

Pets, purity and pollution: understanding the sociology of zoonotic disease transmission

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by

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This thesis is based on research carried out in the Department of Epidemiology and Population Health, Institute of Infection and Global Health, University of Liverpool.
Except for where indicated, this thesis is my own unaided work.

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Abstract

Pets, purity and pollution: understanding the sociology of zoonotic disease transmission

Charlotte Amy Robin

The way in which people respond to zoonotic disease is embedded in their interactions and relationships with animals and the spaces animals occupy in society. Consequently, we cannot understand zoonotic disease transmission without understanding our relationship with animals. This thesis explores human-rat interactions in the context of a group of rodent-borne zoonotic viruses that have recently emerged in the United Kingdom; hantaviruses.

The aim of this research was to explore people's relationships and interactions with rats, to gain a deeper understanding of how they interpret and respond to the risk of rodent-borne zoonotic diseases. This research used an interdisciplinary approach, combining sociology and epidemiology. It was divided into two phases; phase one used qualitative methods, specifically in-depth interviews with selected at-risk groups; pet rat owners, farmers and pest control technicians. Phase two used the findings from phase one to implement a cross-sectional study of pet rat owners.

The data presented in this thesis illustrate how the rat is 'constructed' as a different animal by the groups in this study, despite being the same species. These contrasting constructions of rats influence how the study groups understand risk and health. Pet rat owners create a clear distinction between pet and wild rats; elevating its status from animal to pet sanitises the rat, so it is no longer associated with dirt and disease. Pet rats are safe and clean within the confines of the home and can only be contaminated with disease through contact with the outside world. This conception enables rat owners to interact with their pets with no concern about potential transmission of zoonotic infections. This was reflected in the cross-sectional study of pet rat owners, where nearly all respondents (96%) stated they kissed their pet rat and just over a third (37%) engaged in 'rodentistry'; letting their pet rat clean their teeth. Farmers see rats as a contaminant that pollutes anything it comes into contact with. While other animals exist within defined spaces on the farm, rats do not adhere to these boundaries and are inherently problematic. Pest control technicians understand rats as an animal that is just trying to survive. In this context, rats are not inherently problematic; the problem lies with the humans who define the spaces in which rats are not allowed to exist. For all groups, place is important in how rats are understood and consequently infection control practices were focused at maintaining or repairing the physical or conceptual boundaries around the spaces where rats were, or were not, expected to be.

This work forms the basis for new insights into the sociology of rodent-borne disease transmission, an area of research that has previously been neglected. It highlights the importance of recognising how animals as vectors are understood from different perspectives, and how public health organisations need to consider these perspectives when communicating health messages.

Introduction

Introduction

The transmission of zoonotic diseases is embedded within our interactions and relationships with animals. How people respond to the emergence of zoonotic diseases is rooted in the social and cultural practices that interweave the spaces occupied by humans and animals within our society. Consequently, we cannot understand zoonotic disease transmission without understanding our relationship with animals. This thesis explores human-animal interactions in the context of a group of zoonotic viruses that have recently emerged in the United Kingdom (UK); hantaviruses. Brown rats or Norway rats (*Rattus norvegicus*) are the primary host animal for hantaviruses in the UK. This thesis explores the ways in which people relate to and interact with rats and how this influences their understanding and response to the transmission of rodent-borne zoonotic diseases, including hantaviruses.

Hantaviruses are a genus of rodent-borne viruses within the *Bunyaviridae* family, which, depending on the viral strain, can cause two different clinical syndromes in people; haemorrhagic fever with renal syndrome (HFRS), predominantly found in Asia and Europe, or hantavirus cardiopulmonary syndrome (HCPS), the main clinical syndrome of hantavirus infection in the Americas (Krüger et al., 2011). Hantaviruses are rare in the UK and initially were not thought to be pathogenic, despite a number of possible hantavirus-associated kidney injury cases, dating back to the 1970s (Table 2, Appendix 1). Until recently, there has been a degree of uncertainty surrounding the endemic status of the viruses in this country. This uncertainty was resolved following the isolation of Seoul hantavirus in wild rats (*R. norvegicus*) on a farm in North Yorkshire in 2012, where a resident was ill with acute kidney injury (Jameson et al., 2013a). The same virus was also isolated from the patient, who had reported an increase in the number of rats on the farm prior to falling ill (Jameson et al., 2014). This was the first time the UK that Seoul virus had been isolated from both patient and wild rats, confirming the rats to be the source of infection.

Later the same year, Seoul hantavirus was also detected in another patient with acute kidney injury (Jameson et al., 2013b; Taori et al., 2013). This patient had two pet rats (*R. norvegicus*), which were identified as the source of the infection following epidemiological investigations. Blood and urine samples from these rats were positive for Seoul hantavirus. These two rats were obtained from a larger colony of 21 breeding rats, which were subsequently tested and seven (33.3%) were positive for two different hantaviruses; Hantaan and Seoul (Jameson et al., 2013b). The ensuing investigation of in-contact people identified the breeder and the breeder's partner as positive for both hantaviruses. The epidemiological investigations also revealed that the breeder's partner had been admitted to hospital the previous year with acute kidney damage of unknown origin. An archived blood sample was

retrospectively tested and both Hantaan and Seoul hantaviruses were detected (Jameson et al., 2013b).

Following identification of these cases of hantavirus-associated kidney injury, Public Health England (PHE) launched a seroprevalence study to determine the prevalence of hantaviruses in what they deemed to be high risk populations. The high risk populations were identified as pet rat owners, people with occupational exposure to pet rats (veterinary professionals) and people with occupational exposure to wild rats (farmers and pest control workers). There were positive sera identified in each group (1.7–3.3%), including the control group (consisting of randomly-selected donor blood samples), but around 34% of the pet rat owner group tested positive, demonstrating a previous hantavirus exposure or infection (Duggan et al., 2014, 2017).

PHE has taken this evidence, not only to frame hantaviruses as an emerging threat to public health, but also to contextualise rats as a public health concern, especially given *R. norvegicus* is the host of numerous zoonotic pathogens (Table 1, Appendix 1). Wild rats have always lived in close physical proximity with humans and have an almost parasitic existence; surviving on the periphery of society, ever-present but never truly welcome. In one survey of farmers, over 90% of them reported seeing rats on their farms on a regular basis (Jameson et al., 2013a). While the number of confirmed cases of hantavirus-associated kidney injury remains low, given the high seroprevalence in pet rat owners and evidence of previously undetected cases, it is likely there are many more misdiagnosed or unreported cases in the UK. From the perspective of PHE, hantaviruses in the UK are an emerging threat, which infrequently have a serious impact on human health, yet have the potential to become a major public health concern.

The public health view of rats is clear; however, in general, the human-rat relationship is more ambiguous. Despite all the animosity between humans and an animal that is primarily viewed by society as vermin, there are a growing number of people who have very close relationships with rats; people who keep them as pets. Pet and wild rats are the same species; *R. norvegicus*. Rats were first domesticated towards the end of the nineteenth century, perhaps most famously by Jack Black, self-appointed rat catcher to the Queen (Pemberton, 2014). In Victorian London, Black would provide rats for sport, to entertain the crowds in the rat-pit (where dogs were pitted against rats) and for pets or ‘fancies’ (Birke, 2003). Fancy rats were chosen based on their looks, predominantly coat colour. These rats have been selectively bred as fancy rats for over 100 years, but it was not until the 1970s, when the National Fancy Rat Society (NFRS) formed that pet rats increased in popularity. Regardless of whether the animal is viewed as a pet or vermin, zoonotic infections such as hantaviruses

transcend the boundaries created around constructed categories of animals (Jerolmack, 2008). Hantaviruses do not respect the boundary between pets and vermin, therefore understanding this boundary is essential to the design of health messages that incorporate rat-human relations.

The current drivers of public health policies and interventions are embedded in epidemiology and biomedicine. Interventions are often based on linear models of causation or transmission, focussing on utilising well-established epidemiological and biomedical concepts; identifying determinants of health and risk factors for diseases. Interventions are situated at points along these linear models, often attempting to reduce or eliminate exposure to identified risk factors or modifying ‘risky’ behaviour. For example, the public health response to hantaviruses was to try and reduce exposure to the pathogen, through reducing people’s contact with rats. In addition, PHE attempted to encourage people to change their behaviour in relation to pet rats, advising owners not to ‘kiss pet rodents or hold them close to [their] face’¹.

One of the biggest misconceptions about communicating health messages is that knowledge and information drive behaviour (Kelly and Barker, 2016). Taking a biomedical or epidemiological approach to public health interventions often assumes the explanation of modes of transmission and quantification of risk surrounding the disease can be communicated and people will change their behaviour accordingly. This expectation is unrealistic; ‘no-one who has attempted any sort of health education effort in individuals needs to be told that it is difficult for such people to step out of line with their peers’ (Rose, 1985:37).

This thesis is not arguing that conventional epidemiological and biomedical approaches to public health issues are not appropriate. It is arguing for a more holistic approach to public health; a multidisciplinary approach to health research, combining skills from biomedicine, epidemiology and the social sciences to deliver evidence that is profoundly grounded in people’s experiences, on which to base effective and engaging interventions and responses to public health concerns. Engaging with social sciences at the initial stages of the emergence of new infections will compliment and strengthen the epidemiological and biomedical approaches traditionally employed by public health organisations, as well as identifying new ways forward to approach the issue (Kippax et al., 2011). Incorporating social sciences into our response to the emergence of zoonotic infections is vital for a deeper understanding of the diseases, their impact and how to reduce the risk of transmission.

¹ This is taken from a leaflet produced by PHE; ‘Reducing the risk of human infection from pet rodents’. A copy of the leaflet is available in Appendix 2viii.

Thesis overview

This thesis is presented across six chapters, starting with a review of the literature related to the four key areas that form the basis for developing the research. In chapter one, I explore the social history of rats and discuss how they have been created as a problematic animal. I examine how developments in medicine and public health over the last few centuries have influenced the changing role of the rat in Western society, from generic vermin to public health pest. The next section reviews the literature on hantaviruses, specifically the emergence of this rodent-borne disease in the UK and the public health response. I then outline and examine the literature related to human-animal interactions, focussing on companion animals and health. I look at how animals – specifically rats – can be objects of social enquiry, which leads onto the final section of chapter one; the application of symbolic interactionism to explore human-rat interactions.

Chapter two – epistemological and methodological considerations – is split into three parts. Part one problematises the use of biomedical models of disease for understanding and changing health related behaviour, and sets out why a social constructionist approach is needed to understand health and illness. Part two defines the methodological approach I used for this thesis; a mixed methods approach combining Grounded Theory and an epidemiological study. Here, I set out my decision for using a mixed methods approach and why I have chosen to integrate the qualitative and quantitative data in the subsequent chapters, rather than presenting them separately. In part three, I set out the methods; how the data were collected and analysed, including ethical considerations.

Chapters three to five present the analysis of the data, each divided into three sections; pet rat owners, farmers and pest control technicians. Chapter three – ‘Understandings of rats from different perspectives’ – demonstrates how the rat, as a single species, is understood very differently by the three groups. Chapter four – ‘Rats, risk and health’ – goes on to demonstrate how these different constructions of the same species influence how risk and health is understood by the different study groups. Finally, chapter five – ‘The creation of boundaries for infection control’ – describes the infection control practices used by each group. In this chapter, I demonstrate how, for all groups, the creation of boundaries is fundamental to infection control and the concept of things being ‘out of place’ contaminates them. In this respect, the creation and maintenance of boundaries seeks to maintain the status animals have when they remain in the place they are expected to be.

Finally, in chapter six, I bring all three results chapters together and discuss the implications of how rats as vectors of disease are constructed from different perspectives. I draw on the work of Mary Douglas and her theory of purity and pollution, to interrogate my data and the

theories I have developed from them. This leads on to a discussion about the ways in which hantaviruses are framed within the biomedical model of disease and how this framing does not fit with how people in contact with rats understand risk and disease. Exploring rat-human interactions in this way demonstrates how public health messages need to be tailored to fit with different groups' understandings of the role rats play in the transmission of zoonotic diseases.

Chapter One
Literature Review

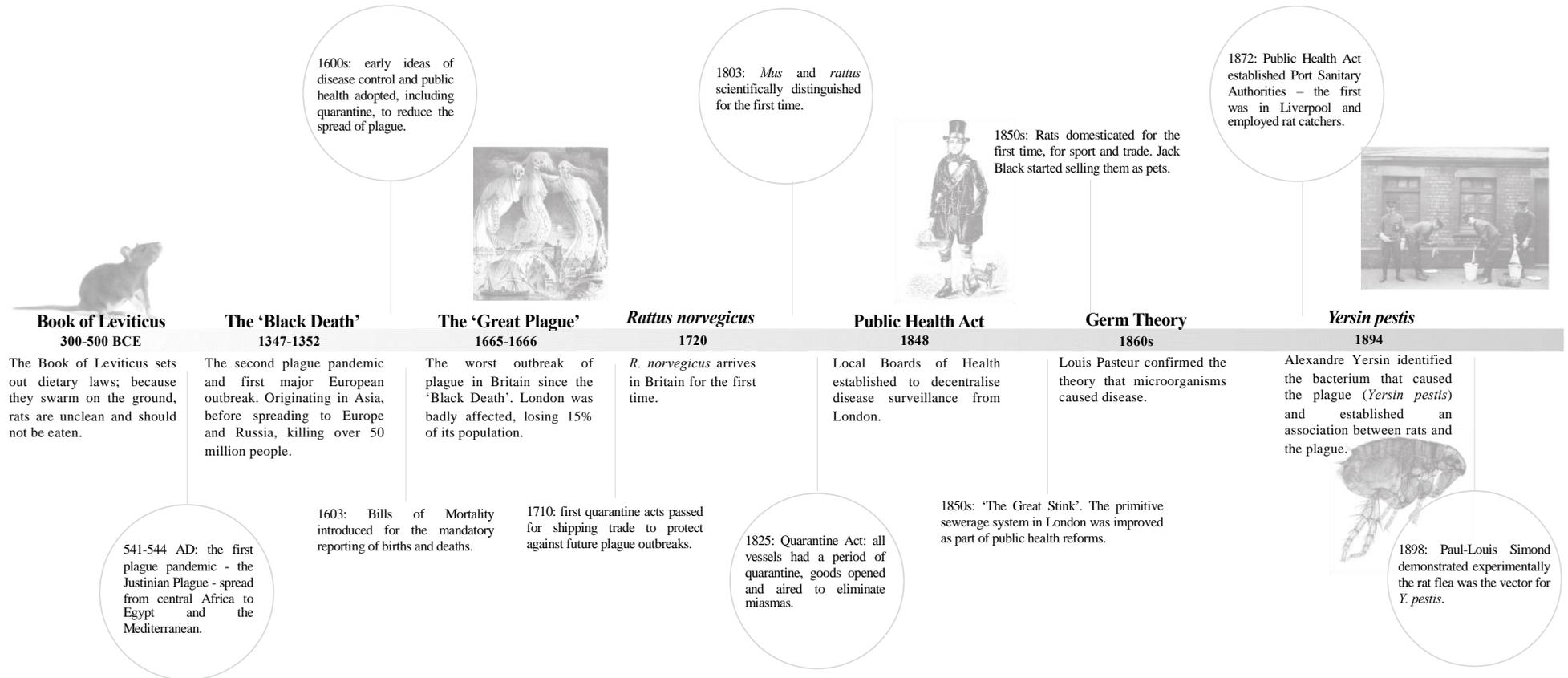


Figure 1: The history of *Rattus norvegicus* and public health. Adapted from Burt (2006).

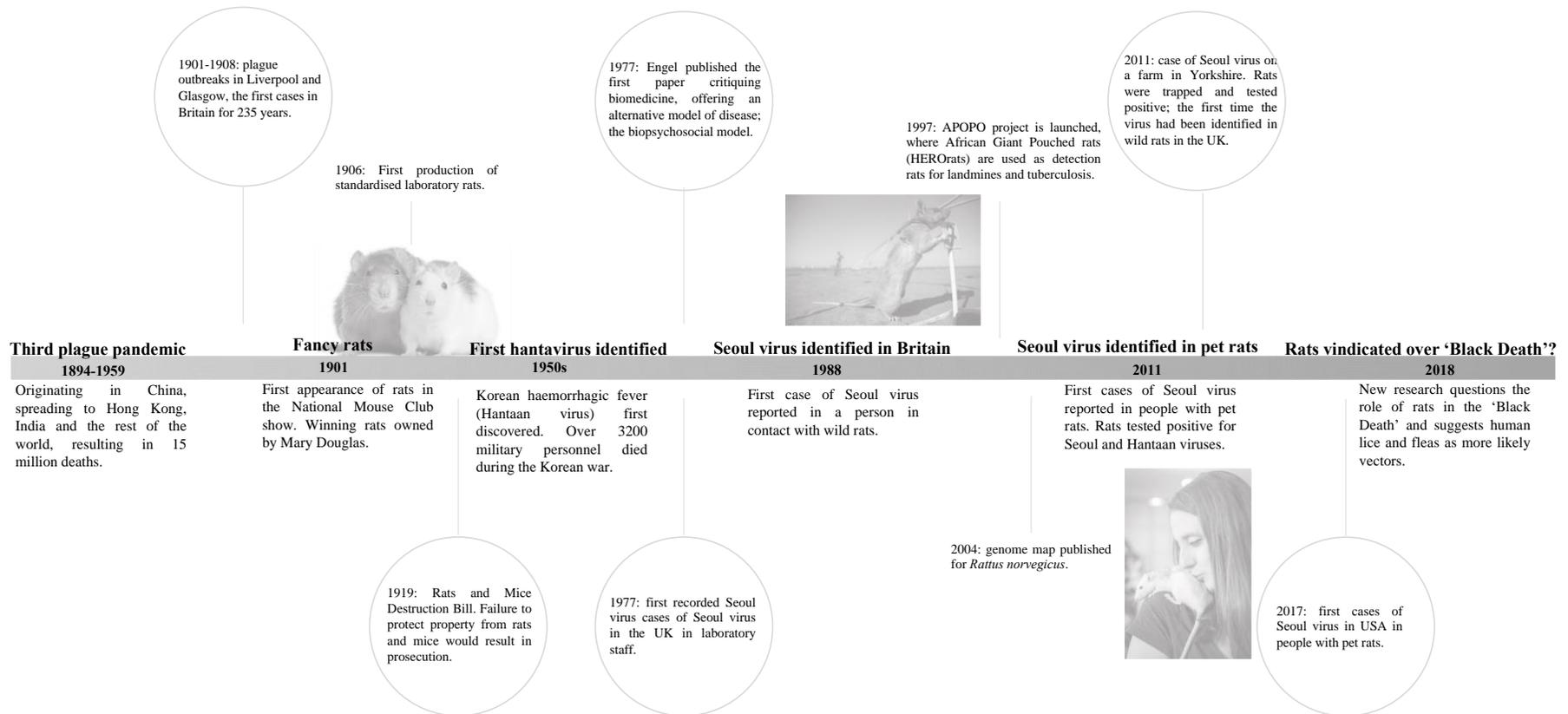


Figure 1 (continued): The history of *Rattus norvegicus* and public health. Adapted from Burt (2006).

'Of all horrors in the world — a rat!'

(Orwell, 1949:145)

Chapter One: Literature Review

The social history of rats

Rats live a synanthropic life, entwined with human history; they exist on the periphery of society, living alongside us. Rats are 'culturally enshrined as one of the most loathed animals on the planet' (Jerolmack, 2008:86), most commonly viewed as vermin, for a number of different reasons. In this chapter, I discuss how rats have transformed from being a scavenger, to a deviant, before finally being labelled as a vector of disease, and how these roles reflect developments in science and public health.

There is no exact moment in history when the status of rats shifted from animal to vermin, but the Book of Leviticus is probably one of the earliest documents that recognises their status. The book from the Old Testament, thought to date from around the sixth century BCE, articulated dietary laws in the context of clean and unclean animals. Rats, because they swarmed on the ground, were thought to be unclean and therefore could not be eaten: 'and every creeping thing that creepeth upon the earth shall be an abomination; it shall not be eaten' (Leviticus 11.41)². In the Old Testament, rodents were associated with plague epidemics. At this time, the association between plague and rodents did not go beyond a prophetic understanding. Rodents were seen as an omen for disasters, but not instrumental in causing them.

Scavengers

Prior to the nineteenth century, rats were just one of many animals labelled as problematic because they were harmful to crops and livestock, stealing and eating human food. In a time of scarcity, this made them a threat to material survival; they symbolised a threat to human civility. Reading literature from the early modern period in England, vermin did not appear to be associated with dirt or disgust (Fissell, 1999). Instead, animals were seen as vermin because they stole human food and outwitted the humans trying to control them. Rats were not necessarily singled out as an animal to be particularly hated or feared at this point, just a pest that needed eradicating (Burt, 2006). They were thieves,

² This is from the King James Version of the Old Testament. Interestingly, Leviticus 11.29–30 specifically mentions mice, but not rats: 'These also shall be unclean unto you among the creeping things that creep upon the earth; the weasel, and the mouse, and the tortoise. And the ferret, and the chameleon, and the lizard, and the snail, and the mole.' However, mice and rats were not scientifically distinguished as separate species until the nineteenth century, therefore the reference to mice in the Old Testament could be a reference to all rodents.

associated with cunning and trickery but did not embody the same sense of revulsion they subsequently attracted. Other animals that were labelled as pests in early modern England, such as kingfishers, osprey and otters are now largely considered rare or beautiful (Fissell, 1999), or at least have been given the status of wildlife rather than vermin. Rats on the other hand, have struggled to shake off the stigma of being labelled as vermin, a stigma that has stayed with them and that for some people, still persists today.

There are two characteristics associated with rats that may contribute towards the longevity of their vermin status. Firstly, they are a particularly fecund animal. With a gestation period of around 3 weeks and up to five litters a year, with as many as 8 young in each litter (Feng and Himsforth, 2014), in favourable conditions a single rat could produce up to 40 offspring a year. Consequently, where other animals once designated the status of vermin were hunted to the point of eradication, rats were more successful at surviving. The prolific breeding of rats will be revisited in the next section, because it not only makes them effective survivors but they were also seen as the antithesis of the sexual repression and modesty that epitomised Victorian society, giving them the status of a moral deviant.

Secondly, rats traverse public spaces without reference to boundaries, unlike other pests that are often associated with certain external conditions. Rats embody the definition of a liminal animal, living on literal and conceptual boundaries of human societies. This brings them into close proximity to people, sometimes living – uninvited – within the private space of the home, whereas ‘wildlife’ remain where they are expected to be, in the wild. Rats are often described as shadowing human societies. In Hans Zinsser’s *Rats, Lice and History*, he describes the natural history of the rat as being ‘tragically similar to that of man’ (Zinsser, 1935:207). More recently, rats have been described as living in a universe parallel to ours; ‘surviving on the effluvia of human society... our mirror species, reversed but similar’ (Sullivan, 2005:2). Their ability to adapt to human societies means that rats have had a significant influence on human history.

This status of being a liminal animal and the crossing of boundaries brings in ideas of being out of place; a key concept from Mary Douglas’s seminal work; *Purity and Danger: An Analysis of Concepts of Pollution and Taboo* (Douglas, 1966). Ideas of impurity, pollution and the boundaries within which these concepts emerge are central to understanding how rats are seen in different settings and will be discussed in detail in subsequent chapters. For the purposes of this introduction, it is important to highlight how the crossing of boundaries, symbolic or otherwise, and being ‘out of place’ is bound up in Douglas’s ideas of impurity and defilement. According to this theory, the act of crossing boundaries pollutes; ‘if we can abstract pathogenicity and hygiene from our notion of dirt, we are left with the old definition of dirt as matter out of place’ (Douglas, 1966:44). In the majority of countries, humans draw boundaries around their home as a private safe space. The rat’s ability to

cross these boundaries uninvited threatens the physical and symbolic boundaries of the home and influences how the animal is viewed.

Harbingers of disease

In addition to their thief status, rats were thought of as harbingers of disease, and were believed to be able to predict the presence of toxic miasmas, before they were recognised as disease vectors (Burt, 2006). One of the most culturally enshrined examples of rodent-borne disease epidemics is the plague, a zoonotic disease caused by the bacterium *Yersinia pestis*. The most notorious outbreak of the ‘Black Death’ swept across Europe in the mid-fourteenth century, killing around a third of the population (Slack, 1988). There were numerous outbreaks of plague over the proceeding centuries, culminating in the last major outbreak in England – known as the ‘Great Plague of London’ – in 1665, where around 100,000 deaths were recorded in London alone.

In medieval and early modern England, when these outbreaks were occurring, causes of infectious disease transmission were explained by various natural or supernatural concepts such as witchcraft, gods, demons, eclipses, comets and earthquakes (Karamanou et al., 2012). It was thought that these disturbances in the natural or spiritual worlds caused noxious effluvium to be released, permeating the air with toxic vapours known as ‘miasmas’. Miasma theory remained the dominant explanation for disease, reinforced by the conditions in urban spaces where densely populated cities emitted putrid smells. People were confined and congested, odious and offensive stenches of putrefaction, excrement and decay contaminated the air, and there was no escape from the human and animal filth that poured into the streets³.

The association between ‘bad air’ and disease was particularly meaningful in poor areas, and began to introduce the idea of an association between a lack of sanitation, inadequate living conditions and poor health. Raging plague epidemics were the catalyst for early ideas of disease control and public health; human movements were restricted, houses were quarantined and nurse-keepers and watchmen were appointed by parishes to tend to the sick and reinforce quarantine procedures (Barnett, 2001). Yet rats, the hosts of this deadly disease, moved freely across boundaries into the private spaces of the home, living up to their name as a liminal animal. Plague epidemics heralded the introduction of mortality statistics to keep a record of deaths, in an effort to monitor how the epidemic was evolving. Information on the size and distribution of populations is the cornerstone of epidemiology, key for developing public health knowledge. The abiding and pervasive effects of plague outbreaks are clear. They set in motion a series of key developments in public health that are thought to be largely

³ In London, the river Fleet was described as ‘a nauseous and abominable sink of nastiness’ and areas of the city where the lower-classes lived were ‘the sinister abscesses of towns’, described as ‘foul and loathsome places’ where ‘the air is much corrupted and infected’ (Dobson, 1997:16).

responsible for the foundation of public health and local health authorities, which today have an important role in protecting and improving the nation's health (Barnett, 2001).

The rat has remained the prime suspect for causing plague outbreaks, or at least had a pivotal role in the disease's transmission via fleas. The accuracy of this rat–flea–human transmission mechanism has recently been questioned, but the issue of its role in causation remains unclear.

Deviance

As previously discussed, prior to the nineteenth century, rats were primarily seen as a verminous species because they stole human food and posed a threat to livestock and crops. Rats were not seen as an object of defilement or disgust; they were thieves. Over subsequent centuries, cultural attitudes towards the rat shifted. There was no single catalyst for this shift, but numerous seismic changes in Western society and culture came together to construct this increasingly complex species.

The eighteenth century brought with it a number of pivotal societal changes that started to add additional layers to how the rat was constructed. Trade and commerce expanded as people felt the effects of the Industrial Revolution, the trade boom led to an increase in the number of ships passing through British ports. With the ships came a new species of rat; the brown or Norway rat (*Rattus norvegicus*). This species of rat outcompeted the black rat (*Rattus rattus*), to the point it became a rarity (Burt, 2006). While black rat populations diminished and receded, brown rats thrived and multiplied; earning them the status of invader: 'this formidable invader is now universally diffused through the whole country, from whence every method has been tried in vain to exterminate it' (Mayhew, 1861:3). This quote comes from the pioneering work of Henry Mayhew, a journalist and social researcher, who wrote extensively about the working classes of Victorian London in his most well-known work, *London Labour and the London Poor* (1861). I will return to Mayhew's London throughout this section, as his fascination with the 'destroyers of vermin' as well as the animals themselves, provides us with insights into how the rat started to become known as a nefarious deviant in Victorian London.

At the turn of the nineteenth century, the rat (*Rattus*) was scientifically distinguished from the mouse (*Mus*) for the first time (Burt, 2006). Now, the rat could be singled out as a species to be hated in its own right; especially (*Rattus norvegicus*), as it was seen as an invasive species, having only arrived on British shores in the 1720s (King et al., 2011). Progressive urbanisation meant that rats were starting to be seen as 'out of place' in human spaces. Prior to the Industrial Revolution, the distinction between human and animal spaces was more blurred; livestock were often kept in the same living space as people (Bradshaw, 2017). Throughout the nineteenth century, home and work, and human and animal spaces became increasingly distinct. Other animals respected these new boundaries, and

only existed within the confines of the spaces dictated to them by humans. Rats did not conform to these boundaries, only serving to amplify the uneasy relationship between human and rat.

Depravity and filth

Throughout the Victoria era, rats started to gain an association with depravity and filth. In a time of pronounced morality and restraint, particularly when it came to sexuality, rats were the antithesis of everything Victorian society valued: ‘unbounded sexual reproduction, a limitless appetite and dirt’ (Burt, 2006:12). Victorian Britain was also a time of immense sanitary reform. To keep cleanliness and purity sacred, Victorian society started to strengthen the boundaries around private spaces of the home, isolating them from anything deemed filthy or taboo. One of the biggest outcomes of Victorian sanitary reform was the improvement of the sewerage system in London. The nineteenth century sewerage system in London was primitive. After the abolition of cesspits in the 1840s, all houses had to drain into sewers, which ran into the river Thames, leaving it heavily contaminated (Cook, 2001). At a time when miasma theory of disease was dominant, authorities were not only concerned about ‘The Great Stink’, but the sewerage system in London was also starting to be seen as a public health concern. In the late 1850s the decision was made to reform the city’s sewers (Cook, 2001). The noxious miasma arising from the contaminated rivers of London was associated with numerous disease epidemics. Improvements in sanitation enabled waste to be more effectively removed from houses, strengthening the separation between purity and contamination by reinforcing the physical and conceptual boundaries around the home. Rats were increasingly seen as out of place in human spaces, forced to inhabit areas that were associated with dirt, including the newly-built sewers. It was around this time rats were starting to become engrained in society as powerfully symbolic of filth. Prior to this development in sanitation, rats – and people – were still living in dirty environments, however they were more interwoven with the fabric of human society, the boundary that separated human and rat was more permeable. The more distinct separation between cleanliness and dirt, purity and pollution, created an order that kept certain things within the boundary of the home and others outside. The rats’ ability to permeate these newly created private spaces meant they were contaminating homes by bringing the outside, in. It was not until these symbolically powerful concepts of purity and pollution started to be physically separated in Victorian Britain, that the rat started to embody filth and defilement. These ideas of filth and defilements were so entwined with morality that for Victorians, rats epitomised the nefarious deviant.

Domestication

Conversely, it was also in Victorian Britain that rats first started to be domesticated, initially for sport in the rat pits, where impatient dogs were pitted against hordes of rats to entertain the crowds. The

keeping of rats for sport provided an income for much of the lower classes of London (Mayhew, 1861). One of the first to start ratting in London was Jimmy Shaw, who at one point had as many as 2000 rats in his home (Mayhew, 1861). The domestication of the rat started to change people's interactions with them, the closer contact increased the risk of bites; Shaw admitted to Mayhew that he had been bitten hundreds of times (Mayhew, 1861). Some people would use caraway or other herbs as repellents to try to stop the rats from biting, although Shaw described this as 'nonsense' (Mayhew, 1861:10). Despite miasma theory still being dominant, ideas that rats could cause illness were starting to be realised. Rat bites were thought of as potentially dangerous, and rats themselves poisonous, although this seemed to depend on where they came from. Shaw explained to Mayhew the different risk posed by rats, depending on their origin: 'the bite of the sewer rat or water-ditch rats is very bad. The water and ditch rat lives on filth, but your barn-rat is a plump fellow and he lives on the best of everything. Sewer rats are very bad for dogs, their coats is poisonous' (Mayhew, 1861:9). This quote highlights the importance that place has on constructions of rats, and even in Victorian Britain we are starting to see different imaginings of rats emerge from the same species. In fact, Shaw goes on to describe sewer rats as a different species: 'if I had my will I wouldn't allow sewer ratting, for the rats in the shores eats up a great quantity of sewer filth and rubbish, and is another specie of scavenger in their own way' (Mayhew, 1861:10).

Rats were also domesticated as part of the pest control trade. The most well-known rat catcher in Victorian London was Jack Black, self-appointed rat catcher to the Queen (Mayhew, 1861). Black had a complex and multifaceted relationship with rats. He had built his life around exterminating them, catching and killing his first rats at 9 years old, but in later years started domesticating them. It is evident that there was a great deal of occupational risks involved with the profession. Black admitted he had nearly died three times because of rat bites, the worst one he describes in detail; the rat ran up the sleeve of his jacket and bit him on the arm. Black explained: 'I shall never forget it. It turned me all of a sudden, and made me feel numb. In less than half an hour I was took so bad I was [obliged] to be sent home.' Black goes on to describe how his arm became so painful and swollen he could not move it. He was in bed for two months because of that bite: 'I was so weak I couldn't stand, and I was dreadful feverish—all warmth like. I knew I was going to die, 'cause I remember the doctor coming and opening my eyes, to see if I was still alive' (Mayhew, 1861:12). At one point in the interview, Black even admitted that he ate sewer rats. To promote his business he would exhibit rats on the streets of London: 'I used to handle the rats in every possible manner, letting 'em run up my arm, and stroking their backs and playing with 'em' (Mayhew, 1861:16). Black would subsequently kill one of these domesticated rats, to demonstrate the effectiveness of his poison. In the same way that Shaw's domesticated rats were bred to be killed for sport, Black's domesticated rats also served a purpose—to help him sell his trade, and on occasion, to play tricks on competitors and potential clients (Pemberton, 2014). In addition to these rats that were kept to be killed, Black also bred 'the finest

collection of pied rats', which he would sell to 'happy families' and to 'ladies for keeping in squirrel cages' (Mayhew, 1861:20). These rats were a variety of colours and at least some of them would have been some of the first rats to be exhibited when rats made their first appearance in pet shows at the start of the twentieth century (Burt, 2006).

Towards the end of the nineteenth century, animals were starting to become objects of beauty and admiration; there was a fascination with creating different varieties and pedigrees (Burt, 2006). Societies, publications and exhibitions served to promote these 'fancies' and fancy rats first made an appearance at a National Mouse Club show in 1901, the winning rat being owned by a Mary Douglas, who became known as the 'mother of the fancy rat' (Burt, 2006). Interestingly, even though the rat fancy developed around the same time as the rat first started to become recognised as a disease carrier, this did not seem to affect its status. A dichotomy between wild and pet rats was starting to emerge; the relationship people had with their pets enabled them to construct the species as distinct from its wild equivalent, highlighting how important this relationship is.

Wild and domesticated rats are the same species; *Rattus norvegicus*, yet they are frequently labelled dichotomously, as 'vermin' or 'pet'. These labels are simply impositions of human perspective on the species and highlight the importance of boundaries in the construction of different categories of animals; rats are a particularly unique species in that they can occupy both categories, depending on how they are constructed by different people. In one study exploring how animals feature in people's lives, participants were asked if they considered any animals to be 'vermin' (Sealey and Charles, 2013). While some people identified rats as vermin, there was a recognition that labels such as 'vermin' were context-specific. For example, one respondent stated; 'no animals are vermin and no plants are weeds. Those are just labels we put on them'. By giving species boundaries, a space within which they are expected to exist, means they can be 'in place' or 'out of place'. Similar to Douglas' theory that dirt is just 'matter out of place' (Douglas, 1966:44), rats become 'vermin' when they are out of place. When Victorians such as Shaw and Black started to bring rats into the home, rather than being out of place, they were expected to be there. These were not vermin, they were domesticated pets. The status of the rat fancy continued throughout the twentieth century – the National Fancy Rat Society was formed in 1976 and it is now estimated there are around 100,000 pet rats in the UK (Pet Food Manufacturers' Association, 2016).

A disease vector

The twentieth century rat became widely recognised as a host and vector for disease. Up until this point, rats had been labelled as scavengers and moral deviants, associated with depravity and filth. The nineteenth century heralded the genesis of germ theory, a theory of disease aetiology and transmission that paved the way for the paradigm shift to a new era of biomedicine; a theory that still

dominates medicine and public health today. The discovery that specific organisms caused specific diseases provided the basis for determining rats were a host of *Yersinia pestis*; the bacterium that caused the plague; providing the evidence that cemented rats' status as a disease vector for the first time.

The transition from miasma to germ theory had gradually been taking place throughout the nineteenth century, but it was not until the 1860s that Louis Pasteur confirmed the theory that microorganisms caused disease (Karamanou, 2012). In the following decade, Robert Koch went on to demonstrate that microbes were disease-specific. It was 1894, when Alexandre Yersin, investigating a plague epidemic in Hong Kong, discovered the same bacteria in human plague patients and dead and dying rats (Gross, 1995). This fundamental discovery established that rats had a role in the transmission of plague, but not how it was transmitted. Simond made this subsequent breakthrough in 1898, when treating plague patients during an outbreak in Southeast Asia, he observed the presence of dead and dying rats preceding human cases. Crucially, he noted that people only appeared to become infected if they encountered rats that had recently died, leading him to hypothesise there must be a vector involved in the transmission. Later the same year, Simond proved experimentally the rat flea (*Xenopsylla cheopis*) was the vector for *Y. pestis* (Gross, 1995). This breakthrough was met with widespread scepticism from the scientific community at the time (Simond et al., 1998). At the turn of the century, miasma theory still predominated and, despite Ronald Ross's work on mosquitos and the malarial parasite during the same period, the idea that insects could act as vectors was not widely accepted (Goss, 1995).

Rats, plague and controversies

Rats are still associated with the transmission of *Y. pestis* to humans. However, a number of authors, have raised doubts about the role of rats in the Black Death. When Yersin made his breakthrough in identifying the bacteria that caused the plague outbreaks in the late nineteenth century, it was taken for granted that this model of rat-flea-human transmission accounted for the Black Death, with historians at the time also accepting this view (Hufthammer and Walløe, 2013). However, more recently some historians have suggested this assumption is unfounded, predominantly based on two points; a lack of evidence of the involvement of rats or fleas in the Black Death and a much faster speed of transmission in medieval, compared with modern epidemics (Hufthammer and Walløe, 2013).

The rat population in Europe in the medieval and early modern period was not large enough to cause such extensive outbreaks of plague (Davis, 1986). In descriptions of plague outbreaks in warmer countries, rats were often described as being prevalent and dead and dying rats preceded outbreaks (McCormick, 2003). Yet sources from more temperate countries rarely mention rats when describing

plague outbreaks (Davis, 1986). In addition, the climate in northern Europe at the time of the Black Death was not conducive to large rat or flea populations (Hufthammer and Walløe, 2013).

McCormick (2003) argued that a lack of written sources may just demonstrate a lack of interest in rats – possibly because they were so prevalent – therefore this cannot be used as substantive evidence rats were rare or absent. The route of transmission, established by Yersin and Simond at the end of the nineteenth century is thought to be efficient enough to sustain large plague epidemics, however these epidemics would have spread slowly, around 12–15 km each year (Hufthammer and Walløe, 2013). Conversely the Black Death spread very quickly, sweeping across England within months (Davis, 1986).

A number of alternative theories have been presented to explain these differences in the Black Death and plague outbreaks in the nineteenth and early twentieth centuries. Hufthammer and Walløe (2013) and Dean *et al.* (2018) have suggested a different type of insect vector may have been the responsible, *Pulex irritans* (human flea) or *Pediculus humanus humanus* (human body louse), neither of which need the rat host to be able to transmit *Y. pestis* bacteria. Research by Schmid *et al.* (2015) puts forward the theory that other rodents, such as gerbils, also played a part in the persistence of the plague in European countries, which would explain why it could spread so prolifically, even without large rat populations. It has also been suggested the Black Death may not have been caused by *Y. pestis* at all. In his re-examination of the historical and epidemiological evidence of the Black Death outbreaks, Cohn (2002) argues that the Black Death was not bubonic plague, but another disease epidemic. He suggests that ‘without argument, historians and scientists have taken the epidemiology of the modern plague and imposed it on the past, ignoring, denying, even changing contemporary testimony, both narrative and quantitative, when it conflicts with notions of how modern bubonic plague should behave’ (Cohn, 2002:1).

Despite this conflicting evidence, rats are currently embedded within many societies as carriers of disease, notorious for their role in the Black Death and subsequent plague outbreaks. The association between plague and rats is so pervasive that it is difficult to look at rodent borne diseases, such as plague, through an alternative lens and imagine a time when rats were not known to carry and transmit diseases to people. Plague is one of the diseases that has had the most cultural impact on human civilisation (Burt, 2006), and because the rat is so deeply associated with these devastating epidemics, it is evident why rats have become so powerfully associated with disease.

Leptospirosis

The end of the nineteenth century also yielded the discovery of leptospirosis, by Adolf Weil in 1886 (Adler, 2015). Leptospirosis is a rodent-borne zoonotic infection, although at the time that Weil made his discovery, there was an epidemiological link with rats, but they were not identified as the host.

The disease was associated with outdoor occupations; those at highest risk were sewer workers, coal miners and rice-field workers (Adler, 2015). The aetiology of the disease remained unknown until 1917, when a group of Japanese researchers established rats were asymptomatic carriers of *Leptospira* (Ido et al., 1917). This, in conjunction with the epidemiological findings, clearly established the rat as the host of the disease. Whereas plague outbreaks are now restricted to Africa, Asia and South America (World Health Organization, 2017), cases of leptospirosis are still observed in the UK, with 72 cases being reported in 2016 (PHE, 2017).

The rat as a public health threat

The discovery that rats could host and transmit diseases to people meant that by the early twentieth century, as well as being controlled because they were a pest, they also became the visible target for disease control (Burt, 2006). Rats were systematically targeted in an attempt to reduce the risk of plague and other rodent-borne diseases. The Rats and Mice Destruction Bill was passed in 1919, which made people responsible for the destruction of rats on their own property, with failure to do so resulting in prosecution. Today, the Wildlife and Countryside Act (1981), makes it an offence to release non-native species into the wild, and according to the British Invasive Non-native Species Strategy (NNS, 2012), *Rattus norvegicus* is still classed as an invasive species. Initially for plague control, the systematic control and destruction of wild rats has become an accepted part of public health; the twenty-first century rat is a public health enemy.

Rats in folklore and popular culture

‘Love them or loathe them, everyone has a rat story’

(Barnett, 2001)

Rats are a complex species, a collection of symbolic meanings, which enables them to fulfil a number of different roles, from objects of admiration to detested vermin. By deconstructing the rat through a public health lens, I have demonstrated that these meanings have developed over time and are reflected in advancements in medicine and public health. We have such a fascination with rats they have permeated most aspects of our society and culture. Stories of rats in folklore, literature and popular culture have helped to maintain the rat’s status.

For example, one of the most well known tales of rats is the Pied Piper of Hamelin. This story has been immortalised as a children’s fairy tale, however it is thought to be based on true events. As the tale goes, in the thirteenth century, the town of Hamelin was overrun with rats. A piper appeared and agreed to rid the town of rats, in exchange for payment. After the people of Hamelin failed to make

the payment, the piper vowed revenge. He returned to the town and led all the children away, never to be seen again. There are various theories to explain what happened to the children of Hamelin in the thirteenth century. Some suggest that the children were actually sent away by their families because of the extreme poverty faced by people at the time, and the story was created to negate the guilt and responsibility felt by the people of Hamelin that they could not do more to save them. Others have suggested the children may have been part of the 'Children's Crusades' of the thirteenth century, where children set out from France and Germany to regain the Holy Land in Jerusalem.

When rats have appeared in literature, they have predominantly been cast as villains. From Beatrix Potter's Mr Samuel Whiskers⁴, who was a thief, to the horrifying human-devouring rats in Herbert's *The Rats*, authors have played on the social construction of rats as deviant, immoral animals to create characters, which, in turn perpetuate society's construction of the species. None so much as the notorious rats in George Orwell's *1984*, where, in the torture chamber of room 101, they represent Winston's worst nightmare. For Winston, the rats were 'the worst thing in the world', but for Orwell, they were a metaphor for a number of different concepts that ran throughout the book. Orwell used what rats symbolise to explore different themes; depravity, betrayal and ultimately the complete absence of autonomy and self-determination. Rats are Winston's worst nightmare because they represent what he perceives to be the greatest evil; betrayal of Julia. In an interesting twist, the rats make Winston rat on and subsequently destroy the one good thing in his life – his relationship with Julia. Metaphorical rats also feature in the story as the 'rat race' in which Winston is trapped. The proles are mindless, insignificant cogs; rats trapped in Big Brother's cage. Winston's fear of rats means he gives up all independent thought and becomes just like everyone else; a mindless, insignificant rat. Interestingly, rats are the only animal mentioned in the book, which is perhaps a comment on their reputation of being survivors, thriving even in situations where human civilisation is struggling.

In addition to the numerous literary characters, rats have featured in countless horror films, are the basis for a number of idioms and have been the inspiration for a number of artists. Rats are a recurring theme with the street artists, including Blek le Rat and Banksy, who include rat characters in a number of their pieces. Perhaps because they see them as a reflection of themselves and other graffiti artists; urban deviants that appear at night to cause damage to property⁵. The frequency that rats occur in folklore and popular culture is a reflection on how ubiquitous rats are in the Western imagination. As Jonathan Burt succinctly sums up: '[the rats'] significance in human culture appears to be out of all

⁴ Beatrix Potter dedicated *The Tale of Samuel Whiskers* to her pet rat Sammy, in a little note that epitomises the dominant view of rats' characters: 'In Remembrance of 'Sammy' the intelligent pink-eyed representative of a persecuted (but irrepressible) race, an affectionate little friend, and most accomplished thief.'

⁵ Banksy once suggested rats are a good role model for the dispossessed: "If you feel dirty, insignificant or unloved, then rats are a good role model. They exist without permission, they have no respect for the hierarchy of society, and they have sex 50 times a day."

proportion to their physical size but parallels the extent to which humans consider them to be integral to, and yet threatening to, their history' (Burt, 2006:88).

Rodent-borne zoonoses

As germ theory proliferated throughout medical research, the idea that rats were hosts of zoonotic⁶ pathogens became more accepted. In 1949, the American Journal of Nursing published an article about rat-borne diseases (Carroll, 1949). The aim of the article was to increase awareness of rodent-borne diseases and the rat's impact on public health. The article focused on six rodent-borne diseases; murine typhus fever, bubonic plague, salmonellosis, trichinosis, leptospiral jaundice and rat-bite fever. Today, *Rattus norvegicus* is recognised as vectors for numerous zoonotic pathogens in the UK (Table 1, Appendix 1). There is a group of rodent-borne zoonotic viruses that are becoming increasingly recognised as endemic in the UK; hantaviruses. Initially thought of as exotic viruses, they are of particular interest at the moment because they have recently been detected in both wild and pet rats in the UK.

Hantaviruses

Hantaviruses are a group of viruses in the *Bunyaviridae* family. There are over 30 different hantavirus species (Clement et al., 2006), broadly divided into Old and New World viruses. New World hantaviruses, endemic to the Americas, include Prospect Hill, Sin Nombre and Andes viruses and are associated with hantavirus (cardio) pulmonary syndrome (HPS/HCPS) in people. The hosts of New World hantaviruses are small rodents, for example *Microtus pennsylvanicus* (meadow vole) *Peromyscus maniculatus* (deer mouse) and *Oligoryzomys longicaudatus* (long-tailed pygmy rice rat), are known to carry Primrose Hill, Sin Nombre and Andes viruses, respectively (Wang Lee et al., 2014). Old World hantaviruses, predominantly found in Eurasian countries, include Hantaan, Puumala, Seoul and Dobrava/Belgrade viruses, and are associated with haemorrhagic fever with renal syndrome (HFRS) in people (Wang Lee et al., 2014). Old World hantaviruses have different rodent hosts, including *Apodemus agrarius coreae* (striped field mouse), *Myodes glareolus* (bank vole) and *Rattus norvegicus* (Norway or brown rat), for Hantaan, Puumala and Seoul viruses, respectively. The hosts of Dobrava/Belgrade viruses are *A. agrarius coreae* and *Apodemus ponticus* (Black Sea field mouse).

⁶ The word zoonosis is derived from the Greek *zoo*, relating to animals or more generally to life or living things, *noso* a person who studies disease and *osis*, referring to a disease, disorder or infection. Its first recorded use was in the American Journal of Medical Science in 1873, in a review that discussed glanders, an equine bacterial disease and hydrophobia, now known as rabies (Bryant, 1873).

Clinical symptoms

Hantaviruses are asymptomatic in rodent hosts and can be in some humans, however when the virus develops into clinical disease, there can be a high morbidity and mortality rate. Rodents are thought to shed the virus in their urine, faeces and saliva. Humans mainly become infected through inhalation of aerolised rodent excreta (Lee and van der Groen, 1989). Symptoms of the clinical disease associated with hantaviruses varies depending on the strain, but generally hantavirus pulmonary syndrome is characterised with influenza-like symptoms; fever, myalgia and headache, abdominal pain, vomiting and diarrhoea (MacNeil et al., 2011). Subsequently, a severe stage of the disease develops, with the onset of pulmonary oedema, hypotension and shock (MacNeil et al., 2011). The case fatality rate for HPS varies from 35–43% (Sargianou et al., 2012), and recovery can take years.

Haemorrhagic fever with renal syndrome also starts with a brief initial phase of fever, malaise, myalgia, anorexia, headache and eye pain (Sargianou et al., 2012). Patients with Puumala have also reported dizziness, loss of vision and other central nervous system symptoms (Sargianou et al., 2012). Following this stage, patients can go into renal failure; severe haemorrhage and pulmonary oedema have also been reported. Patients can suffer from fatigue and muscle weakness for months post-infection. The mortality rate for HFRS varies from 0–2% with Seoul virus to 1–12% with Hantaan and Dobrava/Belgrade virus (Sargianou et al., 2012).

Risk factors

Exposure to rodents is the most important risk factor for developing hantavirus-associated disease (Clement et al., 1997). The majority of cases are acquired in or around the home, with a small proportion of cases associated with occupational or recreational exposure (Peters and Khan, 2002). Specific risk factors include living in close proximity to forests (Abu Sin et al., 2007; Crowcroft et al., 1999), cleaning the home more than once a week (Crowcroft et al., 1999), cutting firewood (Van Loock et al., 1999; Vapalahti et al., 2010), trapping rodents (Van Loock et al., 1999; Vapalahti et al., 2010) and smoking (Clement et al., 2011; Vapalahti et al., 2010). Occupational exposure for construction workers and the military have also been identified as risk factors (Abu Sin et al., 2007; Jan, Clement, 2003). An important observation from hantavirus cases in the United States is an association with people cleaning out log cabins and camping. In 2012, there was an outbreak of hantavirus pulmonary syndrome associated with Sin Nombre virus at Yosemite National Park (Núñez et al., 2014). There were 10 cases, of which three were fatal. The use of infrequently occupied cabins has been suggested as a possible risk factor for hantaviruses; the disturbing of rodents that over-wintered in the cabins, and subsequent cleaning of the cabin induces aerolisation of the virus and lack of inadequate ventilation could increase the risk of transmission (Peters and Khan, 2002). This large

outbreak in the United States brought hantaviruses to the attention of UK public health authorities, with a report on the outbreak being included in the 2012 Department for Environment Food & Rural Affairs (Defra) zoonosis report (Defra, 2012).

In the UK, few studies have been conducted to identify risk factors for hantaviruses. One investigation into hantaviruses in people who lived or worked on farms identified no difference in relative risk when comparing seropositive and seronegative individuals, although it did observe that seeing rodents on the farm during the day reduced the odds of infection (Jameson et al., 2014). Unfortunately, the authors did not determine whether these rodents were mice or rats; as mice are known to be naturally averse to rats, a large mouse population could indicate small rat numbers, consequently indicating a low risk of hantavirus infection.

Epidemiology

There have been two significant hantavirus outbreaks worldwide that have acted as catalysts for the progression of hantavirus research and discovery of new virus strains. Epidemic haemorrhagic fever, or Korean haemorrhagic fever as it was known, was first recognised in the 1950s as a disease affecting military personnel in Korea (Smadel, 1953); 3200 United Nations soldiers contracted the virus during the Korean war (Lee et al. 2014). It was not until the 1970s that the virus was isolated for the first time (Lee et al., 1978), and was named after the river Hantaan on the border between North and South Korea, where the majority of cases were recorded (Clement et al., 2006). Shortly after this breakthrough, Puumala virus was isolated from bank voles in Finland (Brummer-Korvenkontio et al., 1980) and Seoul virus from rats in Korea (Lee et al., 1982). The same year, Prospect Hill virus was isolated for the first time in the USA; the first New World hantavirus to be recognised (Lee et al. 2014).

In 1993, an acute respiratory illness was observed in previously healthy adults, in south western United States, (Nichol et al., 1993). Over an eight-month period, 53 cases were reported, with a case-fatality rate of 60% (Elliott et al., 1994). The outbreak investigation team from the US Centers for Disease Control (CDC) discovered patients had antibodies to a hantavirus similar to Puumala virus (Lee et al. 2014). This was the first time hantaviruses had been associated with an outbreak of severe human disease in the United States, and the first time a hantavirus strain had been associated with acute respiratory illness (Nichol et al., 1993). This new hantavirus was called Sin Nombre (nameless), because local authorities did not want it to be named after their local region (Lee et al. 2014). A number of hantaviruses have been identified since this outbreak, including Andes virus, which is the only hantavirus known to be transmitted from person-to-person (Martinez et al., 2005). Recently, there has been an outbreak of Seoul virus in pet rat owners; the first recorded cases of Seoul virus associated with pet rats in the United States (Fill et al., 2017).

Now, nearly 70 years after the first hantavirus strains were isolated, hantavirus associated illness still represents a growing public health concern worldwide, with over 30,000 cases reported globally each year (Watson et al., 2014).

Hantaviruses in the United Kingdom

Hantavirus-associated HFRS is considered by PHE to be an emerging disease in the UK, however a number of authors casted doubt on this when they suggested hantaviruses might have been prevalent in Britain centuries ago (Bridson, 2001; Heyman et al., 2014). These authors suggest that the English Sweating Sickness, prevalent during the fifteenth and sixteenth centuries, could have been caused by a hantavirus, because of similarities in the clinical presentation and epidemiology of the disease. There were four major outbreaks of the English Sweating Sickness between 1485 and 1551 (Eric Bridson, 2001). Whether hantaviruses have emerged or re-emerged in the UK, the first recorded cases of Seoul virus was in 1977, in four people who worked with rats in a laboratory at the Institute of Cancer Research (Lloyd and Jones, 1986). The first reported case associated with wild rats was in 1988, in a boating attendant in Glasgow (Kudesia et al., 1988). Since then, there have been a number of cases reported in people in contact with wild rats, including the identification of 26 cases in a prospective study of patients in Somerset, presenting to their General Practitioner with suspected symptoms presumed to be associated with hantavirus (Pether et al., 1993). These cases included people who worked on farms, worked with sewage or lived in areas or had hobbies that meant there was the risk of close contact with rats. To date, there have been 52 reported cases of Seoul virus associated HFRS in people in contact with wild rats, plus four in laboratory workers (Appendix 1, Table 2). The most recent case associated with wild rats on a farm in Yorkshire also confirmed the presence of pathogenic Seoul virus in wild rats in the UK for the first time (Jameson et al., 2013a).

Initially, the only cases of hantavirus-associated illness in the UK were in people in contact with wild or laboratory rats. It was not until 2011 that PHE became aware of the possibility that people with pet rats were also at risk of contracting hantaviruses, when Seoul virus was detected in a patient with acute kidney injury (Jameson et al., 2013b; Taori et al., 2013). This patient had two pet rats (*R. norvegicus*), which were identified as the source of the infection following epidemiological investigations, and blood and urine samples from these rats were positive for Seoul hantavirus. These two rats were obtained from a larger colony of 21 breeding rats, which were subsequently tested and seven (33%) were found positive for both Hantaan and Seoul virus (Jameson et al., 2013b). The ensuing investigation of in-contact people identified the breeder and the breeder's partner as positive for both strains of hantavirus. The breeder's partner had been admitted to hospital the previous year with acute kidney damage of unknown origin. An archived blood sample was retrospectively tested and both Hantaan and Seoul were detected (Jameson et al., 2013b).

Following the identification of these hantaviruses associated with pet rats, a number of rat owners who were members of the National Fancy Rat Society (NFRS) volunteered to be tested and 50% of this group were positive for a Seoul-like virus (Duggan et al., 2014). Subsequently, PHE launched a national serosurveillance study to determine the prevalence of hantaviruses in what they deemed to be high risk populations. The high risk populations were identified as pet rat owners, people with occupational exposure to pet rats (veterinary professionals) and people with occupational exposure to wild rats (farmers and pest control workers). There were some positive sera identified in each group (1.7–3.3%), including the control group (consisting of randomly-selected donor blood samples), but the group with the highest seroprevalence was pet rat owners. In the sample of 79 pet rat owners, 34% were seropositive, 96% (n=26) for Seoul virus and 4% (n=1) had a weak positive reaction to Hantaan virus (Duggan et al., 2017). Since 2011, there have been eight clinical cases of Seoul virus in people with pet rats. In addition, a high prevalence (81%) of Seoul virus was detected in a colony of breeding rats in the UK as a result of the seroprevalence study (McElhinney et al., 2017), therefore it is likely cases of Seoul virus are currently undetected or unreported.

The public health response to hantaviruses

Prior to the identification of these cases, hantaviruses were considered as exotic diseases, associated with foreign travel. Following the two initial cases in 2012 and 2013, a risk assessment had been performed by the human-animal infections risk surveillance group (HAIRS), a multi-agency group chaired by PHE. HAIRS performed this risk assessment in April 2013, which involved a review of the available evidence. The risk assessment was based on the probability of human infection with hantaviruses and the impact of these viruses on human health in the UK. In this risk assessment, hantaviruses were framed as unusual; rarely reported and rarely causing acute clinical disease. They were also predominantly framed as a disease of wild rodents, despite acknowledgement of the case in the pet rat owner. The majority of the risk assessment focussed on wild rodents, for example when assessing human susceptibility, forestry workers, farmers and sewage workers were identified as the three main at-risk groups. At this point, hantaviruses were deemed to have a low probability of causing human infection and low-to-moderate impact on human health in the UK.

A subsequent risk assessment by the same group in February 2016 reframed hantaviruses as diseases predominantly affecting pet rat owners. This risk assessment was performed after identification of further cases of Seoul virus in pet rat owners (at this point, 11 cases had been confirmed, of which nine were in people exposed to pet rats or rats bred for the pet food trade) and the seroprevalence study.

Consequently, the 2016 HAIRS risk assessment identified pet rat owners as being at the highest risk from hantaviruses. The risk assessment acknowledged that given the estimated number of pet rats in

the UK, the number of diagnosed cases remains low, but raised the point that as hantaviruses are currently framed as exotic diseases, cases may be missed, resulting in it being underreported. While the probability of the disease causing human infection increased to moderate, the impact of the disease remained at the same level. The risk assessment also described normal behaviours associated with owning pets, such as cage cleaning, as ‘risk activities’.

Following identification of these hantavirus cases in pet rats and owners and the risk assessments by HAIRS, Seoul virus was reframed as an emerging diseases in the UK. From the public health perspective, pet rat owners were seen as needing to be informed about hantaviruses and the potential risk posed. In response to this, PHE launched a leaflet outlining the risks of infection from pet rodents. The leaflet produced, entitled ‘Reducing the risk of human infection from pet rodents’ (Appendix 2viii) included rats alongside a number of other rodents such as mice, gerbils and hamsters. Using the generic term ‘rodent’ neglected to acknowledge the different meanings attached to different rodents, particularly when kept as pets. It also focused on the dominant public health discourse, that rodents pose a risk to human health.

The leaflet provided information on what infections pet rodents can carry, how infections could be transmitted between rodents and humans and how the risk of infection could be reduced by hygiene precautions, including advising owners not to ‘kiss pet rodents or hold them close to your face’. Although pet rodents may appear asymptomatic, the leaflet emphasised that ‘all rodents should be presumed to be carrying infection even if they appear to be healthy’. In addition, the leaflet advised owners not to keep their pets in a bedroom and to wear gloves and a suitable facemask when cleaning them out. The PHE communication of the risks and prevention of hantavirus sit within a biomedical view of the world. As the dominant paradigm in medicine and healthcare over the last century (Wade and Halligan, 2004), attention is focussed on the biological determinants of health and disease, with an emphasis on the pathological basis for ill health.

In the United States, the Centers for Disease Control and Prevention (CDC) issued public health advice to pet rat owners and breeders following a similar hygiene discourse. However, although CDC initially referred to pet rodents in their communication, they go on to describe these animals as small pets; making a clear distinction between pet and wild rodents. In addition, the health of the pet was also taken into account, not just the health of the owner. For example, when advising people not to ‘kiss, nuzzle or hold rodents close to your face’, CDC advised this could scare the animal as well as increase the risk of being bitten (CDC, 2017).

Zoonotic diseases such as hantaviruses transcend the boundaries created around constructed categories of animals (Jerolmack, 2008). Rodent-borne zoonoses do not respect the boundaries between pet and wild rats, therefore understanding the meanings people attach to different categories of animals and how those meanings influence interactions with them is essential to increase our

understanding of the transmission of rodent-borne zoonoses. In the next section, I will explore human-animal interactions and the impact they have on health and wellbeing.

Human-animal interactions

The transmission of rodent-borne zoonoses, such as Seoul virus, is embedded within complex interactions with rats. How people make sense of the emergence of rodent-borne diseases is rooted in the relationships they have with rats and the place rats occupy in our society. To understand fully what the emergence of Seoul virus means to at-risk people, the complexity of the human-rat relationship needs to be explored in more detail.

Human-animal relationships are not new, in fact they are such an enduring and pervasive part of many societies and cultures that they have been described as an ‘intrinsic part of human nature that has shaped both who we are today and how we got here’ (Bradshaw, 2017:19). In other words, human-animal interactions have shaped what it means to be human. Animals have been kept as pets for thousands of years⁷, but even before they were domesticated to become our companions, animals were domesticated by early hunter-gatherer societies when they were reared as sources of food (Bradshaw, 2017). By its very nature, the domestication of animals brings them into closer contact with people, increasing the risk of zoonotic transmission of diseases. Despite the enduring relationship we have with animals, the study of human-animal relationships, and the influence they have on human societies and behaviour is an emerging field in the social sciences (Charles and Davies, 2008). The study of human-animal interactions is complex because of the constantly shifting nature of the roles animals occupy in society, from much-loved companions to a vital resource in a shared ecosystem (Lloyd and Mulcock, 2006). This is particularly relevant for rats, as I have demonstrated in previous sections of this literature review, by deconstructing this species to uncover the different social, cultural and historical layers that contribute to contemporary attitudes and relationships with them. Rats have featured in societies all over the world throughout history. Over time, they have acquired layers of meaning resulting in their deification in India (Rajasthan⁸) and their demise as pests in others. These meanings are so pervasive that they still endure in many societies today. This is a lot to burden for such a small animal; they may be small rodents but rats embody huge symbolic power.

⁷ The earliest record of a dog being buried with a human is around 12,000 years ago in northern Israel (Bradshaw, 2017).

⁸ The Karni Mata Temple in Rajasthan, dedicated to the Hindu goddess Karni Mata, is also known as the Temple of Rats. The thousands of rats in the temple are thought to be descendants of the goddess, and are worshipped and given offerings of food. The small number of white rats in the temple are thought to be especially holy. Some believe Karni Mata symbolises coexistence of disparate and marginalised communities.

Part of the family

There is no denying that people form strong emotional bonds with their animal companions, the connection between human and pet is often described as a family or friend-like relationship (Charles, 2014; Cohen, 2002). In one study exploring family formation and kinship, 24% of interviewed participants included their pets as part of their family, completely unprompted by the researchers (Charles and Davies, 2008). The spontaneity of including their pets in discussions about family and kinship highlights the significance of animals in people's lives. The elevation of animals to pet means that meanings are attributed to them, constructing highly complex 'more-than-animal' animals. In viewing animals as pets, they acquire a status that sets them apart from other animals. The elevated pet status also means we often privilege our pets with the same benefits of being a family member. Pet owners are effectively deconstructing the binary that separates humans and animals (Haraway, 2003).

Pets and health

There is a considerable literature on the impact of companion animals on both the physical and psychological health of humans. There are numerous health claims associated with pet ownership; lowering cholesterol, relieving stress, reducing blood pressure, increasing fitness, reducing the risk of cardiovascular disease, relieving depression; the list appears to be endless (Bradshaw, 2017). In one of the earliest studies on the health impact of pet ownership, (Friedmann et al., 1980) found that pet owners had better survival rates one year post-heart attack, compared with non-pet owners. The findings from this study have been criticised because of the potential confounding effect of age, as pet owners were generally younger than non-pet owners (Bradshaw, 2017). In addition to physiological effects, there is evidence that pets have an impact on psychological health; reducing stress or psychological distress, probably because of the social support that companion animals offer (Allen et al., 2001; Crossman, 2017).

Cause and effect seems impossible to untangle in studies exploring the health effects of animal companionship. As Bradshaw (2017) suggests, will someone with a sedentary lifestyle really choose a dog as a companion, knowing the amount of exercise it needs? Equally, one could question whether someone with a high-octane lifestyle will have time for animal companions or whether someone with existing health issues will choose a pet that reflects how they feel positioned by society; an outsider animal to reflect their own identity? A recent systematic review on the effect of companion animals and child development highlighted a paucity of high quality, longitudinal studies (Purewal et al., 2017). This type of epidemiological investigation is needed to determine causal relationships between companion animals and health outcomes.

In stark contrast to the numerous health claims surrounding pet ownership, come warnings about the potential risks they pose. These health risks are of increasing concern for public health officials, given

the proportion of the UK population who own pets, estimated at around 12 million households, or 44% of the population (PFMA, 2017), and the close contact we have with them. For example, in one survey of dog owners, 19% of dogs slept in bedrooms and 14% on owners' beds (Westgarth et al., 2008). Currently, the most concerning health risks posed by companion animals are dog bites (Kasbekar et al., 2013; Westgarth and Watkins, 2015) and zoonoses. Allergies and asthma, particularly in childhood are also reported as a possible health concern associated with pet ownership, however there is conflicting evidence on the effects of companion animal exposure (Chen et al., 2010).

Zoonoses and companion animals

There have been a number of public health infection concerns associated with companion animals. Two interesting examples are *Toxocara canis* and *Toxoplasma gondii*, both of which were discussed in the public domain. The case of *Toxocara canis* in particular, brought about a great deal of public and political concern, because of the association between toxocariasis and blindness in children and the problem of dog fouling in public parks. At one point in the 1970s, local authorities banned dog walkers from public parks in Burnley, leading to two parliamentary inquiries (Pemberton, 2017). More recently, subsequent research provided evidence for an association between Toxoplasmosis⁹ and schizophrenia (Pedersen et al., 2012). Hantaviruses in pet rats is one of the most recent public health scares associated with companion animals. When the media became aware of the cases in 2012, there were a number of media reports on the cases (BBC, 2013). Interestingly, with *Toxocara canis*, the problem was framed as irresponsible dog ownership (Pemberton, 2017), whereas with hantaviruses, rats were framed as being intrinsically diseased and the onus was placed on the rat owners to protect their own health. This contrasting framing of public health concerns is probably related to how these different species are constructed by Western society. Dogs are loving and faithful companions, whereas rats are still predominantly viewed as vermin.

The inability to untangle the cause and effect relationship is just one factor highlighted by Herzog (2011) for why we need to be cautious about over-interpreting research claiming health benefits of pet ownership. Other factors that problematise the claims include the self-reported nature of the studies and publication bias; the lack of negative results being published. In addition, Herzog calls into question the ontology and epistemological position of the researchers, suggesting people who own

⁹ Toxoplasmosis is a disease caused by the protozoan parasite, *Toxoplasma gondii*. Cats are the definitive hosts of *T. gondii*, and are one of the major sources of environmental contamination, through shedding *T. gondii* oocysts in their faeces (Hill and Dubey, 2002). Small rodents are intermediate hosts, and it is thought that the parasite can manipulate the behaviour of infected rodents, making them easier to predate, therefore enabling the parasite to continue its life cycle in the cat (Berdy et al., 2000). *T. gondii* infected rodents are sometimes referred to as 'suicidal rats' and the mechanism by which *T. gondii* alters the brain function in rodents formed the basis for research on the association between toxoplasmosis and schizophrenia (Khamsi, 2006).

pets are drawn to human-animal interaction research because of the strong bond they have with their own pets (Herzog, 2011), opening them up to the risk of unconscious bias. The vast amount of research in this area, despite no definite evidence for the positive health effects of animal companionship could point towards the sheer determination of researchers to quantify something they feel so powerfully with their own animal companions. This leads us to ask whether the most appropriate method of gaining an understanding of the impact animals have on our lives might be through qualitative research.

Animals as objects of social enquiry

Qualitative enquiry into human-animal interaction and the spaces animals occupy in human societies is an emerging field in public health, driven by the research developments in human-animal studies (Shapiro and DeMello, 2010), and animals now being recognised as legitimate objects of social exploration (Wilkie, 2015). In contrast to the vast amount of quantitative empirical research on the impact of human-animal interactions on human health, qualitative research in this field is still limited. One qualitative study exploring how men with immuno-deficiency virus or acquired immune deficiency syndrome experienced pet ownership concluded that the owner-pet bond had a positive impact on owners' health and wellbeing (Allen et al., 2000). The emotional attachment to their companion animals gave the participants emotional support, which the authors describe as a coping strategy used to cope with the depression, social isolation, stigma and grief associated with their illness. On a more practical level, the routine and responsibility of pet ownership was experienced as motivation to persevere, regardless of their health status (Allen et al., 2000). Similar findings were explored in a mixed-methods study on human-avian relationships, where owners describe how their avian companions helped them overcome depression and loneliness and gave them an overall sense of purpose (Anderson, 2014). In an exploration of how companion animals are constructed by homeless people, they were described as having changed or saved their lives (Irvine, 2013). More recently, a study exploring dog walking highlighted the positive impact on owners' mental wellbeing, with this inter-species activity being constructed as a pleasurable and stress-relieving experience (Westgarth et al., 2017). Interestingly, there is no conclusive evidence base for the positive impact of human-animal interactions on health, yet most of the limited qualitative research in this field highlights the positive and sometimes lifesaving affect people perceive animals to have on their lives.

Rats as objects of social enquiry

Rats have been somewhat neglected from the field of human-animal studies, with few studies focusing on interactions with this liminal animal and the place it occupies in our society (Beumer, 2014; Edelman, 2002). To date, there has been no empirical qualitative research on the health impact

of human-rat interactions; empirical research has focused on the ecology of the species and its status as a vector for disease. The lack of qualitative research exploring human-rat relations is surprising, given the status rats have in our society, where they are predominantly constructed as vectors of disease. In addition, the recent interest in zoonoses and shift towards a 'One Health' framework of public health, interactions with rats would be an obvious point of departure for exploring human-animal interactions in public health. It is perhaps a reflection of how, until recently, animals have been neglected in social science research, but also other fields of enquiry, such as public health and zoonoses. In addition, the absence of rats in human-animal interaction research highlights how pervasive their vermin status is. Despite having been kept as companion animals for over a century, they are still not commonly thought of as a pet. For a deeper understanding of zoonotic disease transmission, we need to include a focus on human-animal interactions. This will enable us to understand fully how interactions with animals shapes how people position themselves within the framework of risk posed by zoonotic diseases.

Symbolic interactionism

Our relationships with animals are symbolic, heavily influenced by the meanings we attached to different species. Animals are not experienced in the same way by all persons or groups and this appears to be particularly true of the rat. There is no single idea of what a rat is; it is a collection of meanings, embedded in history, culture and society. 'A better understanding of the meanings animals hold for people can lead to definitions and measures that are grounded in lived realities' (Irvine 2012:134). These meanings influence our behaviour and it is therefore important to understand them; symbolic interactionism provides a lens through which the human-rat relationship can be examined.

What is symbolic interactionism?

Symbolic interactionism is founded on three main assertions (Blumer, 1969). First, peoples' behaviour is dependent on the meanings they attach to certain phenomena – other people, objects, relationships. Their behaviour is not a direct response to the phenomenon, but to the meaning they have attached to it and what it symbolises (Benzies and Allen, 2001). Fundamental to this assumption, is that 'the world exists separate and apart from the individual' (Benzies and Allen, 2001:544). Everyone has a different understanding of the world, reality, and 'truth', because of how these concepts are created and interpreted. This assumption strongly aligns symbolic interactionism with social constructionism, which is the epistemological framework used for this thesis and will be discussed in more detail in the next chapter. Briefly, social constructionism relates to the creation of knowledge and production of reality by individual and groups of people (Conrad and Barker, 2010).

In the context of health and illness, a social constructionist approach differentiates between disease, as a biological condition and illness, and the meanings people have attached to that disease (Eisenberg, 1977). In this thesis, hantaviruses and other rodent-borne diseases are not universal biological entities, they are a collection of meanings, created and interpreted differently.

The second tenet of symbolic interactionism is that the meanings attached to certain phenomena are created through a process of interactions (Blumer 1969). People do not exist in isolation, their world is constructed and understood within a society. This means there is no such thing as absolute truth, truth is only ever going to be tentative because its meaning is context-specific (Benzies and Allen, 2001). The symbolic meanings people attach to phenomena arise from the way in which other people interact with and react to them (Benzies and Allen, 2001).

Finally, the third assertion of symbolic interactionism is that these symbolic meanings are not static or stable (Blumer 1969). The shared societal symbols people create through social interactions are fragile, and constantly in need of affirmation. Therefore, the individual and social worlds are joined through an iterative process of negotiating reality.

Symbolic interactionism provides a lens, or theoretical perspective, through which we can examine how individuals attach meaning to phenomena in their lives, such as rats and their relationship with them. Examination of how this process leads to behaviour in different contexts has the potential to increase understanding of human health-related behaviour (Benzies and Allen, 2001).

Symbolic interactionism and human-animal interactions

Symbolic interactionism is becoming established as a lens through which to explore human-animal interactions. In human societies, the interactions between people who assign meanings to phenomena have the benefit of a shared language (Irvine, 2008). Conversely, when exploring interactions between humans and non-human animals, the absence of a shared language means we have to rethink how we attach meaning to the animal and our relationship with it (Irvine, 2008). A number of studies have used a symbolic interactionist framework to examine the symbolic meaning attached to the relationships that humans have with animals. One notable and early example is Sanders's work on owners' relationships with their dogs (Sanders, 1993, 2003). He determined that assigning identity to dogs was very similar to how the process works in humans. People would draw on popular cultural stereotypes, based on species and breed, before assigning specific characteristics to individual dogs. Consequently, the dog becomes more than just an example of species or breed, they become individualised. Sanders then goes on to show that the identities of the dog shapes the identity of the owner and people who interact with the dog and its owner consider them to be one unit (Sanders, 2003). Through Sanders's work, we can see how people can assign identity, or meaning, to people,

through the meaning they attach to their animal. If we apply this example to the context of rats, a symbolically powerful animal whose association with dirt and disease is so pervasive, we can see how human-rat interactions could become problematic for people who have a relationship with this species.

This thesis study seeks to use the symbolic interactionist framework to explore rat-human interactions, deconstructing the meanings attached to the both the animal and the relationship, then use those meanings to explore health-related behaviour. Exploring the complexity of how rats as vectors are constructed from different perspectives will give public health professionals a better understanding of why people behave the way they do and is vital to the development of tailored public health messages that fit with different groups' understandings of the role rats play in the transmission of zoonotic diseases.

Chapter Two

Methodology

Chapter Two: Epistemological and Methodological Considerations

Introduction

In the previous chapter, I established how, over time, the rat has been constructed as a species with layers of multiple meanings. To enable me to deconstruct these meanings and use them to explore health-related behaviour, I concluded that symbolic interactionism was an appropriate lens through which to examine rat-human relationships. As a theoretical framework, symbolic interactionism sits within a social constructionist epistemology; knowledge is created through interactions between individuals and their social world. This methodology chapter sets out how I implemented this epistemological approach for my research.

Part one of this chapter outlines the social constructionist epistemology, which forms the foundation of my approach to the research. This includes discussion about why a constructionist approach is needed to understand health, illness and health-related behaviour. In part two, I outline how a constructionist epistemology can be implemented using a Grounded Theory approach, and how interviews and questionnaires can be used as research tools to obtain the data. Part three sets out how I conducted the research, by describing the process of recruitment, how the interviews and cross-sectional study were designed and implemented and how both types of data were analysed.

Outline of research objectives

The aim of this research was to explore people's relationships and interactions with rats, to gain a deeper understanding of how they interpret and respond to the risk of rodent-borne zoonotic diseases. Specifically:

'Does a relationship with rats, and the role they have in social identity, influence understandings of risk?'

For this study, people's relationships and interactions with rats encompassed the intimate bond between pet rat and owner, the tense relationships between farmers and rats, and the professional interactions between pest control technicians and other people's 'problematic' rats. These groups were identified because of their interactions with rats, which potentially put them at risk of hantavirus transmission (Duggan et al., 2017).

This research used an interdisciplinary approach, combining the complementary disciplines of sociology and epidemiology. It was divided into two phases; phase one used qualitative research methods, specifically in-depth interviews. Phase two used the findings from phase one to develop a

cross-sectional survey based on the themes arising from the qualitative interviews; this latter phase was limited to pet rat owners.

In line with the complementary nature of the qualitative methods (phase one) and the development of the epidemiological study (phase two), the qualitative and quantitative approaches will be integrated throughout the methodology and findings chapters. The way in which I have structured the thesis, reflects the interdependence between the two approaches, both of which influenced my understanding of the research topic. While underpinned by different epistemologies, the qualitative and quantitative approaches were designed to be complementary, not divergent.

To focus the research, a number of objectives were established:

1. To explore the nature of the relationship between individuals from different groups and rats.
2. To explore the nature of beliefs about rodent-borne zoonotic disease risk.
3. To explore the knowledge and implications of exposure.
4. To explore beliefs surrounding translation of knowledge and understanding into action.

Phase two of the research also included two additional objectives, focussing on pet rat owners:

5. To determine if this high-risk group take action to reduce the risk of transmission.
6. To determine the motivators and barriers towards health-protective behaviours.

Part One: A social constructionist approach to health and illness

Understanding health and illness

Biomedical model

Models of health and illness have far-reaching influences in healthcare systems, from decisions regarding clinical care for individual patients, to wider public health policies. Since the shift from miasma theory in the late twentieth century, biomedical models have been the dominant paradigm in healthcare, yet cannot offer a comprehensive understanding of many health concerns (Kaplan et al., 2015; McCann, 2016; Wade and Halligan, 2004). Traditional biomedical models operate under three main assumptions; disease has a specific, often single, aetiology, an underlying pathology is always the cause of illness and removal or attenuation of the pathology will result in a return to health (Wade and Halligan, 2004). In biomedical models, a distinction is made between disease and illness. Illness is what patients experience, whereas diseases are what clinicians diagnose and treat (Eisenberg, 1977). Consequently, with biomedical models, the focus is on disease, where it is understood as a single biological entity that is experienced in the same way, by all patients with the same diagnosis. Less importance is placed on how disease is experienced and made sense of by the individual. Models of disease are simply methods of constructing reality, ‘ways of imposing meaning on the chaos of the phenomenal world’ (Eisenberg, 1977:18).

The dominance of biomedicine was starting to be questioned in the mid-to-late twentieth century. The work of McKeown and Illich, contentious at the time and still generating debate today, examined the role of biomedicine in public health. McKeown argued that the decline in mortality following the Industrial Revolution was associated with economic conditions that improved the standard of living, increasing resistance to disease (Colgrove, 2002). McKeown placed less importance on medical advancements and the introduction of public health measures, which he considered have only a marginal influence on population health. By marginalising the role of human agency in improving population health, McKeown attempted to refocus the efforts of public health to incorporate broad social conditions of populations, rather than focusing on targeted interventions (McKeown & Record 1962; McKeown et al. 1972; McKeown et al. 1975). Illich was similarly concerned with the dominance of medicine in public health. His critique of biomedicine ‘pried open the historically impenetrable vault of true belief that medicine is above critique, particularly by those who are not ‘qualified’ (Levin, 2003:925). By critiquing the increasing medicalisation of health and illness, Illich was challenging the hegemony of medicine; the growing dependence and reliance on medical technologies negated the importance of personal experience and responsibility. This, Illich argued, created further issues; ‘the medical establishment has become a major threat to health’ (Illich,

1976:3). For Illich, improved health depended on the willingness and ability of individuals to engage in self-care, rather than improvements and advancements of medicine (Bunker, 2003). Drawing on the ideas of both McKeown and Illich, Engel also criticised the biomedical model. Engel argued that because the focus of biomedicine was on the disease rather than the individual, patients were disempowered (Engel, 1977). According to Engel, the biomedical model ‘assumes disease to be fully accounted for by deviation from the norm of measurable biological (somatic) variables’ (Engel, 1977:130), neglecting to recognise the importance of wider determinants of health. This excessively narrow lens through which clinicians approached healthcare led to patients being viewed as a collection of symptoms to be treated or managed; their experience of illness was disregarded as not relevant to treatment or amenable to scientific study (Borrell-Carrio et al., 2004). Engel argued that disease does not necessarily result in illness; it can be caused by other interrelated factors that can cause illness. The oversimplification of causation has led to reductionist models of disease that do not take into account individual, cultural and social influences on health and illness. It also negates the importance of the meaning of the symptoms to the patient. This is arguably one of the most important concepts to consider when it comes to prevention and treatment of disease, particularly when trying to instigate protective health behaviour in high risk groups.

Biopsychosocial model

Engel proposed a more holistic alternative to the biomedical model; the biopsychosocial model, which recognises the psychological and social factors that contribute to a patient’s experience of illness (Engel, 1977). Engel therefore suggested that to understand and respond to patients’ needs, clinicians should encompass the biological, psychological and social dimensions of illness (Borrell-Carrio et al., 2004). The biopsychosocial model offered a new ontology for medicine; including patient experience alongside biomedical data provided a more comprehensive understanding of health and illness. Simple, linear models of disease were replaced by highly complex constructions of experiences and meanings. In this context, reductionist paradigms, where diseases were reduced to their smallest parts and understood on a molecular level, were insufficient to understand fully and explain a patient’s experience of illness.

McKeown, Illich and Engel’s enduring contribution to medicine – to broaden the clinician’s gaze – is perceived by some as a ‘transformation of the way illness, suffering, and healing are viewed’ (Borrell-Carrio, Suchman and Epstein, 2004:582). There is no doubt that the biopsychosocial model of disease is becoming increasingly popular with health researchers, with over 400 Medline titles containing the word ‘biopsychosocial’ in 2004 (Wade and Halligan, 2004), whereas a current search will yield 1070 titles in PubMed (author’s observation, July 2018).

Behaviour and public health

Reductionist, biomedical models of disease serve public health issues poorly, because of the intrinsic relationship between behaviour and health. This is particularly relevant in the twenty-first century, where the majority of the global burden of disease is associated with behavioural and lifestyle choices, such as smoking, excessive drinking and eating and physical inactivity (Marteau et al., 2012). Effective public health interventions and communication of health messages need to encompass an understanding of why people behave as they do. Why do they make certain choices about their lifestyle, what meanings do they attach to these lifestyle choices and how does this affect their interpretation and response to health messages. There needs to be a shift towards a more integrated way of viewing society and how behaviour is shaped. Behaviour does not exist in isolation, it is the result of social, political and economic structures, which influence people's health, regardless of their autonomy and choices they might make (Kelly and Barker, 2016). Abstracting behaviour from the context within which it occurs is problematic and over-simplistic, yet conventionally many behaviour change interventions and communication of health messages focus on individual behaviour.

The biomedical approach to public health is underpinned by certain assumptions about how health-related behaviour can be influenced and changed (Kelly and Barker, 2016). One such assumption, frequently used by policy makers and public health professionals, is that knowledge drives behaviour and the provision of information will change health-harming behaviour – informing people of the negative consequences of certain actions will result in behaviour change. This approach to behaviour change is based on the assumption that people engage in health-harming behaviour because they are ignorant or irrational. However, this is not necessarily the case; people often understand they are engaging in health-harming behaviour, yet find it difficult to change their everyday practices and lifestyle choices (Marteau et al., 2012). Behaviour is embedded in social practice, engrained in everyday life. Behaviours can help people define who and what they are, their identity is derived from their behaviour and in turn, their identities are created by others on the basis of how they behave. Approaching behaviour change from this perspective effectively means trying to change who people are, not just what they do. Providing people with information, however scientific or evidence-based it is, will not necessarily change people's identities (Kelly and Barker, 2016).

People can and do behave logically; just because we do not understand their behaviour it does not mean their behaviour is irrational. For the individual, their behaviour has meaning and a function, and they are knowledgeable about the decisions they take regarding their health and behaviour. Hilary Graham, in her seminal work on women and smoking, exemplified this by exploring why women with limited resources were still able to find money for cigarettes. The women in the study – who were living in difficult circumstances – explained that smoking was the only opportunity they had each day to have time to themselves (Graham, 1987). In this context, smoking cigarettes performed a function

and from the perspective of these women, was a completely rational behaviour despite the costs, both financial and to their health, associated with the activity. Dichotomies between rationalities have been highlighted in relation to numerous health behaviours, including choice of food, breastfeeding and physical activity (Kelly and Barker, 2016). Understanding these different rationalities or realities, helps us to frame the ‘risky’ health behaviour and understand its functionality. To do this we need to move beyond our taken-for-granted understandings of the world and challenge the dominant paradigms of healthcare and public health. As Kelly and Barker emphasise, ‘it is important not to dismiss the explanations people give of what they do just because the epidemiological evidence demonstrates that what they do carries a health risk’ (Kelly and Barker, 2016:113).

Social constructionism

Exploring different perspectives on health-related behaviour encourages consideration of what constitutes knowledge and the different ways knowledge is created. As a result of examining the literature on human-animal interactions and the communication of health messages, I believe that a broader perspective is needed to understand zoonotic disease transmission. A broader perspective would take into account different types of knowledge and include an understanding of how they are created. Rather than being limited to epidemiological and biomedical models of disease, as conventional public health policies have been, zoonotic diseases should be examined from the perspectives of the people affected. To gain a deeper understanding of rodent-borne diseases and how they are transmitted, we need to explore the meanings people attach to rat-human interactions and how they create knowledge about rodent-borne zoonoses.

Biomedicine sits firmly within a positivist paradigm (Baum, 1995), where the natural world is studied through observation and experimentation. There is a universal reality that can be discovered through scientific method; knowledge about phenomena is acquired from empirical evidence collected through the senses. Understanding how different groups of people create knowledge about phenomena requires a more relativist approach, where all truth (or reality) is relative to the individual. Relativism is closely aligned with interpretivist and constructionist epistemologies, where meanings are created, negotiated and sustained within societies and knowledge about these realities is created, not discovered. Meanings, understandings and categories are instead constructed within societies; they are a result of historical, social and political processes and everyday interactions. This is known as social constructionism, and is the epistemological position from which I am approaching this thesis.

The Social Construction of Reality (Berger and Luckmann, 1966), marked a turning point in understanding the nature and construction of knowledge. Heavily influenced by the German philosopher Scheler, *The Social Construction of Reality* posits a view of the world in which

knowledge and truth are created through the interaction of individuals with their social world. At the same time, the social and cultural worlds of individuals shape the world around them. The social world influences how people behave, resulting in routine and habituation, which over time, become embedded in societal, or tacit knowledge. This knowledge is institutionalised by society or different social groups, to the extent that future generations experience this type of knowledge as objective or 'true'. To gain a deeper understanding of behaviour, we need to deconstruct how this knowledge is created.

From a constructionist perspective, everything we observe is an interpretation, everything is a perception, there is no single true reality that is universal to everyone. Different phenomena can be perceived differently by different observers, as Berger put it, 'the way we see things is affected by what we know, or what we believe' (Berger, 1972). Consequently, there is no single truth, what we might think of as the truth may be very different for others. Significantly, in the context of public health, the truth for individuals can be very different from the truth for experts. These individual truths result in different realities and therefore need to be taken into account. Privileging the truth of experts, without considering these alternative realities is unlikely to result in successful behaviour change interventions (Kelly and Barker, 2016).

A holistic approach to public health research: the complementary paradigms of qualitative and quantitative methods

Qualitative research methods enable us to examine how people make sense of their social world and are ideal for studying complex phenomena, such as human-animal interactions and zoonotic disease transmission. Qualitative research is a stand-alone method of inquiry that enables us to access areas not amenable to quantitative research, but it can also provide a foundation for quantitative research, particularly in emerging fields, which have received little attention to date (Pope and Mays, 1995).

Rather than pitting these two methodological approaches against each other, recently a number of authors have spoken out for greater acceptance of qualitative approaches in health research and the integration of qualitative and quantitative methods (Greenhalgh et al., 2016). This is not a new phenomenon, as some researchers have been advocating combining methods for over 20 years: 'neither qualitative nor quantitative information can stand alone if our aim is to come somewhere close to understanding the richness of the communities we live in and how we might make them healthier' (Baum, 1995:467). Quantitative and qualitative approaches to research arise from different ways of understanding the world and how knowledge is created. They adopt different epistemological positions, yet they are complementary. Rather than viewing these methods as polar opposites, as

already stated above I chose to integrate them in the belief that ‘there is no universal right way to see the world so our methods should explore rather than deny the diversity’ (Baum, 1995: 466).

Mixed methods research is not new, however it has experienced a resurgence in recent years, particularly in public health. There have been numerous contrasting interpretations and definitions of mixed methods research since anthropologists first used ‘mixed research’ in the early twentieth century (Johnson et al., 2007).

Part Two: Methodological Approach

In this section, I outline how Grounded Theory is an appropriate methodology for a constructionist epistemology. I show how Grounded Theory has developed and how Charmaz’s method offers a pragmatic approach to Grounded Theory research. Finally, I discuss the theoretical underpinning for interviews and questionnaires and how they can be used within a constructionist epistemology.

Grounded Theory

Barney Glaser and Anselm Strauss developed Grounded Theory in the 1960s, through their research on death and dying in hospitals (Glaser and Strauss, 1965; Glaser and Strauss 1968). This led to the publication of their seminal book; *The Discovery of Grounded Theory* (Glaser and Strauss, 1967). It was developed as a systematic method to generate theory grounded in empirical data, in response to the loss of status of qualitative methods, and a shift towards more quantitative approaches in sociology (Charmaz, 2006). Consequently, they strived to develop a methodological approach that maintained its integrity as a qualitative approach, but integrated some of the strengths inherent with quantitative methods (Walker and Myrick, 2006). The resulting methodology not only retains the depth and data-richness of qualitative approaches, but also includes the logical and systematic analysis of quantitative methods. Grounded Theory helped to legitimise qualitative research methods at a time when epidemiological methods were acclaimed as the gold standard, and qualitative approaches were criticised as being unsystematic, anecdotal and lacking rigour (Charmaz, 2006).

The epistemological underpinnings of Grounded Theory are derived from symbolic interactionism. The emphasis is on eliciting an understanding of the way meaning is derived from social interactions and the implications this has on people’s behaviour (McCann and Eileen, 2003). In essence, Grounded Theory aims to develop a theoretical explanation of basic social processes (Starks and Trinidad, 2007). In Grounded Theory, researchers are particularly interested in what is important to the participants, the significance of phenomena arises out of the stories participants choose to share (Mills et al., 2006) and what we can learn about participants’ lives (Charmaz, 2006). Within a public health

framework, Grounded Theory enables the researcher to understand how health-related behaviour is meaningful for the person or people engaging in it. Grounded Theory is particularly useful for providing practitioners and policy makers with a theoretical foundation, on which to design public health interventions and messaging (Starks and Trinidad, 2007). In the context of this thesis, using a Grounded Theory approach enabled me to deconstruct the symbolism of the rat, to understand the nuanced, personal meanings people attach to this species, and how these meanings reflected, or were reflected in, individual's responses to the risk of rodent-borne zoonoses.

The central feature of Grounded Theory is the ground-up, inductive methodological approach. In theory the research is approached with no preconceived hypotheses; the researcher is open-minded and flexible (McCann and Eileen, 2003). Grounded Theory aims to generate theory, which is embedded within empirical data. Rather than traditional, hypothesis-driven research, in a Grounded Theory approach theory emerges from the data without the use of predetermined theoretical perspectives. In Grounded Theory, the data have primacy (Glaser and Strauss, 1967).

Glaser, Strauss and Corbin

Grounded Theory in its original conception was the product of two sociologists: Barney Glaser and Anselm Strauss. Glaser came from a positivist, quantitative background, while Strauss's background was in Chicago school pragmatism (Charmaz, 2006). Symbolic interactionism is grounded in the pragmatist approaches of Blumer (1969) and Mead (1934), and Strauss embraced this theoretical perspective. For Strauss, society, reality and identity are constructed through social interactions. Grounded Theory brought Glaser and Strauss together over a shared interest of understanding basic social processes (Charmaz, 2006); however, their opposing ontological perspectives eventually took Grounded Theory down divergent routes.

The belief that theory or new theoretical perspectives will emerge from empirical data is a positivistic approach to qualitative research, making the assumption that knowledge, or truth, is absolute and can be discovered (Mills et al., 2006). This contrasts with Strauss's theoretical perspective that places more importance on the socially constructed nature of reality and the significance of social interactions. While Glaser remained true to his original ideas, Strauss, working with Juliet Corbin, developed a Grounded Theory more in line with their interpretivist epistemology. Glaser's approach to Grounded Theory became known as 'classical' Grounded Theory, to distinguish it from Strauss and Corbin's approach. Strauss and Corbin believe that rather than a pre-existing reality, truth is 'enacted' (Strauss and Corbin, 1994: 279). They reject what they believe is the positivist position of classical Grounded Theory, that truth can be discovered and this truth emerges from data, which represent a single, discoverable reality (Mills et al., 2006). The evolution of Grounded Theory (Strauss and Corbin, 1990) places a greater emphasis on the researcher's position within the research and their

construction of meaning in the process. The importance of the multiplicity of perspectives and truths is acknowledged, enabling analysis of data and construction of theory that is richer, more nuanced and reflective of the context in which the research is being conducted (Mills et al., 2006).

Cathy Charmaz: a constructivist approach to Grounded Theory

Grounded Theory offers a pragmatic approach to qualitative research, providing researchers with a flexible and adaptable method to apply to their research. In *The Discovery of Grounded Theory* (1967), Glaser and Strauss highlighted the flexible nature of their new approach to qualitative research. Cathy Charmaz harnessed this flexibility in developing her own approach to Grounded Theory; '[her] version of Grounded Theory returns to the classic statement of the past century and re-examines them through a methodological lens of the present century' (Charmaz, 2006:xi). In comparison with the classical approach, Charmaz's Grounded Theory assumes there are multiple versions of reality, which emerge in different contexts, created co-constructively by the participant and researcher, rather than a single reality, discovered by a passive, neutral researcher (Charmaz, 2008). A social constructionist approach recognises the researcher's role in constructing the data, which leads to the development of theory. This approach enables exploration of what individuals construct, and how the social construction process develops (Holstein and Gubrium, 2008). From this perspective, meaning is created through an interaction between the researcher and participant (Crotty, 1998). Charmaz argues that a constructionist approach to Grounded Theory allows these questions to be developed further, by including explorations of why these constructions evolve (Charmaz, 2008). Charmaz offers a pragmatic approach to qualitative research; 'systematic yet flexible guidelines for collecting and analysing qualitative data to construct theories 'grounded' in the data themselves' (Charmaz 2006:2). This flexible approach is ideal for applied public health research using mixed methodology, particularly for the development of theory on which to design public health interventions (Starks and Trinidad, 2007).

Interviews

With any research – qualitative or quantitative – the phenomenon of interest frames the questions asked by the researchers and their choice of methods (Charmaz, 2006). Qualitative approaches provide a rich understanding of human behaviour, whereas quantitative methods can filter out some of the more nuanced aspects of behaviour, both of which help the researcher understand the phenomena in question. Unlike quantitative approaches, there is no standard systematic 'one-size-fits-all' approach for empirical qualitative research. Instead, because of the different epistemological starting points, methodological approaches and disciplinary traditions, the focus is on methodological

appropriateness for use in different contexts (Green and Thorogood, 2004). I have taken a Grounded Theory approach for my thesis, specifically following Charmaz's methodological technique. This approach is appropriate for public health research, which is trying to understand health behaviour, specifically for developing explanatory theory for the basic social processes underlying health behaviour (Starks and Trinidad, 2007).

In qualitative research, including Grounded Theory, in-depth semi-structured interviews form the empirical backbone of data collection (Campbell et al., 2013). As a method of data collection, interviews facilitate an in-depth exploration of the phenomena of interest and are often described as a 'conversation with purpose' (Charmaz, 2006). Defining qualitative interviews in this way as 'conversations with purpose' should not detract from their significance. Qualitative interviews are a powerful tool through which, as researchers, we can provide people with the space to account for their behaviour in meaningful ways, to give them a voice and to listen and try to understand how they make sense of their social worlds.

Using Charmaz's approach to Grounded Theory, interviews become a reciprocal process. I am not a neutral, passive researcher, I am part of the meaning-making (Charmaz, 2008). In this context, knowledge is co-constructed between researcher and participant (Crotty, 1998). Interviewees are not just used to gain information from, they are fundamental in the creation of knowledge (DiCicco-Bloom and Crabtree, 2006). Taking this approach to interviews means that rather than ignoring social or power dynamics in the relationship between researcher and interviewee, these respective roles shape the interview. Reflexivity, the process of self-examination of the research experience, decisions and interpretations (Charmaz, 2006), enables researchers to consider the social role of themselves and the participant and integrate reciprocity into the creation of knowledge from the interview (DiCicco-Bloom and Crabtree, 2006). Reflexivity is an important part of the research process and I consider my reflexive position as a researcher in more detail below.

Reflexivity

Reflexivity is an important part of any research process, but particularly qualitative research, as it enables an assessment of how the researcher's positionality has influenced the research process. Recognising and being explicit about this influence enables more objectivity within the research process. This is what Donna Haraway refers to as 'partial perspectives' (Haraway, 1991:183), where recognising our place within the research process and how our identity may impact on that process, results in more objective study. In this section, I outline how my identity and experiences have shaped how I view the social realities of my research participants.

I am a researcher and an academic. My academic background is primarily quantitative, having previously worked in veterinary epidemiology and currently working as an epidemiologist for PHE. Prior to starting my doctoral study, I had no experience of conducting qualitative research and I have found that the shift between these two research paradigms challenged my world views. I am also an animal lover and owner; animals have been part of my life for as long as I can remember. I include the animals I currently 'own' as part of my family, my friends and my constant companions. The animals that I currently count as 'mine', I have spent more time with, shared more experiences with and poured my heart out more to, than any other being. The relationship I have with these animals epitomises the unbroken and relentless bond that can occur between human and animal. Experiencing this unique relationship provided me with an opening, through which to approach the world of rat ownership, despite my only previous experience of rats being unwanted and unexpected encounters with wild rats on the farm where I keep my horse or in the alleyway behind my house.

I did not want to take the rat-human relationship for granted because I thought I understood what it was; however, it became apparent that although I had my own experiences of human-animal relationships, relationships with rats are unique because of the way in which the species is constructed by society. These constructions will be discussed in more detail in the results, but this realisation meant I was still able to enter participant's world as a stranger (Schütz, 1944), more aware of my own preconceptions.

This stranger status was dynamic, so although I entered their world as a stranger, this world gradually became more familiar to me. After I had conducted a number of interviews, I started to become quite protective over my participants, particularly the pet rat owners. At one point, whilst attending a meeting with public health officials, I felt I needed to defend them, advocating for them in the same way they advocate for this species that experiences so much stigma. I realised that I was starting to take the rat-human relationship for granted, which could influence my ability to analyse critically my data. Conducting interviews with farmers and pest control technicians alongside rat owner interviews helped me take a step back and maintain my sensitivity towards the constructed nature of the species and different relationships with them. In addition, the interview I did with the rat owner who contracted Seoul hantavirus from her pets served to remind me that zoonotic diseases do not respect the boundaries we create around them.

In retrospect, before starting my doctoral research, I now realise that I privileged quantitative data over qualitative data, expert opinions over lay beliefs and elevated scientific evidence as the only real reflection of 'truth' about different phenomena in the world. I understand now that this epistemology limited how I constructed my social world. Looking back, I was probably quite judgemental of people who did not follow health advice, or who engaged in health harming behaviour. I would see these behaviours as ignorant or irresponsible, rather than trying to understand the reasons behind why they

were engaging in these behaviours or held these beliefs. Perhaps hypocritically, I never really scrutinised by own behaviour when it came to making decisions about my own health, or the health of my pets. I certainly never considered my pets or interactions with animals to present any risk to my health, or if I did, I would dismiss them as insignificant in comparison to the benefits I gained from the human-animal relationship.

As my research progressed, my views began to shift. As my data became more complicated, I became more aware of the complexity of behaviour, relationships and decisions. This helped me with the analysis of my data, by encouraging me to move beyond my taken-for-granted understandings of this new world I was exploring. This has hopefully produced more nuanced analysis and findings that offer a meaningful insight into the worlds of my participants. This experience of undertaking qualitative research has also fundamentally changed me as a person, how I view the world and the people in it. This doctoral research has been a humbling experience, which will have a fundamental and enduring impact on my life.

Questionnaires

Public health research has to both understand and describe populations of interest. To do this effectively requires both qualitative and quantitative approaches (Baum, 1995). I have previously discussed that integrating qualitative and quantitative methods places equal importance on both approaches; qualitative methods are not simply an additional aspect of a larger epidemiological study, they are integral to designing high quality quantitative methods. Consequently, phase two of the research was designed based on the findings from phase one.

The aim of phase two of the study was to explore what action pet rat owners took to reduce the risk of disease transmission and to determine the motivators and barriers towards these actions. In addition, the cross-sectional study explored some of the key themes arising from phase one, in a larger sample population. Cross-sectional studies are used to describe the prevalence of health outcomes or determinants of health (Coggon et al., 1997). In addition, relationships between determinants of health, such as demographics and outcomes of interest, such as specific health-related behaviour, can be explored to determine if there are any significant associations. Questionnaires are one of the main data collection tools used in social, health and epidemiological research (Bowling, 2005), therefore this was deemed the most appropriate method. Minor changes in question wording, order or response format can affect the results obtained (Bowling, 2005), therefore it was essential to pilot questionnaires on a small sample of the target population prior to the questionnaire being distributed on a wider scale.

Limitations of questionnaire-based studies

Questionnaire surveys are subject to a number of biases, particularly when investigating attitudes and behaviours. Self-reported behaviours may not necessarily reflect actual practice, resulting in response bias or social-acceptability bias. Response bias is a systematic distortion in how questions are answered and is particularly problematic in public health research, where surveys can be used to explore socially unacceptable or stigmatised behaviour (Sedgwick, 2013). Discrepancies between reported and actual behaviours have been observed in health-related research, for example infection control practices in healthcare workers (Jenner et al., 2006), over reporting of physical exercise intensity and frequency (Brenner and DeLamater, 2014; Sallis and Saelens, 2015; Shephard, 2003), smoking status (Graham and Owen, 2003), and risky sexual behaviour (Morisky et al., 2002). This is why it is particularly important to use mixed methods approaches when exploring health-related behaviour.

Part 3: Methods

This section sets out how I undertook the research. Firstly, I describe how study participants were recruited for each group and how data were gathered. I then go on to describe how the qualitative and quantitative data were analysed.

Introduction

From the outset, this study intended to focus on three groups, all of which have different types of interactions with rats, putting them at-risk of rodent-borne rodent borne zoonoses to different extents. The three groups are pet rat owners, farmers and pest control technicians. These groups were initially identified by PHE as potentially at-risk of hantaviruses, following cases being reported in both farmers and pet rat owners. The seroprevalence study conducted by PHE identified pet rat owners as the group with highest seroprevalence (34%), and so formed the focus of my thesis. The other groups in the seroprevalence study had much lower prevalence rates (ranging from 1.7–3.3%), and both farmer and pest control technician groups had lower prevalence rates compared with the control group (randomly-selected blood samples). It may appear inconsistent to include these groups in the study if they were at no greater risk of hantaviruses compared with the general population, despite the potential for contact with rats and being exposed to the environments rats live in. Putting the development of this study into context may help to clarify why these groups were chosen. At the time the idea for this thesis was conceived (2014), there was a lot of interest in farmers' exposure to hantaviruses. The prevalence in the PHE study was low, however Jameson *et al.* (2014) had just published research focusing on farmers, which observed a higher prevalence of 7.6%. There was an

expectation that farmers were at-risk of the virus, particularly if the virus was undetected or unreported. The prevalence of the virus in the wild rat population was, and remains, unknown, but as a population that potentially comes into contact with rats, or rat-infested environments, this meant farmers were a population of interest. They also presented a group that were expected to have a completely contrasting understanding of and relationship with rats, therefore provided an alternative population to compare with the pet rat owners. Similarly, pest control technicians had a low prevalence of hantavirus according to the seroprevalence study (Duggan et al., 2017), and with no reported cases in this group the available evidence does not establish them as a high-risk group. The role of the pest control technician was unique in that they come into contact with rats and the environments rats inhabit, which means they are at-risk of transmission, but they also play an important role in preventing and managing hantavirus cases. They effectively bridge the gap between public and professional, therefore provide a very different perspective from which to explore constructions of rats and health and disease. All three groups in this study are potentially at-risk of any rodent-borne zoonoses, so while PHE were particularly interested in hantaviruses, in this thesis I am concerned with any rodent-borne diseases that participants raised in the interviews.

Recruitment

Pet rat owners

Prior to starting this doctoral research, I had no personal experience of pet rats; I felt like a stranger entering a new world. One of the first things I did to try to understand this new world was to attend a pet rat show. I did this before I started undertaking any interviews, so I could approach it and develop a general impression, without any preconceived ideas about what I might expect to observe.

It was at this show that one of the attendees mentioned that the National Fancy Rat Society (NFRS) maintained a list of registered breeders and ratteries. I thought this would be a good place to start with recruitment. Initially, I contacted three registered breeders in north west England by email, with a brief overview of the research and what was involved with participation. In addition, a more detailed participant information sheet (Appendix 2i) was attached to the email, detailing the purpose of the study, why they had been contacted and the interview process. Participants were encouraged to discuss the study with friends and family and to contact me with any questions or concerns prior to making a decision about participation. Following this initial process, one breeder contacted me interested in taking part in the study; I interviewed this person in September 2015.

In line with a Grounded Theory approach, I spent considerable time analysing the data from this interview, discussing codes and ideas with supervisors, prior to commencing the next interviews. During this time, my first participant also acted as an informal gatekeeper, introducing me to other pet

rat owners who might have been interested in taking part in the study. I was also invited to some of the local rat shows so I could talk to people about participation in my study, and hand out information leaflets for recruitment. I found recruitment quite a difficult process to judge, particularly during the initial stages of the research, not knowing how long it would take to analyse the first interviews.

I set up a study Facebook page, which I called 'A Tale of Two Rats', which acted as the public-facing side of the study (Appendix 2ii). This initially acted as a point of information and contact for people interested in taking part, but slowly developed into a platform for sharing stories and information about rats, and in later stages of the research, for disseminating findings. This website also had a vital role in recruitment for the cross-sectional study and provided the main route of disseminating the online survey. Through a combination of snowball sampling, social media and gatekeepers, I interviewed seven pet rat owners.

Two participants were NFRS registered breeders, one of whom had approximately 30 rats at the time of the interview. Three participants were pet rat owners and owned between four and 10 rats each. One participant owned pet rats previously, but did not have any at the time of the interview (but had the responsibility for caring for pet rats as part of her job). One participant contracted Seoul hantavirus in 2016 from her pet rats.

Farmers

Recruiting farmers for the study was a completely different experience. Rat owners often relished the opportunity to talk about their pets with someone from outside the pet rat community or their immediate social network. This gave me a form of external legitimacy and their interest in rats meant they were also interested in the research I was conducting. My approach to recruiting farmers had to be very different and I initially struggled with the process. I was aware that my position as a researcher would mean that it would be harder to build a rapport with farmers; I do not come from a farming background and have limited contacts in the local farming community. In the early stages of recruitment, a gatekeeper was essential for contacting farmers. A farm vet who was working in the same university department as me offered to put me in touch with some of his farm clients and these clients became my first farmer interviewees.

Aware that I did not want to 'overuse' my gatekeeper, I was keen to become more self-sufficient in recruiting farmers. After approaches to local National Farmers' Union representatives were unsuccessful, I created an information leaflet (Appendix 2iii), which I circulated online and through local agricultural colleges. In recruiting farmers for my PhD, I struggled to recruit farmers through 'cold calling'. I think this was because framing the research in terms of how rats affect health and wellbeing, was too abstract and farmers struggled to understand the importance of the research.

Instead, I shifted the focus of recruitment and highlighted how farmers would be helping me as a student. This approach yielded a number of offers from farmers, three of whom stated they had children or other family members who were currently studying so wanted to help me as a student. Overall, I conducted seven interviews with nine farmers (including two couples).

Pest control technicians

Recruitment of pest control technicians required a different approach from that which I adopted for farmers and pet rat owners. I started by making a list of local pest control companies, using the British Pest Control Association website, limiting my search to north west England. I also included local authority pest control departments. Named contacts using the public address pages of these companies were emailed with a brief overview of the study, plus the participant information sheet (Appendix 2iv). As with the farmers, this approach was not successful with pest control technicians.

Subsequently, I was provided with a list of contacts from the PHE serosurveillance study. These contacts included organisations and people who were involved with the hantavirus seroprevalence study, which PHE conducted in 2013–2014. The contacts were people who had requested to be contacted by PHE with results from the study and their contact details were all publicly available online. The list included water companies, industry magazines and the National Pest Control Technicians Association (NPTA). After contacting these organisations by email, a member of the NPTA contacted me, keen to take part. This participant was also responsible for organising national training events for pest control technicians and invited me to attend a local event to talk to attendees about my research. Over the course of the recruitment phase, I attended two such meetings, presenting an overview of my research to a room full of pest control technicians. I was initially a little sceptical about how they would respond, but I was overwhelmed with people interested in taking part. I had a queue of technicians wanting to talk to me about their work and each one of them had a “horror” story about rats to share. These meetings were not only vital for recruitment, but also formed part of my field notes.

Pest Control News, an independent trade magazine that is distributed to all industries relating to pest management printed an article about my research, which encouraged technicians to contact me if they were interested in taking part. This generated a lot of interest; however as a national magazine this meant I had technicians contact me from all over the country. I was trying to keep interviews within the north west of England to minimise travel time and costs, however I did travel to southwest England for one interview with a female pest control technician. All the other interviews I conducted with pest control technicians were with men, and as a male-dominated industry, I thought it was important to gain insight from a female perspective. In total, I conducted seven interviews with seven

technicians, plus a technician's partner. This brings the total number of interviews to 24 across all three groups.

Interviews

Ethical considerations

Undertaking in-depth interviews as part of a research study presents a number of ethical challenges. Interviews provide rich, nuanced data and enable a direct and personal relationship between researcher and participant. This relationship needs to be handled with care and respect, to ensure participants are protected throughout the research process. Interviews provide a space within which personal stories and experiences are rendered visible, these stories may not have been shared elsewhere, therefore maintaining participant confidentiality was a major ethical concern for the qualitative phase of the study. As detailed in the application I made to the Veterinary Research Ethics Committee of the University of Liverpool (Appendix 2v), standard procedures were implemented to ensure confidentiality was maintained. For example, contact details for participants were stored on a password-protected computer and synonyms used for names of participants or any pets they discussed in the interviews. Protecting research participants' privacy is more complex than implementing these standard procedures and this became more apparent as the study progressed and I became more familiar with the fancy rat community. The fancy rat world is small and many people know each other, if not in person then through the reputation of the rats they breed or own. This presented some difficulties in maintaining confidentiality, particularly when participants were sharing experiences of events that were 'public knowledge' within the community. In one of the interviews I conducted the participant had contracted Seoul virus from her pet rats. The small number of reported cases of hantaviruses in pet rat owners meant that this participant could potentially have been identified by others. This participant had already identified herself publicly, prior to the interview, through a magazine article she had written about her experiences (Appendix 2vi). As such, although I strived to maintain confidentiality by following the study protocol by maintaining confidentiality and using a pseudonym, I was aware that this participant had essentially made the decision to break confidentiality herself, prior to her involvement in my research.

As the researcher conducting the interviews, I felt the moral responsibility to be sensitive to the lives of the people I was interviewing (Benzies and Allen, 2001). As the interviews progressed, the weight of this responsibility became more apparent, as I became more aware of the potential for the interviews to elicit emotional distress, particularly when participants were sharing deeply personal and emotional experiences. A part of the ethical approval for the research, a procedure was put in place to deal with any distress arising from interviews (Figure 2, Appendix 2vii). In addition, a number of

participants shared with me that they actually welcomed the opportunity to share their stories with someone from outside their immediate social community and enjoyed the experience of an ‘outsider’ taking an interest in their world. This was particularly evident with the pet rat owners, where they often felt unable to talk about their pets to non-rat owners. In this respect, the benefits of participating in the research may have outweighed any potential harms to participants.

An additional concern was that interviews may raise concerns or questions regarding rodent-borne infections and risk to personal health, which participants may not have considered prior to interview. This was particularly relevant as hantaviruses had been identified as an emerging zoonosis, suggesting that general awareness of the viruses might be low. As a precaution to minimise this potential risk, a number of resources providing information about rodent-borne diseases were made available to participants. These included an information leaflet from PHE on reducing the risk of human infection from pet rodents (Appendix 2viii) and information leaflets from the Health and Safety Executive on rodent-borne infections, including hantaviruses and leptospirosis (Appendix 2 ix). These were made available to participants on request after the interview, along with the contact details for a number of external organisations that would be able to offer professional advice.

Interviews

Qualitative, semi-structured interviews were conducted with participants between September 2015 and June 2017. Prior to interviews taking place, all participants were provided with a copy of the participant information sheet. Informed consent was obtained prior to interviews starting; participants were required to confirm they understood the nature of the research, and had been given the opportunity to discuss their participation in the study with family and/or friends. In addition, participants were given the opportunity to ask any questions and confirm they consented to the interview being recorded (Appendix 2x). The process of informed consent also included the participant’s right to withdraw from the study, up until the point their data were included in the analysis, and clarifying how their anonymity would be preserved.

I developed an interview guide that gave participants the space to share their stories and experiences as they saw fit, while focusing their responses to ensure I was able to answer my research question (Appendix 2xi). In line with Charmaz (2006), a small number of broad, open-ended questions were devised, which I used flexibly as the interviews progressed. Opening the interviews with a broad question was intended to build rapport and put the participants at ease. The interview guide included an exploration of the participant’s social identity, their relationship with rats and the meanings they attach to them and how they construct ideas of risk in relation to rodent-borne diseases. Revising and adjusting my interview guide allowed me to explore topics pertinent to the research question, as well as pursuing new themes as they emerged from the interviews. Charmaz (2006) suggests that

unanticipated stories that emerge from interviews can be immediately pursued, which helps avoid the tendency to focus on preconceived ideas.

The experience of conducting and analysing my first qualitative interview confirmed this was a skill that takes time and practice to hone. As a novice qualitative researcher, I found the process of analysing each interview as I went along and revising my interview guide to include new, unanticipated leads helped me clarify what I was trying to address in the interviews. This process also helped me to become more sensitive to the nuances of the language used by the participants to share their stories, enabling me to pursue unexpected topics when they emerged during the interviews. As the study progressed and I became more confident with the process, I found I was relying less on the interview guide and could focus more on what the participants were sharing with me, following leads and probing statements of interest to the research.

The majority of interviews took place at the participant's homes. A small number were conducted at participants' place of work; two interviews were conducted at The University of Liverpool, and one in a public café at a service station. Interviews lasted between 40 and 90 minutes. All interviews were recorded using a digital voice recorder and transcribed *verbatim*. I transcribed a number of interviews myself, but the majority were transcribed through a professional transcription company. I listened to all interviews after they were transcribed, to correct for any errors. This also formed the first stage of my analysis.

Reflexive diary

Interviews formed the majority of the data for the qualitative phase of the study, however I also kept field notes, which informed the later stages of my analysis. Following each interview, I reflected on how the process unfolded. These notes covered a description of the context of the interview, the participants' demeanour, any non-verbal interactions, and my immediate interpretation of the interview. I attempted to write notes as soon as possible after each interview, more often than not I wrote these notes while sat in my car before driving back to the office. On the few occasions I did not write the notes immediately post-interview, I found my reflections were not as deep or thoughtful. In addition to reflections about the interview, I also kept notes on any relevant meetings, conferences, workshops or shows I attended. These included pet rat shows, pest control technician training events and a key workshop on hantavirus, at which I was presenting some preliminary findings. Delegates were from PHE, Public Health Wales, Defra, the Animal & Plant Health Agency, and the University of Liverpool. As well as making general notes on the events and the presentations and subsequent discussions, I also recorded notes on any informal conversations I had during the workshop. As I was transcribing the interviews (or checking the professionally-transcribed interviews), I kept my field notes next to me and noted down any thoughts or observations from the interviews. In doing so,

transcribing became part of the analytical process. It acted as a route in to begin to discover what the data were telling me about rats and rodent-borne diseases.

Cross-sectional study

Questionnaire design

The cross-sectional study focused on pet rat owners and aimed to gather baseline data on the nature of the pet rat owning population, describe and define health-related behaviour and test some of the theories developed in the first phase of the research, in a larger sample population. The qualitative interviews conducted during the first phase of my research informed the design of the questionnaire. Sections in the survey included; rat demographics and management, human-rat attachment scale; human-rat interactions; pet rat shows; rat health; owner demographics (Appendix 2xii, Table 3; Figure 2). Questions were designed to make them easy to answer and encourage completion of the survey. A combination of tick box, multiple choice, Likert scales, drag and drop and open-ended questions were included. The survey was designed in Qualtrics (Provo, UT, United States), an online survey tool that provides a platform on which to develop intelligent, interactive online surveys. Qualtrics also supports smartphone technology, allowing participants to access, complete and submit their responses via their mobile phone.

The questionnaire was initially piloted internally at The University of Liverpool, with staff and other postgraduate students who had experience of questionnaire design. I also piloted it with some of the participants from phase one. This was a particularly useful process, which led me to change the language and options provided for some of the questions. For example, the questions about rat health problems and diseases did not initially include enough options, however even following extensive piloting and reviewing of these questions, there were still a number of comments from respondents that not all diseases were covered. A copy of the final survey is included in Appendix 2xiii.

Dissemination

The questionnaire was designed to be disseminated online, so there was no limit to the number distributed. The main method of dissemination was via social media, where I had a cohort of rat owners signed up to the study, who had already expressed an interest in taking part in the survey. The study was also advertised in print media, the NFRS magazine, where it appeared alongside an article about the study. The limitations of using an online platform for surveys is that it is not possible to record a response rate or send out reminders to non-responders; however, Qualtrics software automatically records metadata, such as how many people started and completed the questionnaire.

This enabled a dropout rate to be calculated. The software also records the time taken for each respondent to complete the survey, which was particularly useful for the piloting phase.

Sample size calculations determined that information from 383 respondents was required for an expected prevalence of 50%, with a precision of 3%, assuming a 95% confidence interval and 80% power. This sample size would be sufficient to identify an odds ratio of 2 or greater when the prevalence of any given outcome of interest exposed to the evaluated risk factor was at least 20%. Data were automatically saved in Excel (Microsoft, Corporation, Redmond, WA, United States) and stored securely for further analysis.

Analysis

Interviews

Grounded Theory provides systematic, yet flexible guidelines for researchers to adapt for their own research (Glaser and Strauss, 1967; Charmaz, 2006). I took a Grounded Theory approach with my analysis; embracing the flexibility of the method while staying true to the characteristics that set Grounded Theory apart from other qualitative analytical techniques; induction, deduction and verification (Charmaz, 2006). I initially coded interview transcripts by hand, and subsequently transferred coded interviews into NVivo v11 (QSR International, Melbourne, Australia) to store and manage the data.

The process of qualitative data analysis has been described as a discussion between data, theory, memos and the researcher (Backman and Kyngäs, 1999). This discussion fragments the data, reconceptualises and reassembles them to offer new perspectives on the phenomena of interest. Charmaz (2006) focuses on two main stages of coding; open coding and focused coding. I found that during the analytical process, I underwent a third phase; theoretical coding. Other qualitative researchers using a Grounded Theory approach have also described a three-stage process, for example (Russell, 2014). I found I could relate to Russell's description of the process, because rather than using abstract terms such as 'open coding' and 'focused coding', which are not particularly meaningful to a novice qualitative researcher, she used gerunds to describe the different stages. In a way, this described not just what I should be doing, but what I should be *experiencing* during the analysis process, which was reassuring during the first few interviews I coded. Below, I describe the processes I went through for each stage of my analysis, using the three phases, as described by Russell (2014); waiting and trusting, reflexing and owning, ruminating and obsessing.

Waiting and trusting (open coding)

I initially coded interviews line-by-line, using an open coding approach. During this stage, I had to trust in the concept of emergence (Russell, 2014); trust requires believing that theoretical codes will develop, as each line of data is coded. For this process, I assigned labels to each fragmented segment of data, to categorise and sort them (Charmaz, 2006). Waiting and trusting in the process of line-by-line coding also meant I had to relinquish control over the direction the analysis took (Russell, 2014). The aim of open coding is to remain close to your data, see the nuances in it and remain sensitive to all possible theoretical directions the data may take you (Charmaz, 2006); relinquishing control enabled me to do this.

Line-by-line coding may seem like an arbitrary process, as not every line contains data relevant to the research. It is, however, a useful heuristic device, particularly for a novice qualitative researcher such as myself, coming from a quantitative background where the logic of statistical analysis conflicts with qualitative analysis. Line-by-line coding helped me move beyond my assumptions and preconceived understandings of the world of my participants, to become more sensitive to what my data were telling me. I was able to identify subtle concepts and form ideas from fragments of data that I may have disregarded if undertaking general thematic analysis (Charmaz, 2006).

In this first stage of analysis, a list of codes was developed. Memos on emerging ideas and possible relationships between codes were kept alongside these initial codes and used as a basis for the later development of core themes. At this stage, codes were provisional and subject to change following discussions with my supervisors and undertaking further interviews. The discussions I had with my supervisors were vital in helping me identify gaps in my analysis, which helped me focus subsequent interviews and analysis, as I gained a better sense of the phenomena that was emerging.

Reflexing and owning (focused coding)

As my analysis became more focused, I began to assemble codes that represented similar concepts into conceptual categories (Armitage et al., 2017). To do this, I used the memos and notes I had made during the initial stage of coding. When the codes began to make more sense, I returned to earlier codes and transcripts to explore data that I may have initially overlooked (Charmaz, 2006). In doing so, my coding became iterative, within and between interview transcripts, using the technique of constant comparative analysis (Glaser and Strauss 1967).

It was important to be reflexive during this stage, as reflexivity and awareness of my positionality enabled me to overcome any predetermined ideas about my analysis and remain open to what my data were telling me (Glaser, 1978). Russell notes that the process of reflexing and owning enabled her to privilege her data over her previous studies and professional experiences, these ‘quickly became

secondary to [her] intrigue with the data' (Russell, 2014:44). Similarly, as the analytical process evolved, I was becoming more immersed in my data.

Coding is an evolving process, unanticipated ideas or theories can emerge from the data and can keep emerging during the analytical process (Charmaz, 2006). Through interrogating the relationship between different codes, core themes or theoretical codes began to emerge from the data. These codes would form the basis of my Grounded Theory. I stopped coding and interviewing when no new ideas emerged; I knew at this point I had reached data saturation.

Ruminating and obsessing (theoretical coding)

Theoretical coding explores relationships between categories developed during the focused coding stage (Charmaz, 2006). This process uses the fragmented segments of data from earlier stages to 'weave the fractured story back together' (Glaser, 1978:72). I returned to the technique of constant comparison during this phase, which Russell likens to ruminating; 'going over the data repeatedly, contemplating it' (Russell, 2014:45). In common with Russell (2014), I found myself obsessing over my codes and theoretical categories. The obsessive nature of qualitative analysis was noted by Glaser, when he described analysis as a 'transition from input into depression and out through writing memos' (Glaser, 1978: 24). This process of immersion in the data prior to the emergence of new theories is what Glaser described as a 'drugless trip'. To focus and ground myself during this process, I turned to theoretical literature, specifically the work of Mary Douglas (Douglas, 1966), to help focus my analysis with 'a sharp analytical edge' (Charmaz, 2006:63). This enabled me to construct conceptual models to theorise how each group understood rat-human interactions and the potential risks they posed.

Cross-sectional study

Microsoft Excel was used to manage the data; this included removing any duplicates or incomplete records. Possible duplicates were identified through having identical Internet Protocol (IP) addresses. Initially, 20 records were identified with the same IP address. Using the personal identifiers from each record, I was able to determine if these were duplicate records or two separate respondents submitting a survey from the same IP address. Personal identifiers included email address, occupation, number of rats owned. Through this process, six records were identified as duplicates and removed from the database.

In total, there were 580 responses, however 11% (n=64) of these were either blank or incomplete. Blank records were records that contained no data except the metadata that were automatically entered by Qualtrics, i.e. IP address. Incomplete records were those that contained more than 80%

missing data. These records were removed from the dataset, leaving a useable total of 510 responses. Data were sorted and categorised in Excel, before being imported into R v3.2.2 (R Core Team, 2015) for further analysis.

Statistical analysis

Demographics

The sampled owner population and their owned rat population was described using descriptive statistics. Proportions were calculated for categorical data; median and interquartile ranges (IQR) for continuous data.

Risky behaviour

Three key variables were identified as potentially increasing the risk of zoonotic transmission between pet rat and owner, or transmission of diseases within the pet rat population. These were: practising 'rodentistry' ('rodentistry'; where owners allow their pet rats to clean their teeth); attending rat shows, either with or without pet rats ('attending shows') and; temporarily looking after other people's rats, either friends rats, rescue rats or rats for breeding ('visiting rats'). 'Rodentistry' was identified as an important risk behaviour for transmission of zoonotic diseases. Attending shows and 'visiting rats' could potentially increase the risk of disease transmission within the pet rat population.

Screening of variables and their association with these outcomes was performed using univariable logistic regression. Continuous variables were assessed for linearity and categorical variables used where the linear assumptions were not met. Variables with $P < 0.2$ were considered for inclusion in a multivariable logistic regression model, built using a step-wise backward elimination procedure. Variables remained in the model if they significantly improved the fit (likelihood ratio statistic $P \leq 0.05$). Two-way interaction terms between all variables retained in the final models were assessed. Goodness-of-fit of the final models were assessed using the Hosmer-Lemeshow test statistic.

For Likert-scale questions, Chi-square for trend tests were used to identify associations between the three outcomes of interest ('rodentistry', 'attending shows', 'visiting rats') and other variables. These included rat care and management; rat-human interactions (including the pet attachment scale); perceptions of the risk presented from different types of rats and pets; perceptions on rat shows; perceptions of the risk, preventability and severity of different diseases and health conditions affecting rats (including a number of zoonotic diseases). Statistical significance was set at a value of $P \leq 0.05$.

Summary

This chapter has addressed the key epistemological and methodological considerations of the research, setting out the social constructionist approach I used and why Grounded Theory was an appropriate methodology with which to undertake the qualitative phase of the research. I have also argued that the quantitative phase complements, rather than contradicts, the qualitative methodology. In line with constructionist research, I have considered how I influence the data I collected and its subsequent analysis. This chapter has provided an understanding of why and how the data were obtained, and leaves us ready to explore the key findings, which are presented in the following chapters.

Chapter Three

Understanding rats from different perspectives

Chapter Three: Understanding rats from different perspectives

The findings encompass three chapters, the first of which explores how rats are constructed from the perspectives of pet rat owners, farmers and pest control technicians. The following chapter then explores how these constructions of rats relate to perceptions of risk and health. The final chapter examines the implications of different constructions of the rat for infection control practices.

Part One: Pet rat owners

In the literature review, I examined the different historical, social and cultural layers that contribute to contemporary attitudes towards and interactions with rats as a species. I demonstrated how, over time and in different cultures, rats have acquired different meanings for different people, but within the Western imagination they are predominately seen as vermin. Rats were first domesticated over 150 years ago by the Victorians and have been kept as pets ever since, yet it is difficult for them to shake off their vermin status. By keeping rats as pets, people are bringing what is primarily thought of as a pest, with deep-rooted associations with dirt and disease, into the private space of a home. For non-pet rat owners, the rat in the home is out of place; not only are wild rats considered vermin, the rat as a pet also has the identity of an outsider animal. This status has consequences for both the animal and its owner.

Human-rat relationship

Identity

In viewing animals as pets, they acquire a status that sets them apart from many other animals. In the case of pet rats, this shift in status also sets them apart from animals of the same species. The process of an animal acquiring the status of ‘pet’ requires a relationship or bond to develop. In common with the relationships people have with other companion animals, pet rat owners articulated their human-rat relationship to be kin-like, describing their pets as part of their family:

“I’m an animal person. For me, I just see them as part of my family.” (Rosie)

This quote also demonstrates how these animals are not just a member of the family, they also become part of the owner’s identity, or there is an aspect of their identity that means they are incomplete without the relationship they have with their pet rat. Some rat owners noted that certain aspects of their own identity attracted them to the species as a pet:

“I think if you’re going to have pet rats, you’ve got to be...almost one of two things. You’ve got to be very open minded and very questioning, which tends to lends itself to people that love science, cos then you don’t assume that they’re vilified evil, vermin. Or then you’ve got to be somebody that likes that sort [of] vilified, evil vermin.” (Claire)

This enabled them to look beyond how the species has been historically, socially and culturally constructed, to the animal beneath. Rat owners are aware of the dominant paradigm surrounding rats and the contested status they have as a companion animal. In some cases, pet rat owners are going beyond the assumptions of others and are choosing this species as a pet, not despite their contested status, but because of it:

“I’ve always sort of voted for the underdog, and I think that’s why I like rats. Because people have been so brainwashed about them and they know nothing. Because society says they are bad and evil and disgusting, dirty things.” (Sonia)

Data from the survey revealed that nearly all respondents considered their pet rats to be part of their family, either very much (83.2%, n=422) or quite a bit (13.0%, n=66). A very small proportion (0.4%, n=2) stated they did not think of their pet as part of their family (Figure 3.1).

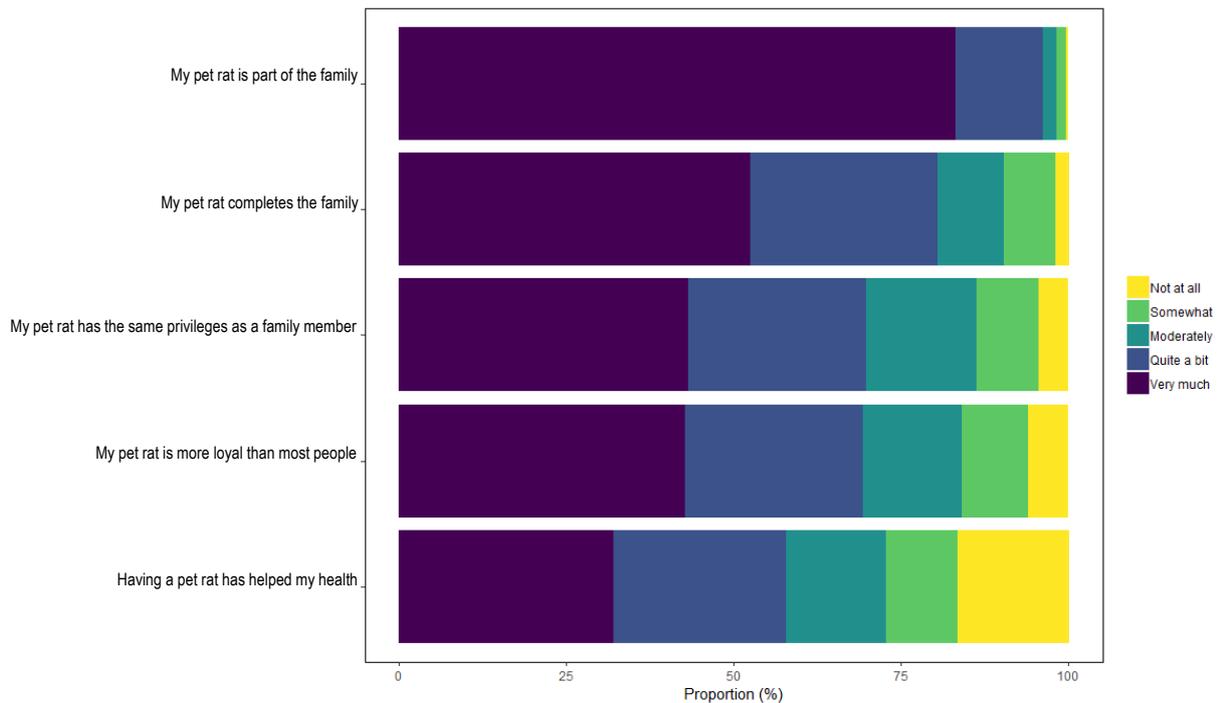


Figure 3.1: Owner perceptions of rat-human relationships from a cross-sectional survey of British pet rat owners (n=510).

The relationship owners had with their pet meant that pet rats were ‘in place’ within the home. In the survey, rats usually had access to one or more rooms in the home, including the living room (34.2%), bedroom (28.9%), bathroom (12.8%) and kitchen (9.6%). The importance of the owner-rat relationship was also demonstrated in the level and type of interaction between rat and owner, with the majority of owners interacting with their rats more than twice a day (64.0%, n=302), for between 1 and 2 hours each occasion (51.2%, n=241). The intensity of the relationship between owner and rat was highlighted by the type of interactions; all respondents let their rats climb on them, 96.4% kissed their pet rat and 36.7% of respondents practised ‘rodentistry’, where they let their pet rat ‘clean’ their teeth¹⁰.

In the interview with Richard, it became clear that pet rats were such an important part of his identity that he would forgo his own health and the health of his partner, to have rats in his life. Richard explained that initially, the couple had decided not to keep pet rats anymore, as his partner was too allergic to them. Richard however, ‘*couldn’t live without them*’ and continued to keep rats as pets. When questioned further about how living with the rats affects them, Richard explained:

“The worst effect, the worst allergy was the wheezing, we both use to wheeze quite a lot and I was ok with blue inhalers, but [my partner] wasn’t, she was finding it quite difficult to breathe sometimes, you know.” (Richard)

This is a stark example of how important rats are to individual identity and how the human-animal bond is often so strong that people will make considerable sacrifices to enable them to continue keeping that relationship in their lives, even to the detriment of their own health. This example of sacrificing personal health for their pet rats also reflects how owners privilege rat health over their own, a concept that will be discussed in more detail in the next chapter.

Rodentistry

Practising ‘rodentistry’ is controversial in the pet rat community, with divergent views on how acceptable it is. In one of the interviews with a pet rat owner, who also bred rats for pets, ‘rodentistry’ was raised as a potential risk to both the owner and rat’s health:

¹⁰ ‘Rodentistry’ is where pet rats cleans their owner’s teeth, nibbling and licking away any remnants of food. A social behaviour in rats, for some owners it is part of the bonding process as they become more accepted by their rats as ‘one of them’.

“I obviously come home to people who haven’t necessarily had rats before. I talk about reasonable precautions like washing your hands, not letting them near your food. Not letting the rat put their head in your mouth, which unfortunately is quite common in some places. It’s not something I’m a big fan of. I know that rats eat their own poo. It’s an important part of their nutritional balanced diet, but I’d rather not let it go near my mouth really. And it’s kind of for both our health really. I mean, a rat could make a mistake and accidentally nip my tongue. My natural reaction, even if you want to avoid it, could hurt the rat.” (Claire)

In the survey, people who bought their pet rats from a pet shop were more likely to engage in ‘rodentistry’. In people who practised ‘rodentistry’, 70.1% bought their rats from pet shops, compared with 51.9% who did not engage in ‘rodentistry’ (Odds Ratio [OR]=2.7, $P<0.001$). Respondents who practiced rodentistry were also more likely (45.9%) to keep their pet rat in their bedroom, compared with those who did not practice rodentistry (32.4%; $P=0.006$).

Outsider identity

Rat owners talked about themselves and their pets experiencing discrimination because of the contested status of rats as pets. Rat owners felt unable to talk about their pets with people from outside the pet rat community, because rats are not conventionally considered to be companion animals:

“I think it’s partly, you know, they are an outsider animal. You can say . . . to people ‘I have a cat’ or ‘I have a budgie’, you don’t get a reaction but rats . . . they’re still not completely accepted.” (Sara)

The contested status of rats as pets has led to the construction of a companion animal with an ‘outsider status’. Parallels can be drawn with the liminal status of wild rats; living on the literal and conceptual boundaries of human civilisations, rats as companion animals are still not quite ‘in place’ for some people. Rat owners also perceived they were being judged because of their choice of pet:

“Some people still think you’re a massive weirdo for having rats in your house.” (Rosie)

Pet rats were also thought of as outsider animals from the perspective of veterinary care, with owners noting there was not the same level of expertise available for rats as there was for other companion animals:

“I think they have fallen between the cracks in a way.” (Sara)

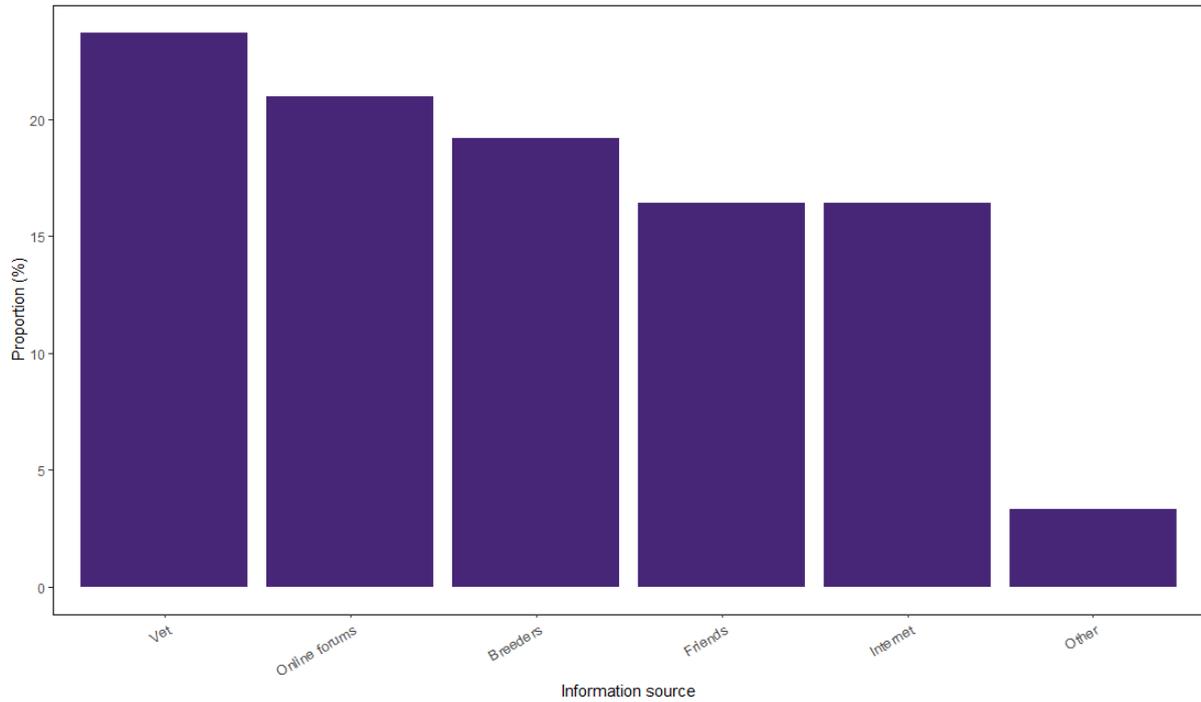


Figure 3.2: Owner-reported sources of information for veterinary advice in a sample of British pet rat owners (n=510).

Owners would sometimes travel a considerable distance to visit a vet they considered to have enough expertise in the species to be able to treat them in the way they wanted. According to the owner survey, the factors affecting decision-making regarding choice of veterinary practice were most frequently previous experiences (25.6%, n=261) and reputation of the clinician (24.8%, n=253). Interestingly, 23.7% of respondents stated their vet was the main source of information of healthcare advice, with 21.0% stating they would use online forums and 19.2% referring to breeders (Figure 3.2). Conversely, some owners articulated tensions around their own decision making regarding veterinary treatment of their pet rats, because of the status rats have in society:

“Maybe it’s the whole stigma of it’s only a rat? That’s embedded in the head, that makes you think, I can’t spend £100 on a rat. Whereas I could spend it on my dog or my cat. And this is this age old thing that rats are vermin and they’re dirty and they carry diseases and I feel the same about the rats as I do about the dog.” (Sonia)

“I have guilt for spending what other people would deem to be an irresponsible amount of money to keep an animal alive because of the stigma that’s attached to rats.” (Sonia)

Affinity with outsider animal

A number of participants recognised a certain affinity with rats because of their outsider status. It was noted in a number of interviews that people with mental or physical health problems felt a connection

with the species, perhaps recognising aspects of their own identity being reflected in this species that exists on the periphery of society:

“I think there are a lot of people in the rat fancier world with various health conditions and mental health as well... I don't really know what it is about rats, they kind of draw...people that might have had a bit of a messy life... people who have perhaps felt like outsiders I think.” (Sara)

“You also get a lot of people with mental health issues [who own] rats too. I would say more than normal. I'm not sure if there's more or if they're more open about talking about it, or more understanding of it. But I think it's because the rats are unloved [laughs] by a lot of people. They feel a kinship? I would say a lot of my animal friends do have varying mental health issues.” (Claire)

In the same way that people with mental or physical health conditions often experience stigma and feel like outsiders, both wild and pet rats are marginal animals. The contested nature of pet rats means that for some people, rats do not belong as a pet; they are out of place within the home. This reflects how people with mental health issues sometimes feel like they do not belong in society, reflecting the rat's outsider status. Unlike its owner, the rat does not engage with the way in which it is viewed by other people.

“When you've got a mental illness that people can't see, they don't understand it. Whether or not they're judging you or not, you feel like you're being judged all of the time, because you feel different and you feel like you don't fit in. Whereas these animals have no concept of that. They're just like, Great. You're here. You give me food. You're my friend. And that's just a big relief, and I think it helped me reintegrate with society.” (Rosie)

This quote also demonstrates the positive impact of human-animal relationships on health and wellbeing. The importance of this relationship, whether it is with rats or any other animal, needs to be understood if there is also the potential for this animal to pose a risk to the owner's physical health. The communication of health messages will need to take place within the context of this important relationship between pet and owner; requiring owners to negotiate a complicated balance between an evidently very fulfilling and important relationship and a potential health risk. This concept is discussed in more detail in the discussion (Chapter Six).

The impact of rat ownership on wellbeing was also reflected in the survey, specifically the influence on concepts reflecting owners' social resources. Rat owners reported their pet rats helped them feel like an active member of a community (72.7%) and broadened their social network (79.3%). The majority of owners felt they had made friends through their pet rats (81.5%). Conversely, rat

ownership did not encourage owners to go out more, with 58.9% of respondents stating they had no influence on this aspect of social contact (Figure 3.3).

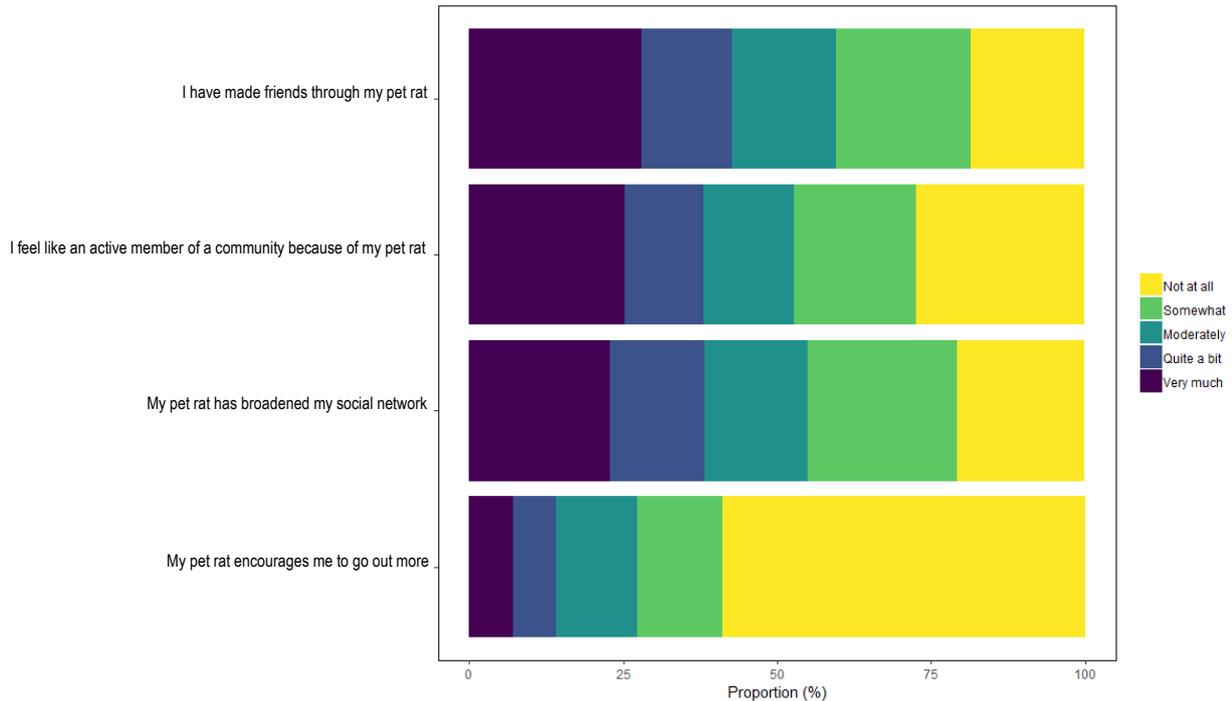


Figure 3.3: Owner-reported impact of rat ownership on factors associated with social resources in a sample of British rat owners (n=475).

A tale of two rats

The relationship owners have with their pet rats legitimises the rat existing within the confines of the home. Pet rats are in place in the home, whereas for non-rat owners, a rat in the home is out of place. To make sense of the contested nature of bringing what is primarily thought of by other people as vermin into their homes as pets, rat owners created a clear divide between pet and wild rats, to the point where they almost become two different species:

“...in my mind, they are two different things. It’s almost like they share the same name, but aren’t the same thing.” (Sonia)

This boundary between pet and wild rats serves a number of purposes. It goes some way to negate the stigma rat owners experience associated with owning rats. In addition, the act of distancing their pet from its wild equivalent helped remove any associations the species has with dirt and disease. Once elevated from its ‘animal status’, pet rats no longer hold the same symbolically powerful associations with dirt and disease that wild rats have.

Hierarchy of purity

In addition to this separation between pet and wild rats, pet rat owners conceptualised different types of domesticated rats. This was articulated as a ‘hierarchy of purity’; rats were more or less pure depending on their origins and what was known about their background (Figure 3.4). Wild rats were the least pure, coming from completely unknown populations and being exposed to all the potential risks associated with the world outside the home. These rats were recognised as a risk to the existing rat population in the home:

“I love [rats], but if there were wild ones coming into my house, it would be a different story.” (Rosie)

“I don’t really want them near my rats [laughs]. Cos they might give them things.” (Claire)

“One of my friends recently had a wild rat in her block of flats. And it was really tough...she [was] having to deal with it, because she had her own rats to protect, but it was quite a difficult situation because you can’t let the rat get in and get established. It was getting towards winter, there was probably a litter due at some point, if it was a girl. You have to deal with them sometimes. It’s just nicer if you can do it humanely.” (Claire)

Pet shop and ‘rescue’ rats were located near the middle of the hierarchy. Pet shop rats come from an unregulated industry, where a lack of knowledge and expertise is not only detrimental to the rats’ immediate welfare, but also limits the advice offered to new owners, leading to longer-term welfare issues. Pet shops were criticised for supporting rodent farms, which were seen as a form of intensive farming of pet rodents. Once in the pet shops, rats were often kept alone, a practise that is unacceptable to pet rat owners. In the survey of pet rat owners, the median number of rats kept was 4 (interquartile range [IQ] 2–7), with only 14 (2.8%) people stating they only had one pet rat (see Appendix 2 xii for a table of owner demographics). The perceived lack of knowledge of pet shops extended to the amount of advice and support they could provide potential owners:

“...then obviously they’re just sold to shops and anyone can buy them and they can have a lone rat...they can keep them in completely unsuitable housing ... there’s no checks at all and then there’s no, there’s no support, there’s nothing.” (Sara)

“We went to another pet shop and there was a lone rat, so I bought her and that was my last pet shop rat [laughs]. ‘Cos...with rodent farms that supply pet shops, there’s no checks on the people who buy them and they’re sort of intensively farmed...I don’t know if you have seen pictures, but they have these racks with like tiny, it’s like big sets of drawers and there’s mums and litters.” (Sara)

The lack of knowledge and expertise of pet shop assistants about rats was reported to result in people being sold rats of the wrong sex, unknown sex or pregnant rats, because the pet shop had been unable to correctly sex them:

“...the guy told me it was a male rat, and it turned out to be a female, I realised after a while it was a female.” (Lucy)

In some cases, unsuspecting new owners would end up with litters of baby rats, which they would then have to rehome or give to rescue centres:

“And my sister came home from a pet shop with a pet rat, a female rat, a white one. And it had babies. So they obviously kept it in the wrong tank, with lots of little boy rats and she was pregnant.” (Sonia)

“A lot of the time it might be pregnant ones you know, people who buy two rats from a pet shop and one of them is a boy and one of them is a girl because the pet shop has not sexed them.” (Sara)

Consequently, pet shop rats were defined as rescued rats because they were seen as in need of being rescued from the inexperienced hands of the pet shops. In addition, rats were thought to be in need of ‘saving’ from pet shops, from living in unsuitable environments or being owned by someone who did not know how to look after them properly. Questions were also raised about the nature of the breeding practices associated with the commercialisation of rats as pets through the larger retailers. Pet rat owners perceived pet shop rats to be less healthy than rats from specialist breeders:

“Genetically they’re not very strong and they can have little weaknesses in their make-up. So we lost both of them...within a year of getting them and we don’t know whether they lied to us about how old they were and they were actually older than we thought they were, or whether they were just poor genetic make-up.” (Sonia)

“So those rats tend to be, they tend to have a weaker genetic strain.” (Sonia)

The purest type of rat in the owners’ hierarchy are those from specialist breeders, where the genetic background can be traced and where contact with other rats is limited and controlled. The ‘pure’ genetic strain of these rats meant owners believed they were less susceptible to health issues such as

mammary tumours or respiratory problems, which are two of the most common health conditions affecting pet rats¹¹.

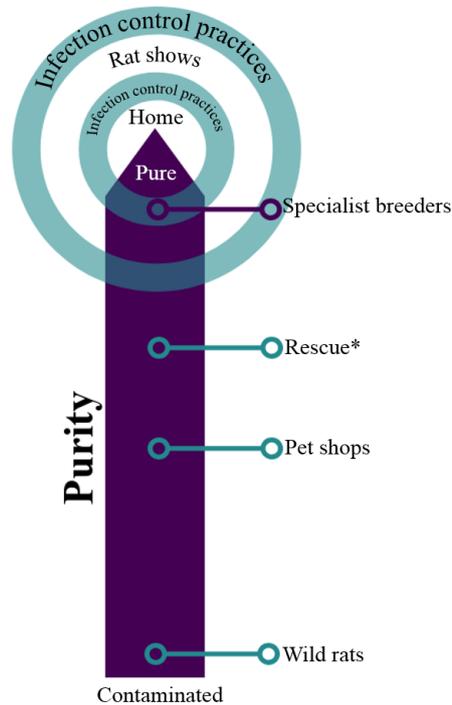


Figure 3.4: Theoretical model of the ‘hierarchy of purity’ pet rat owners use to determine the risk posed by rats from different origins. Rats outside the home are contaminated; purity increases as rats move up the hierarchy. Infection control practices are used to protect the purity of rats within the home and those that attend shows. Infection control practices include quarantine, isolation, avoiding contact, use of gloves, change of clothes, or prophylactic antibiotics. *Rescue rats are rats that have been rehomed from rescue centres or other owners, because they are unwanted or rejected, not necessarily neglected.

As a species, rats do not live for very long. The majority of pet rats live for around two or three years, which is a significant concern for owners when they have formed a close attachment to their pet.

Consequently, the longevity of their pet is very important to them:

“Because everyone wants nice pets to live as long as possible”. (Richard)

This means that as well as producing rats as pets and show animals, the focus of specialist pet rat breeders’ breeding programmes is to improve the health and longevity of pet rats. The breeding programmes and breeding lines have been established over a number of years and are therefore of great value and importance to people who breed pet rats:

¹¹ In the survey, the most frequently reported health conditions were mammary tumours (27%) and mycoplasma (26%), a bacterial infection that can cause respiratory signs.

“So that’s the only reason I really breed, because I want to try and get that and improve them and get them to live longer, happier lives.” (Claire)

“Breeding them is rewarding in terms of I can actually...improve the health, improve the longevity.” (Sara)

Summary

For pet rat owners, the domestication of the rat has elevated its status, sanitising it, so it no longer holds the same associations with dirt and disease that wild rats do. Rat owners have created a clear divide between pet and wild rats, to the point where they almost become two different species. This goes some way to negate the stigma associated with rat ownership. Rat owners are aware of the stigma associated with owning an ‘outsider animal’ and expressed feeling an affinity with this species that is associated with living on the periphery of society.

Part Two: Farmers

Through exploring the social history of rats in the literature review I described how, prior to the nineteenth century, rats were just one of many animals labelled as vermin because they were harmful to crops and livestock. The animosity between farmer and rat is embedded in centuries of tense relationships between the two, with rats initially being labelled as pests because they were scavengers and damaging to crops, before subsequently being established as vectors for disease. It is important to understand how farmers view rats, as a first step towards unravelling farmer perceptions of the risk presented by rodents and rodent borne zoonoses.

Out of place

In some ways, rats are accepted around farms as wildlife that are part of the farming ecosystem. On most farms, there is a constant ebb and flow of rats, coming and going with the changing seasons and the rhythm of farming that the seasons dictate:

“Because we’ve always had livestock in one form or another, rats are quite a feature.” (Freda)

“Each farm’s got its own population of rats anyway, and we don’t know how they’re all moving.” (Freda)

In this context, rats are not necessarily problematic because they are wildlife, existing in places and in ways that is expected of wildlife. There are certain times of year when rats become more problematic for farmers, for example when livestock come in for winter or for lambing – when rats move from the land into the boundary of the farm buildings. By crossing these boundaries, rats are shifting from being wildlife, ‘in place’ within the rural landscape, to being ‘out of place’ on the farm. This shift in status means rats become a problematic animal, or vermin:

“[I’m used to being in an environment where I have contact with rats], although definitely even more so here, because I’ve always been on a sheep farm, so the rats tend to come in at a certain time of year, lambing time. And then you don’t sort of see them the rest of the year, because the animals are out. So coming here, where they’re here all year around was sort of different.” (Charlie)

This concept highlights the importance of place in how animals become constructed as vermin. Rats are not inherently problematic, until they become ‘out of place’:

“I think an animal’s a pest when it’s not welcome. In the same way that everyone says, ‘What’s a weed?’ Well, a weed is a plant that’s in a place it’s not wanted. So actually, wheat or oilseed rape could be considered a weed if it’s in a very expensive cabbage-growing bed.” (Oli)

When discussing what makes an animal vermin, one farmer described an experience with a squirrel, which highlighted how important place is in the construction of different animals. This farmer had left a feed bin slightly open because he had been storing logs in it, and a squirrel had nested in the logs:

“Now, once that squirrel was in there, and I knew it was in there, I then found that just as bad as a rat. It would hiss. I could hear it hissing ... I think it became like a rat then. See what I mean? If you walk through a park, I’m not worried about a squirrel at all, but a squirrel very rarely comes into our circle, like rats tend to. So when the squirrel actually did, I didn’t want to go in there.” (Charlie)

This quote demonstrates how animals are not essentially vermin, they symbolically *become* vermin when they are ‘out of place’. As a species, squirrels are not inherently problematic for people, because they do not often cross the boundaries in the personal spaces of our homes (or farms). Rats on the other hand, are constantly traversing boundaries, which for farmers makes them vermin.

The inability of farmers to prevent rats from crossing these boundaries on their farms means farmers have lost control of their space. Animals that cohabit with people, whether they are companion animals or livestock, have boundaries where their behaviour is acceptable. Rats, like other animals, do not conform to this structure, by moving freely across boundaries on the farm they are consistently out of place, which contributes to their vermin status.

An unbounded contaminant

Farmers consider rats to have no control over their bodily functions; urinating and defecating in any places they occupy. This is no different from any other animal on the farm, except other animals are contained within certain boundaries or spaces – fields or pens. Rats do not respect these boundaries, they travel freely across them, damaging and contaminating these spaces as they move through them. This contamination can be literal and have financial consequences, for example downgrading the quality of produce or rendering feed unusable:

“The damage they do, ‘cos I mix grass seed. Well, if you get rats in grass seed, they’re a disaster. It immediately downgrades that grass seed, ‘cos you’ve got lumps of rat muck in it. You can’t sell that as a prime product. So yeh, that’s the main reason I can’t do with rats around the place.” (Albert)

“The other thing is that when they’ve urinated on the hay, it smells awful and nothing will eat it, so you’ve wasted your stored crop.” (Freda)

In addition to this literal contamination *by* rats, they also *embody* contamination. In this sense, farmers are constructing rats as a vector, with the ability to pollute anything they come into contact with. This vector status is not limited to disease, but also encompasses dirt:

“They are perceived from a farming situation to be a dirty animal that will spread disease. I suppose possibly because they get everywhere and they live in a dirty environment. So they’re quite often in drains and then from a drain carrying animal effluent, they’re suddenly in a feed trough, eating from the feed.” (James)

“Rats are in dirty environments, they live in sewers. Maybe it’s just the fact that they are moving between dirty environments, and therefore spreading bacteria.” (Freda)

There was an exception to this association with dirt, when one farmer recounted experiencing a moment of pity for a rat that he had poisoned:

“It was just...cleaning itself. And...maybe for a split second I felt sorry for it (laughter).” (Charlie)

This pity for a vulnerable animal only lasted a moment, until the farmer hit the rat with a shovel, at which point the rat reverted to being a dirty animal again:

“I just felt sorry for it, for that split second and then I hit it and then once the shovel came off it and it was flat. I was like ‘oh my god, dirty rat!’ It was just like a proper rat then, and it’d got the white on the belly and things, ah I can’t stand them.” (Charlie)

This encounter highlights how fragile constructions of rats are, and shifting perspectives can change what a rat is. The context which made the rat so vulnerable – the poison – suddenly switches to a different perspective, and the rat reverts back to being dirty. This interplay between seeing a single animal from different perspectives demonstrates how nothing is one thing alone, there is no single idea of what a rat is. It is constantly shifting and understanding these shifting ideas is important for understanding how rats are constructed as vectors for disease.

Urban rats and rural rats

For both farmers and pet rat owners, wild rats are uninvited contaminants. The quotes above also highlight that similarly to pet rat owners, the environment in which the rat exists dictates how pure or polluted it becomes. With rat owners, this dichotomy between pure and polluted manifested as rats within the confines of the home being more pure than rats outside the boundary of the home, which were potentially contaminated. For farmers, the type of environment also dictates how contaminated the rat becomes. Farmers articulated a difference between urban and rural rats, with rats living in cities being more contaminated than rats living on farms. Building on this idea that the environment contaminates the rat, this urban-rural dichotomy is based on two concepts. Firstly, human waste is more taboo, therefore invokes more disgust than animal waste. Consequently rats living in cities are more contaminated than rats living in rural areas. Secondly, rats in rural areas *belong*. In this context they are wildlife, until they cross the boundaries of the farm and become vermin. Rats as wildlife are not a contaminant.

“I think in cities, you think, ‘Well, they live in sewers.’ I know there’s nothing we can do about that, but the amount of litter there is in both cities and the countryside – which will attract food waste and suchlike – will attract rats. I suppose in the cities I think, ‘Well, this is human dirt. We could do something about it.’ The fact that there are rats living in the countryside – I mean, they must have a natural environment. I know they have always been associated more with people, but a lot of people seem to be so negligent about their rubbish, and just normal hygiene.” (Freda)

“I think this sort of idea – rats in densely populated areas – I have more disgust for. It’s partly because humans are so filthy and ignorant.” (Freda)

Agency

Battle of wits

Unlike other animals on the farm, farmers have no control over rats and the spaces they occupy. Consequently, farmers engage in a constant battle of wits to try to regain control. In this context, rats are not just vermin, but often described as ‘the enemy’.

“It was a constant battle against rats, but we never won. No matter how many we controlled, you would have the same scenario again and again and again. It was a constant thing.” (James)

“I suppose, they’re seen as the enemy [laughs]. Something that you have to constantly combat. So therefore, battle is probably quite a good way of describing it. You’ve got a war which is never going to be ended so therefore it’s a constant battle.” (James)

In describing them this way, farmers are giving rats a certain amount of agency. Rats are not just ‘out of place’, they have a certain amount of intent behind their behaviour. Whatever the farmer does to try to control the rat, the rat manages to outwit the farmer.

“By that point, I was obsessed. If I went onto a farm, the first I’d be looking for is rat holes. I don’t know why, I just became obsessed by them. I felt it was something in my business I couldn’t control.

Everything else, whether it’s a disease in the wheat, whether it’s a slug on the oilseed rape, or a pigeon on the oilseed rape, I had a solution for it, and I could pay some money, either buy something or do something, and it would go away. But, the rats had defeated me at this point.” (Oli)

Interviewer: *Who do you think’s going to win the war, ultimately?*

Respondent: *The rats I think. Yeh yeh, I think the rats will be here long after we’ve blown ourselves to smithereens. At that point they’ll do very, very well, thank you, because they’ve got free reign then. So in many, many ways yeh, we’ve got the digital age and whatever, but they are the born survivors. They are the real survivors. Without all that sophistication that we have we’re still fighting that battle, which is incredible. That they can still be as persistent as they are, despite technology, despite modern poisons, despite everything. They seem to be able to adapt to everything that we throw at them. They are just as much of a problem, possibly, in some areas, in some respects now, as they ever have been. I’ve got a feeling they’ll be here long after us. (James)*

Removing the façade

Farmers also give rats a certain amount of agency through the effect they have on their identity. When encountering rats, farmers’ reactions would involve them possessing characteristics that did not belong to them, often equating these to ‘girly’ characteristics. In this respect, rats are emasculating farmers, depriving them of their masculine identity; removing their male façade to expose their emotions:

“There’s nothing that will make me scream like a little girl, than a rat.” (Charlie)

“I’m just a girly girl when it comes to a rat [laughs].” (Eleanor)

Rats would have a similar effect on female farmers; rather than removing the male façade, contact with rats would involve them reacting in a way that they would not normally associate with being a farmer; being ‘girly’.

Rituals

In this context, rats are constructed as something to fear. To help manage this fear, farmers sometimes performed rituals to disperse rats and minimise the chances of coming into contact with them. These rituals were associated with certain places on the farm, where they expected rats to be. In addition to the ritual, this assumption would also help manage the emotion, or the fear associated with encountering rats.

Charlie: *“My father hated rats, I remember that. Years ago, you were allowed to blow in meal [animal feed], into a loft and you could walk into it. I just remember Dad would always knock on the door, before he would go in and he’d always... if he hadn’t been there for a while he would always put his socks above his trousers. He always knocked the door, that was definite, that was 100%. And I do that now, for the places I go to, because I’m a little bit... I’m always a little bit scared.”*

Interviewer: *“Why do you knock on the door?”*

Charlie: *“Just to tell the rats that we’re coming (laughter).”*

Emily: *“To disturb them.”*

Charlie: *“Just to disturb them, so they can hear us coming in.”*

Unfamiliar animal

Contributing to farmers’ fear of rats is the unfamiliarity of the species. Farmers do not understand their behaviour, which makes them an unpredictable animal. Farmers may expect rats to be present in certain places on the farm, however they do not know what to expect from the interaction when they encounter them:

“It’s fear. It’s fear, because I know they do bite when they’re cornered and they’re not happy. I just don’t understand how they tick. They don’t have... Behaviourally. I’ve just only ever seen ones running around the farm. They always look petrified of me, and I’m petrified of them, and there’s this stand-off.” (Oli)

“They’re just very random.” (Oli)

“I just don’t really understand them. You could say, “Well, you don’t understand lambs, or goats, or...” But, they do seem to have some kind of way of giving you [pause]... I don’t know.” (Oli)

This construction of rats as an unfamiliar animal is in contrast to the livestock and other animals on the farm, where there is a sense of familiarity that comes from ownership:

“You see, they’re my sheep. I say that; we’ve got cows and everything, as well, but mine are the sheep. And you sort of know what your own animals – where they’ve been, what the situation with them is.” (Freda)

“A cat, you’ll see them, sort of, look at you, and their ears will prick up, and they’ll come towards you with a very ‘defences down’ type of thing. Or, you’ll see that they’ll just jump and they’ll run off. Whereas, a dog might come with its head down, knowing, “Look, subservient, I want to be your friend,” or might come at you... At least you know, if it comes at you with its hackles up, that it’s only just being defensive. It actually transmits some message, where rats just seem to quite happily run up your trouser leg and then bite you. I just don’t know, I just don’t...” (Oli)

This is not just familiarity about how the animal behaves, but also knowing the history of the animal, its health status and control over how the animal is managed. This concept of familiarity has parallels with pet rat owners’ ‘hierarchy of purity’, where rats from breeders where the history of the animal is known is clean and safe. Familiarity also contributes to how farmers understand risk, which will be discussed in more detail in the next chapter.

Summary

The way in which farmers construct rats demonstrates the importance of place in the construction of species from different perspectives. For farmers, rats only become problematic when they crossed the boundary of the farm, moving uninvited into farm buildings. Farmers see rats as an unbounded contaminant, with no control over where they go and consequently have a constant fight to regain control of their farm from this uninvited animal. Farmers confer a certain amount of agency to rats because of the effect that rats have on farmer’s emotions.

Part three: Pest control technicians

In the literature review, I demonstrated how the rat did not emerge as a public health threat until the late nineteenth century. Following the Public Health Act, and the establishment of Port Sanitary Authorities – the first of which was in Liverpool – rat catchers were employed by public health authorities for the first time. Today, pest control technicians work closely with local authority public health and environmental health departments have far-reaching economic, social and public health impact. Pest control technicians have a dual status; they have an important role in preventing rodent-borne diseases yet are also at risk of contracting them.

Familiarity

Pest control technicians need to be knowledgeable and experienced about rats, to enable them to carry out their work. Whereas farmers often feared rats or were worried about being bitten, because they did not understand their behaviour, pest control technicians understood rats' behaviour and were often fascinated by them. Their familiarity with the rat manifested in a number of ways. Understanding why rats behaved in the way they do meant that pest control technicians treated them with a certain level of humanity, which was not always practised by farmers:

“Once you start the pest control, you need to learn about [rats'] behaviour, so that then you can treat it in the best way possible.” (Darren)

Understanding the rat's behaviour meant that pest control technicians understood that whilst appreciating that rats do cause problems, they were not being malevolent in their actions, they were simply exhibiting normal, natural rat behaviour. If anything, it was humans and human society that was causing problems for the rat:

“I think since then there has just been that inbred fear and hatred of them, like I say, because they've been vilified and basically chased away from every sort of accommodation where they wanted to go. They [have] been forced into sewers and other places, again that gives people the idea that they stink and they're horrible creatures, so yes. Not their fault.” (Sam)

“No, mice and rats as well are quite clean creatures, they're constantly cleaning themselves there, and you'll find that it is only because we've vilified them and shoved them into these areas of the sewers and all that, but they are very clean creatures and all animals, like, all mammals, like to live in, what's it called, clean conditions. They don't want to live in filth.” (Sam)

Familiarity with rats also meant they earned respect from pest control technicians, with technicians frequently referring to rats' intelligence and survivorship:

"I think of them as being very smart intelligent creatures, to have co-existed with us for so long, where we have tried to make every effort to kill them, yet they're still there. And we'll never get rid of them." (Chris)

"First thing that comes to my mind is intelligence. Yes, intelligent creatures. They're one of the only creatures that are able to problem-solve." (Sam)

"They are very clever creature really. They're... I wouldn't say the knowledge of them but the behaviour of them is unbelievable. They're strong fighters aren't they?" (Nick)

Unlike farmers, pest control technicians were benevolent towards rats, despite being responsible for killing them:

In a way, I, kind of, like, have an empathy with these animals, because they're doing harm when they come into a scenario where they're in conflict with humans. That's either by chewing at food and basically destroying it... If you find a cereal packet and there's a hole in the bottom, well, a packet, you sling it, that's it. So, the harm that they can do when they come into contact with man is quite significant, but they're doing what they do. It's not malicious, they're just doing what they do. It's with a heavy heart that I do kill animals, really. I don't like doing it. (Darren)

In one particularly reflective part of this interview, this technician articulated that actually, rats are not that different from us:

"Why are we different? Yes, we're different because we can analyse the world, and we are the universe which has become self-aware in that. Saying that, aren't we all the stuff of stars, you know?"

All the elements of the universe are in our bodies, so where were those elements created? They're created in stars. Nuclear fusion, hydrogen to helium, and then the collapse of massive stars. Then, creating the heavier elements. What are our bodies composed of? All the elements. So, in that sense, stars, we're observing them, but we are them. So, the universe itself has become self-aware through us." (Darren)

These quotes highlight that from the perspective of pest control technicians, rats are just being rats. They are retaining their essential animal characteristics, only becoming problematic when they encounter human societies and cross the boundaries into private, human spaces.

Out of place

In common with pet rat owners and farmers, the concept of out of place highlights how important place is in the construction of animals from different perspectives. Seeing animals in different contexts shifts their status from animal to pest, invading the personal spaces in our homes:

“One of the problems is that we’re not used to seeing animals run around. Perhaps in the past, or if you were living on a farm for example, you’re used to rats running around, so you’re not going to be particularly worried about them. But in our society now, because we’re not used to things running around our house particularly, unless we’re under control of them, then they [become] a little bit more of...invaders.” (Elaine)

“I think... if you’ve got something that lives in a sewer and that comes into your house, that’s not a very pleasant kind of thought.” (Elaine)

“In a way, I kind of...have an empathy with these animals, because they’re doing harm when they come into a scenario where they’re in conflict with humans.” (Darren)

“They invade your privacy.” (Jennifer)

Dirt, damage and disease

Dirt

Primarily, for pest control technicians, rats were intelligent animals, which commanded a certain amount of respect. They were animals, not gaining their vermin status until they crossed the boundary into the personal space of the home. In this sense – similarly to pet rat owners and farmers – for pest control technicians there is a dichotomy within rats; they are wildlife, until they cross the boundary into the home. In this context, the characteristics associated with the rat as wildlife become problematic, not because the rat is inherently problematic but it does not belong in the context in which it finds itself. The shift in their status to vermin means they are consequently associated with ideas that have historically always been associated with rats; damage, dirt and disease.

Similarly to pet rat owners, pest control technicians did not see rats as inherently dirty, they were just dirty because of the environment in which they lived. This concept was particularly relevant when associated with human waste, a concept that was also articulated by the farmers in this study.

“In the sewer, whatever people flush down the sewer, they break up and root through with their teeth to find undigested food. If there’s a fault in a sewer that serves the house, the same rat with that muck on runs across the work surface in the morning.” (Matthew)

“I think that’s the thing...if you’ve got something that lives in a sewer and that comes into your house, that’s not a very pleasant kind of thought.” (Chris)

“They been forced into sewers and other places, so again with them living in sewers, again that gives people the idea that they stink and they’re horrible creatures.” (Sam)

There was also a recognition that the rat’s association with dirt because of the environment in which it lives is not wholly negative. The nature of living in areas where humans dispose of waste means rats are actually contributing to that ecosystem:

“And they do live, there’s a lot of rats that live alongside us, without any problem at all, and they probably do quite a lot of good in many ways because they are clearing up a lot of the rubbish that is around. And so we forget that, we forget that actually being on some of these waste tip sites, they’re actually eating a lot of the stuff that’s around, probably doing some good in that particular way. ‘Cos otherwise the stuff would be left to rot.” (Chris)

Unbounded contaminant

In much the same way as farmers viewed rats to be a contaminant, pest control technicians also recognised them this way. Rats were dirty because of the environment in which they originated, but in addition to this they were dirty because they contaminated human places with their excretions:

“The fact that they’ll wee and poo when they’re going, especially urinate when they’re running along, you know? So, everywhere you touch could be contaminated with urine.” (Jennifer)

Damage

In addition to technicians associating rats with dirt, they also associated them with damage and destruction. This association was related to innate rodent characteristics, rather than social or cultural constructions. As this characteristic is essentially rodent, it is common to rats regardless of the

context they are in, highlighting how an essential animal characteristic only becomes problematic when that animal is out of place.

“It’s the damage- you know why they call them rodents, don’t you? It’s a great Latin word called, ‘Rodentia’ and in that language, it means, ‘to gnaw’.

On an adult rat, they have no teeth there. But just at the front. So, they can draw their mouth across the back of the throat, seal it off. Rodents, including squirrels, the teeth at the front open and close in a healthy rat three times a second. And exert a pressure of considerable force. But, if they didn’t...in a year, the teeth would grow to three inches long.” (Matthew)

In some ways, technicians were conflicted, knowing that rats were classed as vermin because of the damage they did and their potential to transmit disease, but aware that they had been singled out, perhaps unfairly, and other animals could also be problematic:

“No, I don’t think [they deserve their reputation as vermin]. They are vermin, obviously, because of damage they do to food and that, but there are other animals, I mean people... Okay, you got lots going, you know, with your disease which some rats can spread really Weil’s disease, but there are other pests as well, which do as much damage as rats, and people don’t tend to think of them as pests. Squirrels are one...” (Sam)

Disease

In addition to dirt and disease, pest control technicians also associated rats with disease. These associations emerged in two ways. There was a recognition of how the rat as a species had been created as a ‘diseased other’ over time, drawing on historical and cultural influences. One particularly pervasive association was with the plague, which was recognised as the basis for why rats are associated with dirt and disease.

“I think [the association with dirt] is more to do with the knowledge that you knew at one time they actually brought, you know, fleas for the Black Death.” (Chris)

“I think we think they’re horrible because we know that they spread disease.” (Jennifer)

In one interview, when discussing these cultural and historical associations with disease, rats were framed as being unfairly associated with the plague:

“They’ve been vilified since medieval times with the whole plague situation that everyone – as soon as you mention rats, I mean, or mention the plague, the first thing that comes to people’s heads is rats.”
(Sam)

Pest control technicians were also aware that rats’ status as a vector for disease not only made them vermin, but also constructed them as a public health threat:

“It’s just that rats are classified as public health pests and they carry a lot of diseases.” (Matthew)

This highlights a level of awareness that pest control technicians have regarding rats as vectors for disease, not specifically with regards to their personal health, but also their professional responsibility to clients and the wider community. This role that pest control have as social agents will be discussed in further detail in subsequent chapters.

Summary

Pest control technicians have a certain amount of respect for rats, this was demonstrated in benevolence towards them, despite having to kill them. To pest control technicians, rats are animals that only become problematic when they cross the boundaries into the private spaces of the home. Pest control technicians are aware of how problematic rats can be when they are ‘out of place’, yet the destructiveness of rats was thought of as more problematic than their vector status.

Chapter Four

Rats, risk and health

Chapter Four: Rats, risk and health

Part One: Pet rat owners

In the previous chapter, I presented data to explain how rats are constructed from different perspectives. Pet rat owners articulated a hierarchy of purity, which differentiated wild rats from pet rats and ranked domestic rats from different backgrounds. Elevating the status of the rat from animal to pet, purifies it, helping to remove any associations the species has with dirt and disease. I contend that it is on this structure, and not conventional biomedical models of disease, that pet rat owners base their understanding of health and illness. This chapter explores this concept in more depth, looking in detail at how owners conceptualise the rat and the implications of this for their health.

Bounded purity

For pet rat owners, their pet is ‘in place’ within the home. Owners have created a conceptual boundary around the home, which provides a controlled environment, within which the purity of their pet rats can be maintained. In this environment, pet rats are isolated and protected. The world outside this boundary is dirty and contaminated and therefore poses a risk to the health of their rats.

“If anything, humans can probably pass things to rats. We are probably more unhygienic than they are because I leave the house and I come into contact with germs and they’re just sitting in their happy little environment.” (Sonia)

In this context, rats are not inherently dirty; they can only become contaminated, or infected, through contact with the outside world. The disease threat is located elsewhere; outside the home. Where pet rats stay in the home, they will only be subject to diseases brought into the home via anything that crosses the boundary into the outside world – people or other pets. This helps to distance the rat in the home as a harbinger of disease; it is not rats that are infected, but the environment in which they reside. Owners have also created a diseased ‘other’, an animal, which through contact with the outside world, is contaminated and potentially poses a risk to the health of their rats.

In the previous chapter, I discussed how rat owners create a hierarchy of purity to differentiate their domesticated rats from wild rats. This hierarchy is important because it frames how pet rat owners understand disease and risk; rats from unknown backgrounds, or where rats have had exposure to environments outside their home pose a potential risk. This concept of a hierarchy was also reflected

in the survey, where wild rats and pet shop rats were thought to pose the highest risk to existing rats in the home. Respondents were asked to rate the risk posed by different animals and people, on a scale of 1–7, with 1 being the highest risk. Wild rats were rated as high risk (1–3) by 86.9% of respondents. Rats from pet shops were also thought to be high risk, with 70.4% of respondents giving them a rating between 1 and 3. Conversely, rats from specialist breeders were most frequently rated as low risk, with 63.9% of respondents rating them between 5 and 7 (Figure 4.1).

The concept of bounded purity keeps pet rats safe and clean within the home; contamination occurs through contact with the outside world. This was reflected in the survey, where 87.8% of respondents agreed or strongly agreed that rats can only catch diseases from the environment in which they live. In addition, 60.1% of respondents agreed or strongly agreed that rats from specialist breeders were unlikely to carry diseases, echoing the belief that these rats are ‘purer’ than other types of rats.

In the survey, pet rat owners were also asked how easy they thought it was to prevent disease transmission, both between rats and between rats and people. While 85.6% agreed or strongly agreed it was easy to prevent disease transmission between rats, only 11.2% indicated they thought the same for disease transmission between rats and people (Figure 4.2).

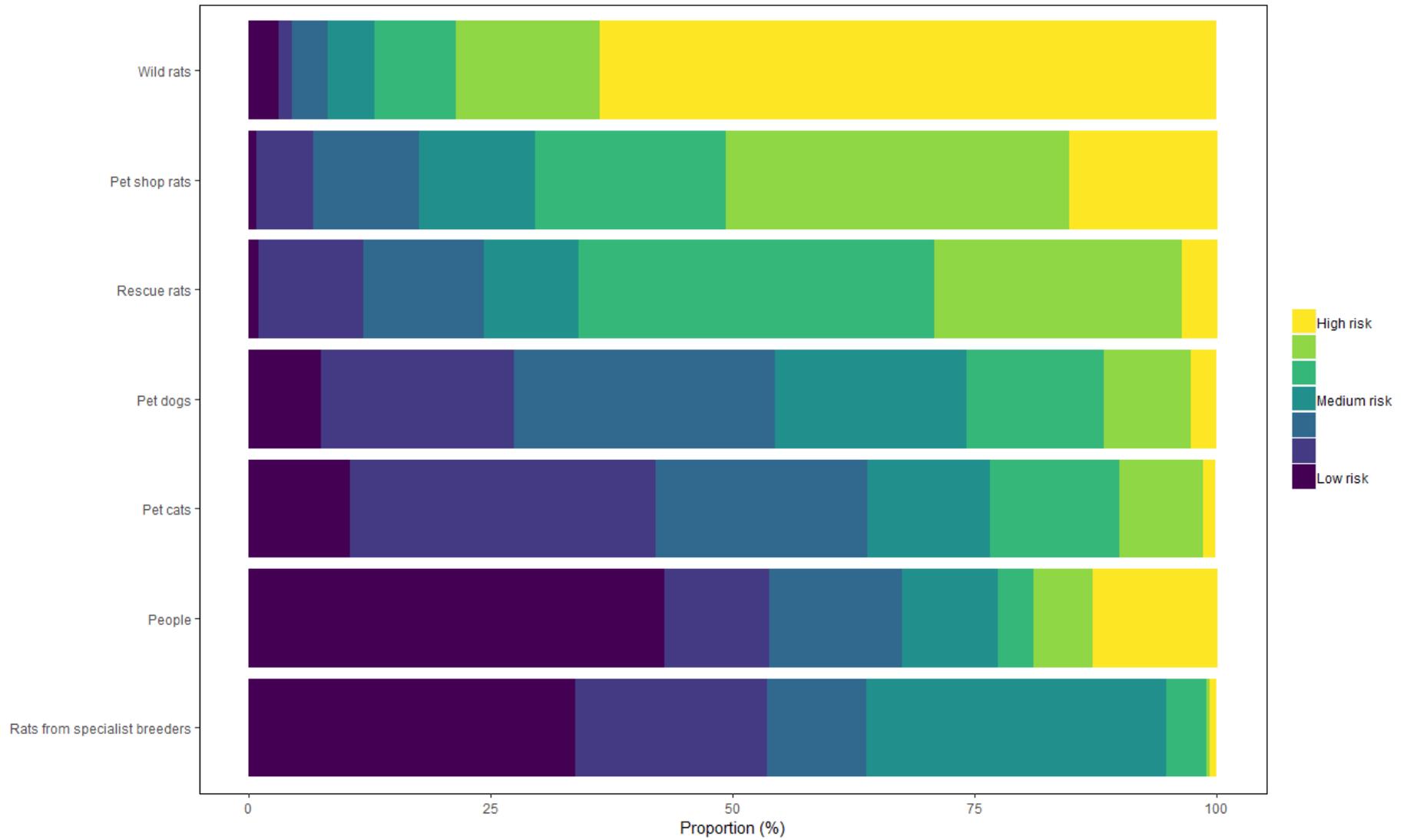


Figure 4.1: Owner reported perception of how much other rats, pets and people pose a risk to their pets, in a sample of British rat owners (n=465), ranked by order of risk, from highest to lowest.

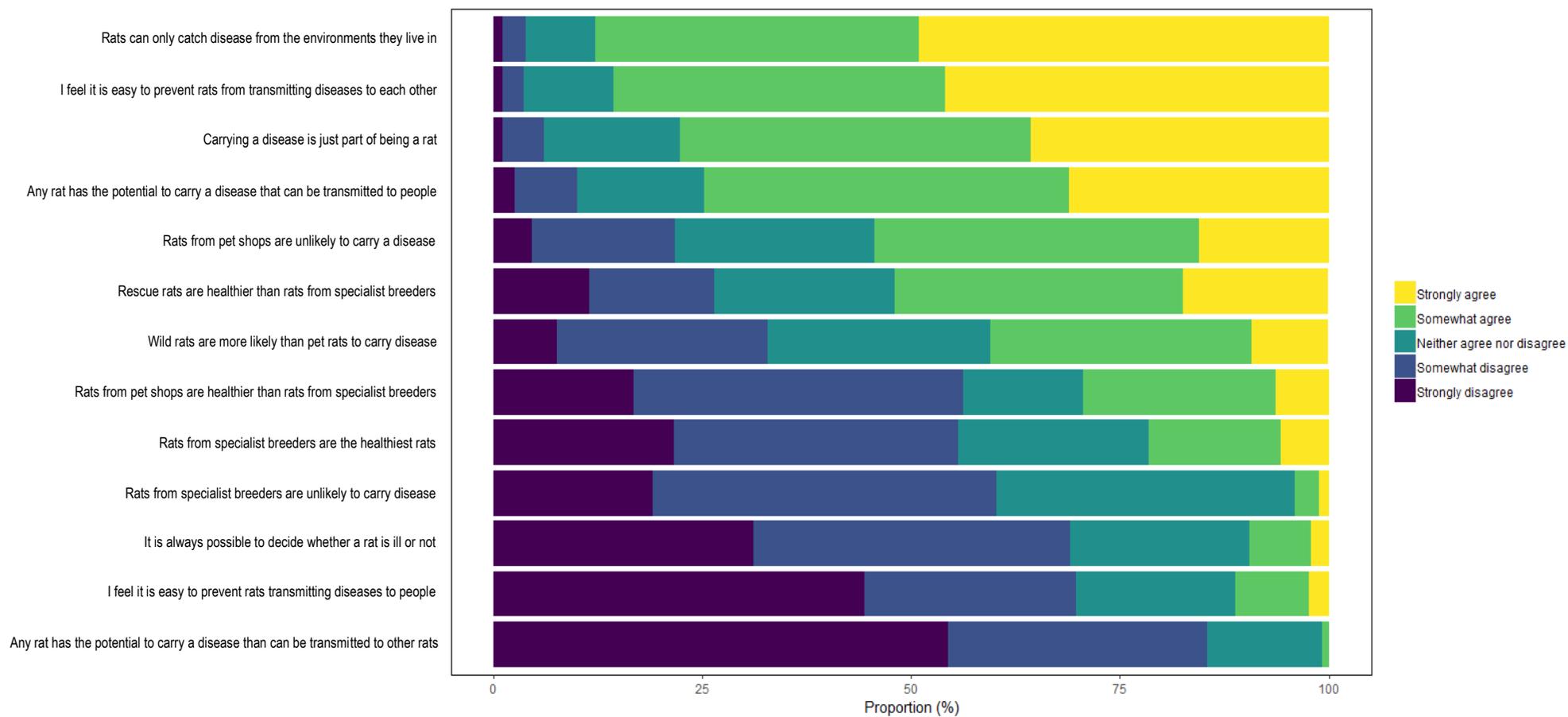


Figure 4.2: Owner reported risk perceptions surrounding pet rats in a sample of British rat owners (n=461), ranked by order of statements most frequently agreed with.

Health concerns

The way in which rat owners conceptualised risk resulted in their rats, rather than themselves, being seen as at risk of infection. This effectively created a hierarchy of health, with the health of their rats taking priority over their own. This has implications for their infection control practises. The risks managed by the owners were directed at keeping their pet, rather than themselves, safe.

“I think rat people are much more worried about their rats getting sick than they are about themselves getting sick.” (Rosie)

This hierarchy of health was reflected in the response to hantavirus, where rat owners were more concerned about the impact of the virus on their pet rats:

“People were basically more worried about their rats than their own health.” (Sophia)

When probed further, Sophia explained that the risk associated with hantavirus was not just to the rats' welfare in terms of possible euthanasia¹², but had far more wide reaching effects on the reputation of the rat as a pet, as well as rat breeders and keepers.

“I remember at the time someone actually saying, ‘I’m not scared of hantavirus I’m scared of the press’. And it was actually the fact that the risk to the fancy in terms of the – well not the good name of rats – but the reputation of rats and the welfare of peoples’ rats in terms of being taken away, was actually perceived as a bigger risk than the risk of catching hantavirus.” (Sophia)

Rat health

As a result of prioritising their rat's health over their own, rat owners were particularly knowledgeable about diseases that could affect a rat's health. Health conditions such as mammary tumours and respiratory infections were consistently raised in the interviews as common health issues affecting rats.

¹² When the first case of Seoul virus was identified in a pet rat breeder in 2011, the breeder made the decision to have her rats euthanised. Subsequently there was a lot of uncertainty in pet rat owners and breeders about whether public or environmental health bodies had the authority to force owners to euthanise pet rats if owners were identified as being seropositive.

“They are prone to, and I was really quite surprised, ‘cos you imagine rats to be very hardy... but they’re not. They are very susceptible to respiratory problems. And we’ve been to the vet for antibiotics for respiratory things for a few of mine, and they get this horrible wheezing on their chest, you can hear their breathing.” (Sonia)

“Respiratory issues, and mammary tumours. Both a bit later in life, that’s probably the two main issues I’d say. But then...they have a host of other things they can get, and you know, they can injury themselves and...all sorts of things like that.” (Sara)

“Female rats are very prone mammary tumours, and they’re not serious at all. They’re just little encapsulated lumps, so I let the vet just cut those out.” (Richard)

This was reflected in the survey, where the most frequently reported health conditions affecting pet rats were mammary tumours (66.5%) and mycoplasma (63.7%), a bacterial infection than can cause respiratory signs in rats (Figure 4.3).

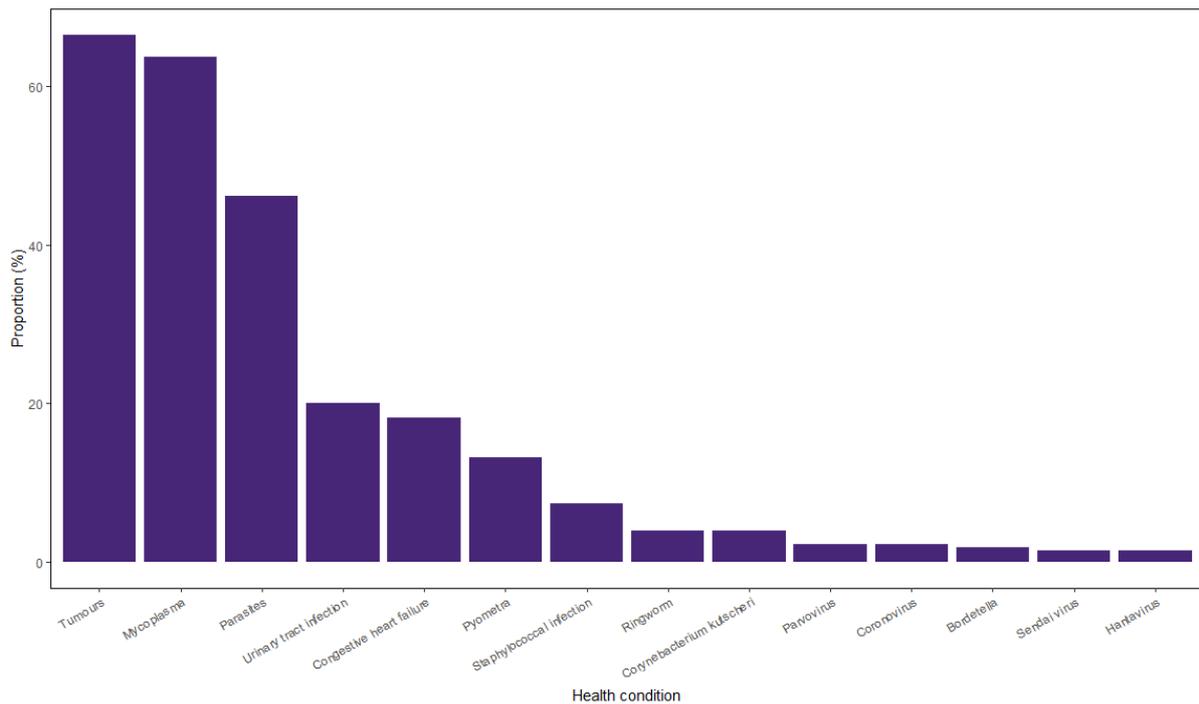


Figure 4.3: Owner reported health conditions in pet rats in a sample of 325 British pet rat owners.

Survey respondents were also asked to rate the risk of their pet rat developing different health conditions, both zoonotic and non-zoonotic (Figure 4.4). Mycoplasma infection and tumours had the largest proportion of respondents rating them as high risk, with 54.2% and 48.6%, respectively. The

infections with the largest proportion of low risk ratings were rat-bite fever with 76.5% and leptospirosis with 76.0%. Focusing on hantavirus, 48.5% of respondents thought it was low risk, whereas 20.9% had not considered the risk. Only 11.9% thought this virus was high risk.

The most common health conditions, tumours and mycoplasma, were considered some of the least preventable, with just 6.0% of respondents stating they thought mycoplasma was preventable and only 1.9% stating tumours were preventable (Figure 4.5, Appendix 4). Conversely, both leptospirosis and hantaviruses were considered more avoidable, with 54.2% and 26.3% of respondents, respectively, stating they definitely thought these infections were preventable.

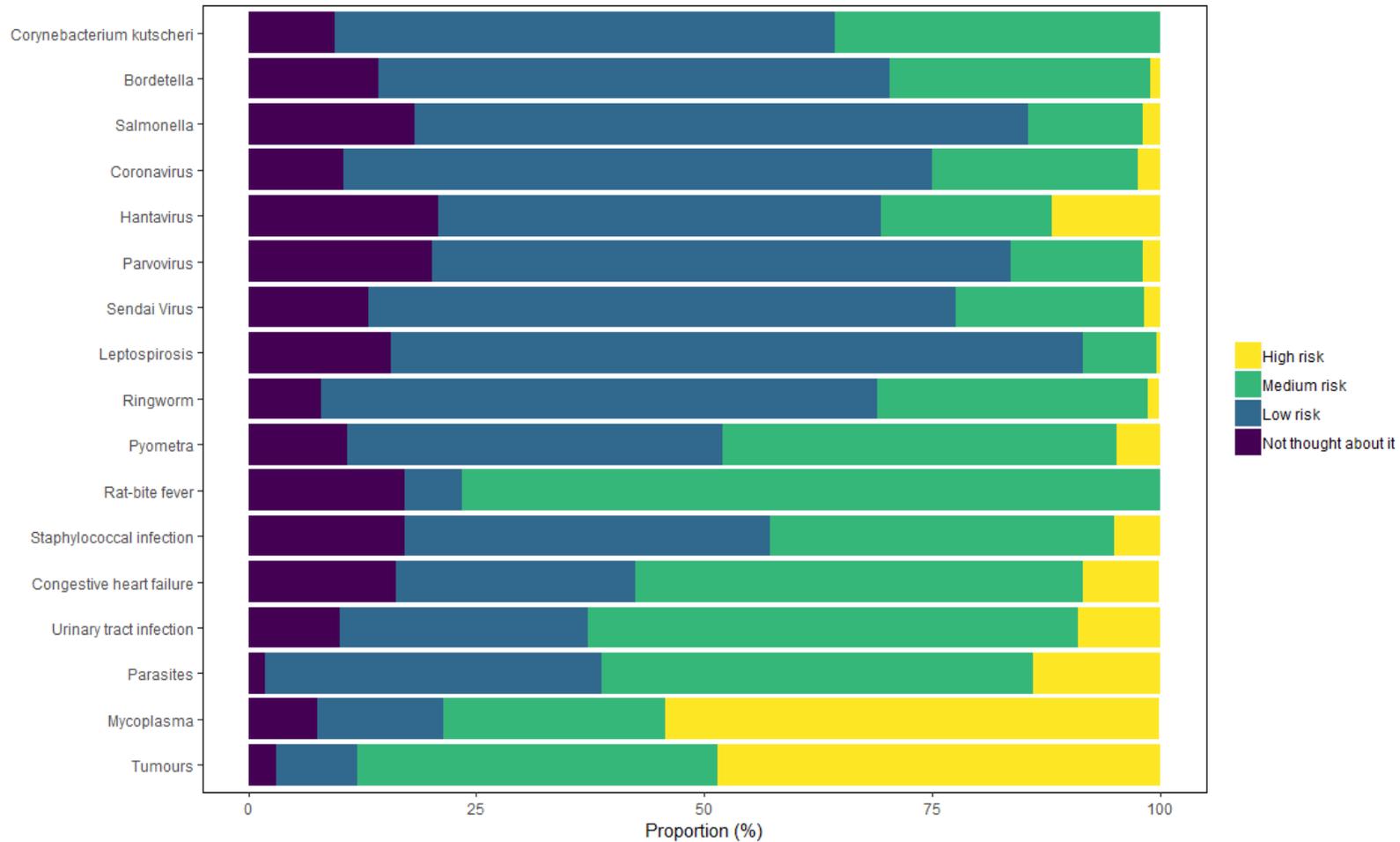


Figure 4.4: Owner reported risk of their pet rats developing different health conditions, ranked from lowest to highest risk in a sample of British pet rat owners. Denominator data for each health conditions is as follows: *Corynebacterium kutscheri* (n=42); bordetella (n=84); salmonella (n=104); coronavirus (n=124); hantavirus (n=134); parvovirus (n=159); sendai virus (n=174); leptovirus (n=225); ringworm (n=249); pyometra (n=213); rat-bite fever (n=251); staphylococcal infection (n=199); congestive heart failure (n=228); urinary tract infection (n=341); parasites (n=388); mycoplasma (n=354); tumours (n=409).

When discussing the effect of rats on their own health and wellbeing, owners were inclined to steer the interview towards the health of their rats, rather than their own health, reflecting the importance they placed on their pet's health, over their own. In one interview, the problem of scent marking was discussed:

“If there was one thing I could change about a rat it would be that they scent mark wherever they walk, they leave a little scent trail so that they can find their way back again. And that's unpleasant, you know, they're effectively, at the end of the day it's urine that they mark with. It's the one thing, if I could wave a magic wand I'd get rid of that.” (Sonia)

This participant described the process of scent marking as unpleasant, however when probed further about the potential risk to her health, did not consider coming into contact with rat urine to be a potential risk to her own health:

“No. Not at all. There are some illnesses that rats can get, but unless they are in contact with another rat that has that illness it's very unlikely they are gonna get anything, and even more unlikely that they're gonna get something they can pass to a human.” (Sonia)

This quote also demonstrates how owners use the concept of bounded purity to understand health and risk. Where rats are protected within the confines of the home, they do not pose a risk to their owner's health. When owners did discuss the health risks associated with rats, they used the hierarchy of purity to distance their pet rats from the wild equivalent, which posed a disease risk to their pet. It was clear that it was this diseased 'other' that posed the risk, not their pets.

“I mean, obviously wild rats do carry disease, they carry Weil's disease and stuff so you have to be fairly careful with the wild population.” (Richard)

In addition to 'othering' wild rats, this quote also highlights how certain zoonotic diseases, such as Weil's disease, are accepted as a potential risk in wild rats. This adds to the wild rat's status as a potential threat to pet rats, but also brings in the additional risk of zoonotic diseases. In this context, wild rats are also understood as a threat to human health. Owners have accepted these types of diseases are a risk in wild rats, but not necessarily in pet rats.

When discussing their own health, rat owners struggled to recall instances where they had caught an infection from their pet rats. When they did discuss infections they were conceptualised as minor,

almost trivial events. They did not elaborate with the same amount of detail, or discuss these experiences as openly as they did when discussing their rats' health. Instances of zoonotic transmission were framed as unusual, one-off events; a result of bad luck. This effectively absolved owners of any responsibility or ability to protect their own health, as well as distancing their rats as a source of infection. This is in contrast to how health conditions in rats were framed; persistent and serious risks, which could be managed by keeping their rats in a controlled environment – maintaining the conceptual boundary to preserve their purity. This contrasting view is central to understanding how pet rat owners viewed the risks associated with disease from their pets.

“I have once, when I got bitten quite badly by somebody’s rat [laughs] at a show. I had to go to the doctor with that one and just double check because it was like round my joint and it swelled up quite badly. And they looked at it. Oh and once I got, it was actually from, I got bitten by some sort of mosquito or something and I got a staph infection. Or I think it was a staph infection, so that kind of thing. That’s quite common in rat owners as well. So I just made the doctor know that it could be – I think they call it rat-keepers finger because rats and humans can kind of transfer that between themselves. I think it was probably just a bit of bad luck because I don’t really suffer from it often.”
(Claire)

In addition to trivialisation of the health risks associated with pet rats, owners may even frame these risks in terms of potential benefits. In one interview, where the owner acknowledged that there were certain infections that rats can carry that can be transmitted to people, this was framed as having a positive impact on the owner's health.

“I think they’re very good for, kind of immune system. It’s like with anything, if you shelter yourself too much from all – and it’s the same approach I have with my rats – they don’t live in a perfectly sparkly clean, overly washed thing, with lots of antibacterials and stuff. It’s a little bit of stuff that’s not great for you is good for you, if you know what I mean. I think that helps.” (Claire)

Socially established diseases

Some zoonotic infections such as leptospirosis (which can cause Weil's disease in people), are understood as a potential risk in wild rats. In addition, domesticated rats, where there might have been contact with 'the outside world', are also potentially at risk of having leptospirosis infection. When discussing these diseases it was apparent these were an accepted risk for pet rat owners. Participants were open to talking about the risk they posed to their own health, and the procedures they put in place to mitigate these risks.

“With wild rats, they can have leptospirosis. So, I have taken in rats a couple of times that have been found outside, so they aren’t wild but maybe someone has released them or maybe they have escaped. People do release rats fairly often actually, when don’t want them anymore. So then you have to treat with antibiotics for two weeks – doxycycline – and then if they do have an infection then that will clear it. And during that time you have to be careful with, when you clean them out, like with the urine. So that’s just, so I do take those kinds of precautions, because that feels a completely kind of different risk, and more contained as well, you know.” (Sara)

There is a long-standing association between rats and leptospirosis. In some ways, it has become culturally enshrined, although not to the same extent as the association between rats and the plague. This tacit knowledge makes the infection and risks associated with it easier for rat owners to accept as a potential risk. In this context, when Sara is discussing the risk of leptospirosis, she frames it as being manageable and controllable. There is a specific treatment available – doxycycline – that contributes to its status as a manageable disease.

In addition to there being easily administered treatment available for leptospirosis, it is also possible to test rats for the infection. This provides rat owners with more autonomy for how to manage or treat the infection, as there are a number of options available. In this context, because leptospirosis is easy to identify and amenable to treatment, it is an accepted risk associated with pet rats.

“I think you can screen for leptospirosis, so if people take in rats from the wild or they’ve been outdoors, which some people do, they will generally screen for leptospirosis. Others will just treat them with doxy for a few weeks. I’ve never needed to, I don’t tend to take in people [sic] from the outdoors and if I do I just blanket treat them. It’s probably nicer on the rat than a blood test.” (Claire)

The way leptospirosis is framed by pet rat owners also reinforces their hierarchy of purity; the disease risk is located outside the home. Rats that exist within the home are protected and isolated from the risk of infections, and consequently do not pose a risk to their owner’s health.

Hantaviruses: matter out of place

In contrast to the socially established diseases that can affect rats, hantaviruses do not fit in with how pet rat owners have conceptualised disease and risk. The virus has not only transcended the clear, defined boundary between wild and pet rats, but it also disrupts their ‘hierarchy of purity’. The first cases of hantaviruses associated with pet rats were in people who bred pet rats, or had rats from specialist breeders. This challenged pet rat owners’ understanding that rats from specialist breeders are purer than rats from pet shops or rescues. In one interview, the participant was aware of hantavirus as a zoonotic infection, yet stated he was not concerned about it. When probed further, he used the

hierarchy of purity to frame the risk. Rescue rats pose a risk because of their unknown background, whereas rats from specialist breeders were seen as healthy and disease free:

Richard: *“The only ones I worry about are rescues and I’ve only had four rescues over the years.*

Interviewer: *Why would you worry about rescues specifically?*

Richard: *Because I don’t know the breeder. If I know the breeder, if someone’s obviously a serious breeder, then I assume they’re gonna breed some reasonably healthy rats and they’ll come from a reasonably safe environment.”*

In this context, ‘safe’ means safe from diseases, reflecting the concept that rats from specialist breeders are purer than rescue rats. Through using this disease model when assessing the risk posed by their pets, owners are not considering rats from specialist breeders to pose a risk to their health. The risk is the rat and where it comes from, rather than the disease itself.

“I think in a way you are much more likely to pick up something from a cat or a dog because they go outside and they can bring all sorts of crap in, whereas the rats live in a protected environment. They either kind of have [hantavirus], or they don’t have it.” (Sara)

This quote provides an example of how the concept of bounded purity influences how pet rat owners understand risk. The rat is isolated within the confines of the home, therefore does not pose a risk, whereas anything that crosses the boundary into the outside world can potentially act as a vector for disease. The above quote also provides another example of how hantaviruses do not fit in with rat owners’ understanding of disease and risk. Hantaviruses are asymptomatic in rats, they are invisible diseases. In addition, it is difficult to routinely screen for the virus. This makes it problematic for owners to determine if their rats have the disease or not. Owners almost have to assume their rats are not carrying the disease, because the alternative is to assume that they are, which would have a huge impact on their relationship with them, or to simply ignore the virus as a potential threat.

Unamenable to treatment

In addition to hantaviruses being asymptomatic in rats, there is no specific treatment for the infection in people. It is a virus, therefore the treatment in human cases relies on treating the symptoms not the infection. This limits the value of hantavirus diagnosis; particularly when owners were concerned about the impact of the diagnosis on the future of their pet rats.

“I thought I’d probably had [hantavirus] and then... I didn’t want to get tested for it ‘cos again, [I was] worried about whether there might be any implications for the rats.” (Sophia)

Compared with the more socially established zoonoses, such as leptospirosis, which may be amenable to treatment, hantaviruses are problematic because they cannot be treated or eliminated. Once the infection exists within a pet or breeding colony, the owner has limited options for how to respond to it.

“You can eliminate [leptospirosis], ‘cos its bacterial isn’t it? So you can treat it. There’s even a clause in the NFRS regulations that if you take on a wild rat you have to have it treated and tested for lepto, you can eliminate it. Whereas with hantavirus you can’t. It’s there and you can’t get rid of it.” (Sophia)

This means that pet rat owners have to live with the invisible threat of hantavirus, which they feel they have little control over. Owners feel limited with what they can do to negate the risk of hantavirus transmission, because it is airborne. Pet rats are an important part of owners’ lives, and owners talked about both themselves and their pets experiencing discrimination. Consequently, owners felt as though they constantly had to defend their choice of pet and advocate for rats as a species. The introduction of hantavirus in pet rats made this increasingly difficult for them, because it added to the stigma surrounding keeping rats as pets.

“We’ve spent so long telling people rats don’t carry diseases and trying to get rid of this whole kind of plague association [pause], that actually it now turns out they do carry this quite serious illness. I think maybe because defending the rat is so hard anyway, that then we’ve lost one of our lines of defence.” (Sophia)

This added another layer to how rat owners conceptualised the risks surrounding hantaviruses. Not only did it pose a risk to the lives of their pets and coveted breeding lines, it damaged the reputation of rats as a species and added to the stigma associated with owning pet rats. In this context, the potential risk hantaviruses posed to human health were comparatively insignificant.

Summary

Rat owners have reframed the animal as a pet. The rat is ‘in place’ within the home and a conceptual boundary keeps the rat clean and safe. The outside world is dirty and contaminated, and anything that crosses that boundary is a potential risk. Within this context, rats can only become infected with

disease through exposure to the outside world. Pet rat owners articulate a more complex hierarchy of purity within pet rats, with rats from specialist breeders being the purest type of rat. This construction not only locates the disease threat elsewhere (the outside world), but also creates a diseased 'other'; a source of infection far removed from their pets. Hantaviruses are problematic for rat owners because they do not fit in with how they understand disease and risk. Hantaviruses have transcended the conceptual boundary around their rats because it was identified in rats from specialist breeders.

Part Two: Farmers

In the previous chapter, I demonstrated how farmers have an uneasy relationship with rats. As wildlife, rats are expected within rural landscapes, yet as soon as they cross farm boundaries and become out of place, their status shifts to vermin. As vermin, rats are problematic, farmers conceptualise them as unbounded contaminants, and engage in a constant battle of wits to regain control of their farm. Farmers give rats a certain amount of agency, through being outwitted and having their identity challenged, and while they associate rats with dirt and disease, these aspects of rats are not necessarily a priority for why farmers want to control rats on the farm.

In this chapter, I explore how farmers understand ideas of health and risk in the context of the farm. In addition, I discuss how farmers conceptualise the risks posed by rats, which despite acknowledging their status as a vector for disease, is principally to the reputation of the farm and their identity as a farmer, rather than to their own health.

Farming culture

For the farmers interviewed for this thesis, farming was more than just a profession or a way of life, it was part of their identity. Farmers were born to farm; land often being farmed by generations of the same family. Farmers saw themselves as custodians of the countryside as well as their farm, they were proud of their farming heritage and traditions associated with it. This enduring relationship with the land and the farm means that farmers were deeply embedded within a farming culture; farming was not just a profession, it was who they were:

“It’s always in the family psyche” (Albert)

This is important because, on a practical level, farming is physically demanding and relentless, as one farmer simply described it – *“tough”* (Emily). Farming was often defined as a family business, and the cultural and historical connections that most farmers have with farming not only increased the pressure to succeed, but also gave farmers the resilience to persevere and progress:

“I was so determined not to fail, and I was hell bent to not go under or make bad decisions.” (Oli)

“In farming, I feel, if you stand still, you’re actually going backwards, because other people are increasing their stock or doing better stuff and producing cheaper meat, and then if you just stay where you are, you’re going backwards because people will overtake you.” (Ben)

Understandings of health and illness

On one level, the resilience and tenacity that farmers need to farm is reflected in how they understand and respond to health and illness. Farmers felt they could withstand adverse effects on their health, because of their identity as a farmer:

“I think we’re probably more resilient. I was talking to a doctor once and he said that he had a farmer in. And he said, ‘Well, you know they’re going to be ill because you never see them.’ So I think they have a higher threshold for knocks and injuries and stuff.” (Charlie)

Going beyond this understanding, farmers’ conceptualisation of health is more than just resilience to illness. The health and wellbeing of the animals on the farm, and the economic viability of the farm, is dependent on the farmer always being able to care for them. This animal-farmer dependency adds to the relentless nature of farming, but also contributes to a sense of responsibility experienced by farmers, particularly livestock farmers. In some ways, the relentless responsibility experienced by farmers was expressed as suppression of their own health to meet the needs of their livestock; regardless of their own personal health and wellbeing, the farm and livestock still needed care:

“It probably is a harder existence. Because you’ve got to get the job done. You’ve got a lot of animals depending on you. If you’ve got the flu, you’ve still got to go out and feed the animals, otherwise they’re going to die. So it sort of makes you do it, doesn’t it?” (Charlie)

“Farming is a three hundred and sixty-five day a year, all weathers...things have to be done [bangs table for emphasis]. You cannot be there one day and off the next. Also, it’s a very traditional father-son, hands on to son, daughter, et cetera. Quite often a family business, where if you’re out of action other people are feeling the pressure. And, quite often they’re family businesses where the success of the business depends on the amount of effort and work that you put in. Because of that I think you’ve got – gradually over the generations – a culture which is that no matter how you feel, no matter what you do, no matter how incapacitated you are, you still get out there and work.” (James)

This quote highlights how a farming culture has created an attitude to health and illness where the health of the farm, whether that is the livestock or the business, takes precedence over personal health and wellbeing. This was particularly evident when farmers were asked what health and wellbeing

meant to them. Farmers had a functional view of health and articulated being healthy as being able to carry out everyday duties on the farm:

“I suppose being fit and healthy to carry out daily tasks and wellbeing – feeling up to doing them.”
(Oli)

“Just no aches and pains and getting on with it.” (David)

In addition to associating health and wellbeing with the ability to continue with their everyday practises on the farm, farmers also associated these concepts with a countryside identity. Concepts such as ‘fresh air’, working outside and interaction with livestock contributed to the farmers understanding of wellbeing. This association between health and the countryside reflects the urban-rural dichotomy that farmers used to distinguish between different types of rats, as discussed in the previous chapter. For farmers, rural rats were cleaner than city rats and therefore posed less of a risk to their health. Similarly, because they lived in rural places, there was an expectation that farmers were healthier than people who lived in cities, but also that farmers needed to have access to the ‘fresh air’ of the countryside to remain healthy:

“Well, health is absence of aches and pains, or something that’s making you feel actively ill, and wellbeing, for me, personally, and I would imagine for most country people, is being able to be out in the fresh air, and it’s more a lifestyle sort of thing. You know, being able to do what you need to do. So, I suppose – well, I was talking to a shepherd last night about this – and the fact that, just recently, three or four local people, farmers, have got cancer. And we were saying we sort of think that, because we’re farmers and we work outside and suchlike, that we’re healthy. So, most farmers would want to be able to go outside and be with their stock. There’s a great sense of wellbeing of working with stock, and suchlike.” (Freda)

Normalisation of risk

The farming culture, part of which is a ‘just get on with it’ attitude to their health, was also reflected in farmers’ attitude towards risks on the farm; to a certain extent, these risks were accepted as part of everyday practises. In the same way that farmers felt they had to continue working when they were unwell, farmers articulated that the nature of farm work meant they had to work in high risk situations, particularly when working alone:

“A lot of time, I suppose, farmers are working on their own and, to get a job done, you probably do need to, probably are taking a few more risks.” (Charlie)

This meant farmers were effectively privileging the farm and the work that needed to be done, over decision about their own health and safety. As one farmer pointed out, this conceptualisation of farming risks was particularly evident in young farmers:

“I think as a young person, particularly young farming people, tend to see themselves as completely immortal. That’s possibly why there are such high incidents of accidents on farms.” (James)

In addition to the risk of accidents, the risk of zoonotic disease transmission was also normalised as part of farming culture. There was an almost fatalistic attitude towards the risk of contracting a zoonotic infection from livestock; risk of zoonotic transmission was conceptualised as an inevitable part of farming. In this context, there was very little farmers could do to minimise the risk of infection. Additionally, contracting a zoonotic infection was not necessarily harmful to the farmer’s health, in some ways zoonotic infections were understood as something that would have a long-term health benefit, through improved immune systems:

“As a child I seem to remember having lots and lots of stomach upsets on the farm. I think as a child you’re a little bit more susceptible to that and that is a more common occurrence, and something that we never sought any advice about. It’s one of those farming mentalities, where what doesn’t kill you makes you stronger. It’s that sort of mentality that you have.

“I think yes, as a child or a teenager, that’s going to mean that you’re going to suffer from various ailments. I do believe that exposure to those kind of bugs eventually strengthens the immune system and self-vaccinates in a way. It is an occupational hazard that most people, I think, on farms just tolerate and work through.” (James)

The exception to this was toxoplasmosis with regard to pregnant women. While toxoplasmosis was just one of a number of zoonotic infections that are part of everyday life on the farm, pregnancy changed women’s relationship to the parasite¹³. This change in conceptualisation of risk, associated with a shift in identity, highlights how important identity is in understandings of risk:

¹³ Cats are the definitive hosts of *Toxoplasma gondii*, however the parasite can persist in the environment meaning livestock can also become infected. Parturition is a particularly high risk and living on or near a farm increases the risk of being seropositive for the infection (Nash et al., 2005).

Ben: *“I was going to say abortion of the ewes this year.*

Emily: *Abortions, obviously with me being pregnant.”*

“No. No [I’m not concerned], because we’ve always lived here. And if I were pregnant, I would be concerned about the abortion that you can catch from sheep, and I know that most farm women, most farmers, that is the thing that you wouldn’t – but we have the cattle tested for TB, brucellosis, BVD, Johne’s – so they’re tested, and if they’re ill, they go. I mean, there are things like anthrax, which when I was little, there was anthrax around about. And because Mum and Dad were very worried about it, I was very worried about it. If something had died, it had to be tested for anthrax. Well, you don’t really hear about that anymore. So, because I’ve grown up with it, most of the time, I would wash my hands before I eat, and I wouldn’t bother. However, when it’s lambing time, you don’t wash your hands, because there just isn’t time. So, no, I don’t.” (Freda)

This quote also provides an example of how the longevity of the experience of living on their farm can act as a barrier to health protective behaviours. Freda has always lived on her farm therefore she does not view zoonotic infections as risks because they have become embedded in everyday life. The practice of hand washing is so engrained that it is not necessarily understood as a behaviour to reduce the risk of zoonotic disease transmission. Consequently, when the relentless nature of lambing prevented Freda from being able to wash her hands, she was not particularly concerned. For farmers, hand washing is an important part of infection control; they place great importance on the integrity of the skin as a barrier. This concept will be discussed in more detail in the next chapter.

Familiarity

In the previous chapter, I explored how familiarity with a species contributes to how it is constructed; farmers, unlike pet rat owners, do not understand rats or their behaviour. They see them as a threat and something to fear. In addition, livestock that have been bred or reared on the farm are ‘purer’ and consequently less of a disease risk than animals from an unknown background. Echoing how owners constructed a hierarchy of purity for their pet rats, this demonstrates how a farmer’s familiarity with the animal and knowing its history makes it less of a risk. Similarly, in the context of livestock causing accidents or physical injury, the risk is reduced for animals where the behaviour is understood and recognised – familiarity with livestock species means they are viewed as less of a risk than unfamiliar animals, for example horses.

“I worry about accidents, because you hear about a lot of accidents happening, just with machinery or people falling or working on your own, and you know, or something. Or you’re in with your cattle – [to Ben] you know you won’t go in a stable with a trained Arabian horse, but you’ll go in with a

new calved heifer – and I might not be there or something. And there might not be anybody there in case something goes wrong.” (Emily)

This quote also reflects concerns about lone working, which farmers have normalised as part of everyday practises on the farm. As part of the farming culture, lone working is something beyond the control of farmers, the pressure to ‘get the job done’ means these risks are accepted as part of being a farmer.

Toxic chemicals

Toxic chemicals are also part of the everyday practises on the farm and farming culture.

Consequently, farmers are constantly having to negotiate the adverse health effects associated with using them. One chemical in particular provides an example of how complex these negotiations are; the organophosphates used for dipping sheep. Farmers were aware of the potential short and long-term health impacts of using these chemicals, yet did not always follow the protocol stipulated by the Health and Safety Executive (HSE, 2013). Farmers discussed a number of reasons why they did not always follow protocol, including physical discomfort. Dipping sheep is physically demanding work, and their immediate personal comfort in this situation was more of a priority than any potential health risks:

“Well, I used to sheep dip. Depending on the day, I mean I’ve dipped in shorts, but I’d always start off with leggings, but it’s just not practical. It’s just the heat. You just die of... There’s no amount of water you can drink when you’re throwing 70, 80-kilo animals into a bath all day. And if it’s 25 degrees, it’s just... So, yes, I’ve done that without [personal protective equipment], yes.” (Charlie)

“I don’t know. I’m sure if I was wearing a mask and the air – the filter thing on your head or the gear, I’d feel worse, because it’s so hot dipping sheep. I’d probably feel worse doing that.” (Ben)

In instances when some personal protective equipment (PPE) was used, again this was to protect their immediate physical needs, such as not wanting to get wet, rather than because of any consideration for the short or long-term health outcomes:

“I think the worst chemical is maybe the dip that we use. That’s the worst... chemical but we just wear waterproofs. It’s more ‘cos we don’t want to get wet.” (Ben)

This dissonance articulated by farmers when using toxic chemicals is not because of a lack of knowledge or awareness about the risks associated them. Farmers know that the chemicals pose a risk to their health. In some cases, farmers even experience short-term health effects of the chemicals, although they would find it difficult to articulate exactly what the chemicals did and how they would make them feel. Not being able to articulate the effects of the chemical, and the short-term nature of the effects of exposure contributed to farmer's decision making regarding use of personal protective equipment. The tangible, physical effect of contact with the chemical – getting wet – was much easier for farmers to conceptualise and articulate.

“Yes you always feel a bit like... you know you've been dipping. Oh, erm...just like erm... I dunno, like... your tummy would feel a bit funny. That's all... Yes, but it would only be like a couple of hours and then that's it then. There's no headaches, nothing painful, I would...” (Ben)

“I don't always feel ill after dipping, it's just sometimes I feel a bit...” (Ben)

“The crovect is another one, the crovect is the same but it's a pour-on. I remember getting a rash with that and just a lot more painful than that. But it's a vital chemical that we need.” (Ben)

This last quote also highlights how farmers view these chemicals as an essential part of farming practise, yet understand that they also have a negative impact on their health. In some instances, farmers rationalised the risk of dipping sheep by comparing it with the risks associated with other health-harming behaviours, such as smoking and drinking. Sheep dipping is no different from any other activities that can kill you over a long period of time. Additionally, not being able to see a tangible link between exposure to chemicals and the resulting health outcomes, because of the long-term nature of the associated health risks, makes long-term health effects of dipping sheep a more abstract concept to understand. In this instance, the risk is only understood if the effect can be directly attributed to the activity.

“You know, sheep dipping might kill me over 40 years, but then so might smoking and drugs and alcohol.” (Charlie)

“Yes, so it's possibly a long-term effect, but then you're never really going to be able to pinpoint that back to the fact that I sheep dipped.” (Charlie)

Interestingly, one participant associated dipping sheep with ‘fresh air’, because sheep dipping is an outside job. The toxic chemical is being dispersed and diluted, reducing its toxicity. In the context of an ‘outside job’, dipping sheep was not risky, therefore negated the need for the use of personal protective equipment. This concept of the outdoors being healthier, or less of a risk, reflects previous concepts farmers articulated about health and wellbeing, where living in the countryside and working outside meant that farmers were healthier than people living in urban places. These concepts were also reflected in the urban-rural dichotomy when farmers were discussing the risks posed by rats.

“It’s an outside job. You’re out in the fresh air as well.” (Emily)

Rats and risk

In the previous chapter, I explored how farmers saw rats as an unbounded contaminant, polluting any space they traversed. While farmers consistently encounter dirt associated with the care and management of livestock, this was deemed an integral and acceptable part of their farming practises. Rats, however, came onto farms uninvited without a role in farming; they, along their excreta were viewed as contaminants. When discussing whether she was concerned about transmission of zoonotic diseases from livestock, one farmer stated:

“I think, actually, I’d be more inclined to throw out mouldy food from the fridge than I would be to think that I was catching it from the calves. So, I think the overall answer is no, I’m not really worried about – however, if I had just touched some hay which was stinking of rats, I would go and wash my hands after that. I certainly would.” (Freda)

When discussing the differences between livestock and rats, this farmer highlighted that there is an awareness surrounding the diseases that rats can transmit to people. However, farmers are aware that livestock can also transmit zoonotic diseases, and contact with livestock was not seen as problematic. This highlights that it is more than just an animal’s status as a potential disease carrier that constructs it as a potential risk, a number of other factors contribute to how this risk is understood.

“Well, I suppose because I know – you’re very aware of the diseases that rats can carry that are transmitted to humans, as in Weil’s disease and the bubonic plague. And also because, I suppose I’m covered in cow, sheep and hen muck most of every day, whereas I’m not, thankfully, touching or knowingly touching, rat muck every day.” (Freda)

Identity

Farmers recognised rats as vectors for disease, yet because farmers went to great lengths to minimise contact with them, the predominant risk rats posed to farmers was to their identity and reputation of the business. Their identity, both self-identity and outward facing identity, are almost inextricable, because being a farmer is so closely bound to the farm. The visible presence of rats on the farm suggests to visitors that the farm is dirty and not run professionally. For a business where heritage and tradition is so important, a family business with all the additional responsibility that entails, the pressure to continue the success of that farm is vital. Anything that could potentially damage the reputation of the farm is an important concern to farmers. The deep-rooted associations rats have with filth and disease create a stigma around them.

“I’m bothered [about rats around the incinerator], because customers come there every day and drop [fallen stock] off, and you don’t want rats. It just doesn’t look professional. And nobody likes rats. So you know, when they see them...You don’t want people to go ‘I was just in Hilltop Farm the other day and there were rats everywhere. You don’t want that.’” (Ben)

“The other thing is that we’d gone from having pigs, where a pig manager would turn up once a day, and then the lorry would go out once a week, to having the general public on the farm. My view was, I didn’t want to go into a pub in the evening, and for people to be whispering at the bar, ‘Oh, that’s the bloke with the shitty horse yard, where there are rats running everywhere,’ do you know what I mean?” (Oli)

In addition to posing a risk to their identity as farmers because of their potential to damage the reputation of the farm, rats also posed a risk to farmers’ self-identity. As discussed in the previous chapter, the way in which farmers constructed rats as a species gave rats agency in terms of changing farmers’ identity, making them possess characteristics that did not belong to them. In this context, as well as rats posing a risk to the identity of the farm in terms of its reputation as a successful and professional business, rats also posed a risk to farmers’ self-identity. Their identity as a farmer is incorporated with the farm as a business and farming culture, therefore protecting their identity from rats is more important than protecting their health from any potentially zoonotic diseases the rats might transmit.

Rat catching as a social event

In some cases, the dispersal of rats from farms was constructed as a social event. Farmers would use the need to eliminate rats from the farm to socialise with other farmers, reaffirming their identity.

Reminiscent of the rat pits in Victorian London, in one interview the farmer remembered a sense of excitement from these occasions.

“As young farmers, we went round each other’s farms controlling rats. So if the last of a stack of bales was about to be moved, we would all get together and do that. All armed with sticks and dogs. I was obviously very excited, because I think you’ve got that sort of hunting type of mentality, but also you know that you’re doing something that is beneficial. So you’ve got the perfect excuse to exercise a little bit of... possibly natural instinct in a farming teenager. So yeh, there was an element of excitement.” (James)

James shared this memory when asked about his first experience of rats, indicating the significance of these events to him and his identity as a farmer. In another interview, although the farmer himself was not directly involved with rat catching, he would allow others to use his farm to participate in this activity, which again almost became a social event or a sport.

Emily: *“So these guys from Liverpool came with their dogs and they caught, what 30 rats?”*

Ben: *Thirty-six in one afternoon. It’s their idea of an afternoon out, you know they bring their dogs, smoke them out, the terriers catch them.*

Emily: *They love it.”*

Summary

In farming, health-harming behaviours, such as lone working and use of toxic chemicals, are normalised. Farmers are embedded within a farming culture, where the success of the farm as a business takes precedence over their own health. This, in conjunction with the relentless nature of farming, has resulted in a certain amount of stoicism; regardless of how they feel, they have to persevere. In this context, relative to maintaining the success of the farm, their own health is less important. Consequently, although farmers are aware that rats act as vectors for disease, the risk posed by rats is to the reputation of their farm as a business, and their identity as a farmer, rather than their health.

Part Three: Pest control technicians

Social agents

In the previous chapter, I explored how rats were seen as central to the business of being a pest control technician. Rats only became problematic when they came into contact with people, when they crossed the boundaries into the private spaces of the home or workplace. Consequently, pest control is not just about trapping, baiting and killing rats; it more holistically addresses (and redresses) such transgressions. A large proportion of the job is offering information, advice and support to people to prevent problems (re-)occurring. In this respect, technicians are acting as social agents, demonstrating the importance of their role in public health.

“I like to keep whoever I’m speaking to, whoever is there – my commercial customers or my domestic customers – keep them involved. And it helps them, in the long run, because if they know what they’re looking for, and all the signs and that, they can start...self-helping, if you know what I mean?” (Sam)

“Sometimes people think pest control is all about killing things. But it isn’t. We save a lot more things than we kill. We give people appropriate advice about bees as they’re about to spray them with fly killer, you know. Saved a grass snake once that somebody thought was, you know. When people say things like, ‘Foxes are killing my chickens.’ We always say, ‘Well, it’s time you reviewed where you’re keeping the chickens.’ So, there is an alternative and holistic approach to it in many cases.” (Matthew)

A holistic approach

The holistic nature of the work makes it more complicated than simply treating the problem – the presence of rats. The clients also have to be included in the response to enable technicians to offer a successful service. This understanding of pest control contributes to pest control technicians’ construction of rats. In addition, in some cases, the people are problematic because they are creating environments that are attracting rats, but not necessarily wanting to change their behaviour to help resolve the problem.

“Very often you know, you go to a premises and it’s fairly obvious why they’ve got a rat problem, because they are not keeping up proper standards. There are sometimes you feel, you know, I don’t want to get involved with this because, yes I can kill a few rats but the problem’s going to come back again, unless they do some basic hygiene housekeeping improvements. And of course that costs money and they don’t want to do it.” (Chris)

Quality of life

The nature of pest control means that technicians are helping people who are feeling particularly vulnerable; feeling helpless because they had an animal in their home they were not under control of. Pest control technicians were aware of the effect that rats had on people, not just because rats are a public health pest, but also because of the stigma associated with having rats in your home. One technician stated this was the first thing he associated with rats:

“The first thing that comes to my mind when I think of a rat is... the effect it has on people’s quality of life.” (Matthew)

Being able to offer a service and help people in their time of need was something pest control technicians found particularly rewarding about their profession. Technicians recognised that the service they offered was gratefully received by customers, who usually expressed relief at handing the problem of the rat over to someone else.

“I like being able to help people, and going out, and dealing with a problem that they’ve got, and seeing a satisfied customer at the end of the day. I like that.” (Jennifer)

“They’re always pleased to see you. Well, if you’ve got a problem, and you turn up and you do a good service, ‘Oh, thank God you got that rat out of my house.’” (Shane)

Dirty by association

Contributing to the effect unwanted rats have on people’s quality of life is the deep-rooted association the species has with dirt and disease. The rat being out of place within the home means that its presence contaminates the home environment. The commonly-held belief that rats live in dirty environments, such as sewers, adds to the stigma of having rats in the home. Not only does the rat contaminate the home environment, but it was also perceived to have selected the home because it was dirty. The rat was seen to connote an attraction to dirty spaces as well as contaminating spaces through their presence.

“It is that association that, it is just a norm that, anything like that – mice or bedbugs or fleas or anything like that – will only live in dirty houses and people just like that think, for centuries probably, that if you’ve got any sort of insect or rodent infestation, your house is dirty. So people just think straightaway, ‘Oh god, what will the neighbours think, I’ve got mice, they must think my house

is filthy', and it is just one of those things that has been passed down generation to generation."
(Sam)

"When I were little, the thing that sticks in my mind...my mum used to be talking to her friends and she would say, [whispering] 'She's got cancer.' And she would whisper it. The same things with rats as well. People were heartbroken at the thought that a rat catcher had to come to their house."
(Matthew)

"People ask me, 'You haven't got rat catcher written all over the van, have you?'" (Matthew)

This shame also extended to the pest control technicians themselves; the association between rats and dirt is so pervasive that the presence of pest control at the home can also result in people experiencing stigma, even if there are no rats there. Pest control technicians recognised this need to maintain the privacy of the home and its occupants.

Dissenting voice

While most people would experience shame when rats infringed on the private space of the home, one technician recounted an example of how he had dealt with a client who welcomed wild rats into her garden. While her neighbours saw them as an infestation, the owner of the house wanted them there and only called the pest control service because her neighbours complained.

"She had rats in her garden. The thing was, though...she loved them rats. There was a cellar underneath a room, with a little glass window. I could go down there and look through this glass window. There were half a dozen or so laying about in the sun, playing in the garden. She'd bought proper rat food from a pet shop and a book about how to care for your rats." (Matthew)

The technician realised that it was a complex situation, not simply because of the rats, but because of the impact of having to inform the homeowner that it is against the law to encourage wild rats to reside at her property. It is an offence not to inform the council if rats and mice are residing at a property in substantial numbers, although as the technician pointed out, no one really knows what substantial means.

"We've been as sympathetic as we could. The work has started. We had intensive visits. We arranged that so it were free for her, because she was saying to me, 'How much is this going to cost me? I've got £20 to £30 in my savings.' I said, I think we can probably waiver it this time." (Matthew)

The technician was aware that there was the potential for zoonotic disease transmission, and did inform the woman that she could become unwell, however, he was also able to see the situation from her perspective:

“I could see her point of view as well. We do an animal sanctuary and similar things happen there. In the animal sanctuary, there’s animals you love. Where do you draw the line? It’s just that rats are classified as a public health pest and they carry a lot of diseases, as I’m sure you know. It’s always difficult.” (Matthew)

This story also highlights the fragile nature of how we construct animals from different perspectives. While rats are classified as public health pests by some, others will encourage them. Pest control technicians encounter similar scenarios with pigeons, which again are thought of as a pest, but are also welcomed by others. These shifting constructions of animals highlight how complex the role of a pest control technician is and how sensitive they have to be. As the quote below demonstrates, it’s a holistic profession, where technicians have a role as social agents, particularly for those who may be experiencing stigma or vulnerability.

“It’s difficult with pigeons for people who live on their own. They look forward to birds coming every morning. It’s not just a case of banging the poison down and grabbing the money. There’s more to it.” (Matthew)

Technicians were also conscious of the amount of trust that was placed in them by clients, especially doing visits for domestic clients. Understanding that everyone’s home is different and everyone has a different conception of what a home is helps technicians understand and respect the boundaries of the home. The female pest control technician interviewed recognised that being a woman meant clients, particularly those who may feel vulnerable, felt more at ease with a female technician.

“Well, I think some people [pause] prefer to have a lady come to deal with a problem. Older people like to see a lady because they feel a bit more secure than having a strange gentleman come into their home, you know?” (Jennifer)

One technician, who worked in a region with a large number of Asian communities, recognised that when he did domestic work he was often dealing with women, whose partners were at work and who

did not speak English. This technician learnt a few words of Urdu, enabling him to introduce himself. He explained that this empowered clients who did not speak English, and meant they were more comfortable with him coming into their home.

Pest control is more than just killing animals; it was seen as providing a service for often vulnerable people and included the prevention of a problem escalating. This draws the focus away from how the profession brings the practises of death and killing into the private space of the home, or workplace. Refocusing the profession and themselves as social agents helps negate the stigma associated with certain practises involved with pest control.

Construction of the home

Pest control technicians frequently acted as social agents, for example when they came into contact with more vulnerable members of society. Elderly people who lived alone or people who lived in environments or conditions that could be deemed socially unacceptable were frequently the clients of the pest control technician. For many of these people their lifestyle made their homes attractive to the rat. In one interview, the technician had been involved with fumigating an empty property, in which the owner had kept parrots. The home had been repossessed and was currently undergoing renovations. The technician's role was to ensure the property was safe for the other people to work in. This was routine work for the technician and the way he reported it was matter of fact, as if he encountered situations like this on a regular basis.

“The guy used to have parrots, and he just let them fly round flat. Parrot poo everywhere on the floors. We don't know how many he had... So I went in and fumigated it all with Jeyes Fluid, because that kills avian flu, to make it right for them to go in and work. Now they've got larder beetles. This flat is riddled with them. They've got to take all the wooden floors up, because it's in such a state. It absolutely stinks. They've got to rip all the floors up. [We were interrupted at this point by a phone call from the site supervisor seeking reassurance there was no risk to the health of the other people working on the site.] “He's just ringing to say, ‘The lads, they're not in danger, are they?’ I said, no, they will not bite you. They're a little beetle, and they live...” [We were interrupted again by the same man reporting that ‘the lads’ were refusing to work at the site until the beetles had been eliminated.]” (Shane)

While the world of the pest control technician was textured by unwanted animals, this was not the case for many of the other tradespeople working in the same environment. Whereas other professions would not be comfortable working in an environment that is infested with beetles, rats or other ‘matter out of place’.

Technicians accepted everyone lived their lives differently, made different choices about their lives and tried not judge them for it. They were exposed to so many different lives and ways of living that they understood there was no single concept of what constituted a ‘home’, everyone’s understanding or construction of the home was different. The exception to this was when they thought a child or animal was potentially at risk, in which case concerns were escalated.

“When I used to work for council, I’ve been in that many houses that it means nothing to me. The only thing I ever noticed – if there were anything wrong when I went to a house, only two things – if there were anything obviously wrong with children or animals that were in the house. At that time, if I thought there was, I used to network it. But those were on the only things. I don’t comment on other people’s houses.” (Matthew)

This understanding technicians had, that everyone lived their lives differently, influenced how they conceptualised risks they encountered during their work. For their clients, these environments are homes and part of their everyday life, so even when working in contaminated environments, technicians did not necessarily think of them as a potential risk.

“Not really, because they’ve lived in it. It’s just the way they live, where they will just stack the household waste in the kitchen in bags. They will just leave it there, and it’s just rotting.” (Shane)

Dirty work

In their role as social agents, pest control technicians are doing ‘dirty’ work on behalf of society. This dirty work can be literal; cleaning up contaminated sites or dealing with rat infestations. The dirty work they undertake can also be conceptual, related to the stigma associated with bringing the practises of death and killing into the home or workplace. In some cases, pest control technicians felt stigmatised because of their profession:

“Pest control is not always popular. There was a time when I started work, in the ‘80s, that pest controllers were receiving letter bombs. I didn’t get to the bottom of it and it wasn’t widely covered in the news, but we got a letter to say be careful with any envelope that smells of oil that comes to your house.

Sometimes at factories, it’s not possible to do the work in the daytime, because the staff gang up on you. You have to go around with security. [They] shout abuse at you and stuff. They shout things like, ‘You fat bastard, is your mother proud of what you do?’” (Matthew)

In addition to experiencing stigma because of his profession, this technician was also sensitive to the effect his job might have on other people, particularly children. In a way, he was acting as a social agent to protect a vulnerable member of society – a child – from the reality of pest control.

“There are parts of pest control that I won’t talk about really, with people who I’m working for. If there are children at the house and there’s a rat in the cage. They inevitably ask, ‘What are you going to do with it?’ I say, I’m going to take it up the moors and let it go where it’ll be happy. But in actual fact, that doesn’t happen.” (Matthew)

“What happens is, the fear of the rat is so great. But when you see it in a cage, it changes. It’s like, ‘Oh aren’t you cute?’” (Matthew)

This quote also reinforces the importance of boundaries in the construction of animals. When a rat is in a cage and remains where it is expected to be, within the boundary of that cage, it is a pet, it is ‘cute’ and no longer a threat. However, when a rat crosses the boundaries of a home, the unbounded and uncontrolled status of the rat shifts from animal to vermin, requiring elimination.

Sanitising the killing process

The use of toxic chemicals go some way to negate the stigma associated with pest control, almost removing the technicians from the reality of it so that killing rats becomes more of an abstract concept.

“Even though I’d put baits down for rats previously, I’d never actually come into contact with them, because obviously they’re shy creatures – they don’t want to be seen, they’re very nocturnal.” (Sam)

“The thing about pest control, it’s strange, because people have said that you’re removed from the reality of it, because you don’t see the animals. What you see is, you put the bait down. The bait gets eaten. It stops getting eaten and the assumption is everything is alright. It’s very rare you see something dying on the floor.” (Matthew)

“Most rat jobs that I do, I don’t come face-to-face with them. Most of the jobs, you know, you don’t see a rat, and it’s just damage, and holes, and signs of them.” (Jennifer)

In a way, the use of toxic chemicals sanitises the killing process, so it becomes less of a taboo. These chemicals are used to decontaminate an environment, purifying the space once again. The paradox

with the use of chemicals is that the same chemicals used to purify spaces from the pollution caused by rats, are toxic in themselves requiring technicians to take steps to protect themselves. This concept will be discussed in more detail in the following chapter.

Health and risk

Being removed from the reality of killing rats means technicians do not necessarily feel at risk of rodent borne zoonoses. Adding to this is the concept that rodent-borne zoonoses are rare, so while they are aware there is the potential for transmission, they feel it is unlikely they would contract anything during the course of their professional work. When discussing both hantaviruses and Weil's disease, both diseases were understood as rare and therefore not something to be concerned about.

“No, not really [worried]. Because you've got actually more chance of getting hit by a bus than catching hantavirus....There are only about eight cases a year.” (Shane)

One technician had contracted Weil's through exposure to rat urine on a job he was doing. Pest control technicians have to carry a Weil's disease card, and as a profession are aware it is a potential risk. However, in this instance it was not considered as a potential cause of the illness, possibly because the initial symptoms are quite non-specific.

“I got it...by doing that [wipes face with hands], with dirty hands. Despite everyone saying, it was the last thing I thought of. I had to go in hospital for ages.

It started off as a cold. I went to the doctors with a pain in my back and the symptoms of flu. The doctor checked me over. So, this cold would never go. They were giving me two or three lots of antibiotics, which in the end, it turned out it kept it under, but I'd grown a big abscess on my liver.”
(Matthew)

Interestingly, despite the severity of the illness, and the long-term health effects he experienced, this technician was not concerned about rodent borne infections, because they were considered unlikely to occur (or, in this case, recur). Despite the severity of the illness, Matthew appeared to dismiss the likelihood of further infection on the basis that it was a rare occurrence.

“I wouldn't worry about [Weil's] myself, because it is quite a rare thing.” (Matthew)

Professional norms

In common with how farmers normalise risk on the farm, certain occupational risks are embedded within every day practises in pest control; they become part of the job and part of the profession. There are a number of ways in which this influences how pest control technicians understand occupational risks. Firstly, because they understand certain risks to be part of the job, they feel they have the professional capacity to manage them effectively. As a professional, they have to do the work regardless of what risks that might entail.

“I don’t worry about it, it’s what I’ve got to do. And that’s what I’m being paid to do. And it goes with the territory as they say, isn’t it.” (Nick)

In addition, the knowledge they had acquired as part of becoming a professional equipped them with strategies that they routinely used to protect themselves against certain risks; for example the wearing of gloves. Their day-to-day co-existence with rats created the circumstances in which risks were routinely managed.

“Like there’s not many fishermen... the odd fisherman gets [Weil’s disease], if they’re at the side of water and there’s rats about. We’re the people...but you never hear of pest controllers getting leptospirosis or farmers very rarely, and we’re the ones who work within the industry.

It’s because we know you wear your gloves when you’re pulling things about looking for where the rats are. So you always wear your gloves. It’s the first thing I do when I walk in a house. I’ve always got me touch gloves on. So it’s all engraved up here [points to head].” (Shane)

“There are risks, but there are risks in any job, and as long as you’re aware of the risks and you can, or just be aware of them so you can, it, it’s not any problem.” (Chris)

This concept of risk and control was exemplified in one interview when discussing the use of ladders. Of all the occupational risks that pest control technicians were exposed to, this participant thought ladders were the most dangerous. This was on the basis that unlike other risks, such as zoonoses or chemicals, where PPE could be worn to reduce the risk of harming their health, there was no routine protective equipment available that could protect technicians from falls. In addition, the use of ladders was part of their job, part of their professional identity, therefore as a professional they felt a certain amount of pressure to undertake work at height, even though it was potentially high risk.

“The biggest risk you’ve got actually, as a pest controller, is ladders. Going up into somebody’s loft and falling through the loft, or actually going up and treating a nest of some kind on a ladder. Because you’re more likely to fall off the ladder and be damaged that way, than you are to get some of the other things. And of course you can take precautions you see? If you go and do pigeons, you make sure that you’ve got all the precautionary things. And the same when you’re dealing with rats, you put gloves on. So the biggest problem is things that you... go a little bit beyond your control. Because you can’t turn round and say ‘well I’m not going up that ladder because...’ ‘Cos [you’ve] got to go and do that job. So that’s the thing that worries me more than anything else, than the fact he’s treating rats.” (Elaine)

Summary

Pest control technicians are doing ‘dirty work’ on behalf of society, often working in contaminated environments. In contrast with farmers, pest control technicians will use PPE when working with chemicals, but not necessarily when working in environments contaminated with dirt or disease. For their clients, these environments are their homes and part of their everyday life, therefore not seen as a risk.

Chapter Five

The creation of boundaries for infection control

Chapter Five: The creation of boundaries for infection control

Introduction

All of the infection control practices identified by participants in this study were directed at maintaining the physical and conceptual boundaries they have created. In this study boundaries were seen as the means by which infection could be controlled. Interestingly, boundaries varied according to the type of respondent. Farmers were more likely to rely on the body's skin as a boundary between the environment and the body's internal workings, while pet rat owners focused on protecting the space within which rats lived. For pest control technicians, they understood their role as restoring and maintaining the physical and boundaries people create around their homes, by removing rats from inside the home and preventing them from returning.

Part One: Pet rat owners

Infection control practices

As previously discussed, pet rat owners were primarily concerned with protecting the health of the rat from external pathogens. Infection control practices were considered critical to sustaining the health and lives of their pets given the short-lived nature of the species and the amount of movement and contact within the pet rat population. Pet rat owners took active steps to protect the health of their rats in the home.

Rats in the home

The rat as a pet is *in place* within the home, and this was reflected in the survey of pet rat owners, where 94.9% of respondents kept their pets within the boundary of the home. In the survey, just over half (52.5%) of respondents kept their rats in a communal space in their home, such as a living room, 31.2% kept their rats in their bedroom and 17.3% in a room in their home specifically set up for their rats, known as a rat room. Keeping rats in a space shared with people, particularly bedrooms, is an important consideration for airborne zoonotic diseases such as hantaviruses, where exposure to airborne particles can increase the risk of transmission.

When deciding where to keep their rats, respondents who kept their rats in communal spaces did so for convenience (33.1%), space (32.7%) and to increase interaction (23.3%) – a small number of respondents specifically commented that as part of the family, they did not want to shut their rats in a separate room (3.9%). Similarly, respondents who kept their rats in their bedroom did so because of the convenience (39.1%) and space (33.1%), however a number of respondents also added that it

improved the bond between them and their pets (10.2%). Managing the risk of infection, either to themselves as owners or to their rats, was rarely a consideration when people were deciding where to keep their pet rats (Table 5.1).

A larger proportion of respondents who kept their rats in their bedrooms – a private and intimate space – engaged in rodentistry (39.3%), compared with only 13.1% of people who did not keep their rats in their bedrooms (P=0.006).

Table 5.1: Reasons owners kept rats in either their bedroom or a common room in their home in a sample of pet rat owners in Great Britain.

Reason for keeping rats in each room	Bedroom (n=159)	Common room (n=268)
Space	94 (33.1)	160 (32.7)
Convenience	111 (39.1)	162 (33.1)
To manage the smell	10 (3.5)	13 (2.7)
To manage the risk of infection to owner	1 (0.4)	2 (0.4)
To manage the risk of infection from other pets	6 (2.1)	1 (0.2)
To manage the risk of infection from wild rats	2 (0.7)	1 (0.2)
To manage the risk of infection from other people	1 (0.4)	0
To help with bonding*	29 (10.2)	–
No choice*	14 (4.9)	–
To protect them from other pets*	10 (3.5)	–
To increase the amount of interaction*	–	114 (23.3)
They are part of the family*	–	19 (3.9)
To reduce disturbance at night (noise)*	–	4 (0.8)
Other	6 (2.1)	14 (2.9)

*These categories were produced from the free text answers when respondents selected ‘other’. Additional, less frequent categories are not included here.

Exploring factors associated with ‘rodentistry’ in more detail, there was a significant trend towards people engaging in this high-risk behaviour having a closer bond with their pet rats, based on their responses to the pet attachment scale. In addition, there was a trend towards agreeing that wild rats were more likely to carry disease than pet rats (P=0.01). It would have been interesting to explore ‘rodentistry’ as a high-risk activity in relation to infection control practices, however the number of responses did not allow further detailed analysis. Analysis of associations between ‘good’ or ‘bad’

infection control practices¹⁴ and ‘rodentistry’ did not provide any evidence of a relationship between these variables ($P>0.05$). Similarly, owner characteristics were assessed for an association with ‘rodentistry’ using logistic regression and no variables remained significant in the multivariable model.

Rat contact

Owners acquiring new pet rats, looking after each other’s rats and attending rat shows, all increase the amount of contact between pet rats. In turn, this increases the risk of disease transmission, and is an important factor for PHE to consider when developing strategies to manage zoonotic infections from pet rats. The amount of movement and contact between pet rats belonging to different owners was recognised by PHE following the identification of the first case of Seoul virus in a pet rat owner and breeder. The following quote is from a rat owner and breeder, who also contracted Seoul virus. She identified a complex web of relationships of owners and their pet rats connected by a common ‘air space’.

“I didn’t have a link with [the first case]. Not a direct link, but [they] rehomed breeding rats to a breeder who is one of my best friends, who I rat-sat for her and she rat-sat for me. And we’d had rats off each other. And then again, my foundation rats had come from another breeder, who again had had those links with [the first case]. And to be honest, with showing, everyone’s mixing their rats and they’re all in the same air space. You know, everyone was only one degree of separation from [the first case] if you see what I mean. So it does seem fairly likely that my rats were as likely as everybody else’s to carry it.” (Sophia)

In the survey, just under a quarter of respondents (24.2%) stated they acquired new rats every 7 to 12 months and just over a quarter (25.9%) ‘swapped’ rats with friends; looking after friends’ rats, rescue rats or breeding rats. In addition to the number of rat owners who attended shows with their rats (35.7%), these forms of contact demonstrate the potential for a significant amount of contact between pet rats, posing a substantial risk of disease transmission.

Quarantine

In the interviews, rat owners demonstrated a breadth and depth of knowledge about infection control practices. One key action was quarantine, which a number of rat owners would routinely enact. The decision about whether to, or how to quarantine would often depend on the origin of the rat, and

¹⁴ ‘Good’ infection control practices were defined as respondents who selected one or more of the following, when asked what they did when looking after other people’s rats; quarantine; washing hands; changing clothes; use of gloves. ‘Bad’ infection control practices were respondents who selected none of these options.

where on the hierarchy of purity it belonged. As discussed in the previous chapter, pet shop and rescue rats would routinely have two weeks quarantine, before being introduced to the home.

Like the [pet shop rat], he was quarantined, and all the rescues where I wasn't sure if there was any other contact with other rats, then they would have two weeks quarantine. Either with a friend's house who doesn't have rats or sometimes upstairs. Which sometimes, it's not full quarantine because for airborne stuff they would still get it, but at least it means, when things transmit through droplets and contact, you are kind of protecting them from that." (Sara)

In one interview, a participant described using 'full quarantine', which she understood as separate airspace. In this example, Claire had a 'rat room' in her garden. So while this building was physically outside the boundary of her home, the conceptual boundary she created around her home, which kept her rats clean and safe, was stretched to accommodate this additional 'outside room'. In addition to this, she would also change a layer of clothing – this demonstrates the expertise and considerable lengths owners will go to, to protect the health of their pets.

"Full quarantine would usually be completely separate airspace. So my rats live out in their room in the garage out there. If I brought some in temporarily that I needed to quarantine, I would bring them in this house. Outdoors is ideal. If you have to [have them in the house] then two doors, at least. And then I would always see to my rats first, before I would go into them. And I would generally change outer layers." (Claire)

Reflecting the different types of quarantine for different rats, the survey respondents also engaged in different practices depending on where the rats came from. For example, for people who looked after their friends' rats, 37.6% stated they kept these rats in a separate room from their own rats, however for respondents who took in rescue rats, 61.5% were kept in a separate room. For people looking after friends' rats, the most frequently cited concern was health problems or injury (35.7%), whereas for people taking in rescue rats, while 36.9% were concerned about health problems/injury, 32.8% were concerned about the risk of infection to their own rats (Table 5.2).

Table 5.2: Frequency and duration of contact, infection control practices and perceived risks of rat ‘swapping’ in a sample of pet rat owners in Great Britain.

	Friend's rats (n=101) n (%)	Rescue rats (n=65) n (%)	Breeding rats (n=23) n (%)
How often do you look after them?	(n=86)	(n=43)	(n=16)
Less than once a year	31 (36.0)	13 (28.9)	9 (56.3)
Once a year	45 (52.3)	20 (44.4)	5 (31.3)
Once a month	10 (11.6)	10 (22.2)	1 (6.3)
Once a week			1 (6.3)
For how long do you look after them?	(n=101)	(n=65)	(n=21)
24 hours	–	1 (1.6)	–
Between 1 and 2 days	1 (1.0)	3 (4.7)	1 (4.8)
Between 2 days and 2 weeks	75 (74.3)	13 (20.3)	9 (42.9)
Between 2 weeks and 4 weeks	21 (20.8)	21 (32.8)	5 (23.8)
Over 4 weeks	4 (4.0)	27 (42.2)	6 (28.6)
Where are they kept?	(n=101)	(n=65)	(n=22)
Same room	63 (62.4)	25 (38.5)	19 (86.4)
Separate room	38 (37.6)	40 (61.5)	3 (13.6)
What concerns do you have about them?*	(n=171)	(n=122)	(n=32)
Escaping	36 (21.1)	13 (10.7)	4 (12.5)
Health problems/injury	61 (35.7)	45 (36.9)	14 (43.8)
Infection to own rats	22 (12.9)	40 (32.8)	3 (9.4)
Death	52 (30.4)	24 (19.7)	11 (34.4)
Other†	6 (4.8)	12 (7.3)	–
What infection control practices do you use?*	(n=126)	(n=164)	(n=14)
Changing clothes	19 (15.1)	27 (16.5)	2 (14.3)
Gloves	15 (11.9)	19 (11.6)	2 (14.3)
Quarantine	26 (20.6)	51 (31.1)	3 (21.4)
Washing hands	60 (47.6)	55 (33.5)	7 (50.0)

*Respondents were able to select more than one response for these questions. †Other includes behavioural problems, becoming emotionally attached, risk of infection from existing rats, unwanted pregnancy.

Broken boundaries and infection control

To understand how owners conceptualise and engage in infection control practices in more depth, it is useful to consider what happens to these practices when the boundary protecting the purity of their rats is broken. This was exemplified in the interview with Sophia, the rat owner who was infected

with Seoul virus from her pet rats. For this individual, the normal infection control practices that were routinely enacted were reframed to encompass protecting the health of her family, especially her baby, as well as her pet rats. Sophia knew that the virus would be in her breeding colony indefinitely, but as she did not want to forsake her breeding lines, she needed to develop a strategy to enable her to live with the virus. This strategy involved strict biosecurity procedures, particularly when her baby was breastfeeding. The competing vulnerabilities that Sophia experienced – wanting to protect her baby and her pets – forced her to disentangle two interlinked lives. The spaces within the boundary of Sophia's home, which she designated as safe or dangerous, pure or contaminated, were negotiated by biosecurity measures aimed at preventing her from transmitting the pathogen from her rats to her baby.

“I mean it's not easy, and I have this whole slightly neurotic kind of clean down routine after I've been in the shed. But at the moment it is feasible to go out there and for [the baby] not follow me. But eventually, he's going to.

So basically, I have my rat clothes. So it's generally first thing in the morning or when [the baby]'s gone to bed. I – and a lot of this comes from the fact that I'm used to working in containment facilities. I've worked in [category 3] as a plant pathologist, which is quite a high level of containment. So I'm used to quarantine type things.

So basically, I have my rat clothes that I put on with various layers. Then I've got a bucket and a water bottle that go in and out to the shed. I'll go out to the shed, do stuff with the rats. Depending on if I'm just handling them, then I've got different levels of clean down routine once I've got in. So, if I'm planning on washing my hair and having a full-blown shower, I'll let them sit on my shoulders and what-not. But if I actually just want to go out and feed them and want to wash my hands afterwards, I'll probably just stroke them and not let them on me.

Then I'll come back in – I do hand sanitiser when I'm out there – then I come back in strip off, wash my hands. Then normally I'll go and have a shower, and I've got a bag by the back door that all the clothes live in.

But then I do have, kind of, various levels. 'Cos [sic] I do think the virus can live for up to 2 days. So I kind of have two coats and I am very aware that when I'm putting stuff back on, am I contaminating myself before I've gone out to the shed. So sometimes, if I don't want to have a shower, I'll put on a different coat and then not wear it for 2 days.” (Sophia)

These infection control practices were aimed at keeping her baby safe, particularly when the baby was at his most vulnerable. The competing vulnerabilities that Sophia was experiencing was constantly changing; as the baby grew and became more independent, Sophia relaxed her biosecurity practices. Taking her baby with her to rat shows with no (known) detrimental effects for him helped Sophia to negotiate these competing vulnerabilities and almost normalise allowing her baby having contact with the rats.

“I think when [the baby] was really little and literally attached to me, skin-to-skin pretty much 24/7. And yeh, probably breast feeding as well, maybe makes a difference, because he is physically...you know, he is breathing in my skin that’s just been in the shed and I am very aware of which bits of me have been exposed and which bits he snuggled up to. Whereas now he’s a bit more sort of independent and I’m chilling out about it a bit more. And I think with every... in terms of just him having contact with the rats, with each show we go to and then he doesn’t get hantavirus, that’s making me chill out a little bit more about him being in the same airspace and touching them and things.” (Sophia)

Following her illness, Sophia described how her relationship with her rats changed. They shifted from being part of her family, integrated within the home, to existing as rats in their own isolated space. This shift, both literal and physical, enabled her to perform a strict infection control regime.

“Having them out in the shed they’re...not part of the family in quite the same way. I think [the hantavirus infection] is one of the things that has made a big difference. I’ve sort of...they’ve become a sort of... rather than being just part of my life in general and popping out of the rat room all the time and having rats out on the sofa and stealing my tea and that kind of thing, they exist in isolation in their own space that I then go to.” (Sophia)

Rat shows

Rat shows provide an example of how infection control practices are implemented in different contexts. They also provide an example of how rat owners understand or construct ideas of disease transmission. First, I am going to discuss the importance of attending these shows for rat owners – the significance of attending shows has implications for trying to engage with owners to change health-related behaviour.

Social worth

In the interviews, participants talked about the effect of attending rat shows on their identity and self-esteem. In this context, attending rat shows contributed to their social worth and were therefore an important part of rat keeping. Shows were particularly important because of rat owners’ ‘outsider status’; attending shows gave them a forum through which they could engage and interact with other rat owners, validating their identity and choice of pet. In one interview, the participant was just about to attend their first rat show, and excitedly described it as:

“Yeh, we’re going to look at other people’s rats, and talk about rats and be a rat geek.” (Richard)

Others had been attending shows for a number of years. These participants explained what an important role rat shows had in their lives as a rat owner:

“They’re all like-minded. We like to hang out, and I never thought you could get such a thing as a rat show because, well, they’re rats. But it just bears true to say that people like to hang around with like-minded people. We really do. We want to be able to talk freely and openly about the fact that we have this irrational love of this weird rodent that nobody else likes. Do you know what I mean? We like to sit and chat about it.” (Sonia)

“It [gives you a connection]. You just go up to random people. Normally, you wouldn’t do that, going somewhere, but because they have a rat, you just go, ‘Oh, what’s this one called?’ It just starts the conversation.” (Rosie)

The popularity of rat shows was also reflected in the responses to the survey. Overall, 43.4% (n=199/458) of survey respondents attended rat shows, of these 35.7% (n=71/199) took their own rats. The mean number of shows attended each year was 4.7 ± 0.5 . The majority of shows had infection control guidelines for attendees (88.1%), of these 32.3% were voluntary and 67.7% were compulsory.

Factors significantly associated with increased odds of attending rat shows were number of rats owned, age group of owner and being a member of a rat club. For each additional rat owned, the odds of attending shows increased by 1.1 (Table 5.2). For club members, the odds of attending shows was over 40 times that of non-members. Respondents aged 26–30 and 31–35 years (OR 3.2 and 3.0, respectively) and 41–45 years (OR 5.7) were more likely to attend shows compared with those aged 18–25 years (Table 5.3).

Reflecting the interviews, the survey respondents who attended shows also thought they had a positive influence on their social networks. There was a significant linear association between attendance at rat and the strength of belief that they had made friends through their pet rats; 73.4% of show attendees agreed their rats helped them make friends (very much or quite a bit), compared with 31.2% of non-attendees ($P < 0.001$). Similarly, there was a significant linear trend towards people attending shows believing their pet rats broadened their social network, with 66.7% of show attendees stating rat ownership broadened their social network (very much or quite a bit), compared with 27.6% of non-attendees ($P < 0.001$). In addition, people who attended rat shows believed their rats helped them feel like an active member of the community; 63.0% of people who attended shows stated they felt like an active member of the community (very much or quite a bit), compared with 29.3% of non-attendees ($P < 0.001$).

Table 5.3: Multivariable logistic regression model for factors associated with attending rat shows in a sample of rat owners in Great Britain.

Variable	Category	Proportion +ve	Proportion -ve	95% CI	Odds ratio	P value
Number of rats (continuous)					1.1	0.018
Member of a club	No	43 (12.5)	300 (87.5)		Reference	
	Yes	78 (86.7)	12 (13.3)	19.6-85.5	41.0	0.000
Age group	18 to 25 years	23 (16.5)	116 (83.5)		Reference	
	26 to 30 years	31 (30.1)	72 (69.9)	1.4-7.3	3.2	0.006
	31 to 35 years	24 (33.8)	47 (66.2)	1.2-7.4	3.0	0.019
	36 to 40 years	10 (23.3)	33 (76.7)	0.5-5.5	1.7	0.366
	41 to 45 years	15 (44.1)	19 (55.9)	2.0-16.6	5.7	0.001
	46 to 50 years	10 (40.0)	15 (60.0)	0.6-8.8	2.3	0.216
	Over 50 years	8 (47.1)	9 (52.9)	0.5-13.5	2.7	0.222

The rat show as a home-from-home environment

Initially, when I was in the early stages of interviewing, it appeared to me to be contradictory that pet rat owners, who placed such importance on maintaining the purity of their rats within their home, would happily take their pets to a show where there were other people and rats. Through exploring this concept in more depth, it became evident that shows offered a ‘home-from-home’ environment; the boundary that owners created around their homes, to maintain the purity of their rats, was stretched to include pet rat shows. To enable this ‘stretching’, infection control practices and protocols were used, such as quarantine procedures, and the purity of rats at shows was maintained as long as attendees adhered to these rules. For example, rat owners are not allowed to enter rats into a show if they have had contact with any new rats in the previous two weeks, or if any of their rats are showing any signs of disease. These rules are partly policed by officials within the society, for example all attendees must report to the show secretary. However, there is also a considerable amount of self-governance; the pressure from other members of the pet rat community to adhere to the rules set within their social groups. In this context, ideas of infection control discussed in relation to attending rat shows were focused on surveillance rather than prevention. The familiarity rat owners have either each other reduces the risk of attending shows; they share the same concerns and work together to uphold the standards they think are required to reduce the risk of infection. This is particularly important, as contravening the rules could potentially have repercussions for everyone attending that show, as discussed in the example below.

Despite these protocols pet rat owners identified risks associated with attending rat shows. For one participant, attending shows was a ‘medium’ risk; she was aware there was a potential risk of infection, however the infection control protocols sufficiently reduced the risk to make rat shows safe enough for her to attend. This participant also thought rat shows benefitted her rats’ immune systems. As a breeder, she wanted to build her rats’ immune systems by exposing them to low levels of pathogens, for when they went to their new homes and she saw rat shows as a safe way of doing this.

“Shows are medium risk I would say. So a medium risk is, I know most of the people that go there, we communicate as best we can, infection control things. People who are attending on the day, and you have to register, even rats you’re bringing along and not entering. They’re given information about what we expect.” (Claire)

Contributing to the risk assessment was the concept that rats from specialist breeders were low risk, regardless of what infection control protocols were put in place. Using the hierarchy of purity that owners articulated in the interviews, the rats attending shows were unlikely to have any infections because they were predominantly from specialist breeders. Those that were not – rescue or pet shop rats – would have undergone quarantine before being fully invited into the home, therefore were considered ‘medium risk’.

“I would say that outbreaks of diseases do tend to come from... ‘Cos I think the fancy is almost like a closed... We don’t have – from what I can tell – there aren’t viruses, rat viruses - not hantavirus - SDAV [Sialodacryoadenitis virus, a type of coronavirus] and things. So things that are equivalent to flu, but in rats. They are not circulating in the fancy all the time. When they come into the fancy they come from somewhere. Whereas ‘cos the rescue and pet shop side of things is so much bigger, I think the viruses are always circulating.” (Sophia)

Rat shows only offer a ‘home-from-home’ environment because there is an expectation that everyone follows the guidelines to minimise the risk of a disease outbreak. When these rules are broken, it can have devastating consequences. In one interview, the participant described such an event, and it provides an example of reactive infection control strategies rat owners put into practise in the event of a disease outbreak in the rat population.

“Round here has been badly hit by a virus. [Someone] lost about half her rats to it. Which was from, somebody had imported rats – from the Netherlands I think – and they’d come sick. And she’d made a stupid call, because she wanted to enter the show that we held and the show had quite strict rules – you can’t show if you’ve had contact with any other rats in the [preceding] two weeks, or if any of your rats are showing symptoms. Unless you contact [the show secretary], and [they] do a bit of digging to see if [they] think if it’s a real thing, or a bit of a one off. But she hadn’t done that, she

brought them in and then several people lost a lot of their rats. It was Sendai [Sendai virus, or Murine parainfluenza virus]. It varies, it can be mild flu or it can kill. So this was quite nasty.” (Claire)

This quote also demonstrates the importance of attending rat shows for owners. In this example, the rat owner engaged in risky behaviour and did not follow the standard guidelines, despite knowing she should. In this case, the rat owner knew her behaviour was potentially risky, but went ahead with it anyway.

“It was a bad time. It was a very bad time. [Pause] It’s [sigh]. [She] was falling to pieces because her rats were just dropping dead. I was trying to go across and help her, but I also had to come back and protect my rats. So I was having to do like a full strip down, shower, not be able to go into them until the next day – it’s got quite a short lifespan thankfully. But, so she was really struggling. I was struggling to support her in some ways as well. So when I was with [her rats], ‘cos I knew they were infected, it was even more rigorous. It was like a complete change of clothes. I’d keep the clothes in one bathroom and then go and get changed in another one. I was paranoid, but its, it was a bit more severe risk than normal.” (Claire)

This demonstrates how, when driven by protecting the health of their pets, rat owners are willing to engage in time consuming infection control practices to manage the risk of disease transmission. In addition, it provides an example of their level of knowledge about infection control. They have the ability and resource to undertake strict infection control practices, and do so to a high standard when they have the motivation. The situation described here also highlights how tight-knit the pet rat community is; the level of support between human members of the community means they are willing to undergo rigorous biosecurity and potentially risk the health of their own rats, to support friends.

Breeding for health and long lives

As well as forming and maintaining a pet rat community, attending pet rat shows was seen as a way of validating breeding programmes. In the interviews, rat owners articulated that rats from specialist breeders were ‘purer’, therefore healthier than rats from unknown backgrounds. The health of their rats is particularly important because rats as a species do not live very long (around 2–3 years). This placed a great deal of importance on the infection control practices owners used, as well as their breeding programmes, the ultimate aim of which is to produce rats that live longer, healthier lives. These breeding lines are of great value and breeders will go to great lengths to protect them, even if that means sacrificing their own health. The importance of these breeding lines became clear, following a cluster of cases of Seoul hantavirus in pet rat owners:

Sophia: *“People were basically more worried about their rats than their own health.*

Interviewer: *Why is that do you think?*

Sophia: *[pause] I think again, because it seemed like it wasn't that big a risk [pause]. And again, 'cos they're your pets and you care about them, and especially with breeding and their lines. People have invested massively over years and years and years, in breeding their lines. And the thought of losing that over, an infection that they might have for a couple of weeks.”*

This quote also demonstrates how owners place not just the preservation of their breeding lines, but also the health of their rats over their own health. This was particularly relevant with an infection like hantaviruses, where the implications for the rat was not known¹⁵. In addition, as there is no specific treatment for hantaviruses, there is limited value in owners having a diagnosis if they do become ill, as it would not change their treatment. Conversely, although rats are asymptomatic, owners believed there was a risk they could be euthanised if they were identified as a source of hantavirus infection. In this, context the risk to the rats was much greater than the risk to the owner.

Summary

When it comes to infection control practices, pet rat owners are knowledgeable and often have the resources to engage in effective biosecurity protocols. These protocols, whether they are aimed at protecting the home or rat shows are consistently designed to protect the health of their own and other pet rats, rather than owners' health. The importance of the boundaries that rat owners construct around their pets and their homes are highlighted when these boundaries are broken. The impact of broken boundaries can be devastating and completely change the relationship between owner and pet. Understanding how these boundaries are created and maintained is essential for public health practitioners who need to engage with this population.

¹⁵ When the first cases of Seoul virus were identified in pet rat owners, there were some concern among owners what the implication for their pet rats would be. This was in light of the rats belonging to the first case being euthanised.

Part Two: Farmers

In the previous chapter I discussed how in farming, health-harming behaviours are often normalised and there is a gap between acknowledging health risks and changing behaviour to protect their health. The risk posed by rats is to the reputation of their farm as a business and themselves as farmers, rather than to their own health. Consequently, when farmers do engage in infection control practices, these are not necessarily to protect themselves from the risk of disease transmission. In this section, I demonstrate how farmers created and maintained the physical and conceptual boundaries, based on their understanding of disease and risk discussed in the previous chapter.

Integrity of the skin as a barrier

Farmers placed great importance in the integrity of the skin as a barrier, preferring to wash hands than wear gloves. In the interviews, farmers discussed routinely washing hands after working with livestock and before eating. For them, this routine practise meant there was no risk of transmission of zoonotic infections from the livestock, or rats.

“If I then have to go and have a sandwich at lunchtime... I will have, in my vehicle, damp hand wipes, because I just can’t bear the thought of knowing what diseases [rats] spread. If I touched a rat, or even if I’d known that I’d touched something before I sat down to have that food, that a rat had been on or near, I would just psychologically be wanting to wash my hands before I did anything else.” (Oli)

“I tend to try and be careful. Like with Orf, for example. If I’m handling a lamb with Orf, I won’t necessarily put on gloves, but I’ll come straight back here and wash my hands.” (Charlie)

In one interview, the farmer spoke about hand washing as part of working with livestock, the two are almost inextricable. Hand washing becomes a habitual reaction following interactions with livestock. This farmer also discussed how he would use latex gloves in some situations, but this was dependent on his ‘disgust reaction’, rather than for infection control.

“I think just sensible precautions. After working with livestock always wash your hands with hot soapy water before eating, etc. I don’t go beyond that, really. Occasionally, like I say, wearing latex gloves if I’m doing something which I think it particularly obnoxious.” (James)

When probed further about what he meant by ‘obnoxious’, James described a situation where he believes he caught *Escherichia coli* from some rotten eggs. He was wearing gloves to remove rotten

eggs from an incubator, however the gloves did not prevent disease transmission. James stated the reason he was wearing gloves was not to reduce the risk of disease transmission, but to protect himself from the smell of rotten eggs persisting on his hands.

“Quite often it’s more... the reason that you would wear latex gloves when handling something like [rotten eggs] is because you just don’t want the smell to persist on you, rather than a disease precaution or protection.” (James)

Not only do smells have a longevity, lingering long after exposure has ended, they are tangible and often evoke a disgust response. In comparison, diseases are often invisible. Unless an animal is showing clinical signs of disease, it is difficult to determine whether an animal is a potential risk for transmission of a zoonotic infection. In addition, with infectious diseases, including zoonoses, there is often a delay between exposure and onset, making the risk difficult to conceptualise. Conversely, smells evoking a disgust response are almost immediate; the disgust response is an innate reaction.

“If I do ever handle silage, I’m aware of the fact that... I’m not worried at all about any disease transmitted from what is effectively pickled grass, but it does really smell, so I’ll occasionally put gloves on to open silage bales, for instance. Just because I want to avoid carrying that smell on me for the next twelve hours, or twenty-four hours, rather than disease. Apart from that, I don’t ever wear gloves on the farm and I know I am handling things where rats may have been and where manure is, from cattle, handling cattle. I think a hand wash is sufficient, really.” (James)

Summary

Farmers place great importance on the integrity of the skin as a barrier, preferring to wash hands than use gloves. The exception to this is when they encounter something they consider disgusting; such as silage or rotten eggs. Smells have tangibility and longevity, whereas diseases are invisible. Smells are immediate, whereas there is a delay between virus exposure and onset of illness, making it difficult for farmers to conceptualise the risk posed by zoonotic diseases.

Part Three: Pest Control Technicians

The practices of pest control aim to restore order, by repairing the broken physical and conceptual boundaries around the home, or workplace. Pest control technicians are putting rats back in their place, removing them from spaces in which they do not belong and preventing them from returning. Technicians use toxic chemicals as part of this process, which sanitises the process of killing the rats, removing themselves from the reality of it. While these chemicals purify the spaces contaminated by the rats, the toxicity of these chemicals requires technicians to protect themselves from potential harm. In this context, the infection control practices that pest control technicians engage in are aimed at protecting themselves from exposure to toxic chemicals, but not necessarily environments that are potentially contaminated with zoonotic diseases.

Use of personal protective equipment

In common with farmers' hand washing, pest control technicians would routinely use personal protective equipment (PPE). For technicians, the use of PPE became part of the job. There were professional regulations that had to be adhered to if technicians wanted to be accredited to specific professional bodies, such as the National Pest Technicians Association. In turn, these practices became habitual, engrained within their identity as professional pest control technicians.

“You have to use the gloves if you're holding rodenticides or if you're picking carcasses up.” (Nick)

“I don't want to be breathing in fumes from chemicals and powders. It's routine. I just put them on.” (Shane)

Pest control technicians understood gloves to be particularly important. Not only were gloves an essential barrier against the harmful effects of toxic chemicals, but they were also used to protect technicians against zoonotic infections, specifically from Weil's disease. This zoonosis can be transmitted through direct contact with rat urine, and it is a well-known risk for pest control technicians; most technicians will carry a leptospirosis card, which identifies them as a pest control technician and ensures any medical professional is aware of this status and their potential contact with rats.

“We've got a card that we carry around, which if I was head down on the pavement and somebody... Or, on the banks of somewhere, or wherever... More than likely, it might be [Weil's disease]. So that

people would know then that if you were flaked out somewhere, that there's a possibility that you may have come into contact with rat urine.” (Darren)

In one interview, a technician revealed that he had previously contracted Weil's disease from contact with rat urine. This had changed his attitude to use of PPE and infection control practices. As well as routinely using gloves, he also shared that he sometimes used liquid hand sanitiser when at work.

“I always have gloves in my pocket. Yes, and hand wash and sometimes I have a little bag with me, with a little first aid kit in, a bottle of hand steriliser. So, no intention of being caught twice.” (Matthew)

Pest control technicians placed great importance on the use of gloves for protecting them against harm, primarily toxic chemicals but also some diseases. When asked if they worried about zoonotic diseases, specifically Weil's disease, the risk of transmission was not a concern because they used gloves. This could also demonstrate the importance of touch in understanding of disease transmission, specifically for infections such as Weil's disease, where the route of transmission is contact, rather than inhalation. If there is a barrier or boundary to stop contact or touch, then you can stop the transmission of disease.

Interviewer: *“So is that something you worry about then?”*

Chris: *I don't, no. Because I always wear gloves.”*

Interviewer: *“Do you worry about Weil's disease?”*

Sam: *If I'm working, in wet areas then I do, yes. You know, you're always conscious of Weil's disease, it is one of those things, you know, occupational hazard. But, no, I don't particularly worry about it, but I do take precautions against it.*

Interviewer: *What kind of things do you do?*

Sam: *Using gloves. Yes, I use gloves all the time.”*

One technician discussed how he would wear a mask if he entered environments that were dusty, and potentially contaminated with rodents. This was framed as a precaution against the dust and rodent hairs, rather than potential zoonotic infections. However, when probed further, he admitted that the use of a mask was not as routine as the use of gloves. Chris was aware of the risk, but not until after he entered the 'contaminated' environment. This highlights the difference between the use of PPE for toxic chemicals and toxic environments. Toxic chemicals are always toxic, there is no ambiguity or

uncertainty about the level of risk. The risk is known before the technician starts the job, so knows exactly what PPE is needed. When entering toxic environments, there is more uncertainty and technicians have to make a decision about what, if any, PPE is needed *prior* to entering the environment.

“I can’t say I always do, because some of the areas, you’re not aware that there’s rats about and as long as you’re wearing your gloves, and then; ‘oh if I’m going into a place which is dusty and probably rat-ridden I’ve got to go back to the van to get my mask, so I won’t bother’ [laughs].”
(Chris)

This quote also demonstrates the importance placed on wearing gloves; as long as he is wearing gloves then Chris is going some way to protect himself from any potential risk. The use of PPE, particularly gloves, has become embedded within the profession.

“We’re the people... but you never hear of pest controllers getting leptospirosis or farmers very rarely, and we’re the ones who work within the industry. It’s because we know you wear your gloves when you’re pulling things about looking for where the rats are. So you always wear your gloves. It’s the first thing I do when I walk in a house. I’ve always got me touch gloves on. So it’s all engraved up here. [points to head].” (Shane)

This quote from Shane also demonstrates that, as professionals, pest control technicians feel they have the knowledge and expertise to protect themselves from zoonotic diseases. Conversely, in one interview, a technician discussed how in some companies he had previously worked for, if he wanted to use PPE then it seen as being ‘soft’ or ‘defective’. In this instance, using PPE was not part of the professional identity and those who chose to use it were not functioning ‘normally’ as technicians. These contrasting examples of different professional approaches to the use of PPE demonstrate how the ‘professional identity’ influences decisions regarding the use of such equipment.

“I’ve worked with some pest control companies where they weren’t really forward thinking. If you insisted on wearing on a mask, or some gloves and you asked where cleaning stuff was, you were somehow soft or defective.” (Matthew)

Restoring broken boundaries: restoring order

Pest control technicians have an important role in public health, particularly for rodent-borne diseases. They are at the front line – working at the boundary between rats and people. Since the early twentieth century, rats have been systematically targeted to reduce the transmission of rodent-borne diseases such as the plague.

Today, technicians take a holistic approach to rodent control, aiming to restore the borders and boundaries around people's homes or places of work, to restore order. These 'border practices' not only prevent rats from becoming 'out of place', they reduce the risk of disease transmission. Part of these border practices are literal; physically identifying and fixing broken boundaries. The pest control technician's knowledge and familiarity with the rat and its behaviour enables them to do this.

"Obviously in the old houses, where cables for water or whatever or new electricity cables have been put through. Builders tend to drill a hole about that big for a cable about that big, and then obviously you've got access there..." (Sam)

"If there's a fault in a sewer that serves the house, the same rat with that muck on runs across the work surface in the morning." (Matthew)

"I took the kick boards off underneath the kitchen units. You could see a hole where the electric wires came through from outside, with a big, four-inch hole like this. You could look straight outside, and you could see by the smell and the dirt where the rat was running regularly." (Jennifer)

Fixing these physical boundaries is part of the holistic nature of pest control, which was discussed in previous chapters. In addition to the literal restoring of boundaries, the conceptual restoration comes from pest control technicians putting rats back in their place. Restoring the natural order, so the rat is no longer an intruder in the home. This is primarily enacted through killing out of place rats, through the use of toxic chemicals. The process of restoring broken boundaries then prevents other rats from becoming similarly out of place in future.

Summary

The 'border practices' of pest control rely on the use of toxic chemicals, for which technicians will routinely engage in infection control practices, specifically the use of PPE, such as gloves. This suggests they place importance on contact as a route of transmission of harmful agents, whether those are chemicals or diseases. The chemicals used by technicians have a dual role; to negate some of the stigma associated with the practices of death and killing that are inextricably linked with their job and to purify environments that are potentially contaminated diseases.

Chapter Six

Discussion

‘If we can abstract pathogenicity and hygiene from our notion of dirt, we are left with the old definition of dirt as matter out of place.’

(Douglas, 1966:36)

Chapter Six: Discussion

Overview

This thesis provides important new insights on the sociology of rodent-borne disease transmission. Specifically, it highlights the importance of understanding how humans view the animals associated with certain diseases before planning public health action. This study focused on three groups of people who had different relationships to the rat; pet rat owners, farmers and pest control technicians. Adopting this diverse sample illustrates the different ways that animals get constructed in different contexts. For pet rat owners – the principle focus of this work – the domestication of the rat has elevated its status, sanitising it, so it no longer holds the same associations with dirt and disease that wild rats have. Rat owners have created a clear divide between pet and wild rats, to the point where they are recognised as two different species. Farmers see rats as a contaminant that pollutes anything they come into contact with. While the place of animals on a farm is heavily bounded by production, yield and profit, rats are seen as unwanted and unbounded. Rats often thwart farmers’ attempts to restrict their movement, which manifests in a constant battle of wits to try and regain control of the boundaries of their farm. For pest control technicians, their work depends on understanding the lifecycle of the rat. Technicians use chemicals to secure the boundaries that rats have usurped. In homes and offices rats are out of place and provide the impetus for a pest control technician to be employed. Technicians often have more contact with the damage created by the rat than the rat itself.

Following numerous cases of Seoul virus in pet rat owners, PHE developed health messages aimed at reducing the risk of infection from pet rodents. The public health perception was that rat owners were unreceptive to these health messages. This provided the rationale for this project, which was designed to explore why pet rat owners appeared to ‘ignoring’ the risk presented by their pets. The study included farmers and pest control technicians as a way of understanding how the views of pet rat owners compared with other groups of people who had regular contact with rats.

The importance of ‘place’

For all groups, ‘place’ was central to their construction of the rat and the risk it poses. While the pet rat is ‘in place’ within the home, the outside world is dirty and contaminated and puts the rat’s health at risk. Within this context, rats can only become infected with disease through exposure to the

outside world. Similarly, the place of the rat's birth is associated by rat owners with the purity of the animal. Rats from specialist breeders were seen as the purest type of rat, compared with rats from pet shops or rescue rats where their place of birth was not known. While it is common to think of rats as 'at home' in urban and rural areas, farmers viewed rats as 'out of place' on their farm. Rural rats were thought to pose less of a disease risk than urban rats, which live in the sewers and feed on the waste of human society. Pest control technicians were the only group of people in this study who expressed some compassion towards wild rats; viewing them as animals trying to survive. Their behaviour in crossing the boundary into the human spaces of home or office defined them as pests and made them a matter of concern for the pest control technicians.

The importance of place in the construction of rats as disease vectors influences the risk they pose to humans and consequently the health protective strategies people adopt when encountering them. For all groups, infection control practices were aimed at maintaining, or restoring, the physical or conceptual boundaries of space, keeping the rat in or out depending on the way the animal had been constructed. Boundaries were central to understanding the experiences of pet rat owners, farmers and pest control technicians, yet despite their importance these boundaries were subject to flex when there were competing needs.

The following discussion focuses on two key concepts that have been developed from the data; the importance of place and creation of boundaries. I will draw together pertinent findings and discuss how these can help inform how the groups in this thesis understand and respond to risk of zoonoses and how this information can be used to inform public health messages. I will also identify some of the limitations of the research and highlight areas where this research could be expanded.

Place of encounter

The coexistence of different and often conflicting human-rat relationships explored in this thesis highlights the complexity of how animals as vectors are understood from different perspectives. The multiplicity of roles rats have is a common theme in literature. Birke (2003) described rats as contradictory, multiple and elusive: '...what the rat means to us is many things at once—just as the animals can be many things at once in their considerable success at colonizing the world in our wake. The rat and mouse, like the coyote, are shape-changers: They can be much-loved pet and hated adversary; they can be dirt personified, and they can symbolize the eradication of disease.' (Birke, 2003: 220).

Fundamental to these different understandings of rats is *place* – the place where the rat resides and the place of encounter. This is a reflection on how rats are viewed; whereas pet rats are associated with human places, wild rats are generally thought to have limited human contact. Place of encounter has been identified as an important aspect of human-rat relationships, because it characterises how these

interactions are interpreted (Beumer, 2014). Beumer discussed human-rat interactions as situated practices. He argued that to understand these conflicting relationships, rather than focusing on the characteristics of the humans and rats that interact, how these encounters are enacted in specific settings should be examined. Beumer draws on the work of Mol (2002), who first used the term ‘enactment’ to describe situated practices. In *The Body Multiple*, Mol explores the treatment and diagnosis of atherosclerosis and demonstrates how a single medical condition can be understood in a multitude of ways. In much the same way, rats embody a multitude of different meanings, depending on the place of encounter and how people relate to them. While to farmers wild rats were pests, they distinguished between rural and urban rats on the basis of the place in which they resided. Sewers with human excrement were deemed dirtier than ditches in fields. Pest control technicians understood rats to be primarily animals, but in their line of work they were defined as vermin. Domesticated rats were much-loved pets.

The importance of place in the construction of rats highlights the need to understand the role that place plays in discourses of purity and contamination. As Duschinsky and Brown ask; ‘what is it about *place*, specifically, that means that ‘matter’ which is ‘out’ of it may well be understood as dirt?’ (Duschinsky and Brown, 2015:2) In *Geographies of Exclusion*, Sibley describes the creation of boundaries and construction of ‘discrete categories’ as an ‘arbitrary act’ (Sibley, 1995: 35). Sibley argues that to overcome this arbitrariness, we use discourses of purity and impurity to construct the ‘inner (pure) self, in contrast to the ‘outer (defiled) self’ (Sibley, 1995: 27). A phenomenon needs a *place* in order for it to be *out* of it; and to enable us to relate to the arbitrary construction of different spaces, concepts of purity and impurity are used.

This concept of traversing boundaries highlights that it is not just place of encounter that is important in how human-rat interactions are conceptualised. The crossing of boundaries to become *out of place* also needs consideration. This boundary crossing characteristic that rats possess is reminiscent of Douglas’ seminal work on purity and contamination. In *Purity and Danger*, Douglas argues that impurity is associated with disorder, with being rejected from social structures that societies create to make sense of their world. When this structure is violated, disregarded or not adhered to, the result is pollution or contamination. From this perspective, pollution is not isolated; dirt is not independently polluting or disgusting, it can only be understood in relation to a whole system of meaning. In this way, rats can only be understood in context. Through the creation of systems and structures, we create boundaries around certain things or concepts, to keep them in their place; to maintain their purity. Douglas argues that for something to become dirty, it needs to be disordered. This implies there is an accepted order, a structure by which matter is systematically ordered. Matter becomes dirty when it moves out of this structure and becomes “matter out of place”. This structuralist understanding of dirt resonates with how rats are constructed from different perspectives. For all groups interviewed for this thesis, rats were not inherently problematic animals; their status changed depending on whether they

were perceived to be ‘in place’ or ‘out of place’. This differentiation between place was particularly evident with the farmers, where until rats crossed the boundary onto the farm, they were animals and part of the local wildlife. Once they had crossed that farm boundary and were out of place, they were vermin and farmers would go to great lengths to eliminate them from the farm. Not only did they become problematic animals, they also became dirty and contaminated anything with which they had contact. Similarly, pest control technicians recognised that rats were not inherently problematic and only became pests when they crossed the boundary into the private space of the home. In some ways, the rats had a dual role for pest control technicians; in their working relationship with the animal it was a pest, yet outside of work it was an animal. This status as pest or vermin had an additional stigma associated with it; once the rats become out of place they were dirty and, by association, the environment in which they appeared was also dirty. From the perspective of the home owner, the rat was contaminating the environment, yet from the perspective of the pest control technician, the home owner had some responsibility in ensuring the environment was not accessible or attractive to rats. Pest control technicians recognised the stigma associated with rats and felt a responsibility to protect their clients from it. For pet rat owners, the structure they created was more complex. While similarly to farmers and pest control technicians they created a dichotomy between wild and pet rats, how pet rat owners articulated hierarchical structure within pet rats was more intricate.

Understanding risk and risky behaviour

One of the key high-risk behaviours that was highlighted in this study was ‘rodentistry’; where owners allow their rats clean their teeth. Data from the survey highlighted that ‘rodentistry’ could potentially be more prevalent than the interviews suggested, with a considerable proportion of respondents reporting they engaged in this behaviour (just over a third). In addition, other health-harming behaviours, such as not washing hands after handling, or not wearing gloves for cleaning out cages were identified in the survey. The survey also highlighted that a large proportion of rat owners kept their rats in their bedrooms; rat and owner sharing the same confined airspace is likely to increase the risk of transmission of a virus such as Seoul virus, which can be shed in rat faeces or urine, aerosolised and inhaled by the owner. From an outside perspective, it may be difficult to understand risky behaviours such as ‘rodentistry’, yet like many other health-harming behaviours they make sense to the people engaging in them (Kelly and Barker, 2016). A classic example of this is Hilary Graham’s seminal work on women in poverty and smoking. Graham explored why women with limited resources were still able to buy cigarettes; they explained that it was their only opportunity for self-directed behaviour in an often-relentless day of caring for young children (Graham, 1987). In this context, smoking was not an irrational behaviour; it made sense to the women in the study as a way of coping with caring in poverty. This approach has been taken in the context of other health-harming behaviours, such as choice of diet (Popay et al., 2003), use of sunbeds (Lake et

al., 2014), physical exercise (Thomas et al., 2008) and drug and alcohol use (Lindsay, 2010), resulting in a considerable literature examining health-harming behaviours from the perspective of those engaging in them. Similarly, by examining the risky behaviours identified in pet rat owners from their perspective, they begin to make a lot more sense. From the perspective of pet rat owners, the rat as a pet is removed from its wild existence to live a domesticated, bounded life. The domestication of the rat sanitises it, almost creating a new species and removing any pre-existing associations the rat has with dirt and disease. In this context, pet rats are clean, free from disease and therefore safe to interact with, including what public health professionals would consider high-risk behaviours. This highlights the importance of understanding risky or irrational behaviour from the perspective of the person or people engaging in it. As Kelly and Barker point out, 'it is arrogant to assume that people consume alcohol, chocolate, or cream cakes because they are irrational or are simply behaving thoughtlessly or stupidly.' (Kelly and Barker, 2006: 112). Similarly, we should not assume that rat owners engage in 'risky' behaviour because they are ignorant or thoughtless. This behaviour is meaningful to them and their relationship with their rats, and this needs to be taken into account by public health messages.

In addition, public health messages targeting pet rat owners need to take into account the status of the pet rat to be effective. For pet rat owners, pet rats are in place within the home – as demonstrated by both the interviews and survey – pet rats are part of the family. In this context, rats are not inherently dirty; they become dirty because of the environment in which they live. Take the rat out of that environment, elevate its status from animal to pet and it is no longer perceived as a risk. In addition to this dichotomy between pet and wild rats, owners also created a structure within pet rats; a hierarchy of purity. This hierarchy defined how owners constructed 'pure' and 'impure' rats and highlights the importance of place and boundaries for understanding of risk. Rat owners have created this structure to make sense of wild and pet rats being the same species and to explain why pet rats are safe, by 'othering' wild rats. By creating this clause in the species, from the perspective of rat owners, wild rats are the potential risk, not their pets.

The analysis and subsequent development of a theory to describe how pet rat owners understand risk – the hierarchy of purity – demonstrates how Douglas' structuralist approach to understanding purity and pollution is too simplistic to provide further insight into the data. The interviews with pet rat owners highlight how a negotiated social order, which is more fluid, is perhaps a more appropriate reflection of how these structures are understood. In the same way that Douglas argues that dirt does not exist independently, concepts such as contamination and impurity are constantly shifting; they can only be understood through a socially produced order. The focus of Douglas' theory is on classificatory and symbolic systems of order and a transgression from that order, which leads to contamination. Consequently, impurity is a deviation from a structured system, rather than from a state of purity. Additionally, the structuralist approach taken by Douglas does not allow for any

uncertainty, vulnerability or inconsistency in the classificatory system, which is taken as a fixed and stable concept. This assumes fixed concepts of purity and impurity, when arguably they are more fluid and context-specific. Purity is defined differently in different contexts; freedom from impurities and contaminants, it can also be described as cleanliness and innocence¹⁶. These contextual definitions demonstrate how purity is socially constructed, a ‘discursive judgement made regarding an object, comparing it to an ideal prior essence free from heterogeneous, foreign or inferior elements’ (Duschinsky, 2011: 313).

The way in which pet rat owners understand the risk of zoonotic infection is based on discourses of purity and contamination, associations between dirt and disease. Rats are not inherently dirty; they become dirty and therefore diseased through environmental contamination; by becoming out of place. With concepts of place and being out of place, comes the creation of boundaries. These boundaries are important for maintaining purity and the interviews in this thesis demonstrated how the creation of boundaries was used for infection control.

Construction of the home

The data presented in chapter four (*‘Rats, risk and health’*), suggests that pest control technicians act as social agents in the killing of rats for pest control. Packaged around the eradication of the rat from the home is support and advice for the client to prevent future encroachment of their space by pests. Disruptions to the boundaries people create to demarcate spaces of ‘home’ challenge the idea that the home is a safe space, their feelings of ‘homeyness’ (Power, 2009: 31). Pests and the pathogens associated with them have been cited as sources of anxiety with the home; ‘unruly, disruptive bodies’ (Power, 2009: 31). Pests rupture the boundaries around the home by bringing the outside, in; connecting the home with outside spaces, when home-making processes ultimately aim to do the opposite (Kaika, 2004)¹⁷. However, as Power (2009) argues, this binary that has been created between the house-as-home and the contaminated outside world is more complex. The boundaries used to create the home are porous. This porosity allows pests as ‘disruptive bodies’ to enter the private space of the home, contaminating and disrupting this space. In this context, pest control technicians are trying to control ‘disruptive bodies’ and help people restore their feelings of ‘homeyness’; remaking the home that pests have ‘unmade’.

¹⁶These concepts are taken from the Oxford English dictionary, which presents three definitions of purity; (i) the state or quality of being morally or spiritually pure; sinlessness; freedom from ritual pollution; ceremonial cleanness; innocence; chastity; (ii) the state or quality of being physically pure or unmixed; freedom from impurities, contaminants, or foreign matter; cleanness, a pure substance or part; (iii) the state or quality of being free from extraneous or foreign elements, or from outside influence; the state of being unadulterated or refined; clarity.

¹⁷ Kaika goes on to explain that the modern home is defined by ‘selective porosity’, where specific, desirable elements of the natural world are ‘selectively’ allowed to enter the home, for example pet rats.

Pest control technicians in this study possessed a comprehensive understanding of the ecology and behaviour of different animal and insect species, which also seemed to extend to humans.

Technicians observed the everyday variation of how a ‘home’ was inhabited. Despite routinely using personal protective equipment when using toxic chemicals, they did not necessarily consider spaces within the home that were potentially contaminated with zoonotic pathogens to pose a risk to their own health. There are two reasons for this inconsistency; firstly the use of toxic chemicals, which is heavily regulated by the professional framework within which they operate, not only dictates the specific protective equipment they have to use, but the nature of the chemicals distances the technicians from the actual killing of the animals. Technicians rarely saw rats, usually relying on owner reports and the detritus left behind as evidence of a rat infestation. The focus of their work was not on clearing up the excreta of rats, which may harbour pathogens, but on the eradication of the animal. Secondly, there was an assumption that the home occupants would become ill if there was a risk from living in the presence of pests.

Creation of boundaries

This thesis demonstrates the importance of place in how people understand the risk presented by rats. To protect themselves from rats, or to protect their pet rats from ‘impure’ rats, the groups interviewed for this study created boundaries. These boundaries sought to maintain a structure of where rats were expected to belong, and in the case of pet rat owners, to maintain the purity of rats within the home. These boundaries could be physical or conceptual, and they dictated the infection control practices used by each group. In other words, infection control practices were focused on maintaining and restoring the integrity of the boundaries created around places or animals that were thought to be pure, or safe.

Spatial logistics on the farm

In this study, boundaries were used to create and define different spaces on the farm, giving farmers their own spatial rationalities, through which they understood disease and risk. In a previous study, it was argued that the way in which farmers understood animal health on the farm involved negotiating different spaces (Enticott, 2008). I contend that human health on the farm also involves farmers’ spatial rationalities. In other words, the way in which farmers understand risk and health is negotiated by how they understand and define the different spaces on their farm.

Enticott’s study highlighted how maintaining animal health on farms required the prevention of pollution from animal movements within and between farms, in the context of bovine tuberculosis (bTB). This requires the definition and creation of ‘safe’ or ‘contaminated’ spaces and an

understanding of how animals move through these spaces. The spatial logistics identified by Enticott in relation to animal health, can be extended to the health of the farmers and may go some way to explain how farmers understand health and wellbeing. While farmers' understanding of health and wellbeing was enveloped in their identities as farmers, they also used spatial logistics to articulate an expectation and need to have access to 'fresh air' to remain healthy. The importance of 'fresh air' was articulated on two levels; to separate urban and rural spaces and also to define different spaces within the farm. The boundary farmers used to delineate an urban-rural dichotomy was applied to their understandings of their personal health, as well as the risk posed by rats. The rural space within which the farm was situated meant that they themselves were healthier than others living in urban spaces, but also the rural rat population was not as dirty or diseased as urban rats. In this context, although farmers did not welcome rats on their farm, they did not necessarily view them to be a risk to their health, in the same way that urban rats were. Farmers had clear boundaries within their farms to define 'safe' and 'contaminated' spaces. These boundaries were important for the production of livestock or other commodities, therefore regulating these boundaries was vital to the success of the farm. Rats, an animal on the farm that farmers do not have any control over – despite their best attempts – defy farmers' spatial logistics by traversing these boundaries. Moving between 'safe' and 'contaminated' spaces pollutes the space and the commodity produced there, from seed stores to animal sheds.

Spatial logistics were also used when making decisions regarding the use of personal protective equipment. 'Outside' jobs, in the 'fresh air' were not necessarily risky, therefore did not need the same amount of protective equipment as other, indoor, jobs. Through the spatial logistics of their farms, farmers are creating their own spatial realities; these realities are part of their everyday work and everyday working life. If that reality does not match with the reality used to communicate messages about reducing risk, farmers will not act on it. When communicating health messages to farmers, whether in the context of animal or human health, government organisations fall back on a population approach – attempting to manage or change determinants of health at a population level (Rose, 1985). This was highlighted in the context of animal health, where advice for farmers on how to reduce the risk of bTB transmission was not compatible with farmers' own individual geography of their farm; there was a 'clash of spatial logics' (Enticott 2008:443). Similarly, when communicating health messages in the context of farmer health, generic information leaflets issued by the Health and Safety Executive¹⁸ about use of personal protective equipment or reducing the risk of hantavirus transmission on the farm did not take into account the contextual nature of different spaces on the farm. As this study demonstrates, the ways in which farmers define different spaces on their farms are unique to each farm and farmer, and not taking these spatial logistics into account makes it difficult

¹⁸ A copy of the HSE leaflet is available in Appendix 2 ix and includes advice such as 'the rodent population should be controlled effectively.'

for farmers to understand how these health messages are relevant and can be implemented on their farm.

The bounded purity of pet rats

Pet rat owners went to great lengths to protect their pets from the contaminated outside world and also to maintain their hierarchy of purity. Not only were they protecting their pet rats from wild rats, but also from ‘impure’ rats from unknown backgrounds. To do this, rat owners engaged in complex infection control practices aimed at keeping rats in their place with a view to preventing the rats from getting ill. The way in which infection control practices were discussed in the interviews demonstrated a depth of knowledge about biosecurity. The boundaries that pet rat owners created around their homes influenced how they understood the preventability of different health conditions affecting rats. Respondents of the survey believed that common health conditions such as tumours and mycoplasmosis were not preventable, possibly because the route of transmission did not involve any contact with the world outside the home. Zoonotic infections such as leptospirosis and hantaviruses were seen as preventable, because of their association with contamination from the outside world. In the main, boundaries and infection control practices were put in place to protect their pet rats from contact with the world outside the home, making it easier to prevent transmission of these infections to their pet rats. Yet, as discussed in the following section, this did not mean that rats were never exposed to environments outside the home.

While the majority of survey respondents believed it was easy to prevent rat-to-rat disease transmission, only a small proportion indicated they felt the same about rat-to-person transmission. While initially this may seem contradictory, because the same principles that protect rats from infection can be employed to protect their human owners, this is neglecting a fundamental concept in the route of transmission; the human-rat relationship. Minimising contact between rats to reduce the risk of disease transmission is fairly straight forward, yet to employ the same practices to reduce the risk of zoonotic disease transmission would be counter to everything the pet rat stands for and means to its owner. Minimising contact with their pets would defeat the point of having them. This highlights how from the perspective of pet rat owners, infection control practices are widely used and understood, yet put in place to protect the health of the rat, not the owner.

Rat shows

As discussed above, rat owners expended considerable effort in protecting their pets by using infection control practices. Initially, this may seem to contradict their efforts to protect their rats from disease. However, from the perspective of pet rat owners, there was a belief that attending rat shows offered a home-from-home environment. The precautions assumed to have been undertaken by other

like-minded rat owners were believed to offer protection to the pet rat. Pet rat owners did not know the extent to which other owners had adopted measures to safeguard the health of the pet rats attending the shows. The assumption of shared values on the basis of the ownership of a pet rat was found to be misplaced when a rat owner contravened show guidelines and attended a show despite having new rats join her colony. This resulted in an outbreak of disease that affected a number of rats that attended the show, including the death of her own and other people's rats. This raises the question of how a group of people who are so careful about protecting the health of their pets are willing to enter another environment over which they have little control. It seems likely that these actions arise from the pet rat owner's needs to be with other like-minded people in an environment in which their pastime is the norm. The presence of rules regarding the management of the pet rat show to prevent the spread of disease among the pet rat population provides a framework, which seems to give pet rat owners confidence to see the show as a home-from-home. Pet rat owners who enter these rat shows put their trust in other rat owners to abide by the show's regulations. This could have been an isolated incident, yet it is possible that this happens more frequently than people realise. There are currently no published data to evidence this, however it is likely that attending rat shows with rats does increase the risk of disease transmission, because of the amount and frequency of contact between rats.

The importance of being able to attend rat shows was highlighted in both the interviews and the survey as being integral to rat owners' identity. The multivariable analysis highlighted a number of characteristics that increased the odds of attending rat shows, pointing towards a certain type of person or a sub-group of rat owners who were more likely to attend shows. People who were members of a club and owned a larger number of rats, in addition to certain age groups (mid-twenties to thirties or early forties), were at increased odds of attending shows. These characteristics suggest this group of owners could be described as 'fanciers' rather than pet rat owners. Fanciers are people with an enthusiasm or special interest in a particular breed, often breeding as well as owning their animal of interest (Burt, 2006¹⁹).

From a public health perspective, these rat shows are potentially problematic because of the increased risk of disease transmission, however because they are such an important part of rat owner's identity and community it is unlikely that an attempt to regulate them would be successful. Instead, to reduce the risk of disease transmission between rats via rat shows, public health messages could emphasise the importance of adherence to guidelines for the health of the rats themselves, rather than owner health. Additionally, public health messages could support rat shows, because of the positive impact they have on people's mental health – by supporting the premise of rat shows and understanding how

¹⁹ The term originates from the early nineteenth century, and refers to people who are particularly interested in animals' pedigree. Langley (1915), quoted in Burt (2006) described fanciers as 'one who by word, action and influence, does all in his or her power to rid this country of the mongrel. The genuine fancier is one who takes a great delight in establishing pedigrees, strains and pure breeds'.

important they are to rat owners, other health messages regarding rat ownership could be more effective.

The emergence of hantaviruses

The hierarchy of purity articulated by pet rat owners when discussing the risk of disease helps them to understand disease transmission. This model locates the disease threat outside the boundary of the home and in doing so, creates a diseased ‘other’; a source of infection far removed from their safe, clean pets. The way in which pet rat owners are ‘othering’ wild rats reinforces the status of their pet rats and contributes to their understanding of risk. The creation of a ‘diseased other’ can help define what is normal (Sibley, 1995), therefore for pet rat owners it is generally accepted within their community that risk of disease transmission is placed with wild rats.

In this context, the emergence of hantaviruses in the UK was problematic for pet rat owners. The first cases of Seoul virus associated with pet rats were in rats from specialist breeders, therefore these infections transcended the ‘bounded purity’ of pet rats, specifically rats from specialist breeders. This complicates the reliance that owners put on the importance of ‘place’ and raises questions about why owners are so dependent on rules and concepts that are not evidence-based. This highlights how people have their own ways of seeing the world – their own realities – that help decision-making. This has been observed in the context of making decisions about other health-related behaviours, perhaps most recognisably with people who choose not to vaccinate, despite evidence vaccinations are safe and effective (Blume, 2006; Kata, 2012). This is particularly problematic in public health, where evidence-based medicine is the cornerstone of public health policy. It also helps to understand why provision of information is not enough to trigger behaviour change.

The emergence of hantavirus was difficult for pet rat owners to relate to, because it did not fit in with how they conceptualise disease and risk. Their identity as pet rat owners may also have had an influence on how they reacted to the emergence of hantaviruses. Sibley argues that where groups have a strong sense of identity, a challenge to their hegemony results in a strengthening of the community structure. According to Sibley, ‘[In] closed, tightly-knit communities with something approaching a conscience collective, it may be that adherence to the rules is more likely in times of crisis, when the identity of the community is threatened’ (Sibley, 1995: 38). If the emergence of hantaviruses threatened this status, this may have acted to reinforce their constructions of purity, effectively making these structures more fixed and impenetrable. This could potentially have an impact on how pet rat owners respond to public health messages about the risk of infection from their rats. A public health message that does not take into account differences between different rodents and the status they have (which is what PHE communicated with their leaflet on the risk of infection from pet rodents), is not likely to be effective.

Hantaviruses transcended the boundary that owners had created around their pets, which they thought kept them isolated from the outside world. This potentially made it harder for pet rat owners to accept, because it was more taboo. This reflects Douglas' anomaly theory of pollution, and was also described by Kristeva in *Powers of Horror*, that anomalies are caused by 'what does not respect borders, positions, rules; the in-between, the ambiguous, the composite' (Kristeva, 1982: 4). In the pet rat community, hantaviruses are an anomaly – they do not fit in with its model of disease. It could be argued that rather than responding negatively to this anomaly, pet rat owners have created a new reality in which hantaviruses have a place, just not in their pet rats. This reaction of pet rat owners to the anomaly of hantaviruses provides another example of how Douglas' theory is reflected in practice: '... life does not always conform to our most simple categories. There are several ways of treating anomalies. Negatively, we can ignore, just not perceive them, or perceiving them, we can condemn them. Positively, we can deliberately confront the anomaly, and try to create a new pattern of reality in which it has a place' (Douglas, 1966: 39). The reality that pet rat owners have created is at odds with the reality portrayed in public health messages. Public health messages need to be based on an understanding of the way in which the target audience thinks about particular issues if they are to stand any sort of chance of being implemented.

Privileging rat health over owner health

Pet rat owners privileged the health of their rats over their own health. This resulted in owners taking more steps to protect their rats' health than their own; in some cases, owners believed they – as humans – posed more of a risk to their rats than their rats did to them. This belief is primarily based on their understanding that the world outside the home is contaminated and they are constantly accessing this environment, whereas the rats are not. From the perspective of owners, their pet rats are framed as being vulnerable and in need of protection; their rats are dependent on them for all aspects of their care including protection from disease and illness. The longevity of the rat as a species and the multitude of different health conditions they can suffer from will no doubt emphasise the need to owners to protect their rats at all costs, sometimes to the detriment of their own health, as demonstrated by Richard (Chapter Three), enduring the effects of allergies to maintain his identity as a rat owner. This protector-dependent relationship between owner and rat almost reflects the parent-child relationship, where parents sometimes sacrifice their own needs to meet those of their children (Katz et al., 2007).

The complexity of this relationship was revealed by Sophia (Chapter Five), when she was describing how she negotiated the competing vulnerabilities of her new born baby and her pet rats, when recovering from a Seoul virus diagnosis. The baby was the priority when he was at his most vulnerable, particularly when he was breastfeeding. Consequently, Sophia engaged in rigorous

infection control practices aimed at protecting the health of her baby. As her baby grew and became less dependent on her, Sophia could relax these rules and refocus on her rats. This scenario highlights the intricacy of relationships with either people or animals that are dependents and the moral obligations and dilemmas that are entwined with caring for them (Kittay, 2002).

Reflections on the research process

In common with all research studies, this thesis is not without its limitations. In the final part of my thesis I reflect on the research process, its limitations and implications for public health practice. I will also discuss further research that would build on data presented in this thesis, adding to the body of knowledge on the transmission of zoonotic infection.

Limitations

One of the key advantages of doing mixed-methods research is having the opportunity to ‘test out’ some of the theories developed in the qualitative phase on a broader population. For this research, the cross-sectional study enabled some of the theories generated through the interviews with pet rat owners to be included in the survey, putting these perspectives to a broader population of pet rat owners. The owner demographics from the survey (Appendix 2 xii) demonstrate a more varied population, compared with the interviewee demographics. Only around 20% of survey respondents were members of a rat club, and the median number of rats owned was 4 (IQR 2–7), suggesting respondents owned, but perhaps did not breed, rats. This difference in demographics between the interviews and survey are perhaps highlighting the difference between rat *fanciers* and rat *owners*. Despite these potential differences in the demographics between the interviewees and survey respondents, the main theoretical concept that arose from the interviews (the hierarchy of purity) yielded similar responses in the survey. This suggests that although the majority of interviewees could be described as rat *fanciers*, the way in which they constructed rats was similar to those who kept rats as pets.

The recruitment process for interviewees may have limited the data produced, particularly for the pet rat owners. To recruit these participants, a snowball sampling technique was used, in conjunction with other techniques, including use of gatekeepers. While snowball sampling and the use of gatekeepers to access research participants is a widely used technique in qualitative research (Devers and Frankel, 2000), the way in which it was employed in this study may have limited the diversity of perspectives explored. I initiated recruitment through contacting registered pet rat breeders; this seemed like a logical approach, as contact details for individuals were publicly available via the National Fancy Rat Society website. This approach yielded a number of participants and generated data from the

perspective of this specific group of pet rat owners and breeders, rather than casting the net wider to include more diverse perspectives. While not all interview participants were breeders, or registered with the NFRS, their perspectives on the difference between pet shop and rats from specialist breeders were relatively homogenous. It would have been beneficial to seek out alternative perspectives and perhaps use purposive sampling to recruit some research participants via pet shops or rescue centres, to ensure any potential divergent views were also taken into account. It is possible that these participants had similar views about the purity of rats from different backgrounds, in which case this would have been further evidence to strengthen the theory developed from the interviews.

The cross-sectional study, as with any survey-based research, was not without its limitations. There is a discrepancy between self-reported behaviour and actual practice. This inconsistency has been highlighted previously, including in relation to infection control practices in healthcare workers (Jenner et al., 2006), where there was no association between self-reported and observed hand-hygiene practices. This highlights how survey data capturing self-reported behaviour should be understood in the context of its generation. According to Jenner et al (2006), the gold standard method for assessing behavioural practices is observation, yet to gain a deeper understanding of people's infection control practices in relation to animals, ethnographic studies would be particularly useful. It would be particularly interesting to conduct ethnographic studies with the pest control technicians, where the culture of the workplace in which the infection control practices are enacted and constrained by, will undoubtedly influence how health-related behaviours are engaged with.

The survey was distributed online, predominantly via social media. This sampling technique is probably reflected in the age of the respondents; nearly half were under the age of 30 years. It was also not possible to determine if there was any response bias using this sampling technique; there was no record of who viewed and subsequently completed the survey. However, as with any survey, it is probably fair to assume there will have been an element of response bias; people are more likely to participate in studies if they are interested in the topic. This will have inevitably influenced the data obtained from the survey – the way in which the survey was framed might have also influenced this. It was framed as a study about the role of rats in society, focusing on people's relationship with them and what owners do to keep their rats happy and healthy. This may have encouraged people who were particularly interested in rat health and wellbeing, or had a particularly close relationship with their pets to take part. While the use of social media and other forms of online media to distribute the survey may have limited the respondents to people who had access to the internet, the geographical distribution of respondents highlight how effective social media is at reaching a broad audience (Figure 2, Appendix 2 xii). A single post on Facebook was shared 84 times and reached 13,180 people, demonstrating what a powerful platform it is for not only recruiting research participants, but also disseminating findings to a wide audience.

Further study

In the methodology chapter, I set out why a broader perspective, incorporating sociological and epidemiological approaches, was needed to understand health behaviour. I drew on the work of McKeown (1962, 1972, 1975), Illich (1976) and Engel (1977) to demonstrate how public health needs to shift away from its reliance on using biomedicine to understand health and illness.

The data presented in this thesis provide further evidence that basing public health messages on biomedical models of disease transmission are not always effective. This was particularly evident with the event of Seoul hantavirus infection in pet rats. Public health messages aimed at pet rat owners were based on conventional, biomedical models of disease transmission; exposure to rats equates to infection and subsequently illness. This is problematic on two levels; firstly the biomedical model assumes a causal relationship between disease and illness and that all disease will eventually result in illness. This linear model does not necessarily work for hantaviruses, where people can be exposed, but not necessarily experience illness. This was demonstrated by the seroprevalance study that PHE conducted; while a third of pet rat owners surveyed were seropositive, only a handful have been diagnosed. While it is likely that a number of cases have been misdiagnosed or unreported, it is not until a diagnosis is made that the virus becomes part of pet rat owners' reality. Secondly, while the biomedical model equates exposure to rats with infection, the data presented in this thesis demonstrate that for pet rat owners, the risk of infection is from *place* rather than *animal*. In other words, for pet rat owners, the risk of infection lies in the world outside their home, and is not inherently within their pet rats. This, along with a greater understanding of people's relationships with their pets, will enable the development of more effective and engaging public health messages about hantaviruses and other zoonotic infections. While this study has provided the foundation on which to develop these public health messages, it was beyond the scope of the study to develop and evaluate potential alternatives. This is the type of research that would naturally lead on from this study, and in this section, I offer some insights for how these ideas could be developed.

One of the themes that came out of the interviews with pet rat owners is that the health of the rat is more important than their own health. The infection control practices that owners engaged in were directed at protecting their pets from contamination (from the outside world, or other 'less pure' rats), however the same practices could also go some way to reducing the risk of zoonotic infections in owners. While this would help to reduce the risk of zoonotic infections, it would not remove the risk; this would only be possible through eliminating all contact with pet rats, which is not a feasible option for owners. Public health professionals need to work within the bounds of the human-rat relationship to develop public health messages that make sense to rat owners and take into account the importance of the human-rat relationship. For example, owners' knowledge and understanding of infection

control could be privileged and reframed so that owners are using their existing knowledge and experience to protect their own health, as well as the health of their pets. Shifting the focus of the current health messages to promoting pet rat health may motivate owners to adopt infection control practices which will also benefit the human. This technique has been used in the United States, where the Centers for Disease Control and Prevention (CDC) reframed their public health messages regarding hantaviruses to include the pet rat in the hygiene discourse. This reframing of these public health messages needs evaluating to determine its effectiveness; this is one area in which the work from this thesis could be developed. Further research with this community to evaluate different types of public health messages would provide further insights into the effectiveness of different methods of communicating with pet rat owners.

This study emphasises the importance of engaging with the intended recipients of the public health message, rather than developing health messages from the professionals' perspective. The latter approach risks an 'us and them' attitude, which could result in isolating the communities with which professionals are trying to engage. Involving communities and groups in the research process is becoming increasingly recognised as valuable and the interest in community-based participatory research is growing (Evans, 2016). Participatory research, including interviews and focus groups with pet rat owners from different backgrounds, would be a valuable development of the work in this thesis. Interventions based on the data presented in this thesis could be evaluated through participatory methods and engaging with pet rat owner communities. This would enable pet owners to be involved in the research process, co-constructing the knowledge about how to communicate health messages with the researchers and other stakeholders.

The co-construction of knowledge about zoonotic infections could also be utilised for other zoonotic pathogens associated with pet ownership. Rats are not the only animal that is welcomed into the home, and other animals that are kept as pets are also known to carry and transmit zoonotic pathogens. Recent examples of outbreaks include *Salmonella enteritidis* associated with pet reptiles and feeder mice (Kanagarajah et al., 2018) and Shiga-toxin producing *Escherichia coli* (STEC) associated with feeding pet dogs a raw food diet (PHE, 2018). These examples highlight an ongoing need for further research into human-animal relationships in the home, in the context of zoonoses.

Co-construction of knowledge can be a useful method of breaking down the barriers between the researchers and the 'researched'. As a recent example of how co-construction of knowledge can be utilised for public health messages, a citizen science project by Lorimer and Hodgetts (2017) invited participants to be part of the research process in a study generating knowledge about the microbiome of their homes. Participants were invited to swab places within their homes to identify what bacteria were present. Lorimer and Hodgetts took this participatory method one step further and asked participants to choose and swab areas within their homes they thought be high risk. In doing so, not

only did the project generate vital data about the bacteria present in the home, but also how the home was constructed from the perspective of its occupants; which parts of the home they thought were likely to have bacteria present. Involving the research participants in the research process in this way could potentially increase the effectiveness of any public health messages that result from the study. This would be a particularly useful approach to use for generating data on zoonotic pathogens and pet ownership, where the emotional bond between owner and pet complicates the communication of health messages.

Conclusions

Emerging zoonotic diseases are a significant threat to health. The emergence of these infections is a result of dynamic interactions between animals and people. The data from my thesis demonstrate that the construction of animals as vectors is highly contextual. This highlights the importance of a sociological approach for understanding the emergence and spread of zoonotic diseases, both globally and locally. This thesis makes an important contribution towards understanding how animals as vectors are constructed in different contexts and illustrates the importance of recognising and including these constructions in the communication of health messages. The data presented here demonstrate how different understandings of what a rat is influences how people interpret and respond to the risk they pose. The importance of place in how rats are constructed also highlights how risk is contextual; it is not a fixed entity that can be measured, it is understood differently in different contexts. Risk is not a tangible thing that can be measured; ‘since there is no single correct conception of risk, there is no way to get everyone else to accept *it*’ (Douglas and Wildavsky, 1983:4). This thesis has demonstrated that behaviour is embedded within social practices, engrained within everyday life. People’s behaviours help people define who and what they are, consequently their identity is derived from their behaviour and how they behave in different social contexts provides them with different identities. Pet rat owners’ responses to the health messages communicated by PHE demonstrated that providing people with facts and information will not change who they are. In this light, behaviour change is not triggered by provision of information. It is naïve to assume that people who engage in ‘risky’ behaviour are thoughtless or irrational. To them, their behaviour is meaningful and functional. Just because their behaviour does not make sense to others, or fit in with the epidemiological and biomedical models used in public health, does not mean it does not make sense – people just need to be given the space to account for their behaviour in meaningful ways.

In setting out to undertake this research, I wanted to provide further insights into how people understand, interpret and respond to the risk presented by rodent-borne infections. In doing so, I have illuminated how rats as vectors are constructed from different perspectives and how fundamental understanding these different perspectives are for understanding people’s behaviour in relation to the

animals they interact with. Taking this approach for my doctoral research has highlighted just how important it is to incorporate sociological methods into public health research; this is an approach I advocate and intend to continue to use in future endeavours.

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Appendices

Appendices

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Appendix 1: Tables of rodent-borne zoonotic pathogens and hantavirus cases in the United Kingdom

Table 1: Zoonotic pathogens isolated from *Rattus norvegicus* in the United Kingdom.

Pathogen	Location	Seroprevalence	Notes	Reference
<i>Leptospira</i> spp.	11 Farms in England and Wales	37/259 (14%) 9/11 farms		(Webster et al., 1995)
	31 farms in Carmarthenshire (Wales)	82/357 (23%)		(Broom and Gibson, 1953)
	England and Wales, rural and urban locations, including sewers.	370/850 (43%)	No difference in seroprevalence between different habitats.	(Broom, 1958)
<i>Listeria</i> spp.	11 farms in England and Wales	5/44 (11%) 3/3 farms		(Webster & Macdonald 1995a)
<i>Cryptosporidium</i> spp.	11 farms in England and Wales	46/73 (65%) 6/9 farms		(Webster & Macdonald 1995a)
	9 farms in England and Wales	46/73 (65%)		(Webster & MacDonald 1995b)
<i>Toxoplasma gondii</i>	11 farms in England and Wales	84/235 (35%) 7/7 farms		(Webster and Macdonald, 1995)
	6 farms in the UK	84/235 (35%) (44% in the cat-free captive population).	A population of captive rats were maintained for 2.5 years (cat-free captive population).	(Webster, 1994)
<i>Coxiella burnetii</i>	4 farms, 9 homes, 1 captive enclosure in England and Wales	Mean prevalence 22% (7%-53%)	Lowest prevalence in the captive population, highest in dairy farms with sheep also present.	(Webster et al., 1994)
	11 farms in England and Wales	44/127 (34%)		(Webster & Macdonald 1995a)

Appendix 1: Tables of rodent-borne zoonotic pathogens and hantavirus cases in the United Kingdom

Hantaviruses	11 farms in England and Wales	5/127 (4%) 2/5 farms	Hantaan and GB* strains identified.	Webster and Macdonald (1995a)
	Somerset, England	4/100 (4%)	First detection of a hantavirus in wild rats in Britain.	(Pether and Lloyd, 1993)
	4 farms, 1 wild fowl reserve, 1 landfill site (Northern Ireland)	11/51 (21.6%)	Hantaan and Seoul viruses detected.	(McCaughey et al., 1996)
		2/8 (25%)	Seoul virus	(Jameson et al., 2014)
	Rats from a breeding colony and rat farm as part of Public Health Wales investigation (South Wales)	Breeding colony 1: 20/30 (67%) Breeding colony 2: 12/15 (48%) Rat farm: 15/30 (50%)	Rats from breeding colony 1, the rat farm and the household were associated with clinical disease in humans.	Public Health Wales data, 2015; unpublished APHA data (taken from PHE zoonosis report 2016)
Oxfordshire and Gloucestershire, England	Household: 2/6 (33%) 17/21 (81%)	There were two clinical cases of haemorrhagic fever with renal syndrome associated with these rats, which required hospitalisation.	(McElhinney et al., 2017)	
<i>Mycobacterium bovis</i>	Farm in Dorset	2/90 (2.2%)	Isolated from lymph nodes of rats trapped on farm with a major outbreak of TB.	(Little et al., 1982)
<i>Salmonella</i>	Urban locations in the Midlands, England	5/50 (10%) rats 8/100 (8%) faecal samples		(Hilton et al., 2002)

NB: other pathogens including *Shiga toxin producing Escherichia coli* (Guenther et al., 2012) and *hepatitis E virus* (Johns et al., 2010) have been identified in *R. norvegicus* populations in Europe.

Appendix 1: Tables of rodent-borne zoonotic pathogens and hantavirus cases in the United Kingdom

Table 2: Cases of haemorrhagic fever with renal syndrome associated with Seoul/Hantaan viruses in the United Kingdom since 1977 (adapted from McElhinney *et al.* 2017).

Year	Location	Number seropositive	Number clinical disease	Possible exposure	Notes	Reference
1977	Sutton	10	4	Laboratory rats	Laboratory staff worked in the post-mortem room, where unwanted rat tissue and carcasses were disposed of.	(Lloyd and Jones, 1986)
1983	Glasgow	1	1	Not reported	21-year-old male ambulance driver. Presented with fever, sore throat and submandibular swelling. Hantaan virus detected.	(Walker and Boyd, 1983)
1986	Northern Ireland	4		Wild rodents?	Of the 4 seropositive farmers, 3 used shavings as animal bedding. 2/27 mice trapped on the farm were positive for hantavirus. No rats were trapped.	(Stanford <i>et al.</i> , 1990)
1988	Glasgow	1	1	Wild rats	The patient was a boating pond attendant.	(Kudesia <i>et al.</i> , 1988)
1989-1992	Northern Ireland	16	16	Wild rats	Seroprevalence in 627 patients presenting with symptoms suggestive of haemorrhagic fever with renal syndrome was determined.	(McKenna <i>et al.</i> , 1994)
1991	Somerset	1	1	Wild rats	Garden Centre Supervisor	(Pether and Lloyd, 1993)
1991	Somerset	4	1	Wild rodents?	Local waterways?	(Pether <i>et al.</i> , 1991)
1991	Somerset	1	1	Wild rodents?	Local waterways?	(Phillips <i>et al.</i> , 1991)
1991	Sheffield	2	1		Patient had visited a poultry farm prior to the onset of illness. Patient's father was seropositive but had no clinical disease.	(Rice <i>et al.</i> , 1993)
1991	Sheffield	1	1	Wild rats	Patient reported living in an apartment close to a river, where the apartment above her was infested with rats.	(Rice <i>et al.</i> , 1993)
1991-98	Herefordshire, Lancashire, Norfolk	41	0	Not reported	A prospective study of 600 farmers over 7 years. Initial samples detected a seroprevalence of 4.7%, a further 18	(Coleman, 2000)

Appendix 1: Tables of rodent-borne zoonotic pathogens and hantavirus cases in the United Kingdom

1992	Somerset	27	26	Wild rats	participants seroconverted during the first year of the study. Prospective study of suspected cases (n=400) and retrospective analysis of blood samples (n=80). Cases included farmers, sewerage workers and people who reported exposure to rat infestations.	(Pether and Lloyd, 1993)
1994	Nottingham	1	1	Wild rats	10-year-old boy, who regularly played in an area infested with rats.	(Watson et al., 1997)
2009	Yorkshire & Humber	1	1	Wild rats	The patient had regular exposure to wild rats and noted the rat population had increased prior to becoming ill.	(Jameson et al., 2013a)
2011	Yorkshire & Humber	1	1	Wild rats		(Jameson et al., 2013a)
2011	Oxfordshire	2	1	Pet rats	See notes below.	(Jameson et al., 2013b)
2012	Wrexham	1	1	Pet rats	The patient was seropositive for Seoul and Hantaan viruses. The patient's pet rats returned to the original breeder in Oxfordshire, who also tested seropositive. Her partner was also seropositive for both viruses and a blood sample from a previously undiagnosed viral illness was retrospectively tested. Antibodies to both Seoul and Hantaan viruses were detected.	(Jameson et al., 2013b)
2013	Gloucestershire	3	2	Pet rats	Initial patient was diagnosed in March 2013. Her 11-year-old daughter was subsequently diagnosed in August 2013. They had obtained rats from a breeding colony, the breeder was seropositive but did not report any clinical illness.	(McElhinney et al., 2017)
2015	Glasgow	1	1	Pet rats		unpublished
2015	Cardiff Area, Wales	7	3	Pet / Breeding rats		unpublished

NB. In addition to these cases, in the process of conducting interviews with pet rat owners, I became aware of a further case of Seoul virus in a pregnant woman. It is unclear whether this case has been reported to public health authorities, but to date, no information has been published in the scientific literature.



A Tale of Two Rats

Exploring the role of rats in everyday life

Participant information sheet

You are being invited to participate in a research study. Before you decide whether to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and feel free to ask us if you would like more information or if there is anything that you do not understand. Please also feel free to discuss this with your friends and relatives if you wish. We would like to stress that you do not have to accept this invitation and should only agree to take part if you want to.

What is the purpose of this study?

“A Tale of Two Rats” is a new project exploring the role of rats in society. We are interested in people’s experiences of rats, and the role they have in everyday life. Love them or loathe them, everyone has a rat story. Embedded within our society as carriers of disease, wild rats are one of our most common, but unwanted, urban neighbours. Classified as vermin, for many people the thought of sharing a home with rats will evoke feelings of fear and disgust. However, there is an increasing number of people who choose to invite rats into their homes; pet rat owners. In contrast to its wild equivalent, the pet rat is viewed as intelligent and sociable and in some cases become part of the family. This project is aiming to explore these differing roles of rats within society, and how interactions and relationships with rats affect our health and wellbeing.

Why have I been invited to take part?

You have been invited to take part as you have expressed an interest in the study, either via our website or in person to one of our research team. If you have changed your mind since contacting us, then please let us know and we will remove your contact details from our mailing list. Taking part in this research is entirely voluntary, and you are free to withdraw up to the point your data are included for analysis, without explanation. If you have any queries or concerns that are not covered by this information sheet please do not hesitate to get in touch (see contact details below).

Summary of responses to key questions:

Q: What are the potential risks/disadvantages of taking part?

A: We do not envisage any risks or disadvantages to you of taking part.

Q: What are the potential advantages/benefits of taking part?

A: There are unlikely to be any direct benefits to you of taking part, we hope you will enjoy having the opportunity to talk about your interactions with rats. Your input will help to increase understanding of how people’s relationships with rats affect their health and wellbeing.

Q: Will my taking part be confidential?

A: Your participation is completely confidential

Q: What will happen to the results of this research?

A: This project forms part of a PhD at the University of Liverpool. The results will be anonymised and included in the PhD thesis, as well as being presented at conferences and published in peer-reviewed journals. Data will be stored in a secure office, on a password protected computer. Data will be stored for up to 10 years.



Q: What will happen to me if I don't want to carry on with this study?

A: You can withdraw from the study at any time, without explanation. Information collected up to the period of withdrawal may be used if you are happy for this to be done. Otherwise, you may request that the information is destroyed and no further use is made of it.

What will happen if I take part?

If you agree to take part you will be contacted via telephone or email to find out when it would be convenient to talk to you. Your interview will be carried out face-to-face with the PhD student, so a convenient date and place will be arranged. The interview will be audio taped so that all the points you make can be fully captured. Interviews are anticipated to last between 30 minutes and an hour. All information you provide will be treated in strictest confidence. Your views and experiences form an important part of this research.

What if I am unhappy or if there is a problem?

If you are unhappy, or if there is a problem, please feel free to let us know by contacting Dr Robert Christley by email (robc@liverpool.ac.uk) or telephone (0151 794 6170) and he will try to help. If you remain unhappy or have a complaint which you feel he cannot resolve then you should contact the Research Governance Officer on 0151 794 8290 (ethics@liv.ac.uk). When contacting the Research Governance Officer, please provide details of the name or description of the study (so that it can be identified), the researchers involved, and the details of the complaint you wish to make.

Who has reviewed the study?

To ensure that your safety, rights, wellbeing and dignity are protected the methods for this research have been looked at by an independent group of people called a Research Ethics Committee. This study has been reviewed by University of Liverpool Veterinary School Research Ethics Committee.

Next steps

Please take time to consider whether you want to be included in this research. The decision to participate is your own and you should feel under no pressure to do so. If you are happy to be involved please complete the accompanying consent form and return it to charlotte.robin@liverpool.ac.uk within a month of receiving this request.

Thank you very much for considering this information.

Charlotte Robin

NIHR HPRU PhD Student

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Follow us on Twitter: @livuni



A Tale of Two Rats

Exploring the role of rats in everyday life

A Tale of Two Rats is a new project exploring the role of rats in society. We are interested in people's experiences of rats, and the role they have in everyday life. We would like to hear from anyone who has an involvement with pet or wild rats; rat owners, farmers or pest control workers.

Why rats?

Love them or loathe them, everyone has a rat story. Embedded within our society as carriers of disease, wild rats are one of our most common, but unwanted, urban neighbours. Classified as vermin, for many people the thought of sharing a home with rats will evoke feelings of fear and disgust. However, there is an increasing number of people who choose to invite rats into their homes; pet rat owners. In contrast to its wild equivalent, the pet rat is viewed as intelligent and sociable and in some cases become part of the family. This project is aiming to explore these differing roles of rats within society, and how interactions and relationships with rats affect our health and wellbeing.

What will it involve?

We are looking for **pet rat owners**, **farmers** and **pest-control workers** to talk about their experiences of rats in their day-to-day life. This would involve having a discussion with one of the research team, where we would explore perceptions of, and interactions with rats. Recruitment will commence in summer 2015, so if you are interested in being a part of the project, or would just like some more information, please **contact us**.

Who are we?

We are a team of epidemiologists, sociologists and public health professionals at the University of Liverpool. This research forms part of a PhD project, which has been funded by the National Institute for Health Research. If you have any further questions, please do not hesitate to **contact us**.

Hate rats? Tell me about it!



Are you interested in taking part in a study with the University of Liverpool about how rats affect our health?

Why rats?

Love them or loathe them, everyone has a rat story. Embedded within our society as carriers of disease, wild rats are one of our most common, but unwanted neighbours.



What do you think?

We are interested in your experience of rats and pest control on your farm. If you have any opinions about rats and want to share them, please get in touch.



What will it involve?

If you want to take part, you will be interviewed by one of our research team. This should last between 30-60 minutes.



A Tale of Two Rats
Exploring the role of rats in everyday life



crobin@liverpool.ac.uk



[facebook.com/taleoftworats](https://www.facebook.com/taleoftworats)

The research is funded by the NIHR Health Protection Research Unit in Emerging and Zoonotic Infections at University of Liverpool, in partnership with Public Health England (PHE). The views expressed are those of the author(s) and not necessarily those of the NIHR, the NHS, the Department of Health or PHE.



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Exploring the role of rats in everyday life

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Why have I been invited to take part?

You have been invited to take part as you may come into contact with rats as part of your day-to-day job. Taking part in this research is entirely voluntary, and you are free to withdraw up to the point your data are included for analysis, without explanation. If you have any queries or concerns that are not covered by this information sheet please do not hesitate to get in touch (see contact details below).

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Dear Rob and Charlotte

I am pleased to inform you that the Veterinary Research Ethics Committee has approved your application for ethical approval. Details of the approval can be found below.

Ref:	VREC347
PI:	R Christley
Title:	Pets or pests: Understanding social and cultural aspects of zoonotic disease transmission
School:	School of Veterinary Science
Department:	Epidemiology and Population Health
First Reviewer:	N Williams
Second Reviewer:	M Hannigan
Date of initial review:	28.7.15
Date of Approval:	31.7.15

This approval applies for the duration of the research. If it is proposed to extend the duration of the study as specified in the application form, the Veterinary Research Ethics Committee should be notified. If it is proposed to make an amendment to the research, you should notify the Veterinary Research Ethics Committee by following the Notice of Amendment procedure outlined at http://www.liv.ac.uk/researchethics/application/forms_and_templates/.

If the named PI / Supervisor leaves the employment of the University during the course of this approval, the approval will lapse. Therefore please contact the RGO at ethics@liverpool.ac.uk in order to notify them of a change in PI / Supervisor.

All serious adverse events must be reported to the Committee within 24 hours of their occurrence, via the Research Governance Office (ethics@liv.ac.uk)

With best wishes

A handwritten signature in black ink that reads 'Carol Gray'.

Carol Gray, Chair, Veterinary Research Ethics Committee

Hantavirus in pregnancy – a HELLPful diagnosis!

In early 2013 the fancy was rocked by news of a case of Seoul Hantavirus transmission from pet rats – originating from an NFRS rattery - to their human owners, resulting in their becoming very unwell. This revelation, that our beloved pets could carry such a serious disease, left many fanciers fearful. Were fancy rats really such a huge health threat to their owners? And what did this mean for our beloved rats?

However, after a little time, reflection and investigation by PHE, it transpired that around one third of fanciers tested positive for past hantavirus infection. This told us two things. Firstly, that most cases of hantavirus infection were probably very mild since no fanciers were aware of having had it. Secondly, that the virus was probably *endemic* in the fancy – meaning that it was widely carried by fancy rats and that there was little sense in implementing quarantines or shutting down affected ratteries.

And so hantavirus became the bogeyman of the fancy. At the back of our minds we were aware of the risk, with occasional reports of rat to human transmission serving to remind us that it was there, but since the majority were unaffected the fancy continued with business as usual.

As someone who'd started breeding shortly after the situation came to light, I took care to ensure my pet owners were aware of the risks and knew the precautions they should be taking. However, since I'd had pet rats for 20 years I assumed that I was probably among those fanciers who had previously had the virus. So when I became pregnant in early 2015 I decided not to follow the advice to get someone else to look after my rats – after all I was probably immune, had litters to breed and shows to attend (and a stud name to earn!), and anyway 9 months was too big a chunk of a rat's life to ignore them for.

Fast forward to June 2016, the day after Baldock show, and I woke up feeling rather funny – lethargic, a bit spaced out and slightly queezy. I put it down to sun stroke – the day before had been hot and Baldock hall has that lovely garden, and I'd probably been out in the sun too long. I woke that night feeling freezing cold, and wriggled over to my husband to steal some of his heat. Only there wasn't any, and he said I felt much warmer than him, even though I felt frozen to the bone. The fever had started.

I went to the GP the next day, who didn't have a clue what was wrong but clearly wanted to feel he'd done something, so put me on antibiotics for a non-existent water infection. It didn't help, and after 2 days of feeling really weird with a rocketing temperature I went back.

Still no clue what was wrong, but since I was pregnant and everything is treated 100 times more seriously when you're pregnant I was admitted to hospital. After some IV electrolytes and paracetamol (IV paracetamol is still the best thing I've ever experienced) I thought I was getting better. Only I wasn't. The fever continued, my potassium and platelet levels plummeted, and on day 5 my feet and legs swelled up like balloons due to oedema. In short my kidneys had packed up, my liver was misbehaving, and I had sepsis.

As soon as a consultant mentioned kidneys the light bulb went on. I'd not dared to say the 'H' word before, partly because hantavirus is described as 'flu like' and this was nothing like the one time I'd had flu, and partly because hantavirus is a notifiable illness and I was worried the local environmental health authority might take my rats away. However, after nearly a week of feeling awful and being given various antibiotics that weren't working, I decided it was worth a mention.

The problem was, while I'd been sitting on the potential hantavirus diagnosis, my doctors were drawing other conclusions. On day 6 I was visited by an obstetrics consultant who announced they were moving me onto the maternity ward, while arranging a space for me at St Thomas hospital in

London due to their state of the art facilities for looking after premature babies. Premature babies!?

Yes, I was very ill, but up until now nobody had been worried about my pregnancy as everything was fine on the foetus front; what on earth had changed??

I found out while being blue lighted past the Houses of Parliament that my symptoms were indicative of a rare but life threatening pregnancy syndrome called HELLP – Haemolysis (breaking down of red blood cells), Elevated Liver enzymes, and Low Platelet count. The only treatment for HELLP is early delivery. I probably don't need to explain that at 23 weeks pregnant this was terrifying.

Determined to keep my baby inside me where it belonged, I put forward my 'differential diagnosis' of Hantavirus to the first doctor I met. He listened, clearly amused and slightly disbelieving that there was a rat fancy, with shows and a committee and registered breeders, and ordered tests for both hantavirus and leptospirosis, which causes similar symptoms and can also be carried by rats. I could tell he wanted me to have anything other than HELLP syndrome just as badly as I did.

Over the next 24 hours I began to feel better – the fever had gone and my legs were slowly going back to their original size ("These aren't my legs!" I would still declare to every passing midwife) and an ultrasound indicated that baby Brewer was A-OK. Then the results came in – my blood was now chock full of hantavirus antibodies that were absent from the blood taken at my 8 week pregnancy check, handily brought out of storage for comparison.

Good news all round, my body was beating the virus, I didn't have a terrifying pregnancy syndrome requiring early delivery, and nobody was telling me to get rid of my rats once I dutifully promised to move them to an outbuilding before the baby arrived.

However, things could have been very different. Reading through case studies from my hospital bed I discovered that a woman in France had also had hantavirus in pregnancy and been misdiagnosed with HELLP, and her baby was delivered before the diagnosis was corrected, at 27 weeks. However, other case studies revealed that the majority of women around the world who contracted hantavirus while pregnant went on to deliver healthy full term babies, just like me.

My take home message is that if you get a mystery illness while pregnant it's definitely worth telling your doctors about Hantavirus. While it may not be treatable in itself, it's important that you receive the right supportive care, and don't end up misdiagnosed with something that has far more serious consequences for you and your baby.

GREY BOX:

About Hantavirus

The hantavirus strain carried by pet rats is called Seoul Hantavirus (SEOV). It doesn't affect the rats in any way, is carried for long periods and is excreted in their faeces and urine.

When passed to humans it can cause Hemorrhagic Fever with Renal (kidney) Syndrome (HFRS) but may also cause milder illness, or no noticeable illness at all.

Symptoms of HFRS may include:

- Fever & Malaise
- Headache
- Diarrhoea and vomiting
- Low blood platelet levels
- Kidney failure
- Liver dysfunction

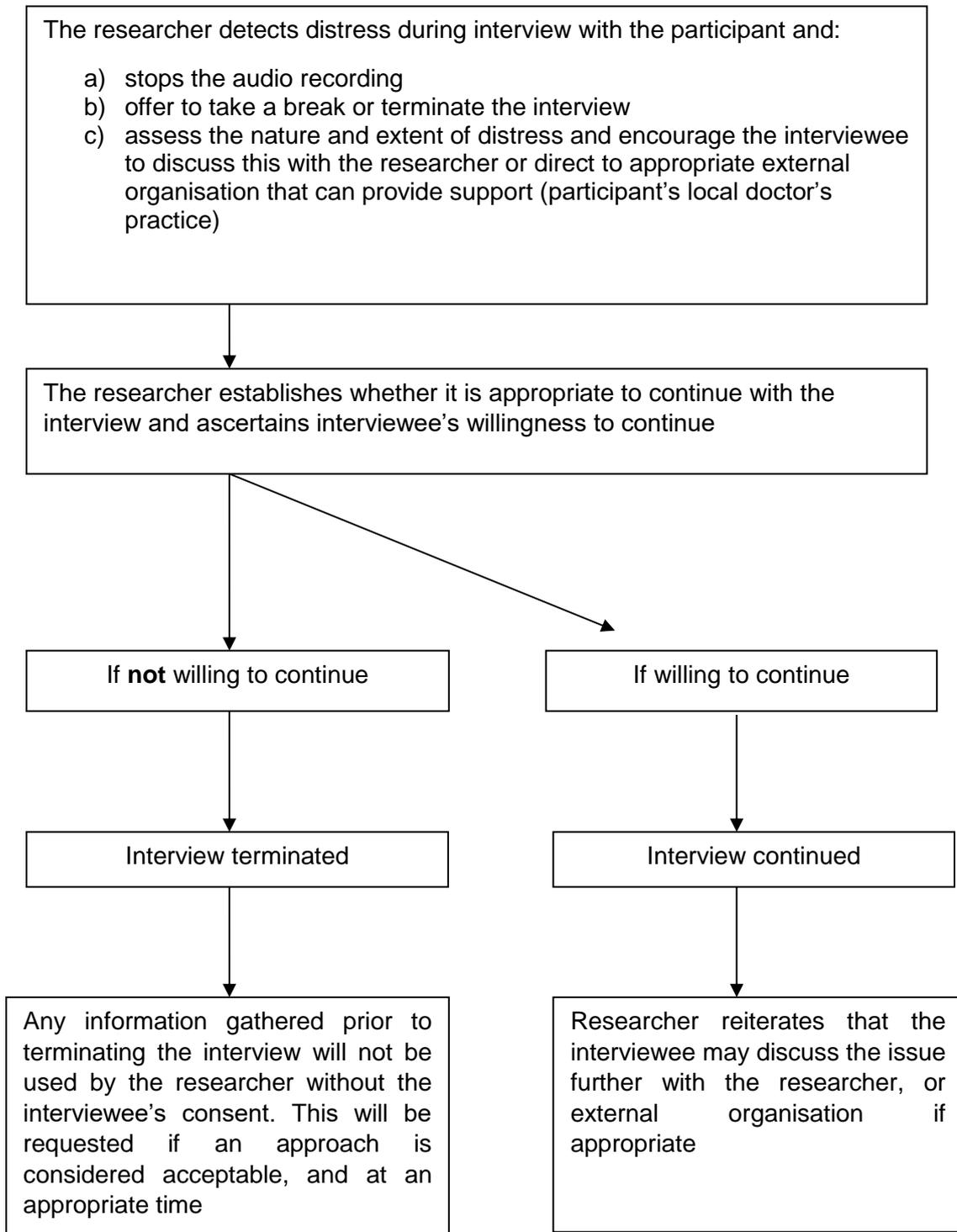
Steps to reduce hantavirus risk include:

- Washing hands after handling rats or equipment

Not kissing rats or holding them close to your face
Keeping rats and their equipment away from kitchens and bedrooms
Regular cage cleaning in a well ventilated area, with gloves and a facemask
Dampening bedding with water and disinfectant and leaving for 5 minutes before cleaning out
Limiting contact with rats while pregnant

Further information on hantavirus can be found on the PHE website and the NFRS forum.

Figure 2: The proposed procedure for dealing with any distress arising during the interviews.



Important Points

- Always wash your hands thoroughly with soap and water immediately after handling your pet rodent, their cage or any other equipment.
- If you are ever bitten by a rodent, the bite-wound should be promptly cleaned and disinfected before being covered by a waterproof dressing.
- Always supervise children when they handle rodents and teach them good hand hygiene.
- If you are ill enough to seek medical attention, tell the GP or nurse that you own/keep/have handled a rodent.
- Full detailed guidance available at the [Health Protection Agency website](http://www.hpa.org.uk)



Health Protection Agency
www.hpa.org.uk

From 1st April 2013, the Health Protection Agency will become part of **Public Health England**.

Public Health England
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Reducing the risk of human infection from pet rodents



Rodents, for example rats, mice, gerbils, guinea pigs and hamsters, are very popular pets in the UK. All rodents can carry bacteria and viruses that can cause infections in people. Although uncommon, these infections may have serious consequences for humans. This leaflet describes the risks of infection from a pet rodent and also gives some basic advice on how to reduce these risks. This advice will help people to prevent infections and serious illness caught from pet rodents.

How are infections passed from rodents to humans?

Rodents can carry infections and not show any signs of illness. Rodents can pass on the infection to humans in their urine, droppings, saliva and dander (akin to dandruff from animals, although not always visible). Infections can be spread by:

- rodent bites or scratches,
- contact with rodent urine, droppings, saliva or bedding,
- contact with objects contaminated with rodent urine, droppings or saliva
- breathing in rodent dander, dried droppings and urine, or dust from dirty bedding materials.



How do I reduce the risk of catching an infection from my rodent?

Following some simple good hygiene rules can help prevent infections from rodents spreading to humans:

- Always wash your hands thoroughly with soap and water immediately after handling your rodent, their cage or any other equipment.
- Hand washing is especially important before eating, drinking or smoking, or if you get rodent urine directly on your skin. See [good technique](#) and [video](#).
- Cover cuts, scratches or sores with waterproof plasters before handling your rodent.
- Thoroughly clean and cover any scratches or bites received from your rodent promptly.
- Do not kiss pet rodents or hold them close to your face.
- Always supervise children when they handle a pet rodent or objects that it has been in contact with and make sure they wash their hands properly afterwards.

What infections can my pet rodent carry?

Rodents, like other pets, can carry many bacteria and viruses that are harmful to humans. As rodents can appear well but still be infectious, all rodents should be presumed to be carrying infection even if they appear to be healthy.

Some of the more serious infections humans can get from rodents include [leptospirosis](#), [hantavirus](#), [rat bite fever](#) and [lymphocytic choriomeningitis](#).

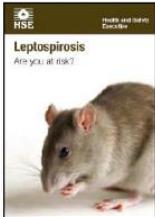
Additional hygiene precautions to further reduce the risk of infection

- Keep your pet rodent and its equipment out of rooms where food is prepared and eaten.
- Keep your pet rodent out of bedrooms or where people sleep.
- Limit the parts of the house where the rodent is allowed to roam freely.
- Clean your rodent's cage regularly in a well-ventilated area, ideally using disposable gloves and a suitable face mask.
- When disposing of used bedding, dampen it with a good amount of water (to stop airborne particles) before adding disinfectant and leaving to sit for at least five minutes. Place the disinfected bedding in a plastic bag and dispose of it in the bin.
- If you remove all the bedding from the cage (and can temporarily keep your pet rodent elsewhere) then spray the rodents' cage with disinfectant. Leave this for five minutes and then rinse and dry the cage before adding clean bedding and returning your pet to their cage.
- Do not sweep or vacuum up rodent urine, droppings, or nests as this creates airborne particles. Use a wet wipe or similar to pick up rodent droppings.
- If you are pregnant, keep your pet rodent in a separate part of the home and ask another family member or friend to clean the cage and care for the pet. Avoid prolonged stays in the room where the rodent is kept.



Leptospirosis

Are you at risk?



This is a web-friendly version of leaflet INDG84(rev1), reprinted 02/12

What is leptospirosis?

Two types of leptospirosis infection can affect workers in the UK.

- **Weil's disease**
This is a serious and sometimes fatal infection that is transmitted to humans by contact with urine from infected rats.
- **The Hardjo form of leptospirosis**
This is transmitted from cattle to humans.

What are the symptoms?

Both diseases start with a flu-like illness with a persistent and severe headache, which can lead to vomiting and muscle pains and ultimately to jaundice, meningitis and kidney failure. In rare cases the diseases can be fatal.

Who is at risk?

Anyone who is exposed to rats, rat or cattle urine or to fetal fluids from cattle is at risk.

Farmers are now the main group at risk for both Weil's disease and cattle leptospirosis: the cattle form is a special risk for dairy farmers.

Other people who have contracted leptospirosis in recent years include vets, meat inspectors, butchers, abattoir and sewer workers.

Workers in contact with canal and river water are also at risk.

How might I catch it?

The bacteria can get into your body through cuts and scratches and through the lining of the mouth, throat and eyes after contact with infected urine or contaminated water, such as in sewers, ditches, ponds and slow-flowing rivers. People working in dairy parlours are often in contact with cattle urine. Rat urine may also contaminate animal feed stuffs on farms.

How can I prevent it?

- Get rid of rats. Don't touch them with unprotected hands. Consult your vet about the cattle infection.
- Wash cuts and grazes immediately with soap and running water and cover all cuts and broken skin with waterproof plasters before and during work.
- Wear protective clothing.
- Wash your hands after handling any animal, or any contaminated clothing or other materials and always before eating, drinking or smoking.

What else should I do?

Report any illness to your doctor. Tell the doctor about your work and show this card. Leptospirosis is much less severe if it is treated promptly. If your doctor decides you have leptospirosis tell your employer, who must then report it online at www.hse.gov.uk/riddor. If you are self-employed you must report it yourself.

To the doctor
The card holder's work may expose him/her to the danger of leptospirosis (either *L. icterohaemorrhagiae* or *L. hardjo*). Early diagnosis and treatment are vital in Weil's disease as jaundice is often absent in the early stages. The illness in *L. hardjo* may also be greatly shortened by appropriate antibiotic treatment. (Your local Public Health Laboratory Service or hospital consultant microbiologist should be able to offer advice and serological testing.)

Further information

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

This leaflet contains notes on good practice which are not compulsory but which you may find helpful in considering what you need to do.

This leaflet is available in priced packs from HSE Books, ISBN 978 0 7176 6455 9. A web version can be found at: www.hse.gov.uk/pubns/indg84.pdf

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Hantavirus Disease

Background Information

Hantavirus infections are caused by a group of viruses which are carried by rodents. They can cause very serious diseases: haemorrhagic fever with renal syndrome (HFRS) in the UK, Europe and Asia; and hantavirus pulmonary syndrome (HPS) in North and South America. They can also cause mild, flu-like illness.

Organism

Hantaviruses – there are several Hantaviruses that cause human infection

Incidence and Transmission

There is evidence of mild or subclinical hantavirus infections in some high risk occupational groups.

HFRS is rare in the UK.

The disease can be carried by voles, field mice and rats. It is generally spread via contact with urine, faeces or saliva from infected rodents.

There is no evidence of person to person spread.

Occupations and processes where hantaviruses may present a risk

Occupational exposure to hantaviruses may occur in those who:

- are in contact with infected rodents;
- are in contact with urine, faeces or saliva from infected rodents; or
- are in contact with water contaminated with urine, faeces or saliva from infected rodents.

Occupations where there may be a risk of occupationally acquired hantavirus infection include:

- farm workers;
- sewage and waste water workers;
- watersports instructors;
- pest control workers;
- street cleaners and waste disposal workers;
- forestry workers; and
- nature conservation workers.

Clinical Information

The incubation period is 2–4 weeks (may be 2 days – 8 weeks).

Mild forms of the disease have flu-like symptoms. HFRS is a very serious disease, with a death rate of up to 15%. Symptoms include fever, headache, nausea, vomiting and kidney failure. Anyone with these severe symptoms who may have been exposed to hantavirus should seek immediate medical attention.

There is no effective antiviral treatment and therefore the only treatment is supportive.

Control

The following control measures reduce the risk of infection:

- The rodent population should be controlled effectively.
- Good occupational hygiene practices should be followed, especially washing with warm water and soap.
- Cuts and abrasions should be covered with waterproof plasters.
- Suitable protective clothing should be worn.
- A suitable disinfectant should be used.

Further Information

[Public Health England – Hantavirus](#)

Interview Guide

Thank you for taking the time to speak to me today. This conversation should take about an hour, but may take more or less time depending on how much you want to say. During our conversation, I may take a few notes but I will be recording the session on a digital voice recorder so I don't miss anything important.

I want to reassure you all your responses will be kept confidential. This means that any information you provide will only be shared within the research team, and we will ensure information is anonymised so you cannot be identified. You don't have to talk about anything you don't want to, and if you feel uncomfortable at any point and wish to take a break or end the interview, please let me know.

If you have any questions before we start, please let me know.

Introduction:

You may be aware of the different perceptions of rats in society; some people view them as pests whereas some people keep them as pets. The aim of this research is to try and understand how and why people think differently about the same animal.

Interview Guide
Introduction
<i>The opening section of the interview is intended to set the scene, initiate conversation with the participant, encourage them to feel at ease within the context and establish a rapport.</i>
Exploration of roles in society
<i>Areas covered: reflection on their roles within society, this may be multiple roles and dependent on the context of the interview, how others perceive their role within society.</i>
<ul style="list-style-type: none"> - Can you tell me what your job involves? - Can you tell me about your first experience of animals? - Can you tell me about first experience of rats?
Construction of rats
<i>Areas covered: how the participant views rats, and their role in society, their view of how other people (within or external to their social network) perceive rats.</i>

<ul style="list-style-type: none"> - What is the first thing that comes to mind when you think of a rat? - Can you think of any other types of rats? - How do your friends/family feel about rats?
Construction of disease
<i>Areas covered: how the participant understands health and illness, in particular hantavirus, and how they position themselves within the construct of the disease.</i>
<ul style="list-style-type: none"> - Can you tell me what the phrase “health and wellbeing” means to you? - Have you ever thought about how your contact with rats affects your health and wellbeing? - Do you know of any diseases associated with rats? (Depending on the outcome of the previous question) - Have you heard of hantavirus? What do you know about it? -
Construction of risk
<i>Areas covered: constructs of risk, in relation to rat-borne diseases, including hantavirus. (This section may be combined with the previous section.)</i>
<ul style="list-style-type: none"> - Thinking about diseases related to rats, is there anything you are particularly worried about? - Have you ever been given health advice on the basis of your connection with rats? - Do you follow any of this advice/is there anything else you do to reduce the chances becoming ill? -
Concluding discussion
<i>This section will draw the interview to a close, and give the participant an opportunity to speak about anything else they feel is important or relevant.</i>
<ul style="list-style-type: none"> - Ask the participant to reflect on the interview, and if there was anything else they want to talk about that hasn’t already been covered. - If they are willing to complete a questionnaire (phase 2), confirm if they are happy to be contacted at a later date, and by what means (email, telephone, post) - End by reiterating the confidential nature of the discussion, and confirm they have the study contact details if they have any questions at a later date

Table 3: Summary of respondent demographics from a survey of British pet rat owners (n=510).

Age (years)	n (%)
18 to 25	139 (27.3)
29 to 30	103 (20.2)
31 to 35	71 (13.9)
36 to 40	43 (8.4)
41 to 45	34 (6.7)
46 to 50	25 (4.9)
Over 50	17 (3.3)
Missing	78 (15.3)
Sex	
Female	394 (77.3)
Male	32 (6.3)
Other/prefer not to say	7 (1.4)
Missing	77 (15.1)
Rat club member*	90 (17.6)
Member of an online forum	349 (68.4)
Median (IQR) number of rats owned	4 (2–7)
Median (IQR) years owned	5 (2–13)

*Member of the National Fancy Rat Society or any affiliated regional clubs.

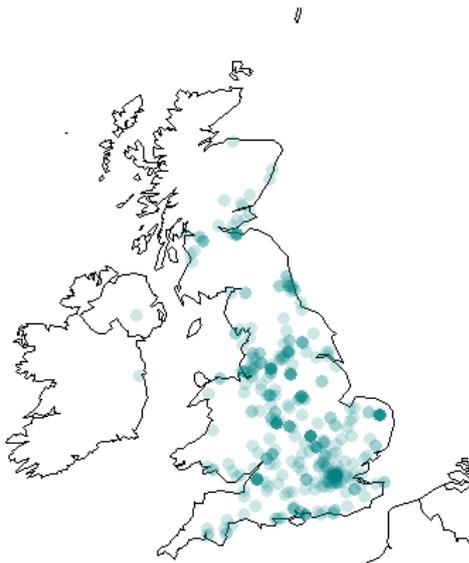


Figure 2: Location of survey respondents based on IP address, from a survey of British pet rat owners (n=510).

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A Tale of Two Rats Survey: Exploring the effect of rat ownership on health

Default Question Block

Thank you for your interest in our project, 'A Tale of Two Rats'. This project is exploring the role of rats in society. We are interested in people's experiences of rats, the role they have in everyday life and how these interactions and relationships with rats affect our health and well-being.

As part of this project, we have been interviewing people who own and breed pet rats. Results from these interviews have been used to develop this survey, which aims to explore the relationship owners have with their pet rats and the effect this relationship has on owner health and well-being. We are also interested in rat health and what types of things you do to keep your rat happy and healthy. Your views are important to us and are a valuable addition to our research.

Before deciding whether to take part, please take time to read the following information carefully and feel free to ask us if you would like more information or if there is anything that you do not understand.

- Taking part in this research is entirely voluntary, and you are free to withdraw up to the point your data are included for analysis.
- Your participation in this research is completely confidential.
- This survey should take no longer than **30 minutes** to complete.

If you have any questions or require further information about the research, please contact Charlotte Robin by email at charlotte.robin@liverpool.ac.uk

<https://livpsych.eu.qualtrics.com/WRQualtricsControlPanel/Ajax.php?action=GetSurveyPrintPreview>

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We would like to share the results of this survey with everyone who has taken part, we will not use your email address for any other purpose. If you wish to receive information on the conclusions of this research please include your email address below.

Please confirm the following before continuing with the survey:

- I am over the age of 16 years
- I consent to taking part in this study

Section 1: Your rats**Section 1: Your Rats**

This section includes questions on your rats, how you manage them, your interaction with them and how your relationship with them has impacted your

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life. It also includes questions on whether you ever look after other people's rats or rescue rats and if their management differs from how you look after your own.

How many rats do you own?

When did you get your first rat? Please give your answer to the nearest year.

Where did you get your first rat from?

- Pet shop
- Specialist breeder
- Rescue
- Other (please specify)

How many of the rats you currently own came from each of the following places? If none of your current rats came from any one of these places, please leave '0' in the corresponding box.

- Pet shop
- Specialist breeder (rats from another breeder)
- Rescue
- Homebred (rats that you have bred yourself)
- Other (please specify)

Where do you currently keep your rats? Please tick all that apply.

- In a bedroom

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- In a common/shared room (within your home) i.e. living room
- In a rat room (within your home)
- In a rat room (outside your home) i.e. garage or shed
- Other (please specify)

Where keep rats loop & merge

Why did you decide to keep your rats in $\$(\text{Im}://\text{Field}/2)$? Please tick all that apply.

- Space
- Convenience
- To manage the smell
- To manage the risk of infection **to myself** (or other family members)
- To manage the risk of infection **from other pets**
- To manage the risk of infection **from wild rats**
- To manage the risk of infection **from people** (including myself)
- Other (please specify)

Visiting rats 1

How often do you get a new rat?

- More frequently than once a month
- 1 to 3 months
- 4 to 6 months
- 7 to 12 months

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- Less frequently than once every 12 months

Do you ever look after visiting/rescue rats?

- No
- Yes

Where do these rats come from? Please tick all that apply.

- Rescue rats (for example, temporarily looking after them until a more permanent home is found)
- Friends' rats (for example, if your friend is on holiday)
- Breeding rats (for example, if you are borrowing a rat for your breeding programme)

Visiting rats 2

Approximately how often do you look after $\{\text{Im://Field/2}\}$ rats?

- Once a week
- Once a month
- Once a year
- Less than once a year
- Other (please specify)

Approximately for how long do you look after $\{\text{Im://Field/2}\}$ rats?

- Up to 24 hours
- Between 1 and 2 days
- Between 2 days and 2 weeks
- Between 2 weeks and 4 weeks

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- Over 4 weeks

Where are the $\{\text{Im://Field/2}\}$ rats normally kept?

- In the same room as your rat/s
- In a separate room from your rat/s

Are you ever concerned about the following when looking after $\{\text{Im://Field/2}\}$ rats? Please tick all that apply.

- Health problems/injury
- Escaping/losing them
- Death
- Risk of infection to your rats
- Other (please specify)

Using the slider/s below, please indicate how concerned you are about these issues.

Not concerned

Concerned

- » Health problems/injury
- » Escaping/losing them
- » Death
- » Risk of infection to your rats

- » Other (please

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specify) Not concerned

Concerned

Do you ever do any of the following when looking after your rats? Please tick all that apply.

- Quarantine (in a separate room)
- Washing hands between handling visiting rats and your own rats
- Changing clothes between handling visiting rats and your own rats
- Use of gloves for cleaning out/handling visiting rats
- Other (please specify)

In the boxes provided, please give a short explanation for what motivates you to perform each of the practices you selected.

Example: advice from my vet

- >> Quarantine (in a separate room)
- >> Washing hands between handling visiting rats and your own rats
- >> Changing clothes between handling visiting rats and your own rats
- >> Use of gloves for cleaning out/handling visiting rats
- >> Other (please specify)

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You have indicated you do not do any of the following when looking after your rats. In the boxes provided, please give a short explanation for what puts you off performing each of these practices.

- >> Quarantine (in a separate room)
- >> Washing hands between handling visiting rats and your own rats
- >> Changing clothes between handling visiting rats and your own rats
- >> Use of gloves for cleaning out/handling visiting rats
- >> Other (please specify)

Example: time constraints

Iterations



The following question is about your relationship with your rat/s. Please indicate how strongly each of the following statements reflects how your

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think about one rat when answering this question.

	Not at all	Somewhat	Moderately	Quite a bit	Very much
My pet rat gives me something to love	<input type="radio"/>				
My pet rat gives me something that I can form a close emotional bond with	<input type="radio"/>				
Having a pet rat has negatively impacted me emotionally	<input type="radio"/>				
My pet rat is my companion	<input type="radio"/>				
My pet rat and I have a special relationship	<input type="radio"/>				
My pet rat is loyal	<input type="radio"/>				
My pet rat provides comfort for me	<input type="radio"/>				
I am worse off because I have a pet rat	<input type="radio"/>				
I like to cuddle with my pet rat	<input type="radio"/>				
I like my pet rat mostly because it is cute	<input type="radio"/>				

Please indicate how strongly each of the following statements reflects how your rat/s have impacted your life. It may be helpful for you to think about one rat when answering this question.

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Not at all Somewhat Moderately Quite a bit Very much

	Not at all	Somewhat	Moderately	Quite a bit	Very much
It is worth giving up other things in life in order to have a pet rat	<input type="radio"/>				
Pet rats take a lot of time but they are worth it	<input type="radio"/>				
My pet rat teaches me to be more loving	<input type="radio"/>				
My pet rat is my friend	<input type="radio"/>				
My pet rat teaches me to trust	<input type="radio"/>				
My pet rat calms me down	<input type="radio"/>				
My pet rat cheers me up	<input type="radio"/>				
I take my pet rat with me to visit people	<input type="radio"/>				
I keep a picture of my pet rat with me	<input type="radio"/>				
I am affected by the way others react to my pet rat	<input type="radio"/>				

Please indicate how strongly each of the following statements reflects how your rat/s have impacted your life. It may be helpful for you to think about one rat when answering this question.

	Not at all	Somewhat	Moderately	Quite a bit	Very much
My pet rat teaches me responsibility	<input type="radio"/>				
My pet rat is fun	<input type="radio"/>				

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	Not at all	Somewhat	Moderately	Quite a bit	Very much
It is worth giving up other things in life in order to have a pet rat	<input type="radio"/>				
Pet rats take a lot of time but they are worth it	<input type="radio"/>				
My pet rat teaches me to be more loving	<input type="radio"/>				
My pet rat is my friend	<input type="radio"/>				
My pet rat teaches me to trust	<input type="radio"/>				
My pet rat calms me down	<input type="radio"/>				
My pet rat cheers me up	<input type="radio"/>				
I take my pet rat with me to visit people	<input type="radio"/>				
I keep a picture of my pet rat with me	<input type="radio"/>				
I am affected by the way others react to my pet rat	<input type="radio"/>				

Please indicate how strongly each of the following statements reflects how your rat/s have impacted your life. It may be helpful for you to think about one rat when answering this question.

	Not at all	Somewhat	Moderately	Quite a bit	Very much
My pet rat teaches me responsibility	<input type="radio"/>				
My pet rat is fun	<input type="radio"/>				

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	Not at all	Somewhat	Moderately	Quite a bit	Very much
and entertaining	<input type="radio"/>				
My pet rat is a financial hardship	<input type="radio"/>				
My pet rat allows me to feel needed	<input type="radio"/>				
My pet rat is someone to lean on and be with me when no one else is there for me	<input type="radio"/>				
My pet rat provides stability for me	<input type="radio"/>				
My pet rat understands me like no one else has	<input type="radio"/>				
Talking to my pet rat makes me feel better	<input type="radio"/>				
My pet rat offers protection/safety	<input type="radio"/>				

The following question is about how rat ownership has influenced your social networks. Please indicate how strongly each of the following statements reflects how owning rat/s has impacted your life

	Not at all	Somewhat	Moderately	Quite a bit	Very much
I have made friends through my pet rat	<input type="radio"/>				
My pet rat has encouraged me to go out more	<input type="radio"/>				
My pet rat has broadened my social network	<input type="radio"/>				

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Not at all Somewhat Moderately Quite a bit Very much

I feel like an active member of a community because of my pet rat



Approximately how often do you interact with your rat/s each day? This includes stroking/picking up, playing/teaching tricks and free-roaming time.

- Less than once a day
- Once a day
- Twice a day
- More than twice a day

Approximately for how long (in total) do you interact with your rat/s for every day? This includes stroking/picking up, playing/teaching tricks and free-roaming time.

- Less than 1 hour
- 1-2 hours
- 3-4 hours

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- Over 4 hours

When interacting or playing with your rat/s, which rooms in your home do they go in? Please tick all that apply.

- Bedroom
- Living room
- Kitchen
- Bathroom
- Other (please specify)

Do you ever kiss your rat or hold it close to your face?

- Yes
- No

Do you ever let your rat climb on you?

- Yes
- No

Do you ever let your rat clean your teeth (sometimes referred to as rodentistry)?

- Yes
- No

Hierarchy

Click to write the question text

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Please look at the images and the list of words below. Drag and drop the words you associate with each image. You can use as many or as few words as you like.

- Items
- Pet
- Diseased
- Intelligent
- Family
- Dangerous
- Risk
- Clean
- Fear
- Healthy
- Safe



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- Animal
- Dirty
- Vermin
- Friend
- Other (please specify)

Click to write the question text



Please look at the images and the list of words below. Drag and drop the words you associate with each image. You can use as many or as few words as you like.

- Items
- Pet
- Diseased

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- Intelligent
- Family
- Dangerous
- Risk
- Clean
- Fear
- Healthy
- Safe
- Animal
- Dirty
- Vermin
- Friend



Other (please specify)

Please rank the following items by how likely they are to carry an infection that could be passed on to your rats, with 1 being the highest risk and 7 being the lowest risk. You can click and drag the options to rearrange the order.

- Pet dogs
- Rescue rats
- Wild rats
- Pet shop rats
- Rats from specialist/registered breeders
- Pet cats
- People

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Please state how much you agree or disagree with the following statements:

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
I feel it is easy to prevent rats transmitting diseases to each other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rats from pet shops are healthier than rats from specialist breeders	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rats can only catch diseases from the environment they live in	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wild rats are more likely than pet rats to carry diseases	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel it is easy to prevent rats transmitting diseases to people	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Any rat has the potential to carry a disease that can be transmitted to people	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rats from specialist breeders are the healthiest rats	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Rats from rescues are healthier than rats from specialist breeders	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Carrying diseases is just part of being a rat	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rats from pet shops are unlikely to carry a disease	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rats from specialist breeders are unlikely to carry diseases	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It is always possible to decide whether a rat is ill or not	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Any rat has the potential to carry a disease that can be transmitted to other rats	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Section 2: Pet rat shows



Section 2: Pet rat shows

This section includes questions on pet rat shows, why they are important, how frequently you attend shows and which shows you attended last year (2016). **You may find it useful to have a calendar or diary to hand when answering this question.** Data from this question will be used to develop a network of pet rats in Britain, which will be really useful for looking at how infectious diseases could be transmitted within the pet rat population.

Do you ever attend rat shows?

- Yes, and I take my rats
- Yes, but I do not take my rats
- No

How many shows did you attend in 2016?

Using the options below, please indicate which rat shows you attended in 2016. The shows have been grouped by region, so you will need to first select the region, before selecting individual shows.

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- Scotland
- North England
- Midlands
- Wales
- South East England
- South West England

Please select which rat shows you attended in Scotland. If you have attended a show that has not been listed, please use the space provided below to enter the date and location of the show.

- 16 January - Paisley
- 12 March - Paisley
- 7 May - Paisley
- 24 September - Paisley
- 19 November - Paisley
- Other (please provide details)

Please select which rat shows you attended in North England. If you have attended a show that has not been listed, please use the space provided below to enter the date and location of the show.

- 21 January - Roundhay
- 31 January - Harrogate
- 20 February - Preston
- 12 March - Sheffield
- 9 April - Gateshead
- 21 May - Roundhay

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- 28 May - Preston
- 16 July - Carlisle
- 16 July - York
- 3 September - Gateshead
- 17 September - Roundhay
- 29 October - Preston
- 3 December - Roundhay
- 17 December - Benton
- Other (please provide details)

Please select which rat shows you attended in the Midlands. If you have attended a show that has not been listed, please use the space provided below to enter the date and location of the show.

- 6 February - Birmingham
- 27 February - Leicester
- 2 April - Nottingham
- 23 April - Ratby
- 4 June - Stafford
- 7 August - Wolverhampton
- 11 September - Milton Keynes
- 1 October - Weedon
- 10 December - Kettering
- Other (please provide details)

Please select which rat shows you attended in Wales. If you have attended a show that has not been listed, please use the space provided below to enter the date and location of the show.

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- 12 November - Cardiff
- Other (please provide details)

Please select which rat shows you attended in the South East. If you have attended a show that has not been listed, please use the space provided below to enter the date and location of the show.

- 16 January - Banbury
- 16 April - Dartford
- 15 May - Portsmouth
- 20 August - Theale
- 15 October - Theale
- Other (please provide details)

Please select which rat shows you attended in the South West. If you have attended a show that has not been listed, please use the space provided below to enter the date and location of the show.

- 20 February - Boscombe Down
- 12 March - Clevedon
- 18 June - Baldock
- 23 July - Cheltenham
- 4 December - Areley Kings
- Other (please provide details)

Do the show organisers provide any guidelines to try and manage the risk of transmitting infections between rats? For example, advice not to

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attend a show if you have had new rats in the previous 2 weeks.

- Always
- Sometimes
- Never

If you have been to a show where guidelines were provided, were they:

- Voluntary
- Compulsory

When attending shows, do you undertake any of your own infection control practices, not specified by the show organisers, to manage the risk of possible infection in your pet rats?

- Yes
- No

If yes, please give details:

Please indicate how strongly each of the following statements reflects your feelings on rat shows.

- | | | | | | | |
|----------|----------|----------|----------|----------|------------|--|
| | | Neither | | | | |
| | | agree | | | | |
| Strongly | Somewhat | nor | Somewhat | Strongly | Not | |
| agree | agree | disagree | disagree | disagree | applicable | |

Appendix 2 xiii: Pet rat owner survey

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	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree	Not applicable
I would worry about the health of my rats if I took them to rat shows						
Attending rat shows provides me with a sense of validation for my breeding programme	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am confident that most other people attending rat shows adhere to show-specific infection control guidelines	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rat shows increase the risk of infections being transmitted through the rat population	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rat shows are the only opportunity I have to speak to other people about my pet rats	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree	Not applicable
It is safe to take my rats to a rat show because all other attendees comply with guidelines put in place to reduce the risk of the spread of infections	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Taking my rats to a rat show is good for their health as it helps them build up a good immune system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I enjoy taking my family/children to rat shows	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It is safe to attend rat shows because most of the rats there are from specialist breeders	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It is safe to attend rat shows because none of the rats there have had any contact with the outside world	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree	Not applicable
I feel uncomfortable taking my children to a rat show because of what other people might think	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Attending rat shows validates my identity as a rat owner/breeder	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel comfortable talking about my experiences of pet rat shows with people I know outside the pet rat community	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Attending pet rat shows makes me feel like part of a community	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Section 3: Rat health

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Section 3: Rat health

This section is about the health conditions your rats experience, what you perceive to be the highest risk and whether you think they are preventable. We are also interested in your decision making surrounding veterinary treatment and what sources you use for health information.

Please indicate which of the following infections/health conditions you are aware of in rats. Please tick all that apply.

- Myco (Mycoplasma)
- Parvo (Parvovirus)
- Sendai virus
- SDAV (Coronavirus)
- Hantavirus
- Lepto/Weil's disease (Leptospirosis)
- Tumours (i.e. mammary or Zymbal's gland)
- Salmonella
- Rat-bite Fever

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- Bordetella
- Staph (Staphylococcal Infection)
- Ringworm
- Pyometra (infection of the uterus)
- Internal or external parasites i.e. fleas, ticks, worms
- Urinary tract infection (UTI)
- Congestive heart failure (CHF)
- CK (Corynebacterium kutscheri)
- Other (please specify)

In your opinion, what is the risk of your pet rat/s getting one of the following:

	Low risk	Medium risk	High risk	Not thought about it
» Myco (Mycoplasma)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Parvo (Parvovirus)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Sendai virus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» SDAV (Coronavirus)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Hantavirus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Lepto/Weil's disease (Leptospirosis)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Tumours (i.e. mammary or Zymbal's gland)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Salmonella	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Rat-bite Fever	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Bordetella	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Staph (Staphylococcal Infection)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Ringworm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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	Low risk	Medium risk	High risk	Not thought about it
» Pyometra (infection of the uterus)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Internal or external parasites i.e. fleas, ticks, worms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Urinary tract infection (UTI)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Congestive heart failure (CHF)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» CK (Corynebacterium kutscheri)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Other (please specify) <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

In your opinion, to what extent do you think the following are preventable in your pet rat/s?

	Not at all	To some degree	Definitely
» Myco (Mycoplasma)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Parvo (Parvovirus)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Sendai virus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» SDAV (Coronavirus)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Hantavirus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Lepto/Weil's disease (Leptospirosis)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Tumours (i.e. mammary or Zymbal's gland)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Salmonella	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Rat-bite Fever	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Bordetella	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Staph (Staphylococcal Infection)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Ringworm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Pyometra (infection of the uterus)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Internal or external parasites i.e. fleas, ticks, worms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Urinary tract infection (UTI)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Congestive heart failure (CHF)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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- » CK (Corynebacterium kutscheri) Not at all To some degree Definitely
- » Other (please specify)

In your opinion, how serious would it be if your pet rat/s had one of the following?

	Not serious at all	Serious	Very serious
» Myco (Mycoplasma)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Parvo (Parvovirus)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Sendai virus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» SDAV (Coronavirus)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Hantavirus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Lepto/Weil's disease (Leptospirosis)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Tumours (i.e. mammary or Zymbal's gland)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Salmonella	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Rat-bite Fever	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Bordetella	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Staph (Staphylococcal Infection)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Ringworm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Pyometra (infection of the uterus)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Internal or external parasites i.e. fleas, ticks, worms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Urinary tract infection (UTI)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Congestive heart failure (CHF)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» CK (Corynebacterium kutscheri)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
» Other (please specify) <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Has your rat/s ever had or tested positive for any of the following. Please tick all that apply.

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- » Myco (Mycoplasma)
- » Parvo (Parvovirus)
- » Sendai virus
- » SDAV (Coronavirus)
- » Hantavirus
- » Lepto/Weil's disease (Leptospirosis)
- » Tumours (i.e. mammary or Zymbal's gland)
- » Salmonella
- » Rat-bite Fever
- » Bordetella
- » Staph (Staphylococcal Infection)
- » Ringworm
- » Pyometra (infection of the uterus)
- » Internal or external parasites i.e. fleas, ticks, worms
- » Urinary tract infection (UTI)
- » Congestive heart failure (CHF)
- » CK (Corynebacterium kutscheri)
- » Other (please specify)

How often do you seek veterinary advice when your rat is ill?

- Always
- Sometimes
- Rarely
- Never

How do you choose which veterinary practice or veterinary clinician to visit? Please tick all that apply.

- Convenience
- Financial constraints

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- My own past experiences
- Practice reputation
- Vet reputation
- Other (please specify)

What are the main sources of information you use for healthcare advice about your rat/s? Please tick all that apply.

- Vet
- Internet search engine
- Internet forums
- Other rat-owning friends
- Breeders/other experts
- Other (please specify)

If you suspect your pet rat is ill, what decisions would you make about veterinary advice or treatment? Please state how strongly you agree or disagree with the following statements.

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
My vet would be the first person I seek veterinary advice from	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I will always call a

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	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
vet for advice, regardless of what clinical signs my rat has	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I will only call a vet when I see particular signs in my rat	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My current financial status influences my decision whether or not to call the vet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel confident that I know what health condition my rat has based on the clinical signs it is showing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel confident with the veterinary treatment or advice my vet provides me about my rat	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Section 4: Owner information

Section 4: Owner information

This section is all about you. We would like to gather some basic demographic information about all of our participants. Remember, this information is completely confidential. You don't have to provide us with this information, but it would be very beneficial to our research if you did.

Please specify your gender:

Male

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- Female
- Other
- Prefer not to say

Please specify your marital status:

- Single
- Married/civil partner
- Divorced/Person whose civil partnership has been dissolved
- Widowed/surviving civil partner
- Separated
- Prefer not to say

Which age group do you belong to?

- 18–25
- 26–30
- 31–35
- 36–40
- 41–45
- 46–50
- 51–55
- 56–60
- 61–65
- Over 65
- Prefer not to say

Are you a member of the National Fancy Rat Society or any affiliated regional clubs i.e. North of England Rat Society, Yorkshire Rat Club etc?<https://lrvpsych.eu.qualtrics.com/WRQualtricsControlPanel/Ajax.php?action=GetSurveyPrintPreview>

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- Yes
- No

Are you a member of any online groups or forums i.e. Fancy Rats Forum?

- Yes
- No

Please state your occupation:**Is your current occupation:**

- Full time
- Part time
- Permanent
- Temporary
- Locum/freelance
- Own business/self employed
- Other (please specify)
- Prefer not to say

What is your total household income?

- Less than £10,000
- £10,000 to £19,000
- £20,000 to £29,000
- £29,000 to £39,000
- £40,000 to £49,000

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- £50,000 to £59,000
- > £60,000
- Prefer not to say

What is your highest educational qualification to date?

- None
- GCSE/ O Level
- Standard/Ordinary (O) Grade/Lower
- AS/A Level
- Higher Grade/Advanced Higher
- Welsh Baccalaureate
- International Baccalaureate
- BTEC/Diploma
- Undergraduate degree
- Postgraduate qualification
- Vocational qualification
- Other (please specify)

**Please provide the first part of your postcode in the box provided below.
For example, if your postcode is CH64 7TE, just write CH64.**

If you have any comments about this survey or the research project in general, please use the space provided below to let us know what you think.

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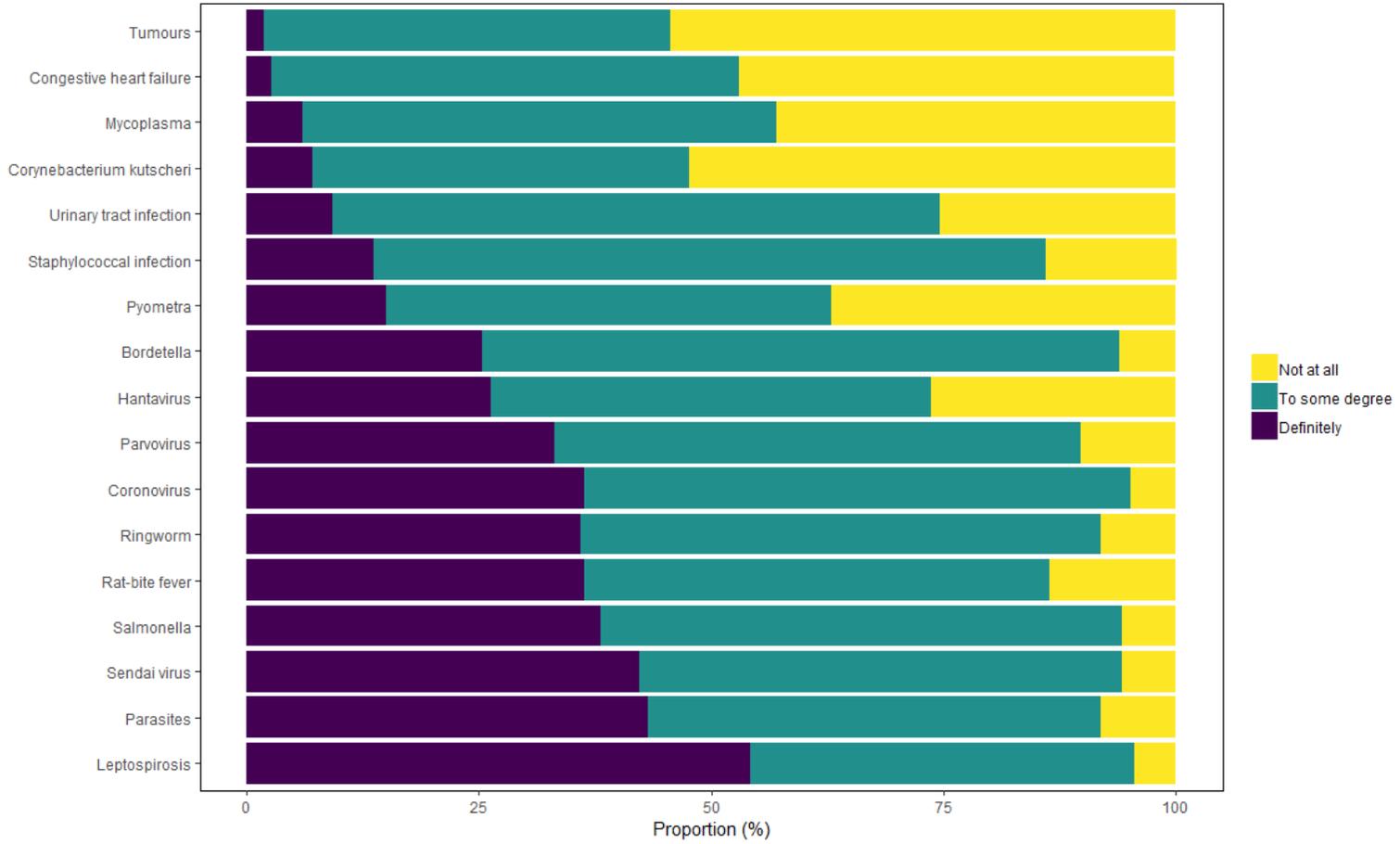


Figure 4.5: Owner reported preventability of different health conditions affecting pet rats in a sample of British pet rat owners, ranked by order of least to most preventable.