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Predicting Risk Perception of Emerging Zoonoses

The case of Q-fever

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Preface

This research has been conducted in the context of the master thesis and concludes the master specialisation Public Health and Society at Wageningen University and Research centre (WUR). This report shows the author her ability to integrate different concepts from the curriculum, and to present the result in a report that reaches the level of a master in an academic program. The research connects to two bigger project conducted by different consortiums. One of the clear goals is thus to deliver a useful addition to that research. First by attributing to the RIVM report: Emerging zoonoses; early warning and surveillance in the Netherlands. Second by attributing to the analysis of a risk perception questionnaire and therewith the research of researcher Marloes Bults.

Acknowledgments

This report commenced in the autumn of 2009. Jim van Steenbergen and Desiree Beaujean in cooperation with Arie Havelaar gave me the opportunity of combining two research possibilities in one half year research assignment. I would like to thank them especially together with the whole team of (LCI). Not only for the opportunity but also for their time and effort during the ups and downs of this study. During this process WUR supervisors Cees van Woerkum and Janneke de Jonge made sure I remained focused and kept an eye on the master regulations. Lots of thanks for their time and efforts. Furthermore I would like to thank a number of people who took the time and energy to share their insights of the field of risk perception and emerging zoonoses; Marloes Bults, Guus den Hollander, Ric van der Poll, Helene Voeten, Caspar Loomhuis, Anne Knol and Juliane Ruzante.

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Chapter 1 Introduction

In the last years, the Netherlands has faced different outbreaks of so called emerging zoonoses with possibly far-ranging implications for public health. In this essay the term zoonoses is used according to the definition of the WHO:

> "any disease or infection that is naturally transmissible from vertebrate animals to humans"(1)

A wide variety of animal species, both domesticated and wild, can act as reservoirs for these pathogens. These infectious diseases affect therefore both the human and veterinary world. Examples of zoonoses that have been problematic in the Netherlands in the past years are: Avaire influenza H7N7, avian influenza, Meticillin Resistant Staphylococcus Aureus (MRSA), Salmonella and more recently Q-fever. In addition to these examples there are numerous zoonoses of potential importance. The relative threats of these zoonoses and subsequently their risk for the Dutch population are however difficult to predict. In this report, attention will be given to the importance of consumers risk perception with respect to strategic risk policy and the relative threat of emerging zoonoses. More specifically attention will be given to the consumers risk perception of the zoonosis Q-fever.

The research objective of this study is

> Identify the most important factors of public risk perception and the intention to behaviour that can potentially be used for early warning and surveillance

To accomplish the above stated research objectives, the three main research questions of this study are formulated as follows:

> 1. What are the main current theories of risk perception?
>
> 2. How applicable are current dominant theories for measuring public risk perception in the domain of emerging zoonoses?
>
> 3. What are predicting factors of consumer risk perception concerning their intentions of behaviour in the case of the zoonosis Q-fever, using the protection motivation theory as an empirical application?

1.1 Problem definition

1.1.1 Risk estimation

> "We hear about so many infectious diseases. I rather not hear about it anymore, it is too much information. I am getting numb."
>
> *(anonymous participant Q-fever Questionnaire august 2009)*

How to manage risks for the society is of great importance for the Dutch government. In terms of health risks, the ministry of health is responsible for policy regarding (the improvement of) public health. According to the ministry the focus lays at prevention and early tracing of life-threatening and chronic diseases, accomplished by immunization and screening programmes. The choice of admissible risk levels should however be placed in a broader political context. In terms of technical policy decisions concerning risk in the Netherlands, equal distribution of the protection of the population is maintained. This protection level can be expressed by a number. Traditionally, the design of managing risks was to translate this technical risk into policy for the management of both prevention and communication. This approach to health risk assessment aims to produce the best possible numerical estimate of the chance or probability of adverse health outcomes for use in policy making (3). In the Netherlands this expressed number is that nobody should be subject to a risk over one in a million (10^{-6}) (4). The feasibility of this decision rule of maximum tolerated risk exposure proved however to be problematic in certain situations. Hollander et al. (5) mention the case of *Legionella*, in which the agreed policy resulted in individual risk level above one in a million. Relying on mainly natural science approaches to risk assessment and management did not always achieve the expected results (3). Accordingly, uncertainty, variability and complexity of a risk can make quantitative modelling problematic, therefore simply calculating the absolute risk to die can be challenging. Besides there are numerous aspects that play a role in risk assessment, such as qualitative and socio psychological factors like social acceptability (5).

1.1.2 Risk perception

Public risk perception plays an important role for successful implementation of prevention, control and management measures (6). It can be argued that the planning of all these measures is in itself part of the risk and therefore the risk is as much a socio-political issue as a biological issue (7). In other words, the risk is not solely a number but should be understood in a larger social cultural and economic context. Analysis of the public perception of a health risk is therefore an important

aspect in both surveillance for policy decision making and the planning of (preventive) measures. The issue how to address risk perception in risk analysis has been discussed over many years. The Health Council of the Netherlands published in 1995*: Committee on risk measures and risk assessment. Not all risks are equal* seeking to answers the question when a certain risk is acceptable to a person. This document focuses on risk decision making and may be seen as a key document in the discussion to add aspects of risk perception to risk assessment. The rapport "*Coping rationally with risks"* issued by the ministry of housing spatial planning and the environment in 2003 further emphasizes to add subjective aspects to the mentioned decision rule of subjected risk. One of the points addressed is which aspects influence public risk perception, showing the growing importance of this matter in the domain of risk assessment. Given this importance, according to Smith (8) as well as Reynolds and Seeger (9), one of the main lessons concerning risk perception learned from the SARS epidemic is the need for a more holistic approach when dealing with, in this case, emerging infectious disease hazards. Holistic, in the sense that the strong focus on emergency responsiveness should change towards a focus on preventive preparedness including preceding knowledge of risk perception aspects due to the limited timeframe of a potential outbreak.

1.1.3 Addressing risk perception

What is risk perception? To answer this question, attention must first be given to the concept of "risk". According to the report *"Coping rationally with risks*" (5) a risk is a multidimensional concept, which can both be calculated in an "objective" quantitative way as well as be seen as a social "construct". The dominant conceptualisation of risk is "the chance of injury, damage, or loss" (Webster dictionary) assuming this risk can objectively be quantified by risk assessment (10). The idea that risk can be described as: probability x harm (sometimes a scenario is added) fits into this perspective. In other words, risk is about rationally weighing the negative consequences of an uncertainty. What influences the public opinion is specifically researched in the field of social sciences. Many social science analyses reject the notion of solemnly rationally weighing the negative consequences, arguing instead that risk is inherently subjective and not "out there". Risk is in this sense seen as a dynamic process. Furthermore is it more and more recognized that current knowledge of reality is limited and thus knowledge about the way risk develops is limited as well (5). A risk by this perspective is what humans invented to help them understand and cope with the dangers and uncertainties of life. The 'social perspective' therefore dismisses the idea of "real risk" or "objective risk" (10).

It is clear that the interpretation of the concept of risk has a direct influence on ideas about how people perceive risks. An integrated way of describing risk perception beyond the mentioned different ways of conceptualising a risk is given by Sjoberg et al. (2004):

> Risk perception is the subjective assessment of the probability of a specified type of accident happening and how concerned we are with the consequences (2)

Differences in terms of what influences and methods how to measure risk perception are sometimes assigned to gaps between different professions or groups. Pidgeon, Kasperson and Slovic (2003) go a step further. In their research concerning the perception of the public to a certain health risk they argue that scientific literature on risk perception and risk communication in itself is still seriously fragmented.

In social scientific literature risk perception is often used as a component of describing behaviour or behavioural change, either for individuals or groups. For example this is the case in the area of health promotion. In this context, different models have been developed in which risk perception is a central element to explain behaviour or behavioural change as illustrated by the Health Belief Model (HBM) or the Protection Motivation Theory (PMT). An example of using the PMT as a general theoretical framework and starting point for exploring risk perception of emerging infectious diseases is the work of De Zwart (11). According to De Zwart, the current limited information in this area gives heed to the need of more insight in risk perception for emerging infectious diseases.

1.1.4 Specificities of emerging zoonoses

Zoonoses are caused by a variety of pathogens, bacteria, viruses, helminthes, protozoa fungi and prions. In consequence of this diversity of organisms, their modes of transmission also differ to a large extent. For example, salmonella is transmitted mostly through food consumption whilst the bacteria *coxiella burnetii* which can cause Q fever its transmission path is mostly airborne. In other words, the only commonly shared characteristic between these diseases is that they originate from an animal reservoir and are directly or indirectly transmittable to humans.

According to Brug et al. (12) is the application of various risk perception methods for infectious diseases thus far not been specifically researched. Applications in the specific area of zoonoses are even scarcer. Furthermore, they conclude there is a gap in research on the applicability of the

determinants used in risk perception research concerning emerging infectious diseases. In order to gain insight into which determinants measuring risk perception have potential use for emerging zoonoses, attention must first be given to the characteristics of zoonoses. As mentioned in paragraph one in the definition of a zoonosis, a zoonosis originates from an animal reservoir and is transmissible from vertebrate animals to humans. The figure below strives to provide insight in the different routes of transmission and subsequently how an individual can get exposed and potentially ill. Two aspects are hereby of importance: at the top side of the figure a list of reservoir possibilities is given. Underneath the corresponding way a person can be exposed to a zoonosis. The main factors of exposure as can be seen in figure 1, developed by the European Food Safety Authority are via direct animal contact, foodborne and via the environment. Globalisation and subsequently travelling is sometimes also mentioned as a potential attributor; however it is not considered a main point of exposure in most research.

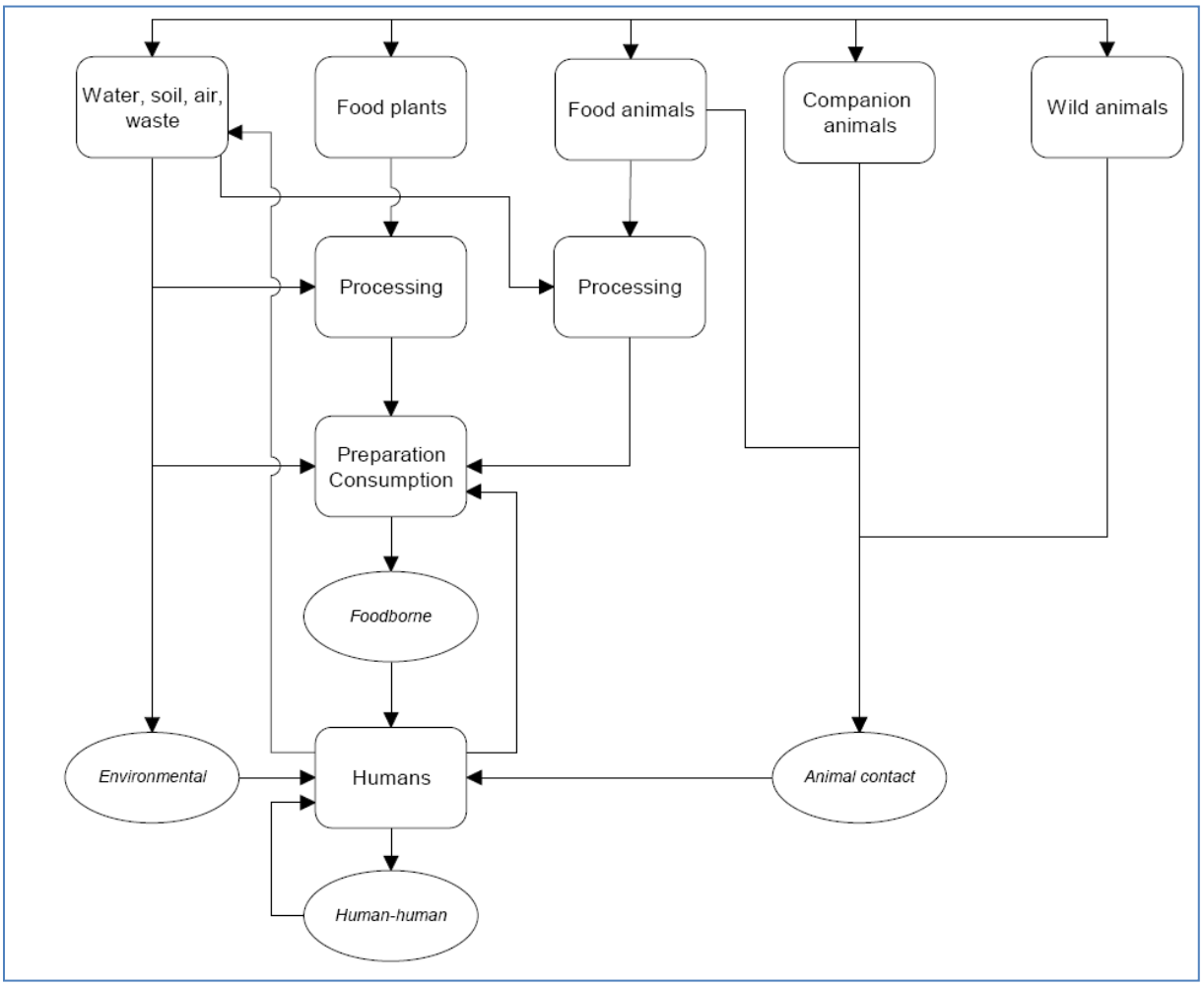

Figure 1 Routes of transmission of zoonotic pathogens (Source EFSA, 2008 (13))

Besides the causal routes of attribution portrayed in figure 1, the human risk of acquiring a zoonosis is affected by multiple other factors influencing the emergence of a disease. These factors include ecological, environmental or demographic that place people in increased contact with the zoonotic agent (14). For example in the case of *Echinococcus multilocularis*, a zoonosis in which humans can be infected via faeces of a fox, it has been shown that environmental, occupational, behavioural and socio economic factors all influenced the individual risk of acquiring *E. multilocularis* (7). In addition, in terms of risk assessment and prevention of zoonoses, they can be related to policy and regulation in not health related areas. During the Q-fever outbreak for example by means of regulations in the veterinary sector. This could be controlling regulations, like limiting the amount of animals that can be held, or through seemingly unrelated regulations like granting building licences for farms. The potential acuteness of zoonotic risks gives heed to potential high level political decision making. Multi-factorial risks are however not exceptional in health risks or risk in general for that matter. The real question that arises is which specific aspects of zoonoses set them apart. Subsequently appropriate attention to the application which determinants measure risk perception should been given. Brewer et al. (15) conducted a meta analysis of influenza studies concerning risk perception of influenza. Assessment wise they formulated three separate dimensions of risk perception from a expert perspective; perceived likelihood, perceived severity and perceived susceptibility. These aspects can most likely also be used for zoonoses. For this study three aspects characterizing zoonoses from a consumer perspective where found in the literature most important concerning consumer risk perception in this context: First, the lack of knowledge of the public, second the multi sectoral area with complex interest and provision of information and finally fear of zoonoses. Theses aspects will be addressed subsequently.

a. Lack of knowledge

Although there is limited information concerning the specificities of emerging zoonoses and public risk perception, one aspect is mentioned several times. According to Holmes (2008) the main difference of communicating about emerging infectious diseases compared to obvious risks, such as flooding, is the “lack of shared understanding of the need for action”. Dealing with emerging diseases there will be less evidence to draw on for the public (16). Since all zoonoses can also be considered infectious diseases this argument can be considered relevant for zoonoses as a sub group. Moreover, two specific papers on zoonotic risk perception; zoonotic infections of dogs (17) as well as a helmintic zoonosis (7), have shown that limited public knowledge had a large influence leading to perceive the risk inconsistent with the actual risk. While the risk of chronic diseases with a larger mortality like cardiovascular diseases are recognized with predisposing factors that have been almost the same for

years, many of the zoonoses are relatively new and have not yet caused problems for the public health in the Netherlands. New threats however emerged during the last decades, on a larger scale like avian influenza or BSE, or emerging in new areas like the West Nile Virus (18-19). People have in most cases limited control over exposure to or contracting of a zoonotic disease. Possibly this explains why infectious diseases like zoonoses can cause large public unrest. Knowledge and uncertainty are therefore important aspects in theories measuring risk perception when it concerns zoonoses.

b. Multisectoral area, complex interests and provision of information

Most zoonoses have impacts on the animal population (domesticated or wild) as well as in the human population. The direct consequence of this characteristic is that in addition to the health sector, the veterinary sector and the environmental sector are mutual stakeholders. Individually for most people human public health is priority number one. However, it can be debated if this is the number one priority in overall risk assessment, it is not the only factors to be accounted. Uncertainty concerning the reasons what moves a certain policy decision forward can be a reason for public unrest. Unclear reasoning and interests could bring about uncertainty and trust issues for the consumer, despite the fact that veterinary, environmental and human health professionals cooperate together. For example by aiming for integration through the so called *One health approach* (20). The two sectors in origin typically serve a different need. Our veterinary sector focuses on proportion principle, aiming on interventions where the cost and benefits are in the most optimum situation for the sector, whiles in the health sector the precaution principal ,focussing on preventing harm before it occurs besides the costs as a part of social protection, plays an important role. Therefore in some aspect the two cooperating sectors have different interests and will provide different information. The multidisciplinary aspects of any zoonosis might cause these different interests to clash, for example on economical grounds.

All these points, such as communication concerning these different interest can influence the risk perception of the public to some extent. In the case of BSE in the United Kingdom, the experience of the inquiry commission regarding the entire period led to the conclusion that a policy of openness was the correct approach. By expressing and exploring political policymaking doubts openly, the public is capable of responding rationally and are more likely to accept reassurance and advice if and when it comes (21). Trust is furthermore found to be closely related to consumer acceptance of information. According to Slovic (10) trust in expert knowledge will make people more acceptant of the risk. Hansen et al (22) add however that if a person already has a strong judgment towards a

certain potentially hazardous activity, such as the consumption of food potentially infected with a zoonosis, "*they will confer trust upon a source which provides a risk message congruent to their attitude, but distrust a source which provided a dissonant message*". Furthermore, disagreement between experts has been shown to act as an amplifier of risk perception (23). Interesting about these mentioned aspects of trust is that the level of openness in the policy decision making process might in addition also influence consumer trust in expert knowledge. This interrelation adds to the complex interests and provision of information in this multidisciplinary field of veterinary and public health.

c. Fear

Zoonoses are infectious diseases and when dealing with infectious diseases historically the word fear is of importance. According to Pappas et al. (19) historically the most significant psychological unrest in relation to human health is related to infection. Lately emerging infectious diseases attracted substantial scientific and media attention. In a historical overview of emerging infectious diseases Morens, Kolkers and Fauci (24) they suggest that infectious diseases have occurred throughout the history and will remain a challenge in the future. The reason for psychological unrest or public fear can be found in the characteristics of infection: transmissible, imminent and invisible (19). This fear might have some relation with the fact that people have very limited control over all these aspects. They further argue that in contrast to the relative stabile fear for more burdensome diseases, like chronic conditions, "germ panic" nevertheless consistently re-emergences causing psychological unrest.

1.1.5 Prioritizing emerging zoonoses

In the context of the research program Emerging Zoonoses (EMZoo) a list of 86 emerging zoonoses have been identified as specifically relevant for the Netherlands. This list has been developed in order to assess the risk, eventually leading to policy priority of potential diseases and subsequently their potential outbreaks.

Apart from the list of relevant emerging zoonoses the first phase of the EMZoo project was to investigate which zoonoses are most important, form the largest potential threat. A system has been developed on the basis of which the zoonoses can be rated and "objectively" evaluated in terms of this potential threat. One dimension, the epidemiological risk, has been investigated. This dimension

is composed of seven criteria, introduction, transmission, economic damage in animal reservoir, animal human transmission, transmission between humans, morbidity and mortality in humans. These criteria represent epidemiological aspects of the zoonoses based on natural science. The EMZoo research group considers risk perception of great importance to the prioritization of the threat of emerging zoonoses. The EMZoo research group wishes to consider risk perception as a separate dimension since research concerning risk perception fits more in field of social science. It might be fundamentally different from the epidemiological criteria, furthermore risk perception may lead to different risk management actions.

The primary priorities when dealing with emerging zoonoses are generally; first the identification of the modes of transmission and second, identification of control strategies in both the human as the animal population. In other words, the first priority is seeking knowledge how to deal with the zoonosis. This knowledge is the input of a control strategy. A component of this strategy for humans will be treatment of already infected people. However, in terms of control and eventually policy making in the long run, the main objective will be to prevent people from getting sick (primary prevention) or finding disease in an early stage to prevent complications (secondary prevention). Therefore the key focus when dealing with emerging zoonoses is of a preventive nature for both veterinary and human health. When assuming both the modes of transmission and the control strategies for a zoonosis have been identified, the next step would be to develop a way to communicate these aspects towards the public. In this regard, lessons can be learned from previous outbreaks. A key finding is that the effectiveness of the control of outbreaks of new emerging zoonoses will largely depend on the behaviour of the population and their willingness to adhere to recommended preventive measures (11). Giving proper attention to risk communication towards the public concerning potential health problems is therefore crucial. Knowledge about how people experience and perceive the risks of zoonoses is limited. In this aspect it remains a challenge to gain knowledge in what way policy messages and measures such as enhanced surveillance or risk communication can influence the perception of the risk. This is in particularly important considering the current “risk society” (25) and the great interest of mass media for (potential) outbreaks.

Zoonotic outbreaks such as the Bovine Spongiform Encephalopathy (BSE) crisis and more recently the Q fever epidemic in the Netherlands have caused public unrest. In terms of dealing with this unrest there is a thin line in risk communication. On the one hand, exaggerated messages concerning zoonoses in the media may lead to panic and influence public life and the economic situation. On the other hand, the public may think a zoonosis is not a serious threat and hence not pay heed to special precautions. According to the research project; “*Risk perception of infectious*

diseases; developing instruments to measure risk perception and implementing instruments for risk communication in order to control (outbreaks of emerging) infectious diseases" (26), there are currently no evidence-based frameworks available for taking into account risk perception in risk communication before or during the control of outbreaks of (emerging) zoonoses/ infectious diseases. Local and national public health authorities are however frequently confronted with both preventive risk communication and outbreaks. Subsequently over the years, the question arises as to what influences the risk perception of the public in the case of emerging zoonoses. An estimation of the risk perception of the public concerning a zoonosis beforehand can therefore be helpful in the development of risk communication. In different fields, risk and the perception of risk have been studied to a large extent. There are therefore numerous theories which describe risk perception with different basis and ways of estimation risk perception. The following study therefore proposes to adopt a wider view and start by gaining insight in different ways of researching the factors of risk perception that could be compatible for emerging zoonoses. After which an empirical study will be conducted by applying one theory concerning factors of risk perception in a predictive model.

1.2 Report strategy

1.2.1 Report objective

The objectives of the proposed research were first to explore dominant or potential ways of measuring risk perception for emerging zoonoses and their potential application for surveillance of emerging zoonoses. Second, the research aimed to identify key predicting factors of the intention to behavior for the specific zoonotic disease Q-fever.

1.2.2 Methodology

In order to give an overview of the dominant public perception of emerging zoonoses, first attention must be given to the dominant theories measuring risk perception. When looking into the sectors potentially related to risk perception of zoonoses, it becomes clear a zoonosis is not just a health related risk, other influencing fields might be environmental or food related risks. These in many ways overlapping fields describing risk perception could potentially give insight for this research.

Using the databases ovidSP and Psychinfo a general search strategy has been conducted in order to find ways of describing and measuring risk perception. Due to the scale of these different areas of potential interest and the sheer size of the field of risk perception, certain deductions had to be made to fit the time, limiting the scale of this study. First, theories measuring risk perception where sought through overview and review articles concerning terms related to risk perception. The vast amount of different theories in different fields all related to risk perception were the reason to narrow this search strategy down. This was conducted by adding search terms such as zoonoses, infectious diseases, specific zoonoses in an OR relation. By assessing the most commonly mentioned theories in theses reviews and overview articles finally four dominant theories were selected.

In order to find more information about each theory the same databases were used. First, to find articles with the name of the theory for general information. Second the name of the theory combined with different terms like zoonoses, infectious diseases in order to gain information concerning the application for zoonoses.

In the second part of this research a statistical analysis using PASW Statistics 18 software has been conducted. Specifically linear regression was used in order to gain insight in the predicting

factors of consumer perception for the intention to behaviour in relation to the zoonosis Q-fever. One of the dominant theories described in chapter two, the protection motivation theory, has been used as the basis for this model.

1.2.3 Structure

In chapter two the four dominant theories regarding the measurement of risk perception will be explained by means of; background, methodology, limitations and their relevance for zoonoses. These four theories are respectively, psychometric paradigm, social amplification of risk framework, health belief model and to conclude the protection motivation theory. The conclusion can be found in paragraph six which focuses on comparing the application possibilities of the four ways of measuring risk perception.

Chapter three will the focus on the analysis of a predictive model of the intention of behaviour. This model has been based on one of the discussed dominant theories, the protection motivation theory. In the final chapter the conclusions and implications of the three research questions will be discussed with a specific sector focussing on the identification of consumer risk perception factors that potentially give insight for early warning and surveillance application.

Chapter 2. Dominant theories

In this chapter the four dominant theories concerning risk perception will be explained by means of; background, methodology, limitations and their relevance for zoonoses. These four theories are, respectively, psychometric paradigm, social amplification of risk framework, health belief model and to conclude the protection motivation theory.

2.2 Psychometric Paradigm

The psychometric paradigm is repeatedly mentioned as the leading contender in the field of risk perception and risk communication (27-28). The psychometric paradigm assumes that with appropriate design of survey instruments, factors that influence individual risk perception can be quantified (10). The idea behind research in line with the psychometric paradigm is that lay and expert people do not deal with risk the same way. In fact, it argues that judgments about risk generally differ between people (29). By using an expressed preference approach, research with a psychometric approach seeks to provide an relative objective analysis of the different ways in which risks are perceived (22, 27).

2.2.2 Background

The origin of the psychometric paradigm lies at the hands of Chauncey Starr. His theoretical research started with the question how to weight technological risks and benefits in order to answer the question how safe is safe enough? (29) In his work Starr used a revealed preference approach, assuming that societies develop a balance between risks and benefits. He found that people are willing to accept a certain risk if the benefits exceed the danger, he describes these risks as voluntary (30). Following this work of Starr, Fischhoff et al (31) were the first to describe the psychometric model. This model has been extended since the launch by Fischhoff et al in 1978. The basis of the model is a theoretical framework that assumes risk perceived by the public is multidimensional and not merely a trade off between benefits and risk perceptions. Thus an individual may be influenced by a wide array of psychological, social, institutional and cultural factors (10). Furthermore research using this approach assumes that these factors and their interrelationships can be quantified and modelled. (10) Hereby identifying and quantifying similarities and differences in risk perception among individuals and groups (32).

2.2.3 Methodology

Structured psychometric scaling methods with a number of explanatory scales are used to produce quantitative measures of perceived risk, perceived benefit and other aspects of perceptions (27, 33) In these scales several hazards such as BSE, and pesticide residue, are listed that were rated by people as high risks, although experts did not always rate them high (28). Multivariate analysis techniques are then used, leading to a quantitative representation of risk perception, unveiling the factors that determine risk perception (33). The hazards are subsequently mapped in a two dimensional space, as can be seen in figure 2 . Through factor analysis the mean ratings of each hazard on the scales are compared, resulting in the main factors describing the variance. Hazards then can be compared on the basis of risk perception. In the earlier mentioned first study by Slovic (31) nine dimensions were used as scales on which people had to rate the "perceived riskiness" of a large number of risks. In subsequent studies the amount of scales differs, usually eighteen (2). Nevertheless the nine single dimensions the participants were asked to rate in this first article concerning risk perception by the psychometric paradigm were:

whether people face the risk voluntarily
the immediacy of the effect of the risk,
the extent of the risks
the potential of the risk
the level of dread for the risk
the severity of the consequences of the risk
the level of knowledge in science about the risk
the level of control over the risk
the newness of the risk

The participants are asked to rate each of these dimensions in a single scale for all of the hazards of that research. In other words, only one question per category is asked to fill in. For example to operationalise the first dimension voluntarily. The scale can be described as; to what extent the population is exposed to the risk associated with each activity, substance or technology voluntarily. Participant are asked to rate this question from low (1), involuntarily to high (7), voluntarily. For the dimension severity of the consequences the scale can be described as; should the risk associated with this activity, substance or technology occur, how likely is it to produce fatal consequences with the rating option of low (1), non fatal, to high (7) fatal.

Through factor analysis two main factors explained much of the variance: the level of dread and the level of knowledge in science and of those exposed. In following research most studies showed the same two factors explaining the largest part of variance; the first was dread risk (severity) and the second if the risk was known. However a third factor was found in later research, the number of people exposed to the hazard. To explain what can be understood by dread risk, Slovic (10) presents a broad definition of experts; the perceived lack of control, dread, catastrophic potential, fatal consequences and the inequitable distribution of risk and benefits. Furthermore experts define unknown risk as unobservable, unknown, new and delayed in their manifestation of harm.

The figure below illustrates the two dimensional map from a research regarding risk perception in relation to food consumption and food production amongst a consumer panel of a private research company (34). This figure exemplifies the importance of two components of risk; unknown and severity, where the latter reflects the dread dimension of risk perception (34). As can be seen in figure 2, Salmonella and bacterial contamination in the right bottom quadrant are relatively known and considered severe. Genetic Manipulation (GM) in the top of the figure is however relative unknown and in terms of severity in the middle. Known voluntary lifestyle risks such as alcohol and high sugar or fat diets are rated relatively low in terms of perceived severity.

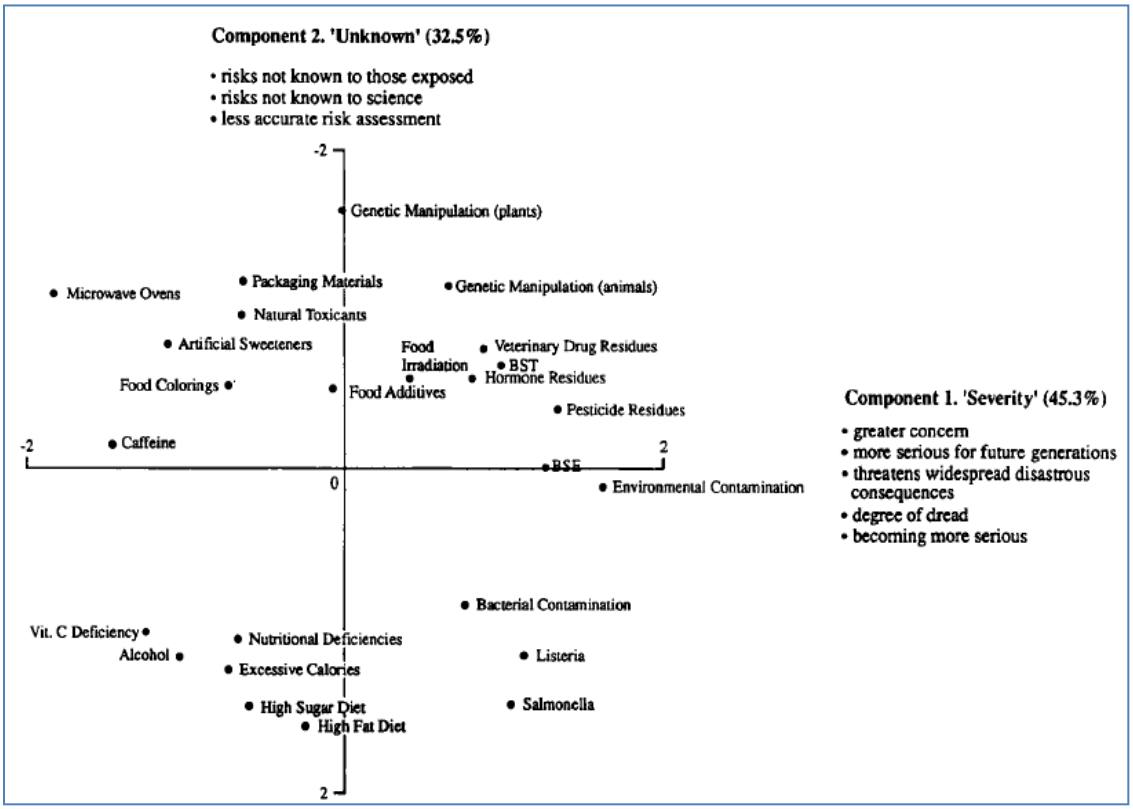

Figure 2. Location of food-related potential hazards within the two-component space (source, Sparks and Sheperd 1994 (34))

2.2.4 Criticism on the psychometric paradigm

One of the criticism regarding many psychometric studies is the potential bias due to academic convenience sampling used to assemble respondents for the research possible not representative for the entire population (27). Another potential limitation of psychometric research is the use of mean data, less subjected to error and not taking individual differences in risk perception into account. They aggregate the data in order to perform factor analysis (35), whilst many studies have shown risk perception differs amongst individuals. Siegrist et al (35) further suggest that personality factors such as the general level of trust and confidence play a role in explaining risk perception.

2.2.5 Implications for zoonoses

The main advantage of research in line with the psychometric paradigm is the possibilities it offers of quantifying and comparing hazards. For risk perception of zoonoses this advantage will give a direct link with prioritization of emerging zoonoses for policy. However in the psychometric paradigm tradition, very general hazards were used rather than specific hazards. For example what respondents think of when asked to rate the general hazard “gene technology” could be different, maybe they thought of genetically modified food, or drugs. Since zoonosis are most likely considered specific hazards for people and most zoonoses will be unknown, people potentially have to rate their perception about something they are not familiar with, which might be problematic. Since this possibly causes limited explanatory power as has been the main potential limitation in research of Siegrist et al. (35) who used more specific hazards . Furthermore the sampling strategy might also be a point of issue. Due to the need of extensive questionnaires, surveillance by this method might be difficult. Adding all 86 zoonoses to a list of hazards would extent the survey tremendously. It does not seem realistic to ask participants to rate such a large number of hazards.

Furthermore, due to a suspected public unfamiliarity of zoonoses and therewith lack of knowledge from the public, zoonoses will most likely score relatively high on the dimension scaling how well-known a hazard is. Since this scale has been found to explain a large part of the variance, combining a large amount of zoonoses like 86 to a list of hazards could influence the results; decreasing the explanatory value and therewith the validity of using this method for this group of diseases. This could be prevented by combining smaller selections of zoonoses to the hazard lists in a random way. The question arises however that if individuals have no knowledge of the zoonosis, some basis information must be given in order to rate them and how this information can be given without biasing the measurement.

As mentioned in chapter one, due to the multi sectoral interest along the causal routes of a zoonosis, information and trust in expert knowledge are aspects that should be addressed when measuring risk perception of zoonoses. In the psychometric paradigm these aspects are mostly taken into account. Therefore these aspects fit into the model.

2.3 Social amplification of risk

The social amplification of risk framework (SARF) tries to explain the various processes through which activities with potential health hazards may become the focus of social and political concern. Subsequently this focus may lead to risk amplification or the opposite, risk attenuation (36). Risk perception is therefore a result of a process by which individuals and groups "learn to acquire or create experiences of risk" (37). The driving force explored in this framework is media coverage (16).

2.3.1 Background

In order to overcome the fragmented nature of risk perception and risk communication research in the late 1980s, Kasperson, Kasperson, Renn and collegeas (36, 38-39) developed an integrative theoretical framework, the SARF. This framework integrates findings from a wide range of theoretical and social science studies. In the context of the social amplification framework there is no such thing as absolute or socially determined risk. Originally risk only had meaning in this framework to the extent that it is a reflection of how people interact within a social context (36). In later research this notion was expanded, arguing that culture also has an impact (37). The framework can be used to explain in what way both social and individual factors influence public risk perception by means of amplifying, reduction or even modifying perception. If amplification modifies the perception of a certain hazard this can potentially result in or "ripple" to secondary results such as stigmatization of people, places and ideas (40) or even to economic losses (36). In figure 3 these ripple effects are shown as effects on different levels, such as industrial, company and victims.

As shown in figure 3, according to SARF the process of amplification starts with a risk event "E", risk perception and subsequently behaviour is influenced by psychological, social, and institutional factors. People gather and react to information, after risk event E individuals or groups then select the characteristics of that risk, sending their interpretation via their personal information channel. Besides this channel the SARF argues that influence takes place by means of a network of formal, such as the media, and informal personal channels or mechanisms (41). People experience risk first of all by these signals (42). Kasperson and Kasperson further argue that such signals are subject to predictable transformations as they filter through "various social and individual amplification station(s)". In figure 3 these stations are described as risk related behaviour, by means of institutions, groups and individuals, leading to particular interpretations and responses by members of the social network of a person.

Social amplification in turn describes why some hazards or events seem to create so called ripple effects with secondary and tertiary impacts spreading like the ripple effects of a stone in the water beyond the initial effects of the hazard. The media may contribute as a primary amplifier. These secondary and tertiary impacts could include the demands for regulatory action by the government, loss of sales, loss of trust in decision authorities or industry, litigation and stigmatisation of a community or product or facility (43).

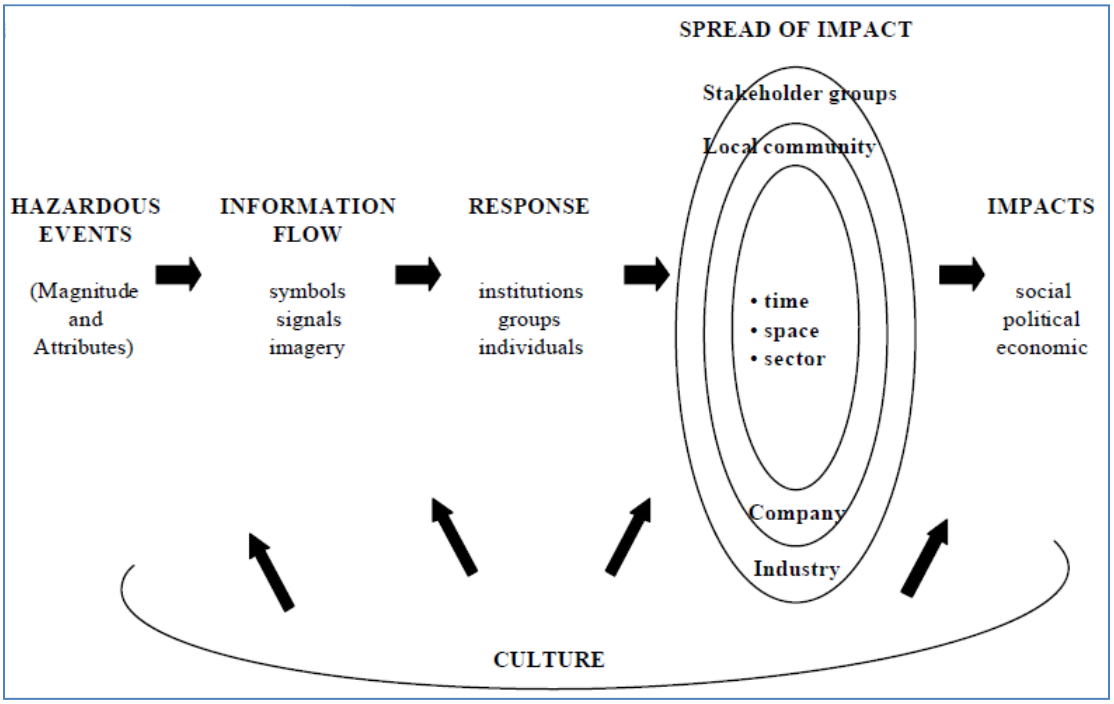

Figure 3. Social amplification framework (simplified version) (Source Petts et al. 2001 (43))

2.3.2 Methodology of the social amplification framework

Since empirical examination of the SARF is rare, there is no single method for using this framework. The framework mainly gives an overview of which factors influence risk perception. Risk perception determinants are important in measuring risk perception, this model does not stipulate how to actually measure these components. For example, to research the relation between risk perception of BSE and increase or decrease of media attention, Frewer et al (44) used the SARF framework. They developing a seven point rating scale questionnaire where participants rated their level of agreement at 53 attitude statements after further analysis was conducted in order to compare attitude with media intention. In contrast, Lewis et al (40) used the framework by comparing media attention for BSE with media attention for the Golf war in that time by means of the number of news articles. Both studies use the framework so research amplification however, apply the principles in different ways.

2.3.3 Criticism on the social amplification framework

The SARF provides a useful terminological framework, however the usability of this framework is limited to studies of the general process determining social attention to risk (45). Sjöberg et al. further argue that more empirical data is needed to further develop the SARF by means of formulation specific theories which leads to testable hypothesis. Not only are current empirical examinations of the SARF rare, they must be opportunistic to some extent (46). The framework namely implies that it is difficult to predict when conditions that trigger risk amplification or attenuation of a risk event will occur. Without foreknowledge of such risk events, planned empirical data collection assessing public attitudes before and after amplification or attenuation has occurred is difficult. (46). A number of attempts to test SARF empirically suggest that SARF can however explain some of the underlying causes and factors influencing social responses (43). Yet, the secondary and tertiary ripple effects proved more difficult to examine. In particular the durability of the effects, and the factors which lead to an issue remain "controversial or receding" (47). Frewer et al. add that these difficulties in predicting when conditions are likely to result in amplification effects make it difficult to examine changes in risk perception that are "contemporaneous with increases and/or decreases in social or media discussion of the risks associated with a particular risk event" (46).

2.3.4 Relevance for emerging zoonoses

The BSE crisis has often been described as a "textbook example" of the social amplification of risk (48-49). Only after the connection of BSE with the human Creutzfeldt Jacob Disease did public perception of risk associated with beef consumption increase in the UK (50). The scope and structuring of the SARF allows the generation of policy suggestions, in terms of planning the proper approach to risks. In terms of applicability for zoonoses, the general framework seems to fit the complex process of risk perception for zoonoses very well. It shows exactly those difficulties of the process of risk perception that risk prioritization of emerging zoonoses is potentially aiming for. However, the framework is thus far mainly used to address manifestations of amplification and attenuation (36) and does not address the core relevance for risk perception of emerging zoonoses surveillance namely, the development of normative criteria for judging the outcomes of social risk amplification and gaining insight in the potential risk perception beforehand. The complexity of the SARF makes the application for surveillance somewhat unpractical. In terms of early warning and surveillance this framework however provides those factors that were found to be of importance for public risk perception of emerging zoonoses, such as fear, familiarity and the multi sectoral field with different interest at stake. Potentially this model can be used as a general framework. Furthermore

the conception that public risk perception can be intensified and attenuated by social process provides the basis of research in the specific relation of the media and risk perception as during the BSE crisis. This idea has for example been researched in different studies concerning newspaper coverage of food safety issues and consumer confidence by De Jonge et al. (51-52). Consumer recall of food safety incidents was for example found to be positively related to media coverage (51).

2.4. Health Belief Model

The main concept of the Health Belief Model (HBM) is that the decision to engage in healthy behaviour depends on the personal beliefs or perceptions about a disease and the strategies available to decrease its occurrence (53). In other words, people weigh the perceived health threat versus an evaluation of the recommended behaviour. The model hereby attempts to explain and predict the actual behaviour.

2.4.1 Background

The HBM is a value-expectancy theory, regarding behaviour as a subjective value of an outcome. The HBM is one of the oldest models of health behaviour. It was developed during the nineteen fifties by social psychologists Hochbaum et al. (53) in order to understand why people do not partake in preventive and early warning surveillance programmes, such as vaccination or screening (54). Originally the model suggested that decision making in public health was apart from socio demographic factors, influenced by four basis premises; perceived susceptibility of the risk, perceived severity of the risk, perceived benefits of preventive behaviour and perceived barriers to the behaviour (54). In addition, the model was in later years also used to describe other behavioural aspects and more complex health behaviour such as lifestyle related changes, smoking cessation and healthy eating. The variable self efficacy was then added. Self efficacy relates to “the conviction that one can successfully execute the behaviour required to produce the desired outcome” (55). Among other research to Schafer et al. found in the application of HBM to food risk self efficacy amongst the factors of most impact on public behaviour (56).

2.4.2 Methodology

The aspects of the HBM can be measured and used by a variety of techniques ranging from surveys to clinical interviews. In figure 4 the previously explained premises are translated into the following; the likelihood of behaviour to reduce a threat depends on the expectation together with the perceived threat. Expectations encompass the two basic premises perceived benefits minus barriers in addition to the added factor, perceived self efficacy. As can be seen in figure 4 another dimension is added, labelled "cue to action". That is, the HBM suggest a change of behaviour can be influenced by events or people, for example concerning zoonoses a cue to action might be that a family member with Q fever can influence other family members to take precautions when dealing with goats. Furthermore in figure 4 the top indicates that an individual's background influences the initiation of any behaviour, the individual socio demographic factors therefore inherently influence all aspects of health behaviour.

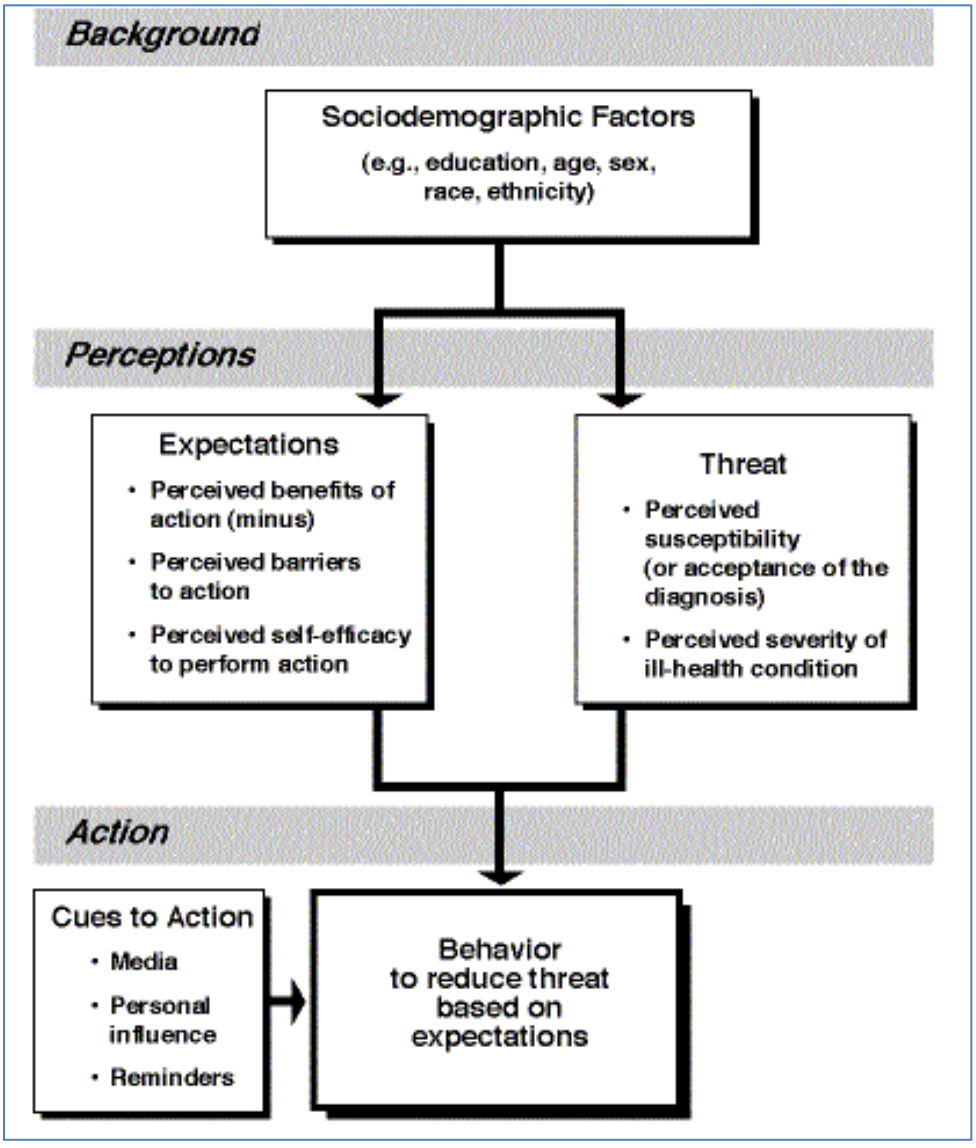

Figure 4. Health Belief Model (Source Rosenstock I., Strechter et al. (1994) (57))

2.4.3 Criticism on the Health Belief Model

The HBM has generated a widespread application of research and has been accepted by different fields of health professionals, including physicians, dieticians and health educators. The model has therefore been evaluated over the years, identifying several limitations. One of the main criticisms suggests that the HBM is in fact not a model, but a collection of variables possibly describing healthy behaviour (58). According to Rimer (59) most concepts of the research have received substantial empirical support. This relates however to the following. There has been scale development in some topic areas. Nevertheless different researchers measure variables differently and there is no clear development of the collection of variables. Strecher and Rosenstock cautioned users of the HBM to be mindful when using components of the model, since variables measured out of the context of the model makes results difficult to explain. Phuannukoonon et al. argue that especially tropical disease control programs have used the HBM despite the limitation of the application and usefulness. The limitations they mention is related to the scope of the model. It remains limited in addressing broader dynamics involved in disease control, such as social, cultural, economic and community dynamics (60). Leppin (61) furthermore suggests that behavioural models such as the HBM mainly focus on how risk perceptions and other cognitions influence behaviour. In other words risk perception as an aggregation of individual assessment. Therefore the question how risk perceptions are formed has been met with little attention (61) while this aspect, in combination with the mentioned broader scope is futile for the surveillance of emerging zoonoses.

2.4.4 Implications for zoonoses

In terms of surveillance of zoonoses, knowledge about the health threat is measured in this model since it is an aspect of perceived severity and perceived susceptibility. The focus of the HBM lays however at the weighing of the threat in combination with an action of the participant. The key concept of the HBM concerns an analysis closely resembling a economic cost benefit analysis. Cost and benefits in the sense of how people conceive a health threat and subsequently how they look at their risk behaviour to cope with the threat. This way of conceptualizing the aspects how people will behave might be of interest for zoonoses as well. At this moment, direct clear existing measures developed for decreasing the individual risk of an emerging zoonose have not been developed yet. However, some examples of potential interest do exist. For example in Thailand the HBM has been adopted as the principle theory for dengue haemorrhagic fever (DHF) prevention and control (60). The model contributes mainly to the development and evaluation of control messages for DHF by providing specific insights in terms of behavioural determinants.

When relating the specific aspects of zoonoses with the HBM the multi sectoral aspect of emerging zoonoses as described in chapter one is not an explicit consideration within the HBM. Only *cues for action* (see figure four) might give room for that aspect. Finally the aspect of fear has been addressed in this model by means of the aspect perceived susceptibility and severity. When used to measure risk perception for emerging zoonoses this model provides elements that can be used as tools to develop a suitable surveillance survey for emerging zoonoses.

2.5 Protection Motivation Theory

The Protection Motivation Theory (PMT) is part of health related behaviour research approaches which focus on the question of how individual risk perception influences decision making and consequently behaviour (61). In that sense the PMT shares many constructs with the HBM discussed in the previous paragraph. In this model risk perception is not the central aspect, it is merely one component relating to health behaviour and attitude. Furthermore in the PMT risk is defined in line with the likelihood of contracting a disease.

2.5.1 Background

One of the dominant theories describing health related behaviour is the PMT (62-63). The original Protection Motivation Theory (PMT) as described by Rogers (62) investigates the effects of fear appeals on persuasion. This research focused on the effects of threatening health information on attitude and behaviour change of the public (63). The theory has been developed from a category of theories with expectancy and value constructs.(62-63).

The main variable to explain behaviour in the protection motivation theory is the idea that a certain behaviour is the result firstly of perceived values and secondly expectation of the outcome (64). Accordingly, the two underlying processes influencing behaviour that are used in the model to specify and explain these variables are threat appraisal and coping appraisal.

As shown in figure five, two possible strategies in precautionary behaviour can be distinguished, the maladaptive and the adaptive response. This means either healthy (adaptive) or not healthy (maladaptive) behaviour. As mentioned, in the original model the protection motivation depends on two aspects; threat and coping appraisal, illustrated in the middle of figure five. Threat appraisal encompasses different concepts: the perception of the severity of a health risk is combined with the perceived vulnerability of a person to determine the perceived threat. A person however also values certain intrinsic and extrinsic rewards for the risk. For example the pleasure of petting an animal when dealing with the threat of a zoonosis can be considered a non-negligible reward. These intrinsic and extrinsic rewards minus the perceived severity and vulnerability lead to a certain threat appraisal or risk perception. On the other hand, an individual his or her coping appraisal also encompasses three factors. The first, self efficacy is already explained in the previous paragraph concerning the Health belief model. Self efficacy relates to the perception of an individual to be able to successfully execute the behaviour required to produce the desired outcome (55). Second, response efficacy

deals with the efficiency someone beliefs the protection motivation (the response) will lead to decreasing of the perceived risk. Finally the PMT argues that subtracting response cost from both response efficacy and self efficacy leads to the coping strategy.

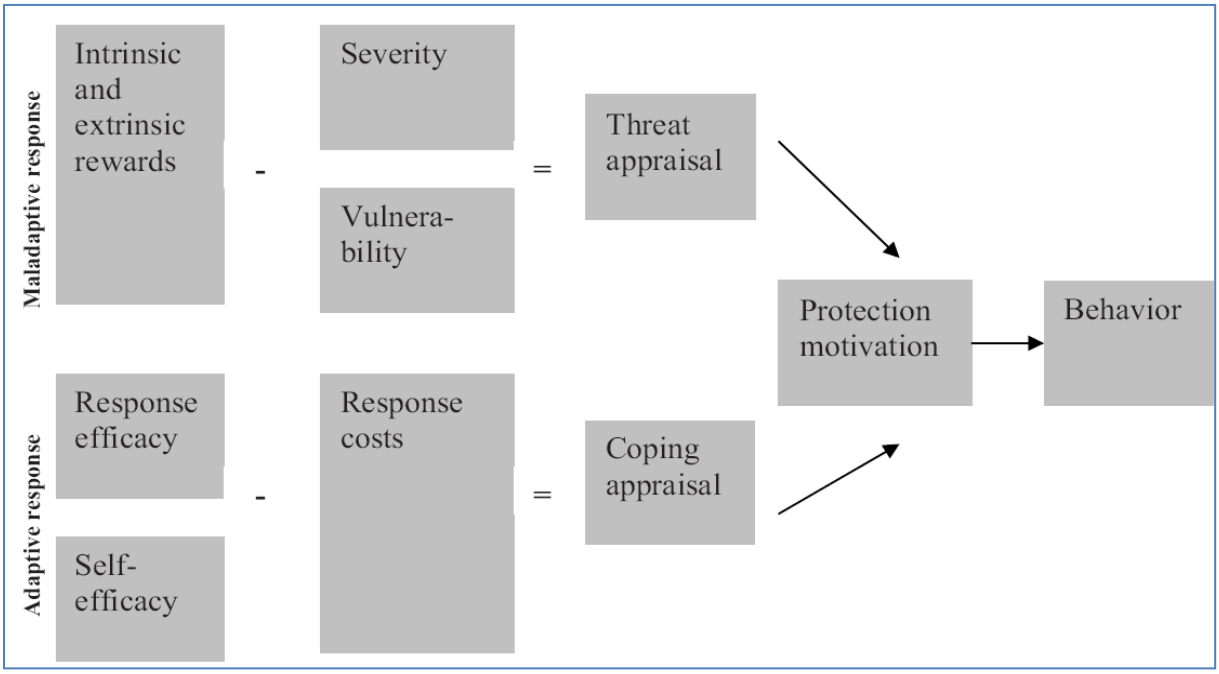

Figure 5. The Protection Motivation Theory (Source Zwart, 2008 (65))

2.5.2 Methodology

The most recent version of the theory assumes that the motivation to protect oneself from danger is a positive linear function of beliefs that: the threat is severe, one is personally vulnerable, one can perform the coping response (self efficacy) and the coping response is effective (response efficacy) (66) .The PMT is mainly used as a general theoretical framework for example for influencing and predicting various health related behaviours. Besides the PMT shares large similarities with the HBM in terms of the application of research, it ranges from questionnaires to clinical interviews but surveys and experiments are favoured. In most research rating scales are used to measure threat appraisal and coping appraisal in which participants need to rate for example their perceived severity, vulnerability and comparative vulnerability.

2.5.3 Criticism on the Protection Motivation Theory

Many of the criticism on the HBM also relates to the PMT. As the HBM this model assumes process comparable to a cost benefit consideration. An important limitation is that not all variables in this model have been identified (67). Furthermore, according to Zwart (65) the PMT specifically lacks factors focussing on social aspects influencing risk perception.

2.5.4 Implications for zoonoses

The PMT in fact has already been used as a framework measuring risk perception in emerging infectious diseases like SARS and avian influenza (65). Perceived severity, vulnerability and susceptibility are important aspects that give some insight in the fear of participants. However the scope of perceived risk perception in this model is so focussed on the participants weighing for protection motivation there is limited room for influencing factors like received information or emotional aspects such as fear and trust. The PMT uses a more rational approach, considering individuals make an assessment of the risks. For emerging zoonoses the multi sectoral area might be of potential influence of the risk perception. This aspect is not addressed as such in this model. In the earlier mentioned research in emerging infectious diseases like SARS one of the aspects that has been added were aspects of affectivity.

2.6. Application for zoonosis

In searching aspects that can predict a very high or very low public risk perception four models were reviewed in order to see which aspect might be useful for predicting risk perception of emerging zoonoses for surveillance and therewith policy prioritization. The table in appendix one gives an overview of those aspects describing first, the various methods, critics of the method, and finally the three specific aspects most relevant for zoonoses; lack of knowledge, multi sectoral and fear.

The *background* of the different models model shows the complexity of the dynamic process labelled risk perception. As a result the biggest difference between the models lays in the way each model tries to simplify this process of risk perception. The psychometric model focuses on comparing risk estimates on group data, while the two behavioural models, the Health Believe Model and the Protection Motivation Theory focus on aspects influencing the individual or group risk behaviour while the SARF focuses on the whole process including signallers like the media.

In terms of *method*, the SARF provides merely a framework with somewhat broad factors that lead to some extent towards an individual risk perception. The HBM, PMT are both models in which risk perception can be seen as a descriptive factor of why people behave in a certain way. The PP on the other hand, provides a more structured way of scaling the perception of risk and by this scaling gives insight which aspects are most relevant for risk perception based on more or less commonly used scales. In that aspect, the PP is different from the other three theories, choosing per definition a quantitative method, while the HBM, PMT and SARF have been used both for quantitative and qualitative research. Also in terms of variables, the HBM and PMT have no predefined ready to use set of variables for emerging zoonoses. A choice can be made of variables that seem fit to the specific research as long as they are used to describe to different aspects of these models. For example how to measure self efficacy is not pre defined. For a large part previous research methods can be used. The PMT has for example already been used for SARS, a disease that resembles a zoonosis to a great extent. The SARF does not have a predefined aspect either. This framework however assumes underlying relations that can be used to describe risk perception. In order to use the framework a new set of variables must be designed.

Some limitations have been indicated in all four models. Concerning the psychometric paradigm the issue of aggregated data has been mentioned several times. Research has shown that individual preferences and characteristics influence the risk perception. Furthermore in most psychometric research the risks participants are asked to rate risks that are rather broad and known to the

participant, like alcohol. Asking participants for a specific hazard like the zoonotic *Pumaala* virus potentially influences the results, since people are most likely not familiar with this virus and have no information besides the name to base their rating on. In order to simultaneously rate specific hazards and broader hazards, adaptations need to be made.

In chapter one, three aspects that are of particular importance for zoonoses have been defined. In terms of the aspect lack of knowledge all models implement this by different variables. In the psychometric paradigm the *lack of knowledge* could be measured by; newness of the risk and level of knowledge in science about the risk. These variables are commonly used in scaling risks, the factor of how known a hazard is, has even been found as one of the main aspects of explaining the variance of risk perception within research using the psychometric paradigm. Within the HBM and the PMT the actual knowledge of an individual about the hazard or risk is not a specific component, it is however usually measured. For example in the PMT by the denominator threat appraisal and in the HBM by the denominator threat.

One of the shared characteristic of emerging zoonoses is de *the multi sectoral area, complex interests and provision of information* due to the different sectors, such as the human and veterinary health sector that are involved. The impact of this specific characteristic of the risk of zoonoses is not easy to measure since this is not an easily defined variable. However in the SARF this aspect is one of the main components. As mentioned before, in the SARF there are no predefined variables. So there is not an existing method how to measure this impact. In the psychometric paradigm one could use many variables, however none of which have been found describing most of the variance. Finally in both the behavioural models the PMT and HBM, this aspect does not partake in the general model. Only the HBM aspect “cues to action” would enable this aspect directly into the model.

The aspect *fear* is especially measured by the psychometric paradigm under the denominator level of dread. This aspect has actually been found to describe most of the variance and therefore seems repeatedly to be of great importance for the risk perception of hazards. In addition the level of perceived control and the level of perceived involuntariness could also give insight in the level of fear. In both behavioural models fear is an aspect that is taken into account by means of other variables. For example in the PMT it could be measured by the variables vulnerability and severity, indicating the level of worry or fear, also called perceived threat in the model. In this way it can be seen as an outcome of perceived vulnerability and perceived severity. In the HBM the measurement of the level of fear is less clear, it could be measured by the perceptions of both expectations and threats. In the SARF fear is easily implemented in the first process, especially in relation to the so called step, risk related behaviour, individual interpretation and response.

Chapter 3. Risk perception of Q fever

In the first two chapters two aspects of emerging zoonoses and risk perception have been discussed. Firstly what characterises emerging zoonoses as a group and secondly looking into ways of measuring risk perception for this group of diseases. In chapter two, four theories have been mentioned as ways to measure and potentially predict risk perception factors of emerging zoonoses. In this chapter this assumption will be tested by an empirical application of one of the theories in order to answer the final research question; *What are predicting factors of consumer risk perception concerning their intentions of behaviour in the case of the zoonosis Q-fever, using the protection motivation theory as an empirical application?* The choice of using the Protection Motivation Theory is twofold. Firstly, in order to identify key factors of consumer risk perception the SARF framework, as described in paragraph 2.6, is to broad for direct application. Studies in line with the PP would fit very well to find risk perception factors. However this research also tries to gain insight in behavioural intentions for practical application. For those insights, using the PP is not an obvious instrument, since it is not developed to search for reasoning beyond key factors. Both behavioural models seem to fit more direct to this research question. Since the PMT already been used as a framework measuring risk perception in emerging infectious diseases this model has been the first choice. The second reason to use the PMT is the opportunity to use and existing questionnaire and dataset with the Protection Motivation Theory as theoretical framework. This questionnaire has been developed to gain insight in the risk perception and information need of the zoonoses Q-fever. By using this survey an opportunity arises to apply the PMT to identify predicting factors of consumer risk perception their intention of behaviour in the case of Q-fever by means of a predictive model.

3.1 Background

The emerging zoonosis Q-fever is a zoonotic infection caused by the bacteria *Coxiella burnetti*. During the second half of 2007, a human outbreak of Q-fever took place in the Netherlands. After the mentioned outbreak, in 2008 and 2009 the number of human cases steadily increased (68). Q-fever is now considered an important public health issue in the Netherlands. Transmission between animals and humans occurs for the most part by inhalation of infectious dust or droplets (69). Due to this transmission route, human prevention measures cannot be specified. Manifestations of Q-fever in humans differ to a large extent; infection can lead to both acute and chronic disease (69). In 2009; 60% of the 2,368 reported cases were asymptomatic (68). Serious complications, such as pneumonia, hepatitis and pericarditis or prolonged illness, including persistent fatigue can occur. Mortality due to Q-fever is uncommon (69).

In the Netherlands, abortion waves on dairy goat and sheep farms have been linked to most of the human Q fever cases. This has lead to increased policy attention leading to drastic veterinary control measures such as the culling of pregnant goats and sheep starting in the end of 2009. The concentration of dairy goat and sheep farms differs between areas in the Netherlands. In 2007, Q-fever cases were concentrated in one region of the province of Brabant. In this region most of these dairy goat and sheep farms are concentrated. Over time other regions throughout the Netherlands followed with an increase of Q-fever cases.

As discussed in chapter one, one of the first priorities when dealing with a new or emerging public health issue is the identification of the modes of transmission. This information is then used for the identification of control strategies in both the human as the animal population. In terms of human control strategies, no specific measures were issued. As mentioned, the Dutch government did issue a number of veterinary measures to control the Q-fever outbreak in 2009. The effectiveness of the different undertaken veterinary measures is difficult to predict. However, the expectation is they will have an impact for the Dutch population in 2010 and 2011 (68). In risk policy not only chance and magnitude of a risk are taken into account, other societal aspects such as familiarity and the distribution of the risk in the population also play a role (70). In that aspect the different regions may be of importance. Analysis of the public perception of a health risk is therefore an important aspect in both surveillance for policy decision making and the planning of (preventive) measures. This is the one of the background ideas of a questionnaire concerning the risk perception in terms of preventive measures for Q-fever. Being able to measure predicting factors of consumer risk perception can lead to more effective outbreak control. Furthermore, individuals willingness to adhere to potential preventive measures for a zoonotic disease such as Q fever gives insight in the risk perception of emerging zoonoses in general.

3.2 Method

In order to gain insight in the application of the Protection Motivation Theory for the zoonosis Q-fever an existing dataset regarding consumer risk perception of Q-fever has been used. A predictive model based on the PMT has been estimated in order to predict factors of consumer perception concerning their behavioural intention. The different concepts of this predictive model will be measured by means of the questions from the existing survey fitting to each specific concept.

3.2.1 Data collection and sample

The data used for this research originates from an online questionnaire study developed by a consortium consisting of GGD-Rotterdam, RIVM-LCI and University Maastricht. The questionnaire has been developed with the Protection Motivation Theory as a conceptual framework, supplemented with other relevant concepts. These other concepts that are not explicitly integrated in the PMT, were considered important to include by an expert meeting of the mentioned developing consortium. The questions are based on an existing questionnaire used in studies on risk perception and precautionary behaviours of the general public during outbreaks of SARS (71) and avian Influenza (72).

The questionnaire has been administered during the Q-fever crisis from 14 till 21 August 2009 to a representative internet panel (www.flycatcher.eu). This panel exist of 20.000 members of whom the distribution of demographic variables (gender, age and level of education) is comparable to the level of the general Dutch population. Flycatcher is ISO certified and the panel meets high quality requirements. One important aspect of the moment of administering the questionnaire is that at the time of administering, relatively limited national media attention was given to Q fever. Only in the end of 2009 and the beginning of 2010 national media attention increased and national mainly veterinary measures were issued. Exposure to information regarding Q-fever might therefore be different between the Dutch provinces, more specifically, between different epidemiological areas. Therefore quotas were set of approximately 500 respondents per previously indicated region of epidemiological transition. The first group existed from respondents of the provinces Groningen and Friesland (32,6%) where no cases of Q fever were reported at that time. The second group from the provinces Utrecht and Limburg (34,3%) had recently reported cases and the third group from the province Noord-Brabant 33.1% already had ongoing reports of Q fever patients.

From the 2,511 approached panel members 1,670 responded. After reviewing the questionnaires 61 were excluded due to incompleteness, leading to a response rate of 64% (1,670-61/2,511). Panel members received 1.50 Euro for completion of the survey, which could be

exchanged for gift vouchers. By gender, level of education and age quotas were set for the sample to be comparable for the Dutch population. Of the respondents 54% was female. They differed in age (mean 44,4 range 14-88) and education level (low 27%; medium; 40%; high 33%). From the respondents 64% reported to be employed at the time of the survey. From the total group 8 (0.5%) reported to have experienced Q fever in their direct family (self, partner, children) and 19 (1.1%) of the respondents indicated to work in a sector related to goats and sheep.

3.3 Analysis

The first analysis serves as an indicator for the general level of risk in terms of vulnerability and severity. In order to give some idea of the level of threat appraisal a comparison between perceived vulnerability and perceived severity of Q fever and other diseases will be given.

The second analyses focuses on the principle idea of adding the concept region of habitation to the predictive model. The idea of adding this item is originates from the supposed relation with familiarity of Q fever. This idea will be assessed by comparing consumers familiarity with Q-fever (yes or no) with the different regions of habitations stated in paragraph 3.2.

Thirdly, the main analysis of an estimated model to identify factors influencing the consumers behavioural intention measures presented to prevent Q-fever. To assess the extent to which the intention to follow proposed measures for Q fever is due to the threat appraisal components severity and vulnerability, the coping appraisal components self efficacy and response efficacy, feelings of fear and demographic factors (i.e., region of habitant, age, gender and education level) a linear regression analyses was conducted with the intention to behaviour as dependent variable. In order to test this predictive model, multicollineairity was tested for the entire model (figure six) using the variance inflation factor (VIF). No reason to assume multicollinearity was found (VIF values close to 1, significance below 0.1).

The final analysis is an addition to the estimated model. This will include one aspect. The relation between the dependent fear and the consumers perceived vulnerability and severity will be analysed.

3.3.1 Analysis of the estimated predictive model

In association with the PMT the following predictive model of factors influencing the intention of behaviour was estimated and depicted in figure six. The top and bottom arrows depict the threat appraisal with the concepts severity and vulnerability and the coping appraisal with the concepts, self efficacy and response efficacy of the PMT as described in chapter two. The concepts chosen to be added to the PMT framework are depicted in the middle of the figure. These concepts are fear, as well as the demographic variables gender, age, education and the region of habitant of the respondents. One of the reasons to add the concept fear is that according to research in line with the psychometric paradigm fear is one of the main predictors for risk perception (chapter two). In paragraph 2.6 it was specifically mentioned that fear is sometimes also indicated as a outcome from the threat appraisal aspects perceived severity and vulnerability. Besides, in infectious diseases fear is general presumed an important predictor.

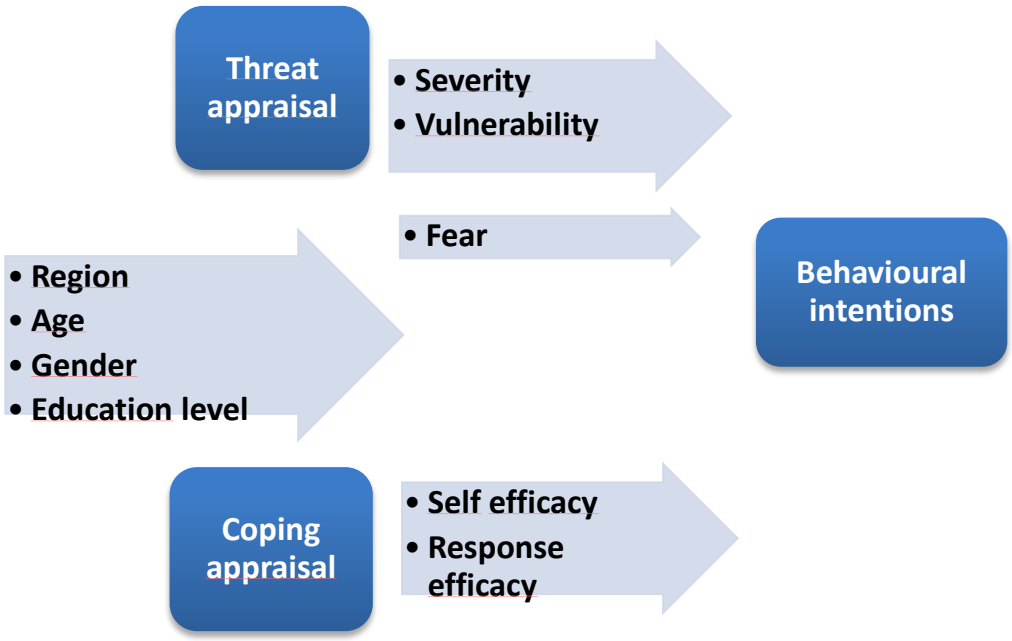

Figure 6. The Predictive model based on the Protection Motivation Theory

All the concept in the model have been measured on a five point scale. Some concepts are constructed by multiple items. The dependent variable behavioural intention is composed by two main questions for seven proposed measures*; if governmental institutes advice this, would you follow the following measures* and *if governmental institutes advice this, to which extent do you expect to actually carry out the following measures?* The participants rated their intention to carry

out the proposed preventive measures relatively high (M 3.93, SD .77). Using factor analysis and testing for inter correlation the seven measures were considered one measure (correlation between the items was relative high 0.31 – 0.88 with α 0.93). The proposed measures were:

practice better personal hygiene (e.g. wash hands more often),
avoid areas infected by Q-fever,
avoid contact with goats and sheep,
do not use raw dairy product (like cheese),
wear face masks,
seek medical advice with the onset of flu like symptoms,
take antibiotics.

.

The four main constructs of the PMT; perceived severity, perceived vulnerability, response efficacy and self efficacy were constructed by the following items. Perceived severity was measured by two questions; Q-*fever is a severe illness, Q-fever is very harmful to my health.* Perceived severity, the mean of this item is relatively high (M 3.48, SD .79) indicating that the participants find Q-fever on average relatively severe. Perceived vulnerability was measured by the question; *How likely is it that you will be diagnosed with Q fever in the next twelve months*. Self efficacy was measured by one question for the seven proposed measures; *if governmental institutes advice this, would you be able to follow the following measures*. Response efficacy was measured by one question for the seven measures; *do you think the following measures help to prevent you from being infected with Q-fever*. The added concept fear was measured by three questions; *Are you worried about Q-fever, how afraid are you of Q-fever, how often do you think of Q-fever*. The participant indicated to fear Q-fever relatively low (M 2.0 SD .66). The demographic concepts, age, level of education (low, medium, high), gender and region (North-Brabant, Limburg and Utrecht, Groningen and Friesland) were also measured. For all the multi item constructs the correlation was calculated using a cut of point above 0.7 to assess sufficient correlation. In table one an overview is given of each of the concepts. The questions used for this study can also be found in appendix two.

Table 1. Mean and Standard deviation combined constructs

	Mean	Std. Deviation	α
DEPENDENT BEHAVIOURAL INTENTION • ***willingness to follow measures*** • ***expectation to carry out measures***	3.93	.77	.93
PREDICTOR SEVERITY • **Q-*fever is a severe illness*** • ***Q-fever is very harmful to my health***	3,48	,79	.79
PREDICTOR VULNERABILITY • ***likeliness diagnoses next 12 months***	2,63	,77	-
PREDICTOR SELFEFFICACY • ***ability to follow measures***	3,93	,72	.84
PREDICTOR RESPONSE EFFICACY • ***expected affectivity measures***	3,44	,62	.71
PREDICTOR FEAR • ***sense of worry*** • ***level of fright*** • ***amount of consideration***	2.00	,66	.84

3.4 Results

3.4.1 Threat appraisal in broader light

One way of conceptualizing risk perception in line with the PMT is to consider it a product of perceived risk and perceived severity. In this research this approach has not been considered for the empirical application, however to give insight in these two aspects in relation with other medical conditions the following can be noted. Using Pillais trace, there was a significant mean difference of severity between the diseases V= .87 (F (5,1604) = 2215,1, *p>,*0.05) The respondents perceived Q-fever (M 3.67, CI 3.6-3.7) somewhat more severe than the Mexican flu (M 3.45, CI 3.4-3.5.) The medical conditions HIV / AIDs, a heart attack and diabetes where on average perceived more severe. Furthermore a significant mean difference of vulnerability was found using Pillais trace V=.75 (F 5, 1604) = 974,8, *p>,*0.05). The respondents indicated to perceive their vulnerability of acquiring Q-fever higher than their vulnerability of acquiring HIV / AIDs, a heart attack or diabetes. They however believed to be more vulnerable to the Mexican flu and ordinary flu. In other words, the respondents believed on average to be less vulnerable to Q-fever then to Influenza however considered Q-fever on average more severe (figure seven). The majority of the population (77.7%) indicated not to have taken any measures for the prevention of Q fever that far.

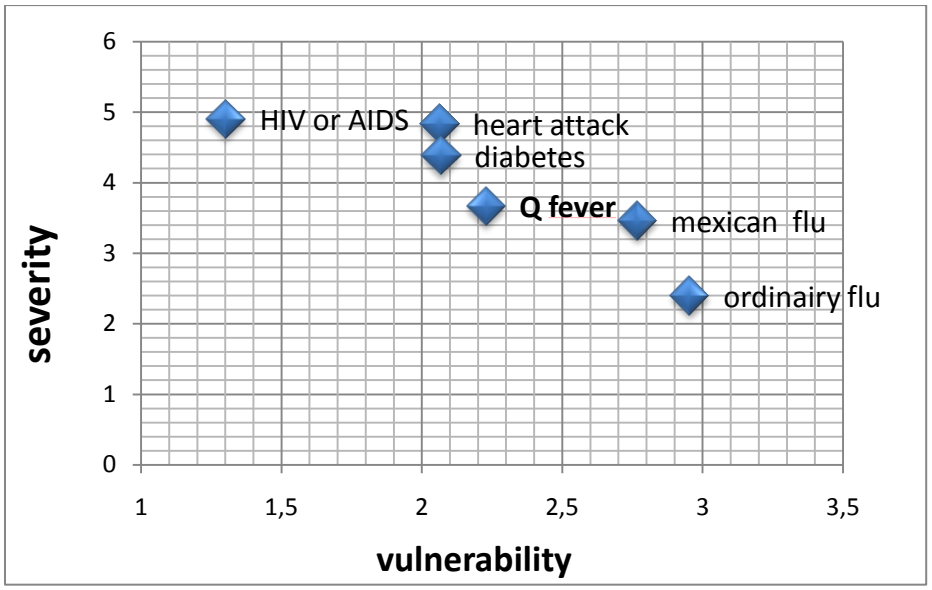

Figure 7. Comparison perceived vulnerability and severity of Q fever

3.4.2 Q-fever related to region of habitation?

In paragraph 3.2.1 the assumption that living region of the participant is related to hearing about Q fever has been pointed out. The original reason of the questionnaire developers to include the aspect region was a potential difference of exposure to information of Q fever between the regions the region of habitants. In the beginning of the questionnaire the general question; *Have you heard of Q fever*? was asked 15.3% of the total research group responded not to have heard of Q fever. As shown in table two, region three; Groningen and Friesland (the region with the least Q-fever cases), the least people (79%) indicate to have heard of Q-fever. In region one; Noord-Brabant (most Q-fever cases) most (90.6%) people indicate to have heard of Q fever.

Table 2. Frequencies of living region and Q fever familiarity

Have you heard of Q fever	*n*	No	Yes	Mean	SD
Total researchgroep	*1609*	*15,3%*	*84,7%*		
Region 1: Noord-Brabant	532	9,4%	90,6%	1,91	,29
Region 2: Utrecht & Zuid-Limburg	552	15,6%	84,4%	1,84	,36
Region 3: Groningen & Friesland	525	21,0%	79,0%	1,79	,41

β ***α***

A one way between subjects ANOVA was conducted to compare the region of habitation to indicated familiarity with Q-fever. There was a significant effect of the region of habitation and having heard about Q fever, (F (2, 1606) = 13,86, $p<0.001$). Post hoc comparison using the Games Howell test ($p<0.05$) indicated that the mean score for region one was significantly different than region one ($p <0.01$) and region two ($p <0.01$) difference α. However, region two (Utrecht and Zuid-Limburg) did not significantly differ from region one (Groningen and Friesland) ($p = 0.06$ difference β). These results suggest that living in the region with the most and longest ongoing Q-fever cases, Noord-Brabant has an effect on indicated familiarity with Q-fever compared to living in other regions where no (region three) or very recent (region two) Q-fever cases where reported. However living in Utrecht and Zuid-Limburg or Groningen and Friesland where Q-fever cases where not or recently reported did not differ regarding extent of familiarity with Q-fever ($p=0.06$). From this analysis the item region is considered to be indicated as a potential predicting factor for preventive behavioural intentions and therefore will be added to the general demographical factors, age, level of education and gender.

3.4.2 The estimated predictive model

Linear regression analysis has been conducted on the suggested predictive model in paragraph 3.2. Region of habitation, level of education did not have a significant effect on the behavioural intentions. In the final model the predictors, self efficacy, severity, fear, response efficacy, age and gender where found to explain 65% of the variation (R^2 .65 adjusted R^2 .0,648 p <0.005). As can be seen in table three a higher self efficacy has by far the largest effect (β = 0.67 p <.001) and is therefore the largest predictor of the intention to undertake behavioural measures. A higher response efficacy has an effect of (β =.18) on the behavioural intentions of the participants. Furthermore an increase in the consumers perceive of fear or severity the more they intent to apply the proposed preventive measures(subsequently an effect of β .099 and β.049). The older the participant are the higher their behavioural intention. The smallest effect is related to the gender of the participants. In comparison to male, females have a small positive effect on the intention to take measures (β = .047 p <.005).

Table 3. Final predictive model report

Dependent Variable: Behavioural Intention				
	B	SE B	*β*	*P*
(Constant)	-,050	,085		
***SEVERITY**	,049	,015	,051	>0.001
***FEAR**	,099	,019	,085	>0.001
***SELFEFFICACY**	,707	,018	,670	>0.001
***RESPONSE EFFICACY**	,181	,021	,147	>0.001
***AGE**	,004	,001	,075	>0.001
** **SEX (male = 0)**	,071	,024	,047	>0.005
VULNERABILITY				0.32
REGION				0.82
LEVEL OF EDUCATION				0.63
R^2 = 0.65 (* p < 0.001, **(p < 0.005)				

The analysis has led to the following final model visualised in figure eight. From the suggested predictive model depicted in figure six the following concepts perceived vulnerability,

living region and level of education, did not have a significant relations with the intention of behavior.

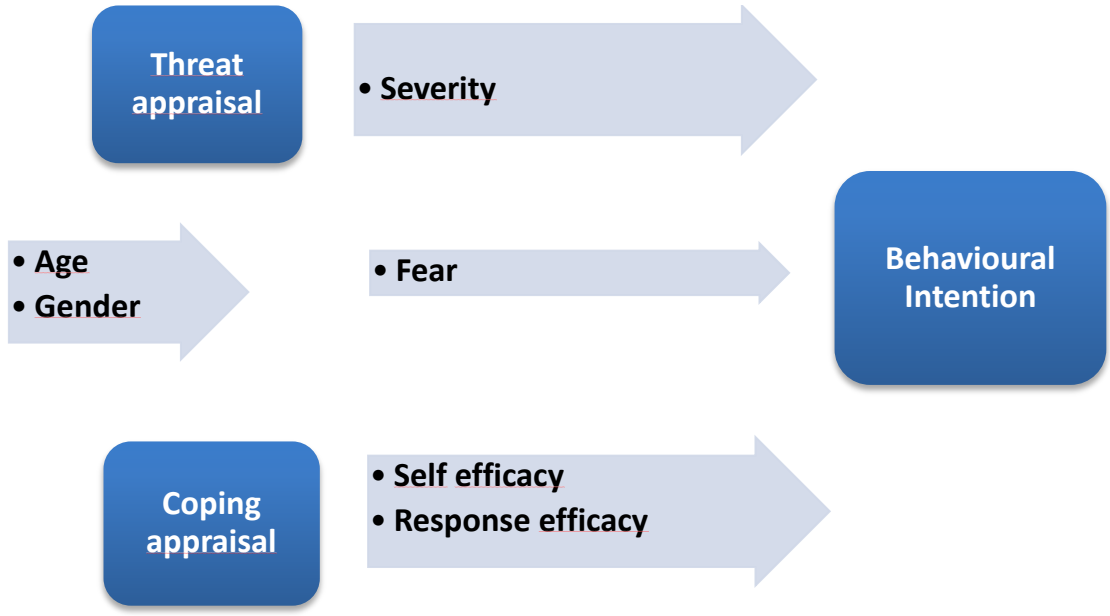

Figure 8. Predictive model based on the Protection Motivation Theory

3.4.3 Additional analysis

Additional regression analyses have been conducted in order to research the underlying relations between the concepts of the model. Since the concept fear is added to an existing theory and in the psychometric paradigm actually regarded as an outcome, additional analysis has been conducted to investigate the relation between fear and the concepts of threat appraisal perceived severity and vulnerability.

Table 4. Relation fear, severity and vulnerability

Dependent Variable Fear			
	B	SE B	β
(Constant)	,610	,081	
SEVERITY	,196	,019	,235
VULNERABILITY	,268	,020	,313
$R^2 = 0.17$ $(p < 0.001)$			

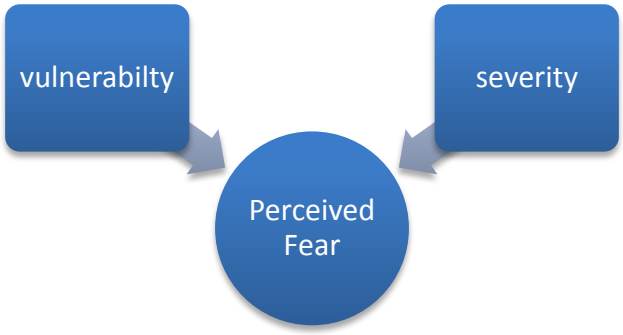

Figure 9. Relation fear, vulnerability and severity

It was found the concepts perceived severity and vulnerability account for 17% of the variance of the concept fear. Vulnerability has the largest effect (β .313 table four). Therefore, even though perceived vulnerability did not have a significant relation with the outcome variable intention to behaviour. Through the concept of perceived fear, perceived vulnerability might have influence on the intention to follow preventive measures. Perceived severity might have double influence, both direct as through perceived fear. However, it remains unclear if there is full mediation of both models at the same time.

3.5 Implications

The final estimated predictive model can be considered to have a relatively high R since 64% (adjusted) of the variance can be accounted by the final predicting factors; self efficacy, severity, fear, response efficacy, age and gender. In view of the fact that no multicollinearity has been found, indicating the overall variance is actually 64%. The aspects perceived vulnerability, living region and level of education, did not have a significant relation with the intention of behaviour. However, additional analysis resulted in a significant relation between the concepts fear, severity and vulnerability. Vulnerability and severity are significantly related to the level of fear people indicate to feel for the zoonoses Q-fever. A relatively low R, 17% (adjusted) of the variance of the concept fear can be however only be accounted by severity and vulnerability. It does not mean that perceived vulnerability has an indirect effect at the intention of behaviour through the concept fear. Nor can be concluded that perceived severity a dual effect has on the intention of behavior, direct (β 0.051) as well as indirect (β 0.235) through the concept fear (β 0. 058) since full mediation has not been tested Both relations can only be seen in separate models. The results do however add to the argument that fear could be considered an outcome of risk perception.

The aspect region was not found to be significantly related to the intention to engage in proposed behavioral measures. Even though the familiarity of Q-fever differed significantly per region of habitation this demographical variables had no effect on any of the concepts as can be seen in table five. Neither the level of education. Age and gender where related to different concepts throughout the model (self efficacy and fear). The effect of gender on the dependent is however very small (β 0.047) indicating the difference of intention between male and female very limited. Small differences in gender concerning the intention to engage in behaviour is commonly found in risk perception research. Slight differences in the perceived self efficacy and fear (both slightly higher effect for female over male) are also commonly found over different kind of diseases.

Furthermore in the final model, the predictor self efficacy accounts for the largest effect on the dependent intention to behaviour. This means that people who answered one point higher to one of the measures indicated with the question; *if governmental institutes advice this, would you be able to follow the following measures* have a higher intention to actually undertake the measures. The same in the case for fear, response efficacy and perceived severity, however the effect of each of these factors on the dependent is relatively smaller. Finally being female has a slightly positive effect on the intention to engage in behaviour in comparison with male.

Chapter 4 Conclusion and discussion

In chapter two insight is given to different ways to measure risk perception in chapter two. In chapter three these insights are followed by an empirical application of predicting factors influencing the intention of behaviour, closely related to risk perception in chapter three. In this chapter the results from these two parts will be placed in perspective. Specific attention is given to the future directions.

4.1 Theoretical considerations, strengths and weaknesses

Even though risk perception seems to be a very thought out concept, there are many differentiating factors not only in definition of the concept, also in research methods. The four models of focus for this study have been used to measure risk perception (not the outcome in all models however) and each have pros and cons that enhance or limits their usability for surveillance of emerging zoonoses to some extent.

The psychometric paradigm seems to include most of the specific aspects required for measuring risk perception of emerging zoonoses. Compared to the other three methods this model however seems to be a simplification of the process. Especially since the aspect of multi sectoral interests and information is limitedly measured. Therefore it is more difficult to see if this aspect is influencing the risk perception, while for policy reasons this is very relevant information. The SARF on the other hand might be too complex to be able to give insights beforehand. First of all, due to the assumed dynamic process besides, the second part of this framework, the spread of the impact, is extremely difficult to measure, hardly any research has been done, only after a certain outbreak of the risk, like BSE.

In addition the psychometric paradigm uses aggregated data, while other research indicates that individual socio demographical characteristic might influence the risk perception. In this model it would be difficult to see if the risk perception differs between certain groups, while this is of relevance for risk surveillance. Furthermore the psychometric paradigm usually uses fairly broad definitions of hazards. In terms of specific zoonoses this could be problematic.

The psychometric paradigm is less detailed and needs limited adaptation of variables. It gives insight in the comparability of the hazards and gives limited insight in other influencing factors besides the level of knowledge and the severity of the hazard. It can potentially also be used to compare perception of different zoonoses although the fact that most emerging zoonoses are

unknown to the public may result in a lack of resolution. This could potentially be over come by clustering emerging zoonoses in groups with more or less similar characteristics.

The PMT and HBM seem to be rather similar. The key aspects of both models exemplify a rational process of an individual, while the HBM includes the aspect clues to action. The usability of these models is rather high, since both can be adapted by choosing variables to measure the different aspects influencing risk perception. This aspect of adapting by fitting the variables to the specific situation is however at the same time one of the main critics for both models. Since the variables differ between researchers and research areas the validity of each variable or combination of variables could be an issue.

In conclusion, none of the models seems to be fit directly to be used in public risk perception surveillance of emerging zoonoses. In all cases variables need to be adapted or developed. The SARF seems to include most aspects that might be of relevance for risk perception of emerging zoonoses. The usability of this model is however limited, it might be too complicated to functionalise. The SARF can be used a background framework of all aspects influencing risk perception. A potential application could be the development of systematic real rime, review of information flows in of news media and social networks resulting in a early warning system for all 86 zoonoses individually.

Both the PMT and the HBM give a framework and potential variables, they focus however to a large extent on the actual behaviour and usually measure risk perception after a certain risk is already known. Little is known about the application for estimation beforehand. This is also the case for the SARF, since what influences ripple effects is considered so dynamic, very limited research has tried to predict this aspect.

4.2 Application of the PMT

By taking the opportunity of using the PMT as a framework for predicting risk perception, the intention to engage in preventive behaviour can be used as an dependent. This can give insight in those factors of risk perception predicting the intention to engage in proposed preventive measures.

When applying the PMT to the zoonosis Q-fever the most commonly found predictor self efficacy has been found to predict the intention to behaviour. Self efficacy, one of the coping variables is according to a large scale meta analysis for different studies using multiple PMT components of PMT indicators one of the common predictors (73) Milne et al. even found self

efficacy to be most significantly associated with intention in the predictive direction (74) This results has also been found by Maddox et al(63) who specifically researched the variable self efficacy. So far the results are in line with other research using the PMT.

Vulnerability was not significant related to the intention to protective measures. Additional analysis learned vulnerability is however significantly related to the aspect fear. This could be explained by the limited knowledge the respondents indicated to have regarding Q-fever, 15.3% indicated never to have heard about Q-fever at the start of the questionnaire. Besides when assessing their vulnerability in relation to other medical conditions Q-fever was indicated at approximately the same level of 2009 pandemic (H1N1) Influenza A. In an unpublished research by Bults et al (2010) concerning a time research of 2009 pandemic (H1N1) Influenza during the pandemic, perceived vulnerability was found to increase over time. Bults et al. conclude this might be an effect of the increasing number of infected cases, future research will show if this is also the case for Q-fever.

In addition, the demographic factors, region and level of education where not significantly related to the intention to undertake measures. Some remarks have to made regarding this.

4.3 Study strengths and limitations

Some strengths and limitations to the literature search and the analysis have to be addressed. Starting with the literature search. One strength of this study is the combination of risk perception and zoonoses. To the authors knowledge this combination has not been studied before while it has been indicated there is a lack of knowledge in the area of emerging infectious / zoonotic diseases area and zoonoses (12, 65) also recommended by the recently published Emzoo report (75). A limitation concerns however the search strategy. Due to the broad research question and limited time a systematic research was considered to time extensive. This lead to the choice of a les repeatable and time consuming literature search. Furthermore, by narrowing the search directly down towards risk perception measurements already associated to infectious diseases. And choosing a more subjective strategy potential interesting areas such environmental risk assessment have therefore not been taken into account. This can be seen as a limitation of this study. Besides, the search strategy focuses on zoonoses, however since risk perception and zoonoses is not a well researched area, research concerning emerging infectious diseases is also included. This might have influenced the research.

Concerning the usage of the questionnaire one of the strengths is the timeframe. In contrast to many other studies this questionnaire has been administered during the outbreak and before the actual conducted measures, giving the opportunity for surveillance and time trend research. For example during the 2009 Influenza A (H1N1) pandemic many studies were conducted in an earlier (76) or later state. This research focuses on predictive analysis, time trend research is currently being conducted. Furthermore due to using an internet panel less social desirability bias than personal interviews is created, besides a high response rates (64%) was achieved.

Some limitation have to be indicated as well. Due to time constraints the questionnaire was not pre tested. This is one of the first attempts to specifically look at risk perception van zoonoses with surveillance, using an already designed questionnaire. Therefore the chosen dependent might not be the optimal dependent to give an indication concerning the risk perception. Besides, not all aspects that might be of interest, such as response cost where asked in the questionnaire.

The internet panel that responded to the questionnaire might not be fully representative for the Dutch population. Not only due to the medium (internet panel research) but mainly due to the quotas of specific regions. Since region was not found to have a significant relation with the intention to undertake measures this quota setting might have led to bias.

4.4 Future directions

Strongly depending on the objective of measuring risk perception and assumptions beforehand, this research suggest to not just look into known ways of risk perception measurement. The PMT has been successfully used by other researchers in the field, mainly during and after an outbreak. The application of Q-fever has been another example of such an application. The results of the predictive model match other research to a large extent. However, since this application revolves around fictive measures the strength for surveillance of zoonoses is limited. Most of the suggested measures in the questionnaire are not indicated for the prevention of Q-fever , leading to a very shallow information.

This research therefore proposes two potential applications specifically of surveillance of risk perception for emerging zoonoses. Some limitations have been indicated in all four models. None of the models seems of direct use in surveillance of risk perception concerning emerging zoonoses. In all models variables need to be adapted or developed, hence there is a necessity to tailor make the application. The two options are; The psychometric paradigm can provide insights in the public risk perception of zoonoses in comparison with other hazards. It can potentially also be used to compare

perception of different zoonoses although the fact that most emerging zoonoses are unknown to the public may result in a lack of resolution. This could potentially be over come by clustering emerging zoonoses in groups with more or less similar characteristics. The SARF can be used as a background framework of all aspects influencing risk perception. A potential application could be the development of systematic real rime, review of information flows in of news media and social networks resulting in a early warning system for all 86 zoonoses individually.

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Appendix

Appendix 1 Overview of tools to measure risk perception for emerging zoonoses

	Method	Critics	Lack of knowledge	Multi – sectoral	Fear
Psychometric paradigm	Psychometric scaling based on a number of explanatory scales Mapping several hazards Mainly using mean data	No segregation for individual perception Zoonotic hazards might be to specific	Could be measured by: • Newness of the risk • Level of knowledge in science about the risk		Could be measured by • Level of control • Level of dread • Level of involuntariness
Social Amplification of risk framework	General framework for researching relations No specified variables	Framework for processes Limited empirical examinations No clear variables To complex to examine ripple effects	Could fit to • Information flow • Interpretation and response	Considered very important aspect in; • Information flow • Interpretation and response • spread of impact (rippling)	Not specifically mentioned, possibly fits under • interpretation and response of an individual

Health belief model	General framework Mainly using surveys and interviews Variables differ between researchers Rating scale survey measuring aspects of risk perception	Should use whole model not just components No clear variables Limited attention how risk perception is formed	Could fit to • Perceived susceptibility • Perceived severity	Could fit to • Cues to action • Perceived susceptibility	Could be measured in the overall category of perceptions by both • Expectations • Threat
Protection Motivation Theory	General framework Mainly using surveys and interviews Rating scale survey measuring aspects of risk perception		Could be measured by The overall category • Maladaptive response • Adaptive response	Not specifically mentioned, could fit in • Response efficacy • Response cost	Could fit in • Vulnerability • Response cost

Appendix 2 Survey Questions Q fever

August, 2009

Dear Sir/Madam,

You might have noticed the media attention for Q fever. To better understand how people in The Netherlands perceive the risk of catching Q fever, how they perceive measures to prevent spreading Q-fever, and which information should be distributed, we have developed a questionnaire.

We would like you to complete this questionnaire. Filling out the questionnaire will take 15 minutes. We request you to answer all questions. The results will be processed anonymously and will be only used for research purposes. This research is being carried out by GGD Rotterdam-Rijnmond in cooperation with the National Institute of Public Health and the Environment.

We thank you for your cooperation!

What is your sex?
Male /Female

What is your age

In which province do you live?

What is the highest education you received?
Low / medium / high

Are you employed at the moment?
No / Yes

Did you ever hear about Q-fever?

Did you or one of your family members ever have Q-fever?
No
Yes: yourself
Yes: your partner
Yes: your child/children

Q-fever is caused by bacteria. Animals can transmit these bacteria to humans. Goats and sheep are the largest source of illness among humans. Most people catch Q-fever by breating air contaminated with the bacterium know to cause Q-fever. However, sometimes they may also get ill from eating or drinking raw milk products.

Indicate how serious you consider Q-fever.

Q-fever is a severe illness
Totally disagree
Disagree
Do not disagree, nor agree

Agree
Totally agree

Q-fever is very harmful to my health
Totally disagree
Disagree
Neither disagree, nor agree
Agree
Totally agree

How awful would it be if you were to be diagnosed by the following diseases in the next twelve months? Common influenza, diabetes, Heart attack, Q-fever, H1N1 flu, HIV or AIDS
Not bad at all
Not bad
Fairly bad
Bad
Very bad

Indicate in the following questions your perceived chances of becoming infected with Q-fever.

Do you think you could get Q-fever if you do not take precautions?
Definitely not
Probably not
Maybe not, perhaps
Perhaps
Definitely yes

How likely is it that you will be diagnosed by the following medical conditions in the next twelve months? Common influenza, diabetes, Heart attack, Q-fever, H1N1 flu, HIV or AIDS
Very unlikely
Unlikely
Not likely not unlikely
Likely
Very likely

The following questions are about feelings of concern about Q-fever

Are you worried about Q-fever?
Not at all worried
Not worried
A bit worried
Worried
Very worried

How afraid are you of Q-fever?
Not at all afraid
Not afraid
A bit afraid
Afraid
Very afraid

How often do you think of Q-fever?

Never
Seldom
Sometimes
Often
Continuously

The following questions concern measures that could be taken to prevent Q-fever. Preventive measures are actions that you could undertake to prevent or fight Q-fever.

(Please answer each measure)
Practice better personal hygiene (e.g. wash hands more often)
Avoid areas infected by Q-fever
Avoid contact with goats and sheep
Do not use raw dairy product (like cheese)
Wear face masks
Seek medical advice with the onset of flu symptoms
Take antibiotics medication

Do you think the following measures help to prevent you from being infected with Q-fever?

How would you feel about taking the following measures to prevent you from being infected by Q-fever?

How would the following measures to prevent you from being infected by Q-fever reassure you?

If governmental institutes advice this, would you be able to follow the following measures?

If governmental institutes advice this, would you follow the following measures?

If governmental institutes advice this, to which extend do you expect to actually carry out the following measures?

Questions or comments?

This is the end of the questionnaire. We would like to thank you for your cooperation!
For most recent information from official sources you can visit the website :www. rivm.nl