sample that was published in *Critical Public Health* but that did not use the term posthuman. This article was also located within the 'General/One-Health' cluster.

Mwacalimba's (2012) article in *Critical Public Health* was clustered within the 'One-health' grouping in our analysis. Mwacalimba explored avian influenza preparedness in Zambia. The article does not engage with the term posthuman or any of the posthumanist social theory. It does, however, show the limits of the 'One-health' paradigm by showing how humans and animals are entwined through agriculture and culture. The focus, however, is on understanding how Western concerns regarding avian flu and corresponding international standards overdetermined the preparedness strategies developed in Zambia. This meant that pressing, local human and animal health needs went unaddressed (see also Giles-Vernick, Owona-Ntsama, Landier, & Eyangoh, 2015). Critique here is thus focused on the political economic as opposed to the posthuman. But in the process, the political and economic difficulties associated with integrating human and animal health through the 'One-health' paradigm become increasingly clear. Mwacalimba's article therefore serves as an important lesson for advocates of the 'One-health' paradigm, as avian flu preparedness in Zambia came to be largely controlled by agricultural groups rather than medical or public health groups in a manner that stymied integration. Mwacalimba thus provides an important critique of 'One-health' by following the policy. A posthumanist intervention would ask: what might avian influenza preparedness in Zambia look like by now, following the birds as well?

Discussion

It is interesting to note the rise in public health research involving non-human animals since the 1990s, which from 2006 onwards is even stronger than the rise in the general public health literature. The increased interest in zoonotic diseases accounts for some of the rise in research regarding nonhuman species within public health. High profile zoonotic diseases such as SARS or H1N1 have been a stimulus for this area of research (see also Craddock & Hinchliffe, 2015; Porter, 2015). The heightened concern with zoonotic diseases is exemplified by the change in the name and scope of the *Journal of Veterinary Medicine, Series B* to *Zoonoses and Public Health* in 2007. The focus in this strand of the literature is to understand the pathways through which diseases cross species. But this research agenda also goes

beyond nonhuman animals to consider how other-than-animal entities, such as chemicals, also shape human health (see Washburn, 2013 for a discussion). The porosity of individual and species bodies is of key *concern* within this body of research.

The public health literature engages with nonhuman animals in another, distinct way, however. While an extensive part of the literature focuses on zoonotic diseases, public health research also engages in standard biomedical research involving animal models. Biomedical research has long used nonhuman animals as surrogates for humans in research, and public health does this is as well (Friese & Clarke, 2012; Lewis, Atkinson, Harrington, & Featherstone, 2013). The animal model paradigm presumes that species retain certain biological forms and processes through evolution, making it possible for one species to stand as a surrogate for another. This is why Ankeny (2007) argues that comparison is always part of the modelling process, even if it is implicit in the case of 'exemplary' (Bolker, 2009) models. Here the porosity of species bodies is a key *resource* for public health research.

What links these two discrete areas of scholarship is the 'One-health' paradigm. This is clearly demonstrated in Figure 1 (see Supplementary Material), where the 'General/One-health' cluster lies in the middle, between these two literatures in the bibliographic coupling map. The rise in research regarding nonhuman animals in public health is therefore also accounted for by the publication of key articles on the 'One-health' paradigm in the beginning of the 2000s. These articles were frequently cited in later years. As such, the development and further expansion of the 'One-health' literature within the field of public health has boosted the number of publications addressing nonhuman species from the late 2000s onwards. It serves as a link between public health research on zoonotic diseases and public health research that uses animals as models.

The 'One-health' literature is medical in its orientation, and has not engaged with the social sciences (Craddock & Hinchliffe, 2015; Wolf, 2015). This is confirmed in the analysis of the key cited publications within this cluster, which are all published in medical and veterinary journals. From our analysis it can be concluded that the concern with nonhuman animals within public health is based upon the discourse of the 'One-health' paradigm. The critical posthumanist theory from within the social sciences was only present in an extremely limited number of publications. The neglect of the critical posthumanist literature within public health is not surprising, given the concerns of the 'One-health' paradigm and its perceptions of the social sciences. For example, the 'One-health' paradigm has been critiqued for its reliance upon the deficit model, wherein the role of the social sciences is limited to helping to communicate scientific and medical truths to an uninformed public (Craddock & Hinchliffe, 2015).

Conclusion

Interest in nonhuman animals within public health has been informed by the discursive practices of the 'One-health' paradigm, as opposed to the discursive practices of 'posthumanism'. Many of the contributions that Rock et al. (2014) contend posthumanism can make to public health are arguably also already being made by One-health, such as foregrounding: (1) the importance of nonhuman entities for improving human health and subjective well-being (Rock et al., 2014, p. 337; Zinsstag et al., 2011), as evidenced by infectious disease (Jones et al., 2008; Rock et al., 2014, p. 338; Taylor et al., 2001), (2) the use of animals as sentinels (Rock et al., 2014, p. 338; van der Schalie et al., 1999); and (3) the range of nonhuman substances (e.g. microbes, carcinogens) that shape human health (Rock et al., 2014, p. 338; Spellberg et al., 2008). Both posthumanism and One-health also challenge the sharp delineation between physical and social environments (Jackson, 2003; Rock et al., 2014, p. 339).

As such, for posthumanist theory to influence public health research, the differences between 'One-health' and 'posthumanism' needs to be discussed as well. Both posthumanist social theory and 'One-health' emphasize the mutual dependence of humans, other species and other things. But where posthumanist thought is rooted in a philosophical problem, 'One-health' is rooted in an organizational problem. The agency of nonhumans is in turn a focal point and site of potentiality in the more philosophically oriented, posthumanist literature, whereas nonhuman agency is either not considered or considered a problem in the One-health literature. Further, where posthumanism argues that we

need to better understand human interactions with other species and things in historically, culturally and politically contingent ways, 'One-health' starts with a biomedical model to argue for a greater integration of human and animal medicine. Finally, and as Green (2012) has pointed out, there is still the assumption of a hierarchy in terms of whose health matters most in the 'One-health' paradigm; it privileges the securitization of human populations in the global North (see also Craddock, 2015; Craddock & Hinchliffe, 2015; Hinchliffe, 2015). The prioritization of certain humans over other humans and other species is contrary to posthumanism. The critical edge of posthumanism could therefore be particularly useful to public health research.

There is a growing social science literature that seeks to critique the 'One-health' paradigm, and these critiques are therefore relevant to current public health research addressing non-human species as well. A recent special issue of *Social Science & Medicine*, for example, critiqued One-health for failing to address power relations (Craddock, 2015; Craddock & Hinchliffe, 2015; Giles-Vernick et al., 2015), which has in turn meant that the social, political and economic embeddedness of human-animal interactions is not addressed by 'One-health' advocates (Coffin, Monje, Asiimwe-Karimu, Amuguni, & Odoch, 2015; Woldehanna & Zimicki, 2015; Wolf, 2015). Posthumanist theory can help public health researchers address these concerns, which are certainly shared by critical public health scholars.

Social scientists have begun to put forward other analytic approaches to the 'One-health' paradigm. This includes cultural anthropology (Wolf, 2015), ethno-ecological history (Giles-Vernick et al., 2015) and participatory epidemiology (Coffin et al., 2015; Paige, Malavé, Mbabazi, Mayer, & Goldberg, 2015). We suggest that posthumanist theories and methods could similarly move forward research concerns with non-human species in public health, particularly critical public health but also more applied public health approaches rooted in social epidemiology.

What would happen if public health research involving non-human animals started with a posthumanist injunction, as opposed to a 'One-health' injunction? If 'One-health' calls for the integration of medical and veterinary expertise, posthumanism would call upon researchers to 'follow the non-human'. Here the non-human agent that is of interest – the animal, the virus, the microbe – is traced as it interacts with humans and other nonhumans. It is a very micro-level approach to seeing how more meso- and macro-level entities, such as networks or structures or meshworks of agency, are produced and/or how diseases are enacted at material and symbolic levels. What would happen if public health research took this up, and began to follow around the nonhuman species of interest and concern for human health? How might that change our analyses? Couldn't public health extend such an approach in the process, by also showing where these relations can be transformed in order to improve the health and wellbeing of humans and other species as well?

Haraway (2008, p. 3) developed her notion of 'becoming with' by asking 'what do I touch when I touch my dog'. Haraway shows that, to answer this question, she needs to tell the natural, social, cultural, political and economic history of her dog's breed through colonialism alongside the natural, social, cultural, political and economic processes shaping her interactions with her dog today. As such, a posthumanist theory that starts with the nonhuman species that is of interest must describe things like local, national and international laws and policies, the history of social relationships between different people and other species and things, the symbolic meaning of nonhuman species within a particular context and the kinds of opportunities and problems these present. But in telling the natural histories of animals or other things as political and economic and cultural and symbolic, the key posthumanist insight could be combined with existing epidemiological practices in a manner that could produce both better knowledge and better policies. As Rock and her colleagues point out, posthumanist approaches are useful to public health because they shift the analysis of infectious diseases from a chain of causation towards a greater understanding of the relationships that drive the incidence of zoonoses (Rock et al., 2014, p. 338). Starting with the nonhuman, tracing its relations and applying critical social theory seems to us to be a necessary next step in public health research involving nonhuman agents.

It is important to emphasize that, while the injunction to 'follow the actor' is more often aligned with actor network theory, we are advocating for a posthumanist approach that is more consistent with Haraway's (1989, 1991, 2008) scholarship then Latour (2005). This is because Haraway uses critical

social theory in following nonhuman actors, while Latour does not on the basis of his commitment to a flat ontology. This flat ontology cannot, however, address many of the limitations of the 'One-health' paradigm, as described by the emerging social science literature.[2] We advocate for a posthumanism that engages with history, culture and politics – the stuff of critical public health – in pursuing alternatives to One-health. Such a posthumanist approach has the capacity to both critique and intervene in the processes through which human and nonhuman health alike is 'enacted' (Mol, 2002), in ways that may currently be illness producing.

Notes

1. We would like to thank one of the anonymous reviewers for their comments on this point.
2. That said, Tirado, Gómez, and Rocamora (2015) have analysed influenza using Actor Network Theory and so provide a crucial insight into how the injunction to follow the nonhuman can be put to good use in the context of public health.

Acknowledgements

We would like to thank Sara Cooper and the other organizers of the conference '25 Years of Public Health Criticism: Critique and Nostalgia in Public Health' at the London School of Hygiene and Tropical Medicine for asking us to give a paper on the topic of posthumanism and public health. This conference paper was the basis for this article, and comments at the conference helped tremendously in revising and refining our arguments here. We would also like to thank Angela Cassidy for her comments and suggestions on our handling of One-health in an earlier version of this paper, and Juan Pablo Pardo Guerra for his comments on the bibliometric analysis. The comments from two anonymous reviewers helped us to improve the paper tremendously, for which we are very grateful.

Disclosure statement

No potential conflict of interest was reported by the authors.

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