University of Alberta

Risk Ranking: Investigating Expert and Public Differences in Evaluating Food Safety Risks

by

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A thesis submitted to the Faculty of Graduate Studies and Research
In partial fulfillment of the requirements for the degree of

Master of Science

in

Food Science and Technology

Agricultural, Food and Nutritional Science

Edmonton, Alberta

Spring 2008

Your file Votre référence
ISBN: 978-0-494-45906-5
Our file Notre référence
ISBN: 978-0-494-45906-5

ABSTRACT

The allocation of resources with respect to food safety issues requires that decision-makers prioritize these issues, which may conflict with the public's opinions on these matters. These differences between the experts' perception of risk and that of the public were examined. A modified Carnegie Mellon risk ranking model was used to rank six food safety issues. The six food safety issues used in the discussions were: Bovine Spongiform Encephalopathy (BSE), *Escherichia coli* O157:H7, *Salmonella*, botulism, Paralytic Shellfish Poisoning (PSP), and acrylamide. Focus groups were conducted using public (*n*=29) and expert (*n*=21) participants, and a public survey was commissioned to further explore the focus group results. Key themes were identified from the focus groups as reasons why risks were rated high or low. Explanations for why choices were made included *availability*, *affect*, *numeracy* and *optimistic bias*. The effect of *attribute framing* seemed to be the most influential in a participant's choices.

DEDICATION

For those who have always believed in me. This work is dedicated to my family.

ACKNOWLEDGEMENTS

There are so many people who have helped me on my way to completing this thesis:

My parents, Barb and Don, even though we are at different ends of the country, have always supported me in whatever I chose to do and it always feels like they are next to me.

My brother, Steve, who has always believed in me and that has never been forgotten.

Dr. Lynn McMullen, for her experience in graduating students under her wing. Without those little nudges this would have been much more difficult.

Dr. Cindy Jardine, for her expertise in this sometimes fuzzy area of research, and knowing what it takes to complete a thesis while juggling many other undertakings.

Dr. Sean B. Cash for providing perspective on this work – and perspective on life.

The Consumer and Market Demand Network at the University of Alberta for providing funding for this research and the opportunity to present the results at the Agricultural Institute of Canada Conference, November 5-6, 2007, Edmonton, Alberta.

Alberta Agriculture and Food, for the opportunity to take a paid education leave, without which I would not have been able to complete this program.

To all the folks at Alberta Agriculture and Food who supported me in this endeavour, especially Sandy Honour, Greg Orriss, Les Lyster (who convinced me over lunch one day to do this), and Alison Look.

Ned Ambrus, for accurately transcribing the focus group discussions that were a major contribution to this work.

Michael Gingras for suggesting, in the middle of my program, that I go jump off a bridge. And then helping me to do it (twice).

Michelle Hoyle, for years of friendship and support in anything that I've chosen. And for the excellent dinners to make up for the graduate student diet.

Chris Thombs, for always being there for me, and providing most needed distractions when I could not focus. And especially for pointing out that this thesis was "like your concrete albatross", on watching me carry my data around with me everywhere, from fear of losing it.

To my fellow graduate students who provided a sounding wall and many laughs over the years, especially: Melissa Haveroen, who saved me many a time from going insane; Merry Turtiak, you provided me with perspective on my program and allowed me venting time. And Jovana Kovačević, for always being there for me.

To the many locations in Old Strathcona and beyond, for allowing me temporary office space throughout my program, most notably the Second Cup at the Varscona.

I would be remiss if I did not acknowledge the sacrifice of the trees that allowed the completion of so many drafts.

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1 Introduction

Risk ranking may conjure up images of an ordered list in which the highest risks are followed by the lowest risks on a simple numerical scale. However, there are many difficulties in simplifying and using such an approach. For example, one of the principles of risk assessment is that a single number cannot be used to satisfactorily characterize a risk, or to set one risk as being higher than another. As one set of authors has stated, "No numerical rating of risks can be strictly objective, because individual ratings are influenced by inherently subjective values" (Thomas & Hrudey, 1997, p. 15). Even with this in mind there have been attempts to use methods to express more than one ranking using a single number for each rank (Deisler, 1997). The question is why are there attempts to determine a ranking method for risks? One answer to this question is that in order to properly allocate resources to mitigate the effects of hazards, governments must place a priority on certain hazards deemed the most important (FSRC, 2003; Taylor & Hoffmann, 2001). There is quite simply not enough money nor people and other resources to deal with all known important hazards and certainly not in a reasonable timeframe.

Risk is and will always be a part of our lives. Analyzing and managing risks can be as simple as a decision not to cross a street without looking both ways, to more complex decisions of which stocks to invest money in. Covello and Mumpower (1985) and Mierzwicki (2003) present a comprehensive history of risk analysis, dating from 3200 B.C. in modern day Iraq. The Asipu peoples of this time examined possible outcomes of a decision to be made and weighed them to determine whether it was favourable or not. Probability theory, originated by Pascal in the 17th century, has given rise to not only the mathematics of probability, but also to a means of quantifying risk. Since Pascal's time, life expectancy tables, actuarial tables, common law and government intervention to manage risks have been developed.

Risk ranking has been used in engineering (Covello & Mumpower, 1985), insurance (Bond & Crocker, 1991), terrorist threats (Leung *et al.*, 2004), and environmental concerns (Hansen *et al.*, 1999). Even though there are many applications of risk ranking in the private sector, governments are responsible for the public good in general, including transportation risks, disease outbreak, building codes and food safety regulations. Risk ranking is therefore an important tool for governments to examine and consider in the development of policy.

The ranking of food safety risks is described as "a useful initial procedure in any risk assessment as it enables prioritization of action" (Baird-Parker, 1995, p. 33), and has led to public discussions that were effective in helping set policy (Long & Fischhoff, 2000). In terms of food safety risks, much of the concentration has been on foodborne pathogens. Many foodborne pathogens appear to be equally important in terms of human health impact but many of the resources are allocated to dealing with issues that scientists have indicated are a very low risk in terms of human health. As an example, *Escherichia coli* O157:H7 has been implicated in many foodborne illnesses and outbreaks, causing an estimated 52 deaths in 2000 in the United States (ERS, 2000) and has received a great deal of media attention over the years. In contrast, Bovine Spongiform Encephalopathy (BSE) has received much more attention in recent times, even though the human health risk has been shown by experts to be extremely low (CDC, 2004), and only approximately 160 deaths worldwide have been attributed to the human form of the disease over a period of 20 years (eight per year). Yet the Alberta (Canada) government committed many millions of dollars to studying and mitigating the effects of BSE in 2003. It is clear that a judgment on spending is not based solely on the mortality statistics for a disease agent. Rather, the political, economic, societal, and technological impacts play a role in any ranking and decision-making.

2 Review of the Literature

The central theme of this research was the ranking of food risks using a modified ranking instrument. This instrument was initially developed for ranking hazards in non-food applications. Included in the ranking exercise was the consideration of risk perception, both by experts and laypersons. Depending on the desired outcomes of the research there were many methods to choose from, each with benefits and drawbacks. The following sections review the literature for these methods and clarify the objectives of the research.

2.1 Risk Ranking Models

2.1.1 Common considerations in risk ranking models

In all approaches to risk ranking there is subjectivity in the decisions made. This is reasonable, given that there are many subjective decisions made in risk assessments and other undertakings used as the starting point for risk ranking. Even when using computer-based models there is subjectivity. The data inputs and weightings given to them are dependent on the choices of experts in the fields. Because of this there are many assumptions made during the ranking exercises. Regardless of the model used, there are common considerations employed in their development. For all risk ranking models evaluated here, these are:

1. The ranking exercises can be time consuming
2. Risks are inherently complex and cannot be simply described
3. No one model can account for every assumption and various ethical / social factors

4. To reduce complexity, risks and their attributes need to be categorized in some manner prior to any ranking exercise
5. The risks themselves are secondary to the actions used to mitigate the risks (Fischhoff, 1995)

Another general theme in the literature reviewed is that any ranking exercise cannot be used as a simple formula to make decisions. As stated by the Food Safety Research Consortium (FSRC), "government policymaking cannot be reduced to a formula" (FSRC, 2003, p. 3 of Backgrounder). There are just too many factors involved in ranking including cultural differences, economic costs, societal costs and severity of an illness. Each one of these factors can influence whether a higher-ranking priority is reduced to a lower ranking or vice versa. It was also suggested in the literature that any model will have to be modified as further research is completed and societal priorities change.

Several methods have been used in ranking risks. There were approaches that relied on the scientific information available on the topic and then used this information as inputs in a computer model. An algorithm then assigned a rank based on weightings given each of the criteria and the ranking was a matter of relatively simple computation. Other approaches have used personal judgment and a "risk versus severity" table or matrix to assign rankings. Some approaches have attempted to combine both of these designs to determine what the comparative ranking values were between risks. Each of these designs is described in the following examples of approaches used in different jurisdictions.

2.1.2 Models

Risk ranking models vary considerably in their design and scope. The relative merits and shortcomings of available models are reviewed here, beginning with the United States Environmental Protection Agency (USEPA). The USEPA publication *Unfinished Business* in 1987 set the stage for risk ranking of human health hazards. One conclusion from the 1987 report was that public perception of risks drives the resource allocation. The priorities of the general public were not consistent with what the USEPA experts determined to be the priorities. This conclusion had consequences, since it was dependant on the selection of rankers to determine the most important risks to manage. Projects in which risks were ranked were conducted in 1990 and 2000 to determine the comparative risks of environmental hazards (USEPA, 1990). One of the findings of this undertaking was that "comparative risk projects are not considered classical science endeavors" and that the rankers were aware of the uncertainties and lack of credible data available. This statement indicated the difficulty in ranking risks according to the known science. As well, the rankers were USEPA staff, which had implications of bias. The increased knowledge of a hazard could have been offset by the bias of being involved in the technical dealings of the agency. However, this project was valuable since it brought awareness of the complexity of ranking risks.

Another finding of the USEPA model was that the categorization of risks and their attributes was inconsistent throughout the project. This factor was considered in the review of the Carnegie Mellon model below. The USEPA model, though, did bring forth questions as to how ranking of risks can be conducted to satisfy all audiences, both technical experts and public. Acknowledging this finding, a group of researchers sought to construct a model that would fit the requirements for both expert groups and public groups.

Carnegie Mellon Model

Risk ranking using the Carnegie Mellon University (CM) model (Florig *et al.*, 2001) attempted to simplify the process, using lay public as the rankers in the initial undertaking. In the original test bed for this process a hypothetical school was used, with all possible hazards being considered, from school bus accidents to airplane crashes. A five-step process was constructed for this approach:

1. Risks are categorized or classified in one of several aspects (agent or hazard, location, persons affected, time-effect, etc.)
2. Risk attributes are determined for each category
3. Risk summaries are developed for each risk. These summaries can include the list of attributes and what the experts have determined are the characterizations for each attribute (e.g. low, medium or high factors). The summary also has a brief description of the risk and references for technical information if needed.
4. Risk rankers are selected and the risk rankings are performed.
5. An assessment of the rankings is done.

The categorization in Step One has been the subject of much debate (Morgan *et al.*, 2000). For a ranking exercise to succeed the categories must be clear and manageable. As Morgan *et al.* (2000) indicated, the USEPA risk categorization in particular had not been clear on this point and this led to confusion on the final rankings. One example of how the categorizations were difficult in the USEPA project was that some categories were based on the agent responsible for harm, while others were categorized by the medium (air or water) that was affected. Without a uniform categorization it was difficult to compare risks directly. The CM model attempted to clarify these categorization problems with descriptions of the categories given in the risk summary sheets used by the rankers.

Another concept that had to be clarified was the assigning of risk attributes in Step Two. As with categorization, the attributes of a risk can be classified in different ways. Examples of risk attributes used in the CM model were the number of deaths per year and the time between exposure and health effects (Florig *et al.*, 2001). Most risks are multi-attribute, meaning there is more than one way in which a hazard can affect the outcome, and this can prove to make the ranking process more complex. With Steps One and Two having such ambiguity it would seem that there is no balance in the system. However, the most useful feature of this ranking method was the use of risk summary sheets. Risk summary sheets were not only a summary of the available information on the risk, including the categorization and the attributes, factors such as the known science about a risk were also given. The risk rankers could then decide if more weight should be given to a risk, depending on the information available. The risk summary sheets were clear and concise. Being only a few pages in length, many risks could be reviewed by the rankers in a relatively short period.

While laypersons were used in the original testing, the CM model described has also been tested using risk managers as the rankers (Morgan *et al.*, 2001). The findings, based on both individual and group exercises, were analyzed using regression analyses. The conclusions that the investigators arrived at were that the method could be applied using subjects (rankers) with different backgrounds, both laypersons and technical, and that the results of both individual and group work had a strong correlation. In an application of this method, Willis *et al.* (2004) used environmental hazards in one ranking exercise and found that rankings by both individuals and groups were also consistent with each other.

Food Safety Research Consortium

While the CM model used a subjective approach to the ranking of risks, another method has been developed that utilizes computing power. The recently (2003) developed Food Safety Research Consortium (FSRC) is an example of a need for some type of risk ranking approach to satisfy both the government and public needs for deciding on where to spend resources for food safety issues.

If one looks at the various categories of hazards that are found in food, usually they are restricted to physical, chemical and biological categories. Most of the concentration has been on biological and chemical hazards since physical hazards are usually point sources and are not as common as biological or chemical hazards. A large body of work has been completed on chemical assessments in foods but most of the concern seemed to focus on biological (microbial pathogens) hazards as the priority. There are plans to assess chemical contaminants in the future, but the FSRC opted to begin with biological hazards. The model used for ranking of risks utilized a computerized system, built within Analytica software, called the Foodborne Illness Risk Ranking Model (FIRRM) to make decisions. The model was initially restricted to four microbial pathogens: *Salmonella*, *Escherichia coli* O157:H7, *Campylobacter jejuni* and *Listeria monocytogenes*, although the FSRC had chosen 28 foodborne pathogens and 40 food categories to include in the full model. This initial selection of pathogens was used because data were available for these pathogens, both in characterization and effects / costs of a host becoming infected. Cost was the economic portion, through an evaluation of the monetary costs of hospitalizations and the loss of Quality Adjusted Life Years (QALYs), for example.

The FIRMM developers acknowledged the potential shortcomings of the model, one being the uncertainties in any scientific data used. For the three methods of collecting data (outbreak data, risk assessment and expert panels) to be used in the analysis there were some concerns. Using outbreak data as an attribute has uncertainties built into it. Outbreak data only indicates unusual occurrences and not the standard transmission patterns (FSRC, 2003). The risk assessment method is expensive in both time and personnel and currently there are only handfuls that are used. A shorthand risk assessment method also was used by FSRC in an attempt to collect useful risk information. This method determined an estimate of illness using data on consumption patterns of foods, sources of contamination and risk factors. But the data gaps that existed in these shorthand risk assessments meant that they could not be used effectively. Finally, there was data collection via expert panels. The members of these panels were leading scientists in their fields. However, the response rate was poor and basing judgments on only a few persons' experience lent much bias into the ranking.

The strength of the FIRMM model lay in its use of computing power. Once all of the relevant data had been inputted, it was only a matter of using the logic of the computer to produce an answer. Of course there were uncertainties in the data that had been inputted and so these were propagated through to the rankings. The

FIRMM model relied heavily on epidemiological data and expert opinion, both of which have been shown in the FSRC literature to have gaps and biases.

Australia / New Zealand

Food Standards Australia New Zealand (FSANZ) has used a risk versus severity approach in its ranking of food safety risks in seafood products (FSANZ, 2004). While the FSANZ mandate is to ensure a safe food supply in processing and manufacturing, prior to 2002 there were gaps in scientific knowledge of some primary production sectors, including seafood. Seafood is the fourth largest food commodity in Australia / New Zealand and exports of the products are highly valued. For this reason a risk analysis approach was taken for the seafood sector, to further ensure the safety of the products. Hazard Analysis Critical Control Point (HACCP) systems have helped to control foodborne hazards at the processing level. This proactive approach controls food hazards systematically. An inventory is taken of all known hazards for a food product. These hazards are evaluated for their likelihood of being present in an ingredient or during a processing step. The hazard is then assessed for whether it can be controlled via a processing step or through a program such as cleaning and sanitation. Those hazards that are determined to be of the highest human health concern are controlled by processing steps designed specifically for control of the hazard.

While there are HACCP-based programs for points on the food continuum outside of processing, the primary production sector has had little regulation in this area. FSANZ also determined that the application of HACCP has not made a distinction between significant public health hazards and ones that may have less severe consequences. For this reason a ranking of risks from seafood products was undertaken as a part of the Primary Production and Processing (PPP) Standards development. Other PPP Standards were being developed for the Poultry Meat and Dairy industries using the same approach.

A Standard Development Committee for each commodity assessed the science known for the hazards. Public and stakeholder consultations of these scientific findings were used and fed back to the Ministerial Council, to ensure transparency of the process. Consultation also helped to ensure that any actions taken by FSANZ were feasible, cost-effective and beneficial to the public; therefore these considerations were taken into account for priorities to be set. The rankings of the risks, though, were performed qualitatively in a matrix. The attributes used are similar to the CM model (FSANZ used duration of illness, likelihood of death and potential for ongoing adverse health effects, for example). The actual method of ranking was unclear, but it was suggested that a more informal approach was used.

It was evident from one example in the FSANZ seafood assessments that even within a commodity group there was a considerably large risk versus severity matrix (FSANZ, 2004). For this reason one recommendation was to categorize commodities rather than look at all foods and deciding what should be "high" or "low" risk, when ranking the risks. Within the seafood category there was much variance in relative risk, from bivalves (high-risk) through to ciguatoxin in chilled fin fish (considered medium-risk). Although the severity of each was high, the overall relative risk ranking varied. This type of ranking may have led one to believe that all seafood has high risks associated with it, until likelihood of exposure was considered.

FSANZ acknowledged that the rankings were not firm. For example, with new epidemiological data, these rankings may change. One downside to ranking risks in the manner used by FSANZ was that while those risks rated "high" are notable, there was less distinction between the low and medium rated risks. In all cases a reviewer of the rankings would have to have the table interpreted, or become familiar with the background on each risk to either accept or challenge the rankings. Having to research the rankings would seem to be counterproductive to performing rankings in the first place, but this adds to the theme of rankings being modified as new information is learned – the rankings are a starting point to allocate resources.

New Zealand

The New Zealand Food Safety Authority (NZFSA) has used risk profiles as one of the steps in managing food safety risks. A risk profile was defined by NZFSA as "a document that provides a summary of relevant information on a specific food safety issue" (NZFSA, 2000a). The risk profile format is similar to a risk assessment, with the steps of hazard identification, hazard characterization, exposure assessment and risk characterization detailed. These documents were considered guidance for the NZFSA, risk managers and food industry personnel. The risk profile was endorsed by the Codex Alimentarius Commission (CAC) and has been developed for several bacterial pathogens, including enterohemorrhagic *Escherichia coli* (CAC, 2003). Twelve risk profiles were developed by NZFSA, with many more planned. However, the risk profiles are lengthy (the *E. coli* risk profile is 38 pages) and while comprehensive, they would be burdensome for laypersons to utilize in a ranking exercise, and public participation is desirable in these types of decisions. The risk summary sheets used in the CM model were less comprehensive, but were more readable and restricted to four pages each. Given the choice of using risk summary sheets or risk profiles, the former would be preferable for use in a risk ranking exercise.

The actual method of ranking risks was not clear from the NZFSA literature (NZFSA, 2000b). There appeared to be reliance on the risk profiles to describe whether a risk was significant to public health. A comment provided by the organization is that a risk ranking method may be developed to assist in decision-making, but no timeframes were given.

European Union

Two approaches used in the European Union (EU) were the European Union Risk Ranking Method (EURAM) and the Interdepartmental Liaison Group on Risk Assessment (ILGRA). EURAM is a computerized tool used for prioritizing risks from high production volume chemicals. The EU proposed in 1993 that there was a need for the evaluation of environmental and human health concerns regarding chemicals produced in member countries. The four steps used in these evaluations were data collection, priority-setting, risk assessment and risk reduction (Hansen *et al.*, 1999). Other ranking methods were described in Hansen's paper, but the advantage of the EURAM method is that it contained a comprehensive database for the assessment of the more than 100,000 chemicals in the EU market.

As Hansen described EURAM, it used an exposure-effect model to calculate the human health and environmental scores. This method relied on the data being accurate for each substance and that the uncertainties associated with them were minimal. The exposure data were described using simple models. It was also indicated that there is political influence in the rankings for human health concerns, lending bias to the process.

The potential problems with the use of risk ranking for decision-makers were echoed by the EU Interdepartmental Liaison Group on Risk Assessment (ILGRA). ILGRA is a committee-based priority setting body. Risk ranking is deemed important and desired as a "Richter Scale" to compare where resources should be spent. The difficulties with any simple rankings, as summarized in ILGRA (1996) included public perceptions of various risks, the use of estimates for risks being translated into estimates of rank, and questions of how to appropriately compare "peas with planets".

Canada

Health Canada (HC) sets policy for food safety in Canada and administers the Food and Drug Act. However, the Canadian Food Inspection Agency (CFIA) is responsible for enforcing these food regulations. There are overlaps within provincial and municipal jurisdictions with respect to enforcement, but the CFIA has the mandate of safeguarding the food supply. In order to ensure that resources are being applied to risks to the food supply in proportion to their risk, a Risk Analysis Framework was designed (CFIA, 2004). This framework used risk analysis principles as per the CAC guidelines.

Similar to the NZFSA, the CFIA made use of Risk Analysis Profiles to describe a risk in the food supply. The profile was neither a complete literature review on the topic, nor was it intended to be an overwhelming description of the risk. Rather it was a starting point to managing the issue at hand. The CFIA has stated that these profiles may, on their own, be enough to deal with an issue and therefore a formal risk assessment would not be required. As in other jurisdictions, there was a method of ranking the risks. However, it was noted that this ranking method was to help prioritize the allocation of risk analysis resources, rather than a method of prioritizing risk management activities.

The method chosen by the CFIA to prioritize risk is an additive scoring matrix, with weighted attributes (e.g. health and trade concerns) multiplied by the assigned score of an activity (e.g. importation of bovine embryos). The result was a risk index score. The scores used for each activity seemed arbitrary and this in turn had an impact on the final risk index. With the resulting risk index determined in this way, the final rankings were both subjective and potentially biased.

2.1.3 Comparing and contrasting the models

The models and methods described run the gamut from relatively simple scoring performed by laypersons to complex computerized systems, such as the EURAM. Table 1 summarizes the similarities and differences between these approaches.

Common to all of the methods used is a lack of available scientific data, or at the very least, gaps in the science. The choice of rankers did differ though. In the CM model it was shown that both laypersons and technical persons can perform the rankings effectively, using the same risk summary sheets. In all other models the task was designed more for the technical person.

Table 1. Risk ranking model characteristics

Aspect	Ranking Method: USEPA[1]	CM[2]	FSRC[3]	FSANZ[4]	NZFSA[5]	EURAM[6]	CFIA[7]
Input data source	USEPA sources	Varied according to project	Epidemiological data; experts; risk assessments	Experts; credible literature	Experts; credible literature	IUCLID[8] chemical database	Experts; credible literature
Categories defined	Inconsistent	Yes	Yes	Yes	Unclear	Yes	No
Attributes defined	Inconsistent	Yes	Yes	Yes	Unclear	Yes	Yes
Risk summary description	Varied between workgroups	Risk Summary Sheets	None	None	Risk Profiles	None	Risk Analysis Profiles
Rankers	USEPA staff	Technical /laypersons	Computerized	FSANZ staff	NZFSA staff	Computerized	CFIA staff
Ranking method	Mathematical / computer	Manual	Mathematical/ computer	Manual	Unclear	Mathematical / computer	Manual

[1] United States Environmental Protection Agency
[2] Carnegie Mellon
[3] Food Safety Research Consortium (Foodborne Illness Risk Ranking Model (FIRMM))
[4] Food Standards Australia New Zealand
[5] New Zealand Food Safety Authority
[6] European Union Risk Ranking Method
[7] Canadian Food Inspection Agency
[8] International Uniform Chemical Information Database

The use of summary documents for the various risks to be ranked also varied. The CM model used simplistic risk summary sheets, yet they were detailed enough to include all relevant information necessary to perform rankings. Both the FSANZ and CFIA risk profiles were lengthy and not user-friendly for the ranker with limited knowledge on the subject. Using computing power for the ranking task had advantages: the vast amount of data available for some hazards can only be efficiently sorted and ranked by systems such as EURAM. The use of categories and attributes for the risks was found in most methods and some form of risk summary document seemed to be a characteristic of the more formal methods.

Risk ranking has been developed in many jurisdictions as a tool to manage limited resources. It is clear that there was not one model or method that can be applied to all of the different hazards and risks. The CM model could be applied to food safety risks and the relative ease of use by different rankers made this model the best fit for this application. The FSRC approach is in its infancy but shows promise. FSANZ and NZFSA both used their respective methods to allocate resources to food safety concerns, but there was not a clear model to adopt. The CFIA methodology was only used to determine priorities for risk assessment and was not designed for ordering food safety risks for priority in action.

2.2 Risk Perception Research

The previous section examined risk ranking models and how subjectivity influenced each model's application. Subjectivity is based on personal values and knowledge and this subjectivity can influence both expert and public judgment of risk. Perceptions of risk also are influenced by values and knowledge. It is therefore necessary to review how perceptions of risk may change between different groups of rankers.

Perception of risk is a well-studied concept. Modern, formal theories on why people thought one thing was riskier than another arose from evaluating new technologies such as nuclear power. How the experts in the field perceived the risk versus how the public felt about it was one area focused on in earlier work. Chauncey Starr asked the question "How safe is safe enough?" (Starr, 1969; Fischhoff *et al.*, 1978) with respect to a wide range of risks. Starr's work concentrated on whether an activity was voluntary or involuntary. Voluntary activities (such as riding a bicycle or skiing) lend a person a degree of control. Involuntary activities however, are based on someone else's parameters and the values of the individual may not match. Having a nuclear reactor built in your neighbourhood is an example of being subjected to an involuntary activity. According to Starr this would typically result in a higher perception of risk by the person in that neighbourhood, even though the experts considered that nuclear power is safe in that location. Conversely, cigarette smoking may be considered a high risk activity by the experts, but given that it is a voluntary activity, many people who smoke don't associate it with a high risk. Using the same smoking example, a person being subjected to second-hand smoke is incurring an involuntary risk and therefore the perception of higher risk may be present.

Knowledge deficit

The difference of opinion between experts and laypersons was also explored in the knowledge deficit model (Hansen *et al.*, 2003; Hilgartner, 1990). There was a general notion that these two groups perceived risk differently due to a lack of knowledge on the public's part. This knowledge deficit (also known as the knowledge gap model), is still prevalent in many researchers' attitudes toward risk communication, even though much of the literature does not support it. Hansen *et al.* (2003) discussed the knowledge deficit model. Generally, if the layperson does not follow scientific advice, then it is because they have a limited knowledge of the science. But the idea that the public may have concerns about a risk that goes beyond the science was a criticism of the knowledge deficit model. A lack of current research on knowledge deficit models indicated a shift to another explanation of risk perception. One shift was to the psychometric paradigm, which used elements of Starr's work as well as heuristics to explain risk perception.

Heuristics

The use of heuristics in risk perception was first explored by Amos Tversky and Daniel Kahneman (Tversky & Kahneman, 1974; Kahneman, Slovic & Tversky, 1982). Their research on how people evaluated probabilities in gambling led to descriptions of heuristics (Kahneman & Tversky, 1984). Heuristics are defined in psychology as simple rules, either intuitive or learned, that help people make decisions. People generally do not evaluate daily events or risks by using probabilities or making lists of possible outcomes, and so heuristics are used (Tversky & Kahneman, 1983). Of these, the availability heuristic is used by a person to evaluate a situation based on how easily something comes to mind. For example, the risk of losing all of one's computer hard drive data may be assessed as quite high if a person's acquaintances have had this happen recently. Another example is the risk of contracting foodborne illness. This may seem higher than public health statistics show if a person has been subjected to many news stories about foodborne illness outbreaks. Support for the availability heuristic was also found in research conducted on product failures (Folkes, 1988). Using hypothetical failure scenarios, it was determined that when a product had an atypical name, research subjects were more likely to recall this product as having a higher failure rate than those products with typical names. This type of evaluation showed that when availability heuristics were employed by persons, it resulted in judgmental bias. Heuristics and the biases associated with them led to an increase in research within the psychometric paradigm.

Psychometric Paradigm

The voluntary and involuntary activities from Starr's work were expanded in Paul Slovic's research (Slovic, 1987) in which the factors of 'unknown risk' and 'dread' were included. In Slovic's model four quadrants in a factor space were used to illustrate the locations of various hazards. Hazards that are known and have little dread factor include downhill skiing, home swimming pools and alcohol consumption. As the hazard becomes less familiar and the dread factor increases, hazards such as nuclear fallout and DNA technology appeared in the quadrant characterized by high dread and unknown risk. Slovic described this model as using multivariate analysis and psychophysical scaling to determine quantifiable risk perceptions. Along with this quantification, the risk perception was also predictable to a degree. The psychometric paradigm model is important in understanding how persons perceive risk and can be useful in interpreting responses to surveys and focus group discussions. However, the model is not without flaws. Starr's paper was not accepted without debate (Slovic, 1987). Slovic himself commented that the results of using the psychometric approach only provided general views on risk perception and more work needed to be done (Slovic, 1992; Miles & Frewer, 2001; Siegrist, Keller & Kiers, 2005). This lack of depth, as Slovic called it, is noted, although the model has been continually updated as more risk perception research has been conducted.

Affect heuristic

One current approach in risk perception research that has received much attention involves the affect heuristic. The positive or negative feelings (affect) about a risk are used by a person to evaluate the riskiness of something. Much of the research on affect has been conducted by Paul Slovic and Melissa Finucane (Slovic *et al.*, 2004; Slovic *et al.*, 2007; Slovic & Peters, 2006), with Slovic's criticism of the psychometric paradigm being a driving force. Zajonc (1980) also supported this approach, arguing that we do not merely see objects; we see them in a positive or negative manner. By this use of affect we often buy cars or clothing because of the feeling we get from observing them. It is worth mentioning that this use of feelings about a risk is opposite to the use of analysis in evaluating a risk, but is part of thinking processes that involve both (Epstein, 1994; Sloman, 1996). This dual-process way of thinking, which Epstein called the cognitive-experiential self-theory, can be most easily thought of in terms of having to make a decision in which the heart (feelings) and mind (analysis) both play a part. While there are situations that involve analysis in decision-making, affect on its own can help to explain how a person determines riskiness. Using one of Slovic's four factors, dread (Slovic, 1987; Slovic *et al.*, 2007), it can be seen that high dread factor in evaluating risks leads to a strong negative affect about the risk.

Another important finding of using the affect heuristic in evaluating risks is probability neglect (Slovic & Peters, 2006; Sunstein, 2003). An explanation of this neglect is: if there is a strong positive or negative affect brought about by a potential outcome, then a person is likely to be insensitive to either high or low probabilities of that outcome. Terrorism threats were used by Sunstein (2003) to illustrate probability neglect. Due to the highly emotional reaction by the public to such threats, the low probability of a terrorist attack is not taken into account, and people tend to overreact.

One area of the affect heuristic identified as needing further work is in numeracy. Slovic and Peters (2006) presented this as a potential problem in using the affect heuristic in communications to the public. Because many risk communication messages contain statistics, this may have an effect on the positive or negative feelings associated with an event. For example, a risk management strategy designed to save 150 lives may feel differently to the public than one in which a 10% reduction in deaths can be achieved out of a total number of 1,500 persons, even though mathematically they are equivalent. One investigation into numeracy (Peters, 2006a) determined that depending on how numbers were presented, a person's judgment of risk could differ. The numerical format also had an impact on risk perception when statistics were presented as frequencies instead of probabilities. When frequencies were used the risk was perceived as higher than if probabilities were given (Keller, Siegrist & Gutscher, 2006). This research indicated how the presentation of material (attribute framing) given to different groups may influence their decision-making. As well, another study by Keller, Siegrist and Gutscher (2006) observed that risks presented over a longer time frame were considered higher risk than those presented in a short time frame. The implications of these findings are many when considering using focus groups for data collection, since they are sources of potential bias.

Optimistic bias

Another concept that is important to consider in risk perception is optimistic bias (also called overoptimistic bias). This is the "...tendency for people to underestimate their personal susceptibility to risks in relation to other people's susceptibility to those risks." (Sparks & Shepherd, 1994 p. 800). This tendency is important in any risk perception research since any bias will affect the legitimacy of the results. While other forms of bias (selection bias, measurement bias) can be accounted for somewhat by methodology selection and statistical analysis, optimistic bias proves more difficult to remove or account for in data analysis. Some of the reasons that persons may have optimistic bias include considering a hazard over which a person has more control, a stereotype exists for persons at-risk of a hazard, or the person may want to keep their self-esteem by stating that they are at a low risk (Weinstein, 1980; Weinstein, 1987; Sparks & Shepherd, 1994). Sparks and Shepherd (1994) elaborate that one of the tendencies of optimistic bias is for a person to expose themselves increasingly to a risk, thinking that it will not affect them as it does others. An implication of this for a focus group interview is that the true risk is ignored, and this may lead to results that are not compatible with fact.

2.3 Risk perception research–food safety

Literature on public perception of food safety has grown since the 1990's (Sparks & Shepherd, 1994; Miles & Frewer, 2003; Hansen *et al.*, 2003; Miles & Frewer, 2001; Cook *et al.*, 2004; Kirk *et al.*, 2002; Knight & Warland, 2005; Rosati & Saba, 2004, as examples). Much of this research on food risk perception has been based on the efforts of researchers on general risk perception, as described in the previous section. Many of these studies have used questionnaires (Rosati & Saba, 2004; Sparks & Shepherd, 1994), or questionnaires and telephone surveys in combination (Kirk *et al.*, 2002; Knight & Warland, 2005; Miles & Frewer, 2003). The aforementioned research studies involved consumers/general public participants only.

While there has been little research comparing the judgment of risk of experts in the food science/food safety discipline with laypersons, research studies that have focused on experts versus laypersons in judging risk in general terms have been conducted. Studies have involved diverse risk domains (Slovic, Fischhoff & Lichtenstein, 1985; Lazo, Kinnell & Fisher, 2000), toxicology (Kraus, Malmfors &

Slovic, 1992; Slovic *et al.*, 1995), nuclear waste (Flynn, Slovic & Mertz, 1993; Barke & Jenkins-Smith, 1993), ecological risk (McDaniels *et al.*, 1997; Wright, Pearman & Yardley, 2000) and fear of the millennium bug (Gutteling & Kuttschreuter, 1999). In an evaluation by Rowe and Wright (2001), the results of these nine studies on perception of risk between experts and laypersons were analyzed. The overall finding of Rowe and Wright's work was that it is unknown whether experts and laypersons judge risks differently. Demographic information and day-to-day activities of the experts were considered important in determining whether there was ecological validity in these types of studies. If an expert in a particular field had no daily involvement in judging risks that were a part of the study, one might conclude that their judgment is no different than the layperson. Rowe and Wright went even further in stating that if there were differences between experts and laypersons, this does not mean that one or the other has more validity. There are implications for the food safety industry, since food safety policy is generally developed by experts in the field, sometimes after consultation with the general public. Without a consistent explanation for what is important to the stakeholders (the public in this case) it will be difficult for governments to implement these policies.

Another example of this type of comparison research was conducted by Florig *et al.* (2001) using the Carnegie Mellon Risk Ranking Method. While Florig *et al.* state that this model was designed to be used primarily by laypersons, experts may also use it. The comparison of the results between experts and laypersons may give insight into potential differences on judging risk between these two groups. Van Kleef *et al.* (2006) conducted a multi-country, focus group-based body of work with both laypersons and experts in food safety as participants. This research involved questioning the participants on five food issues: Bovine Spongiform Encephalopathy

(BSE), genetic modification, high fat diets, pesticides and *Salmonella*. The focus of this research was on food risk management and was considered exploratory. One of the interesting results from this work was that many of the experts suggested that consumers did not know enough about the food issues that were presented. This result is in contrast to the trend of moving away from the knowledge deficit model described earlier in this section. In addition, it was noted that consumers and experts have some similar notions regarding risk management, but the differences between these two groups overall is greater than this similarity. It is clear there are no consistent explanations for the perception of risk by individuals. Increased research into this area will hopefully generate this consistency.

2.4 Objectives of Research

There are many risk ranking models in use by organizations and governments. Each of these models has been tested and none of them is considered perfect in design or applicability. A risk ranking model that can be applied consistently is desired by these organizations. Food safety issues are complex and in order for governments to properly mitigate these issues, a valid ranking approach is needed to help establish priorities and resource allocation. Public consultation is another factor that must be considered and currently there is not a consistent method in use for this.

The objectives of this study were to:

1. Validate a modified Carnegie Mellon (CM) risk ranking model to be used for the ranking of food safety issues.
2. Evaluate rankings between public and expert groups to determine similarities and differences between the rankings based on the reasoning of the public and expert group participants.

3 Methods

This research was conducted using three methods of data collection. Qualitative methods were used to determine major differences between consumers and experts with respect to ranking of food safety issues via a paper-based ranking exercise. Focus group interviews explored the reasoning behind the ranking choices. A quantitative consumer survey was commissioned to support the focus group results. This mixed methodology, or methodological triangulation, has been used in previous research (Wolff, Knodel & Sittitrai, 1993) to validate findings. Because this work was exploratory and not used to develop theory, the data collection and analysis were not confined to a rigid procedure (e.g. Grounded Theory).

The first method involved ranking of predetermined food safety issues, performed by individual participants in a non-interactive group setting. Upon completing the exercise these same individuals then became members of the focus groups. The individual risk ranking exercise using a modified form of the Carnegie Mellon (CM) Model for risk ranking was the primary form of data collection. Semi-structured discussions were then conducted with the focus groups as a secondary data collection method. The focus groups were comprised of either public (non-scientific background) or defined experts in food safety. Discussion as a group resulted in expansion of ideas and reasoning about ranking selections. Key findings from the focus groups were used as the basis for the survey questions.

3.1 Model and Risk Summary Sheets

The CM risk ranking model was described in the review of the literature. This model was chosen since it had been applied successfully using both consumers and experts involving hypothetical risk situations and because of the utility of the Risk

Summary Sheets (Florig *et al.*, 2001). The model followed the Florig *et al.* (2001) five step process:

1. Food safety issues were categorized as an agent or hazard.
2. Risk attributes were determined for each food safety issue.
3. Risk Summary Sheets (RSS) were developed for each food safety issue (Appendices A-F). These RSS included a summary of the agent/ hazard, a list of attributes and what the scientific literature determined were the characteristics for each attribute (e.g. low, medium or high factors). The RSS also contained information on risk mitigation for each agent / hazard and references for technical information if needed.
4. Risk rankers were selected (public and expert participants) and the risk rankings were performed.
5. An assessment of the rankings was done.

The inclusion of risk mitigation strategies was a departure point from the original CM Model and this was the modification to the model. The consistent format of the model allowed for a valid cross-risk comparison by the participants.

3.2 Food Safety Issue Selection

Food safety issues that were used in the risk ranking exercise were:

1. "Mad Cow Disease" - Bovine Spongiform Encephalopathy (BSE)
2. *Escherichia coli* O157:H7
3. *Salmonella*
4. Botulism (*Clostridium botulinum*)
5. Paralytic shellfish poisoning (PSP)
6. Acrylamide

These issues were chosen as some are commonly reported in the media and they have both differing prevalence and severity of consequences. BSE was included since the Alberta beef industry had experienced recent cases of the disease beginning in 2003 and there has been a high level of media attention to the issue. *Escherichia coli* O157:H7 and *Salmonella* were chosen since they are common foodborne illness agents and have been associated with many recalls. These issues therefore frequently appear in the media and should be highly recognized by all participants, not just the experts. While botulism and PSP are not as prevalent in Canada, botulism has still appeared in the media due to sporadic outbreaks. Paralytic Shellfish Poisoning was included since it is rare worldwide, and thus provided balance with the higher profile issues described. Acrylamide was added so that the issues were not restricted to biological hazards, and the agent has been found in many different types of foods. A similar use of issues was presented in previous research (Miles and Frewer, 2001; Rosati and Saba, 2004). The issues present a range of concerns, from bacterial to chemical and high dread factor. The number of issues was restricted to six to limit the length of the individual exercise and to ensure focused discussion on a few issues, rather than overwhelming the participants. As well, the goal of the research was not merely to rank a large number of issues. Rather, the goal was to investigate the reasons behind the ranking choices and so issues had to be chosen that were expected to be familiar to all participants.

3.3 Participants

Prior to conducting any data collection the project was granted approval by the Faculty of Agriculture, Forestry, and Home Economics (AFHE) Human Research Ethics Board (HREB) (see Appendix G for certificate). A total of 29 consumers participated in eight focus groups during the week of July 24 to 28, 2006 at the University of Alberta. Since the research was exploratory in nature, defined generalized groups were used. Participants were recruited through Nexus Research

(Toronto, Ontario). Equal numbers of males and females participated, and the age ranged from 18 to over 65 years.

Table 2. Public participant demographics

	Focus Group 1 (*n*=9)	Focus Group 2 (*n*=7)	Focus Group 3 (*n*=6)	Focus Group 4 (*n*=7)	Total (*n*=29)
Age (years)					
18-30	2	2	2	1	7
31-40	0	2	0	2	4
41-50	3	1	1	1	6
51-60	2	0	1	0	3
>60	2	2	2	3	9
Gender					
Male	4	3	3	3	13
Female	5	4	3	4	16
Number of persons in household					
1	2	2	0	1	5
2 or more	7	5	6	6	24
Children (under the age of 18 in household)					
Yes	1	2	2	3	8
No	8	5	4	4	21
Occupation					
Full-time	5	4	4	4	17
Part-time	0	0	0	0	0
Self-employed	1	0	0	1	2
Other	0	1	1	0	2
Unemployed	1	0	0	0	1
Retired	1	0	1	2	4
Looking after the household	0	1	0	0	1
Student	1	1	0	0	2
Highest level of completed education					
No schooling	0	0	0	0	0
Elementary	0	0	0	0	0
Junior high	1	1	1	0	3
High school	6	5	2	2	15
Vocational / technical	0	0	1	2	3
Community college	1	0	0	3	4
University – undergraduate	1	1	2	0	4
University – graduate degree	0	0	0	0	0
Family income					
30-39k	2	3	2	2	9
40-59k	4	2	2	0	8
60-79k	1	0	1	3	5
>80k	2	2	1	2	7

Education ranged from some high school to University degrees. One exclusionary criterion was that the consumers must not have an advanced knowledge of food safety, determined by their not having a University degree or other qualification in biological sciences specifically, and not hold a position in a food related industry or organization. The demographic characteristics of the consumers are provided in Table 2.

Expert group participants were recruited through personal contacts of the researcher and the research supervisory committee. A total of 21 participants were involved in six focus groups between April, 2006 and December, 2006. Experts were recruited from federal and provincial Ministries and academic institutions. Experts were defined as having met two criteria: (1) a minimum of a University degree or technical diploma in the biological sciences or a related discipline and (2) experience in the food industry, food science research, food safety, food policy, or food regulation. The general backgrounds of the expert participants are provided in Table 3.

Table 3. Expert participant characteristics

Focus Group	Organization / affiliation	Primary job function
1 (*n*=3)	Ministry (3)	public health policy (3)
2 (*n*=3)	Ministry (3)	food safety policy (3)
3 (*n*=4)	University (4)	research (4)
4 (*n*=4)	Ministry (3); regulatory body (1)	extension (3); regulatory enforcement (1)
5 (*n*=4)	University (4)	research (4)
6 (*n*=3)	Ministry (2); regulatory body (1)	extension (2); regulatory enforcement (1)

3.4 Pre-testing

Prior to conducting the focus groups pre-tests of the model and questions were performed with a consumer group (*n*=2) and an expert group (*n*=2). Pre-testing was necessary to ensure that the exercise could be completed in a reasonable amount of time and that understanding of both the instructions and the RSS were consistent between groups. Modifications to the model and questions were done as necessary. The changes were in clarification of wording in the RSS. Some of the comments on wording were that it was too technical for the consumer groups and those definitions should be provided. However, since the instrument used was the same for both the consumers and experts there was a need for specific technical language to remain in the text for consistency.

3.5 Procedure

Attending the consumer focus group sessions were the researcher, an assistant and the Principal Investigator for the project. Focus groups were designed for eight persons performing the individual exercise at once in one room. For each focus group the participants were welcomed and refreshments were provided along with general conversation, to ensure a non-threatening and open situation. The room was designed for focus group research and so there were microphones and one-way glass on one wall. Participants were assured that no one was behind the one-way glass and that only the researcher's recorders would be turned on with permission. Each participant signed an attendance sheet and an information sheet was provided to each participant and read to them. This sheet contained a summary of the purpose, background, methods, issues of confidentiality, benefits of the research, risks of the research, use of the information and contact information (Appendix H).

It was emphasized that this research was part of the fulfillment of the researcher's Master of Science thesis project and that there were no influences from outside agencies or organizations. It was also explained that funding for the project was obtained through a non-political entity and that there was no expectation of certain results. The in-kind contribution from Alberta Agriculture and Food (AAF) was the researcher's education leave agreement with AAF. As per AFHE Human Research Ethics Board guidelines, the participants were then asked to read and sign a consent form (Appendix I) once they were satisfied that they were properly informed of the details of the research. The participants had a chance to ask questions and clarify any point contained in the information sheet and consent form prior to beginning the exercise. Demographic information was then collected via a brief questionnaire (Appendix J). Participants could choose to receive a summary of the results of all focus groups by filling out an additional form with name and e-mail address (Appendix K).

Individual ranking exercise

Once the researchers had obtained informed consent, the exercises were explained. The first exercise was to have the participants read through the six RSS and have them determine which food safety issue was highest risk (ranking of number one) to lowest risk (ranking of number six). Their results were entered along with associated comments for each issue on the Risk Ranking Sheet (Appendix L). While it was preferred to have strict rankings of one through six, it was acceptable to have multiple issues having the same numerical ranking if the participant felt strongly about it. The individual exercise was typically completed within 30 minutes. Questions pertaining to the material only could be asked during the individual exercise. Typically this involved clarification of the RSS information (e.g. definitions).

Focus group discussion

Following the individual exercise the group was split into two groups of four, one group remaining in the same room with the researcher while the second group went to a second room with the assistant. The Principal Investigator moved between rooms to ensure that if one group was expanding on a topic that may be of use in the overall research, that both groups discussed this topic. Expert groups typically had four participants and so only one group discussion was held. Prior to the focus group discussion the participants were again informed that the discussions would be digitally recorded. If there were concerns by a participant about having a portion of a discussion recorded, the recorder would be turned off for that part. As well, if within a month, the participant had reservations about a comment they had made, they could contact the researcher to have that portion removed from the record.

The focus group discussion was designed to be semi-structured, with six key questions, followed by general discussion on the topics. The key questions are provided in Table 4. The first two questions focused on the highest and lowest rankings and the reasoning behind each. Each participant was asked in turn about his or her choices and reasons. This was asked since there may have been information not provided by the participants on the Risk Ranking Sheet that would be revealed during a discussion. The next question asked about the fifth and sixth ranked issues, those deemed of least concern. The rankings of third and fourth issues were not discussed.

Table 4. Focus group questions

Key questions
What are your two highest-ranked food safety issues and why?
What are your two lowest-ranked food safety issues and why?
Has anyone's answers caused you to change your order?
Is there any food safety issue that is missing or should have been included on this list?
How safe is the food supply?
Who is responsible for food safety?

Since the research was focusing on potential major differences between the expert and consumer groups, the extremes of the rankings were most valuable. Third and fourth rankings were retained and are provided in the results. After discussing these rankings the question was asked whether the comments of the other participants had changed anyone's rankings and why. Whether someone has changed their answers based on hearing others' comments gives an indication of how group dynamics plays a role.

Next the question of whether any other food safety issues should have been included was asked. Since the six issues ranked are clearly not exhaustive or representative of all food safety concerns, the question of whether something else should be added was needed to get an indication of the awareness, in general, of the participant's knowledge of food safety issues.The final two questions for the groups were how safe they felt the food supply was and who was responsible for the food supply. These questions may give an indication of the level of trust in the food safety agencies/industries. All of these questions relate to the risk perception of the individual. Following the focus group exercise the participants were thanked and presented with a cash honorarium for their time. The exercises took no more than two hours to complete, including instruction and paperwork time.

Public survey

A telephone survey was conducted between April 11 and June 18, 2007 by the Population Research Laboratory (PRL), part of the Department of Sociology at the University of Alberta. The questionnaire was pre-tested by professional interviewers on 20 Edmonton area households. Based on the findings of this pre-test, modifications were made to the questionnaire prior to conducting the survey. The target participant population for telephone interviewing was all persons 18 years of age or older who, at the time of the survey, were living in a dwelling unit in Alberta that could be contacted by direct dialing. From this population, three samples were drawn to cover the province of Alberta, including the Edmonton metropolitan area, Calgary metropolitan area, and the rest of the province ("other" Alberta).

Approximately 400 people were sampled from each of these areas. A Random-Digit Dialing approach was used to ensure that respondents had an equal chance to be contacted whether or not their household was listed in a telephone directory. The survey selectively targeted equal numbers of males and females.

A total of 9200 interviews were attempted during this period, with 1207 completed interviews. The estimated sampling error, at the 95% confidence level and assuming a 50/50 binomial percentage distribution, was ±2.7%. Survey estimates for the area sub-sample of 400 are estimated to be within ±5%, at the 95% confidence level. The survey was administered through a multi-station Computer-Assisted Telephone Interviewing (CATI) system installed on a local area network at the PRL. The Ci3 Wincati System is a PC-Windows based product of Sawtooth Software, Northbrook, Illinois. This system facilitates the exchange of information among interviewing PC stations and supervisor stations linked using a file and database server during the data collection period. Supervisors monitor call dispositions, field edit, validate data and generate progress reports. The data were tabulated and cleaned using the SPSS for Windows statistical package (a product of SPSS Inc., Chicago, Illinois). The data cleaning process included wildcode, discrepant value, and consistency checks. To analyze and interpret the results of the province-wide survey, the samples were combined as a single sample. The three sample areas were therefore weighted in proportion to the Alberta population represented by each.

Five survey questions were asked, following the focus group key question format. The survey design did not include the RSS and so questions were modified to reflect the missing RSS (i.e. the questions were not open-ended). The questions and answer choices are provided in Table 5.

Table 5. Public survey questions

Questions and multiple-choice answers
1. Of the following six issues, which is the <u>most</u> important to you in terms of food safety? [1]
2. Why did you rank this as most important? [2]
I and/or someone I know has been affected by this issue
I hear a lot about this issue on TV and/or in the newspapers
I don't know anything about this issue, and that makes me more frightened of it
A lot of people are affected by this issue
The health consequences of this issue are particularly dangerous
3. Of the six issues listed previously, which is the <u>least</u> important to you in terms of food safety? [1]
4. Why did you rank this as least important? [2]
Neither I nor anyone I know has ever been affected by this issue
I don't hear a lot about this issue on TV and/or in the newspapers
I don't know anything about this issue, and that makes me less frightened of it
Not very many people are affected by this issue
The health consequences of this issue are not very dangerous
5. Who do you think is <u>most</u> responsible for food safety in Canada? [2]
Food producers (like farmers)
Food processors (such as a company like Kraft or Nabisco)
Food retailers (like Safeway or other grocery stores)
Restaurants
Government (like public health inspectors or agriculture departments)
Everyone has some responsibility

[1] the six food safety issues listed were the same as in the focus group exercise
[2] the reasons given were based on the focus group responses

3.6 Data Analysis

> Those who want to use qualitative methods because they seem easier than statistics are in for a rude awakening (Taylor & Bogdan, 1984, p.53)

3.6.1 Ranking exercise

Individual rankings from public and expert exercises were summarized in frequency tables. The Mann-Whitney statistical test was used to determine the significance of differences in ranking choices. This non-parametric statistical test was chosen because it is used to compare two unpaired groups and it was assumed that the dependent variable is not a normally distributed variable.

3.6.2 Focus group exercises

Digital audio recordings of the focus group discussions were transcribed verbatim immediately following the interviews. Content analysis was applied to the focus group data following a five step process described by Taylor-Powell and Renner (2003): (1) getting to know the data, (2) focusing the analysis, (3) categorizing information, (4) identifying patterns and connections, and (5) interpreting. Getting to know the data involved reading the transcripts and listening to the audio recordings of the focus group interviews multiple times. Errors were corrected and accuracy ensured during this step. Focusing the analysis identified key areas that would be explored. While the key questions in the interview schedule were the primary focus with coding, emerging themes were also captured. Categorizing information involved coding the data, finding themes and organizing them.

The data were divided into meaningful segments through an open coding process, and then organized into useful categories (Seidel & Clark, 1984; Knodel, 1993).

Coding was done manually using coloured highlighting to distinguish key questions and answers. These codes were then further refined to establish patterns in responses to key questions.

3.6.3 Public survey

The resultant data set from the Alberta survey contained 1207 cases. Summary statistics of the data and all other statistical outputs were generated using SPSS. These statistics included frequencies of responses, correlations and linear regressions between answers to the questions and demographic information. Recoding of certain categorical variables was done to allow for proper regression analysis. Categorical variables were recoded for the highest and lowest-ranked food safety issues, education and Alberta location. The answers to each of the questions regarding highest and lowest-ranked food safety issues were recoded as dummy variables so that each answer could be analyzed separately. Education was recoded as a dummy variable so that an education status of high school completed or less was differentiated from completion of post-secondary education. Similarly, Alberta location was recoded to differentiate between urban (Edmonton and Calgary) and rural (the rest of Alberta in the survey). Regression and correlation analyses were executed to investigate the contributions that education and geographical location had on answers to the questions about ranking of food safety issues.

3.7 Reliability and validity

Reliability refers to consistency in the experimental design and data collection techniques (Taylor, Gibbs, & Lewins, 2005). In this research project concerns regarding reliability included different interpretations of scientific information in the RSS and consistency of focus group format. To minimize inconsistencies the same instrument was used for all groups (Neuman, 1991), the moderators were constant, and the format of the focus groups was consistent. Additional concerns arose from the development of coding schemes used in the transcript analysis.

Inter-coder reliability was essential in the analysis in order that themes discovered in the data were consistent. Following a suggestion from Lombard, Snyder-Duch, and Campanella Bracken (2002) a sampling of the focus group transcripts, one each from the public and expert groups was used to compare the coding scheme of the researcher with an independent coder. The independent coder was not involved in the research. Any discrepancies in the coding scheme and resulting themes were discussed until agreement was reached on these schemes. Percent agreement between the two coders was calculated, as suggested by Craig *et al.* (2000) and Fahy *et al.* (2000) and found to be 77.3%. Discussion on discrepancies between coders resulted in 100% agreement.

Winter (2000) discusses validity in qualitative research and states that it is not a universal concept, and has been used interchangeably with the term reliability in the analysis of qualitative results. Validity for the purpose of this research means that the interpretation of the results truly reflects what happened (Johnston & Pennypacker, 1980). To help minimize the chance of analysis that was not accurate, methodological triangulation was used (Foss & Ellefsen, 2002). Survey results, using the emergent themes from the focus groups, were used to support the focus group analysis.

4 Results

Results are presented in three parts: the individual ranking exercise, the focus group discussion and the public survey results. To examine the basic differences in the ranking between public and expert participants, individual rankings were compiled as simple frequencies. While many of the rankings were similar and it appeared that there was overall agreement in rankings, there was a significant difference for the ranking of one of the food safety issues, acrylamide. This difference in ranking was further explored in the focus group discussions and the reasoning behind the difference was elucidated. Since the public survey questions were based on the major findings of the focus group discussion, the results obtained from it helped to further support the key findings of the focus groups and support the conclusions drawn from this research.

4.1 Individual Ranking Exercise

The results of the individual ranking exercise are summarized in Table 6. Raw rankings are provided in Appendices M (public) and N (experts). *E. coli* O157:H7 and *Salmonella* were chosen as the two food safety issues with the highest ranking by the experts, at 38.0% and 52.4%, respectively. *E. coli* O157:H7 was chosen as the highest food safety issue by 41.4% of the public participants and *Salmonella* was chosen by 20.7%. Acrylamide was selected as the number one food safety issue by 34.5% of the public participants, but none of the experts considered acrylamide to be the highest risk. Of the six food safety issues, only botulism and PSP were not ranked highest by any participants of the public group. None of the expert participants ranked BSE or acrylamide as highest and BSE was not ranked second highest by any experts.

Table 6. Public (n=29) and expert (n=21) rankings of six food safety issues expressed as percentages of the total group

	Food safety issue											
	BSE[1]		*E.coli*[2]		*Salmonella*		Botulism		PSP[3]		acrylamide	
Rank	Public	Expert	Public	Expert	Public	Expert	Public	Expert	Public	Expert	Public	Expert
1	3.4	0.0	41.4	38.1	20.7	52.4	0.0	4.8	0.0	4.8	34.5	0.0
2	13.8	0.0	41.4	61.9	34.5	19.0	6.9	14.3	3.4	4.8	0.0	4.8
3	27.6	14.3	6.9	0.0	13.8	19.0	41.4	57.1	3.4	4.8	13.8	0.0
4	20.7	19.0	10.3	0.0	6.9	4.8	17.2	19.0	31.0	47.6	17.2	9.5
5	13.8	28.6	0.0	0.0	20.7	4.8	24.1	4.8	20.7	23.8	20.7	42.9
6	20.7	38.1	0.0	0.0	3.4	0.0	10.3	0.0	41.4	14.3	13.8	42.9

[1] Bovine Spongiform Encephalopathy

[2] *Escherichia coli* O157:H7

[3] Paralytic Shellfish Poisoning

Table 7 shows the results of the Mann-Whitney U test for analyzing differences between rankings of the public and expert participants. All food safety issue rankings between expert and public groups are significantly different ($p<0.05$) except for the rankings for *E. coli* O157:H7.

Table 7. Mann-Whitney U test scores between public and expert group rankings

	BSE[1]	*E.coli*[2]	*Salmonella*	Botulism	PSP[3]	Acrylamide
Mann-Whitney U	184.000	282.000	195.000	187.500	206.000	125.000
Z	-2.428	-.491	-2.229	-2.453	-2.032	-3.630
P value (2-tailed)	.015	.623	.026	.014	.042	.000

[1] Bovine Spongiform Encephalopathy

[2] *Escherichia coli* O157:H7

[3] Paralytic Shellfish Poisoning

4.2 Focus groups

Content analysis of the transcripts from the focus groups resulted in six distinct categories of responses for Question #1 and four categories for Question #2. These two questions asked what the highest and lowest ranked food safety issues were, of the six presented. Since the number one and number two ranked issues are the extremes of the rankings, answers were grouped and presented together for coding purposes. The same rationale was applied to the number five and number six ranked issues. Each final coding category is presented below as a theme, along with selected quotes from each of the two groups, public and expert. Percent agreement between two independent coders for content analysis was determined to be 77.3%. Discussion on discrepancies between coders resulted in 100% agreement.

4.2.1 Highest-ranked food safety issues

Prevalence and/or severity

> For just those three, they're basically the heavy hitters...
> (*E. coli* O157:H7, *Salmonella* and botulism)
> [Public participant #3]

The majority of comments for the food safety issue ranked as the highest related to *prevalence and/or severity*. This category included comments from both the public and expert participants on the high number of cases or outbreaks, the ease with which a person could contract the disease associated with the issue, the agent being found in many different types of foods or most eaten foods, and the high consequences of being afflicted with the agent (lifelong illness or death). There appeared to be a resigned attitude from all participants toward the highest ranked issues, as if there was little, if anything, that could be done to eliminate these risks from the food supply.

> Very few people would eat none of the foods listed, so the risk would be really high.
> (acrylamide)
> [Public participant #11]

> I don't think it's ever going to be possible to eliminate them from the food system.
> (*Salmonella* and *E. coli* O157:H7)
> [Expert participant #8]

Knowledge and control

> Because to me, there's nothing scarier than the unknown. (acrylamide)
> [Public participant #6]

The second highest number of responses fell into this category. Criteria for inclusion into this category included that the issue was difficult to control, or that there is high scientific knowledge about the issue yet it still affects many people. Participant comments focused on having knowledge of a particular issue and how this knowledge affected their ranking decisions. If there was a great amount of knowledge then the participants were more likely to have confidence in their rankings. If there was not much knowledge available on the issue, many public participants justified a higher ranking of an issue based on this theme. This was a departure point for the public and expert groups, with many of the public participants commenting on the unknown being frightening, especially with respect to acrylamide. Although some of the expert participants were not as familiar with acrylamide as a food safety issue, it was not fear of the unknown, but fear of the known issues that caused them to rank an issue higher. If there was little information available then experts were willing to wait and see if it became an issue in the future, with a cautionary approach that it could indeed become an issue. There were exceptions to this generalization in the public groups. As one participant commented:

> So the unknown doesn't scare you? [Moderator]
> No, how can it? If you don't know about it, it can't scare you.
> [Public participant #28]

Individual experience

> I have friends and family that live in England, and I have family that have been sick from it, and three of them died, so, kind of personal. (BSE)
> [Public participant #2]

The category of *Individual experience* included a participant's having fallen ill from the food safety issue, knowing someone who had been ill from it, or having a family member in a high-risk group, such as a child. An individual's experience with an issue was therefore assumed to encompass the family unit as well, since one's children or close relatives being ill may be considered a personal experience. While an individual's feeling of susceptibility to contracting a disease seemed even across the public and expert participants, this category had fewer responses than the previous two categories. Many of the public participants spoke of having had the illness associated with the issue, or of knowing someone who had been afflicted.

> ...could have more serious consequences, but these are the ones that I think my kids will be exposed to the most. So I want to minimize that risk.
> [Public participant #14]

Expert comments focused more on the susceptibility of infants and other high risk groups (immunocompromised, for example), rather than on their own personal risk.

Awareness

> It's just so rampant, I mean, you hear so much about it. (*E. coli* O157:H7)
> [Public participant #6]

You hear more about *E. coli*, so, people tend to be scared of it more.

[Public participant #9]

The appearance of food safety issues in the common media, including television, internet and print, defined *awareness.* Obtaining knowledge from medical professionals was also included here for the public participants, since personal, professional knowledge was limited, due to the restriction on having formal training in biological sciences for these participants. This category was mostly made up of public participant comments. Seven comments from the public participants fit into this category but only one was recorded from the experts. While both the public and experts were aware of media attention on a subject, it appeared that the public participants regarded this as more significant in their ranking decisions.

Trust

I've always been sort of skeptical of public restaurants and places like that.

[Public participant #10]

I'm surprised there are not more people that are sick...I've walked out of restaurants, where I just, I look at it, and I'm like, I couldn't eat there if I was starving to death!

[Public participant #22]

Trust was also heavily weighted to the public participants, much the same as *awareness.* As a category, *trust* was defined as the feeling toward all food handlers, from the farm level to the retail level, including government regulators and policymakers. The exclusion for this category was the trust in other consumers, including themselves, since the handling of food by the participant was considered to be a daily event, and each participant felt that they themselves knew exactly how they had handled each food item. In contrast, there was a lack of trust in other food handlers simply because the participant was not there to witness how they had done something.

Specifically the trust in the food handlers at restaurants was noted many times. A few of the public comments indicated that people felt large food processing corporations were merely looking to make more money and so cared little that people might fall ill from consuming their products. In contrast, experts did not identify trust as a major reason for ranking issues as higher.

> Everybody blames the government when this happens...when it was just really a corporate guy just looking for some money that is the real culprit.
>
> [Public participant #24]

> My biggest concern is *Salmonella*, because I've been through it a few times and it's bad, and it's very easy to spread, and I don't trust restaurants to practice safe food handling techniques.
>
> [Public participant #12]

Economic burden

> But yeah, the sheer numbers cost the system, cost to health of many individuals that are affected...
>
> [Expert participant #9]

The economic effects of a food safety issue were brought forward only by the expert participants. *Economic burden* was defined as the cost, in dollars, of foodborne illnesses, and how that cost would affect decisions made by risk-rankers in determining what the highest risks were to the public in general. While this is a difficult measurement to consider, the fact that it was mentioned only by the expert participants lent it weight in evaluating the differences between public and expert attitudes.

Many of the experts commented that their choices were made based on what the illness would cost the industry and the healthcare system. They did not disregard the human illness component, but rather translated them into dollar values. The absence of specific comments by public participants does not exclude them from this feeling, since the data gathered were not exhaustive.

4.2.2 Lowest-ranked food safety issues

Low prevalence and/or severity

> I have a better chance of winning the lottery. (PSP)
> [Public participant #15]

> I just look at it this way...the chance of basically one of these viruses trying to kill me is about the same as me getting hit by a bus (general comment)
> [Public participant #3]

A majority of the comments from both public and expert participants fell into this category of responses. In contrast to the *high prevalence and/or severity* that many public and expert participants rationalized as their reasons for selecting certain food safety issues as high risk, *low prevalence and/or severity* was the opposite. This category was defined by low numbers of outbreaks or cases, low exposure to the agent, and being exposed to the agent not having dire consequences. The absence of data to support that many persons are affected by a particular food safety issue or that it can be debilitating if exposed to it, led many participants to indicate that a food safety issue ranked as low was less of a concern than those with scientific numbers to support them.

Experts commented that even if an issue led to severe consequences, the idea that it was such a low probability in terms of exposure placed it very low on the ranking list. Comments for this category focused on having controls in place to deal with the issue and that the likelihood of contracting disease from the agent was low. It was also noted that even if a person became sick from a particular agent the consequences were not high enough to warrant much caution. Public participant comments related more to never hearing about an issue affecting anyone in their social circles.

> I don't know anybody who knows a friend who has a brother's cousin's roommate that had mad (cow), you know what I mean? Nobody has it, so, it's just, you know...I think there's more important things to worry about. (BSE)
> [Public participant #15]

> Overall there are few cases, there is prevention in place, and that was largely it. It doesn't impact that many people. (botulism and PSP)
> [Expert participant #19]

Personal control

> But it's found mostly in junk foods and everybody knows junk food's no good for them (acrylamide)
> [Public participant #10]

The notion of avoidance behaviour was mentioned in several of the groups and this concept was included in *personal control*. Other criteria for *personal control* centred on knowing what ingredients were in a food product and the participant's not being in a high-risk group (e.g. elderly or immunocompromised). Public participants indicated that if they did not consume products that were known to potentially contain a food hazard then they had less to be concerned about. Many of the comments focused on heavily processed 'junk' foods or specific foods they did not eat (such as seafood). Many of the responses specified that because a person was not exposed to the hazard there was no worry over it.

> So if you have such a concern, about it, then just avoid shellfish. You know? You have the ability to practice avoidance.
> [Public participant #5]

> But you eat at McDonald's by choice. You buy food in a grocery store because you have to eat, you know?...I think your expectations are a little higher in the grocery store, then they are in McDonald's. I know mine are! But I'm just saying that the way I perceive it, that I've made a bad choice to go to McDonald's to eat in the first place...the risk is higher there because it's crap, you know. Why don't you stick your face in a bucket of grease?
> [Public participant #6]

Risk understanding versus scientific knowledge

> I think the whole BSE issue is just blown way out of proportion...it's being treated like a contagious disease which it's not.
> [Public participant #9]

This theme was related to *low prevalence and/or severity* but focused more on either being geographically removed from the issue (e.g. shellfish in a prairie location, notwithstanding the global aspect of food supplies) or else indicating that there were more serious issues that should be dealt with. The idea that the popular media had made the issue larger than it really is, was described by some participants as well as the issue being evaluated not being a food safety issue at all. Some comments targeted the issue discussed (for example acrylamide) as being the 'flavour of the day' and that another food safety concern would replace it in the near future. Both experts and public participants made comments that fit into this category, with the majority of comments voiced by the experts.

> And it's not really a food, a food problem, there's definitely more chemicals that we should be worrying about. (acrylamide)
>
> [Expert participant #16]

No fear of the unknown

There was almost equal representation for this theme from both the public and expert participants. Comments concentrated on why an issue was not a concern because of a lack of scientific evidence that an agent affected human health. It was noted that if there was not a clear connection between the food issue being discussed and high numbers of humans being affected, then there were more important issues to focus on.

> and we don't know enough to necessarily say that, any direct consumption of foods, with these formed acrylamides is going to cause, some, even some sort of illness what the illness would be, what the ill effects would be for such a thing. Like we have an idea or you know, from animal testing, but that doesn't necessarily mean that that's what's going to happen in humans, right?
>
> [Expert participant #13]

There's no...linkage that they have established between the levels of acrylamide found in fried foods and human consequences...

[Expert participant #21]

In contrast to the unknown being a fear in many of the public groups, especially with respect to acrylamide, some participants stated that this lack of evidence influenced them in ranking acrylamide the lowest:

Just because there's no known cases, well, a lot of unknowns there, but I just thought, you know, there's no known cases... (acrylamide)

[Public participant #20]

I also read an article about...drinking water out of the bottle one day at work and I received an e-mail from a friend of mine (about) plastic esters?

[Public participant #8]

Whatever! Oxygen will kill you too. You get to a point where you can't,..., live your life like that.

[Public participant #6]

4.2.3 Participant Influence

While almost one third of the public participants would change their rankings based on hearing others' choices, very few of the expert participants would change theirs. Most of the changes were to a higher ranking of acrylamide in the public groups. The major reason for this was that not much was known or understood about the health effects of ingesting acrylamide. Table 8 summarizes the changes and the reasoning.

Table 8. Potential ranking changes based on focus group discussion

Rank would change	Public frequency	Expert frequency	What would change	Reasoning
Yes		3	Acrylamide (2) (higher)	Don't know enough about it
			Paralytic Shellfish Poisoning (1) (lower)	Second thoughts about issue-it's not a concern
No		18		
Yes	10		Acrylamide (9) (higher)	Concern about the unknown factors
			E. coli O157:H7 and botulism (1)	Should be ranked the same
No	19			

4.2.4 Additional food safety issues to consider

Question #4 asked if there were food safety issues that should have been included in the exercise. Both the public and expert participants provided answers that were quite varied. The responses ranged from chemicals added to foods, either as pesticides or in packaging, to concerns over bacteria not included in the original six issues and viruses. Other noteworthy concerns were food employee hygiene and allergens. However, most comments related to technological concerns. One public participant summarized how technology has changed her concerns with respect to the food supply:

> I'm thinking about a tomato that I have sitting on my counter, for 3 weeks, and it never changed shape, I just watched it, it was red the whole time, and it got to be almost, like the thing. Like I was focused on this thing, and I'd lift it over to see if it was rotting from underneath, and it didn't, it was still nice and red, and big. 3 weeks, finally I cut it open, and it was, just the same. And I thought oh my god. To think that I could have eaten that. But, it stayed that way, what did they add to it; did they inject it with something, to let, I mean, if you pick, if I pick my own home grown tomato, it would never last 3 weeks. It would rot, but to have this perfectly, I mean, you could

have done a still painting of it, and I'm, I'm concerned about what do they put in our foods that can keep a tomato perfectly shaped, not shriveled up, not rotten, anything for 3 weeks, on your kitchen counter? Hello, that's not even normal.

[Public participant #16]

Other than those food safety issues presented in the exercise there were many suggestions on what additional food issues should be included in a food safety issues ranking exercise.

Table 9. Additional food safety issues that participants felt should be included in the exercise

Public participant additions	Food employee hygiene (5) Plastic chemicals leaching into food (4) Avian Influenzae Trichinosis *Campylobacter* Norovirus Genetically Modified Organisms (GMO) Trans fats butters cholesterol sugars (food value of) education/training estrogens/steroids pesticides
Expert participant additions	Norovirus (2) *Campylobacter* (2) Pesticides (2) Allergens (2) How the food system is managed (risk management versus risk identification) Heavy metals Teflon agent *Listeria* Hepatitis Organic foods Geography (the importance of an issue based on this) Obesity Chemical residues

Additions that would be made by both public and expert participants included some bacteria (*Campylobacter* and *Listeria*) viruses (Norovirus), and pesticides. There were also issues identified that were not agent-specific: hygiene, education and training, and geography as it relates to the relative importance of an issue are notable. Table 9 summarizes the issues that were discussed.

4.2.5 Safety of the food supply

> I haven't stopped eating, so obviously I feel it's safe!
>
> [Expert participant #20]

All expert participants responded that the Canadian food supply was either very safe or at least not in serious jeopardy. There were some comments that safety depended on what part of the food chain was being discussed, but overall there were no concerns with Canadian food. However, public participants had different views on the state of the Canadian food supply:

> Is it safe as it is, you know, can be? No, but I mean, as it probably will be, is this, you know, are you willing to pay, you know, $10 for an apple?
>
> [Public participant #15]
>
> Out of ten, ten being the worst and one being the best; to have to pick it I'd rate it a five.
>
> [Public participant #24]

The comment above was indicative of the general responses from the public participants. In contrast to the experts, 'safe', 'not safe' and 'variable' were almost equal in terms of responses to this question from public participants. Concerns about additives, preservatives and heavily processed foods were common.

> But I can leave that bread on the counter for, for about five weeks before it walks away.
>
> [Pubic participant #17]

It's like Cheez Whiz, I heard somewhere that Cheez Whiz is one molecule shy of being a plastic.

[Public participant #27]

4.2.6 Responsibility for food safety

Expert participants felt that responsibility for the food supply was shared among all players throughout the food continuum. Most of the experts interacted with many different aspects of the food chain through their work and so this was to be expected. Theirs is a broader exposure to what regulations are in place and the various jobs of the food industry, government and food handlers. But there were also comments about consumers not taking enough personal responsibility for their home food preparation:

I think people...don't take as much responsibility for their own section as they should do. But then, I think you've got to have something like a governmental body setting out the guidelines...

[Expert participant #10]

...like consumers maybe not taking responsibility for food safety, and realizing that there is some responsibility involved, the food is not going to be 100% sterile...we still have students taking food micro (sic) who think that some food should be completely sterile.

[Expert participant #17]

Public participants focused on the government's role in protecting the food supply, but also ceded that everyone has a part to play in some way. The public comments in reference to the responsibility of government health and food safety departments included:

> I think we have several of those departments; the problem is, is that they're usually stretched so wide, and so thin, and that's another area, that lets things go through. [Public participant #9]

4.3 Public survey

There were 403 completed interviews from the Edmonton Metropolitan area, 402 from the Calgary Metropolitan area, and 402 from the rest of Alberta, for a total of 1207 completed interviews. The number of interviews completed in each location represents the proportional breakdown of the Alberta population, as per the 2005 census. Five questions within the survey instrument asked about food safety issues, following the focus group question scheme. The first question asked which issue was the highest ranked with respect to food safety importance. Table 10 summarizes these highest-ranked food safety issues from the survey.

Table 10. Highest-ranked food safety issues from public survey

Food issue	Frequency	Percent
Salmonella	371	34.2
Paralytic Shellfish Poisoning	20	1.8
Acrylamide	19	1.8
Escherichia coli O157:H7	500	46.1
Botulism	85	7.8
Bovine Spongiform Encephalopathy	90	8.3
Total[1]	1085	100

[1] Responses of 'don't know' (88) and 'no response' (34) were removed from the total

Similar to the focus group rankings the survey results indicated that *E. coli* O157:H7 and *Salmonella* were the two highest-ranked concerns, with 46.1% and 34.2% of respondents ranking these as the top two concerns, respectively. In contrast to the high ranking given to acrylamide by the public focus groups, acrylamide was only ranked highest by 1.8% of the respondents in the survey. Response options for the reasoning on choices for ranking were closed in the survey as opposed to the focus group discussion where they were open-ended. Because of this, comparisons between coded categories and survey results were not direct. Since the survey instrument was designed based on the analysis of the focus group transcripts, there were similarities in responses that could be compared. Table 11 presents these closed-ended responses for why a food safety issue was chosen as the highest concern.

Table 11. Public reasons for choosing highest-ranked food safety issue

Reason	Frequency	Percent
I and/or someone I know has been affected by this issue	151	14.4
I hear a lot about this issue on TV and /or in the newspapers	312	29.8
I don't know anything about this issue, and that makes me more frightened of it	26	2.5
A lot of people are affected by this issue	184	17.6
The health consequences of this issue are particularly dangerous	375	35.8
Total[1]	1048	100

1 Responses of 'don't know' (22) or 'no response' (15) and those who did not answer the ranking question (122) were removed from the total.

Reasons for choosing a food safety issue as high aligned with the focus group participant reasoning. More than one-third of the respondents (35.8%) indicated that the health consequences of an issue concerned them (*prevalence and/or severity*), 17.6% chose numbers of persons affected as being their reason (*prevalence and/or severity*), and 29.8% indicated that exposure to the issue via the media was their reason for ranking an issue high (*awareness*).

Lowest ranked food safety issues were also selected from the same list of food safety issues in the survey. Table 12 summarizes these results. Bovine Spongiform Encephalopathy (BSE) was selected by 41.9% of the respondents and PSP was chosen by 31.6%, as the two most common responses. In comparison, within the public focus groups BSE was chosen by 20.7% of the participants and PSP by 41.4%.

Table 12. Lowest-ranked food safety issues from public survey

Food issue	Frequency	Percent
Salmonella	49	4.7
Paralytic Shellfish Poisoning (PSP)	327	31.6
Acrylamide	139	13.4
Escherichia coli O157:H7	21	2.0
Botulism	65	6.3
Bovine Spongiform Encephalopathy (BSE)	433	41.9
Total[1]	1034	100

[1] Responses of 'don't know' (41) and 'no response' (10) and those who did not answer the ranking question (122) were removed from the total

The respondents' reasons for these choices are provided in Table 13. Similar to the focus group results, 38.0% of the respondents reasoned this was a low risk food safety issue because not many persons are affected (*low prevalence and severity).* A food safety issue that has not affected the respondent or anyone within their social contacts was given as a reason by 26.8% of the respondents.

Table 13. Public reasons for choosing lowest-ranked food safety issue

Reason	Frequency	Percent
Neither I nor anyone I know has ever been affected by this issue	268	26.8
I don't hear a lot about this issue on TV and/or in the newspapers	114	11.4
I don't know anything about this issue, and that makes me less frightened of it	139	13.9
Not very many people are affected by this issue	380	38.0
The health consequences of this issue are not very dangerous	98	9.8
Total[1]	999	100

1 Responses of 'don't know' (17) or 'no response' (18) and those who did not answer the ranking question (173) were removed from the total

4.3.1 Statistical Analysis of Public Survey

Correlation analyses between the highest (Appendix O) and lowest (Appendix P) rankings and the *education* and *location* variables indicated that there were no strong correlations between the highest or lowest rankings and either *education* or *location*, using Pearson's correlation coefficient. Only *E. coli* O157:H7 showed some positive correlation with respect to *education* ($p<0.00$) and BSE negatively correlated with *education* ($p<0.02$), indicating that participants with greater than high school were more likely to choose *E. coli* O157:H7 as a highest-ranked issue, and were more likely not to choose BSE as a highest-ranked issue. For the lowest-ranked issues similar results were obtained. The only food safety issue that had a significant correlation with *education* was *Salmonella* (Pearson's coefficient= -0.09; $p<0.03$), indicating that those participants with a greater than high school education were less likely to choose *Salmonella* as a lowest-ranked issue.

To fully investigate the potential connections between the food safety issue rankings and *education* and *location,* regression analyses were performed and produced similar results. For the highest-ranked food safety issues (Appendix R), *E. coli* O157:H7 (t-stat=3.56; $p<0.00$) and BSE (t-stat= -3.12; $p<0.02$) were significant with respect to *education*. For *E. coli* O157:H7, a coefficient of 0.11 for *education* suggested that those participants with greater than high school education were 11% more likely to select *E. coli* O157:H7 as a high concern. A coefficient of -0.09 for *education* (BSE) suggested that those participants with greater than high school education were 9% less likely to choose BSE as a high concern. Although these were statistically significant, the R^2 value of 0.013 for *E. coli* O157:H7 and 0.009 for BSE suggest that there was not a compelling contribution from *education* to the choice of rankings, with only about 1.3% of the choice explained by *education* for *E. coli* O157:H7 and 0.9% of the choice explained by *education* for BSE. These findings were consistent with the correlation results. For the lowest-ranked food safety issues (Appendix S), only *Salmonella* (t-stat= -2.89; $p<0.04$) was significant for *education*. A coefficient of -0.09 for *education* suggested that those participants with greater than high school education were about 9% less likely to choose *Salmonella* as a lowest-ranked issue. As was the case for the highest-ranked food safety issues, the R^2 value of 0.008 suggests that there is little contribution from *education* in explaining the ranking choice. Overall, there did not appear to be major influences by *education* or *location* for ranking decisions in the public survey.

5 Discussion

To the best of our knowledge this research represents the first time a modified risk ranking model such as the Carnegie Mellon model has been used to compare rankings of food safety issues by public and expert participants. This research was exploratory and not conducted in an attempt to prove any concepts. Rather, it was used to validate a risk ranking model and as a starting point to determine if and how different groups of people rank food safety issues. A by-product of this research was how these differences may help in deciding on recommendations for improving risk communication, through different formats of message delivery.

It might have been expected that public and experts would have contrasting views in their ranking choices, based on the residual popularity of the knowledge deficit model in risk perception research (Brunk, 2006; Sturgis & Allum, 2004; Hansen *et al.*, 2003). While there was some evidence to support this conclusion in the present research, the majority of the rationales used by all participants were similar, as indicated by the common themes that emerged from the focus group discussion analyses. This conclusion was made with the exception of the high ranking given to acrylamide by the public groups in the individual exercise. While both experts and public participants' reasoning for their respective choices were slightly different, the emergent themes from the focus group discussions reflected that the two groups were congruent when it came to final decisions. Areas in which experts and public participants showed disagreement included *awareness* and *trust*, in the highest-ranked food safety issues. The *unknown* as a factor appeared in both groups' discussions but for different reasons.

Our results indicated that overall, both public and expert participants were most concerned with those food safety issues that are highly prevalent and have notable consequences. These results contrasted somewhat with work done by Slimak and Dietz (2006) in which they concluded that the public were concerned about low probability/high consequence risks, while experts were primarily concerned about long-term impacts. Additionally, the BSE ranking by both groups in our research was low (a low probability/high consequence issue itself). Rosati and Saba (2004) determined that BSE was one food issue that was of great concern to public participants in their study of food issues and reliability of information sources. As well, Setbon *et al.* (2005) described decreases in beef consumption that were due to BSE media attention alone. While our work does not refute these two studies in totality, it does indicate that there are no general assumptions that can be applied when assessing the level of risk associated with an issue, be it food safety or in the case of the Slimak and Dietz's study, ecological risks. That such varying results related to risk perception would be found in studies of food safety was one conclusion of Renn (2005).

Numeracy and attribute framing as an explanation

The high rankings of *E. coli* and *Salmonella* deserve attention. The most common explanation for choosing these food safety issues as highest concern was the *prevalence and severity* of the agent. This was based primarily on participant evaluation of the mortality and morbidity data associated with each food safety issue, as detailed in the RSS for each issue. Apart from the somewhat obvious link that larger numbers leads to larger attention, the effects of *numeracy* and *attribute framing* also help to explain these results (Peters *et al.*, 2006a). This is especially true when participants have these numbers directly in front of them to examine and compare with the other issues. When presented with risk information in numerical form, individuals judge the numbers in ways that are unique to their *numeracy* style. *Numeracy* refers to an individual's ability to 'use or understand numerical techniques of mathematics' (Random House Unabridged Dictionary, 2006). For example, if information is given as percentages rather than as probabilities the significance of the number may be interpreted differently even though the two are mathematically equivalent. While an in-depth analysis of the effects of *numeracy* on risk ranking was outside the scope of this research, it is sufficient to state that the format of the RSS could have affected each individual's decisions since mortality and other statistics were presented in a mixed format. Thus, *attribute framing*, or how an attribute is presented (in written form) is also important to consider, since some of the information was presented as percentages, some as mere numbers and some as qualitative values.

Investigating the effect of *numeracy* and *attribute framing* further, the potential contributions to ranking choices based on demographics was assessed. It was tempting to try to correlate certain demographic variables such as level of education and Alberta location to relate *numeracy* and rankings. However, as Peters *et al.* (2006a) emphasized, the degree to which a person is numerate is not correlated with general intelligence. Thus, the effect of *numeracy* should have been consistent across all individuals in the focus groups regardless of demographic differences. In another study, Setbon *et al.* (2005) focused on BSE in France during the epidemic of 2000 and how it affected beef consumption in France. Similar conclusions as the present research were obtained when investigating possible linkages to demography. In line with Peters *et al.* (2006a) and Setbon *et al.* (2005), survey participants' demographic variables were found to have no correlation to risk perception. In our research we determined only weak correlations between *education*, Alberta *location* and the rankings of *E. coli* and *Salmonella*. *Numeracy* may have had some effect on choices made in rankings, but its contribution is not likely a large one.

Availability as an explanation

Another explanation for the high rankings of *E. coli* and *Salmonella* is found in the *availability* heuristic. How feelings regarding an issue are triggered by recent exposure to the issue, be it in the form of the various media or by personal experience, was an important consideration for our research. *E. coli* and *Salmonella* are known by their names in part because of the many large-scale outbreaks associated with them. By presenting a list of some of the more well-known food product outbreaks/recalls it is possible that another type of recall occurs-the memory recall of the individual, with respect to what messages have been received about the products and associated food safety issue.

Support for this concept is found in how some foodborne outbreaks have been well-documented in the media: Jack in the Box restaurants in 1993 (*E. coli* O157:H7), arguably one of the most infamous foodborne illness outbreaks; Hudson Foods' ground beef contaminated with *E. coli* O157:H7 in 1997 (25 million pounds); Walkerton, Ontario municipal water supply contaminated with *E. coli* O157:H7 in 2000; fresh spinach contaminated with *E. coli* O157:H7 in 2006 (throughout North America); Cadbury chocolate products contaminated with *Salmonella* in 2006; peanut butter contaminated with *Salmonella* in 2007; Topps Meat Co., *E. coli* O157:H7 contaminated ground beef in 2007 (21 million pounds) (recall incidents retrieved from CFIA, 2007; FDA, 2007). The link established between these large-scale incidents and an individual's personal recall is described well by the *availability* heuristic. Memory recall and association therefore may have played an important role in determining the high rankings of both *E. coli* and *Salmonella* in this research.

The frequency of comments relating to *awareness* and media exposure to the food safety issue was much higher for the public participants than for the experts in the focus groups. And as Rosati and Saba (2004) concluded in their study, the public was most concerned about food safety issues that were well known to them. Even more support for this was found in the public survey results where survey participants had only the *name* of the food safety issue with which to make a determination of which was of most concern. Without any other information provided, survey participants chose these two food safety issues as highest. Further to this point, when presented with several items to choose from, there seems to be a propensity for people to focus on those they are familiar with or have been exposed to more often. This is one of the cornerstones of consumer product advertising, as described by the mere exposure effect (Baker, 2003; Tom *et al.*, 2007). By repeated, or even single exposure to a product through advertising, a person develops positive feelings toward the product. Awareness of a product through marketing can lead a consumer in a certain direction when shopping in a competitive marketplace. People tend to purchase items they are familiar with and this familiarity is borne out of the constant bombardment of advertising they are exposed to. The reasoning of the survey participants for their highest and lowest concerns may also have been affected by the mere exposure effect. Only closed-ended responses were provided for the participants. Without being able to elaborate on their answers they were committed to choose one of the available responses.

Similarly, an analogy may be made where food safety issues are thought of as products. The advertising in this case is the media attention given to an issue. Participants in both the public and expert groups commented on this, and that they were very aware of *E. coli*, *Salmonella* and botulism, both from media exposure and personal knowledge (*individual experience* and *awareness*). The rankings of *E. coli* and *Salmonella* as highest in both groups supported this concept. The very small percentage of participants who ranked PSP high further support this: Many participants had either not heard much about PSP or stated that the issue was not on their minds-they may have heard about it, but only remotely. The comparison by one public participant of acquiring PSP to winning the lottery emphasized this point.

The role of affect

The *availability* heuristic helps in part to explain these common bacteria (*E. coli* O157:H7 and *Salmonella*) as important food safety issues, but it does not completely account for the high ranking given to acrylamide, which has not received as much media attention. It is possible that other than the RSS containing many 'unknowns' for the attributes of acrylamide, the mention of a chemical name would have a negative impact on a person's perception of it as a risk. In risk perception research this is the role of the *affect* heuristic (Slovic & Peters, 2006; Slovic *et al.*, 2005; Peters *et al.*, 2006(b); Slovic *et al.*, 2007). Using similar food safety issues as in our research, Kuttschreuter (2006) was able to illustrate this role of *affect*. In her research she determined that when people were asked about dioxin contamination in chicken versus *Salmonella* contamination in chicken, they were most concerned with the dioxins. Even though *Salmonella* is a well-known food safety issue the mention of a chemical instilled more fear in her study participants. Our focus group results were consistent with this finding and how *affect* would influence decisions, especially when associated with the use of a lesser-known chemical among more well-known issues. Both *availability* and *affect* are related in that the recall of an event is linked with feelings (Slovic *et al.*, 2004; Keller, Siegrist & Gutscher, 2006) and so the combined effect of these two heuristics in this research may be substantial. *Affect* may therefore help to explain much of the high rankings given to acrylamide, but there was an interesting finding in our research when the public survey was conducted.

The dichotomy of the unknown

The public survey results did not support the role of *affect*, if the explanation is that the name of a chemical will result in a higher ranking. There were few survey participants who chose acrylamide as a high risk. The survey participants did not have the benefit of having the RSS in front of them, or having any more information available to them besides the name of the issue. It could be that when focus group participants were confronted with a RSS that has many of the attributes of an issue listed as 'unknown' (as in the case of the acrylamide RSS) rather than as numbers, the highly numerate person cannot directly compare this qualitative attribute description with those numerical values from the other food safety issues. The two choices are either to ignore the unknowns and rank the issue low, or focus on the unknowns and increase the rank because of this uncertainty.

There was a curious dichotomy that emerged when the *unknown* was investigated in the focus group discussions, beyond the previous discussion on *numeracy*. While many of the public participants viewed the *unknown* as fearful, as supported by the comments on acrylamide, there were almost equal numbers of participants who felt that the unknown was not a concern. This seemingly contradictory approach to rankings can be further examined using the following quote as an introduction:

> There are known knowns. These are things we know that we know. There are known unknowns. That is to say, there are things that we know we don't know. But there are also unknown unknowns. There are things we don't know we don't know.
>
> [Donald Rumsfeld, Press Conference at NATO Headquarters, Brussels, Belgium, June 6, 2002]

This initially confusing quote from the former United States Defense Secretary helps to illustrate this point. *Known knowns* in the context of this research are the published scientific literature. Even though there are unknowns in everything we encounter, some of them are easily dismissed since they are taken for granted (the *known unknowns*). For food safety issues this could be interpreted as the gaps in the science that are still being investigated. Because of ongoing research these gaps will hopefully be filled in and the resulting *known knowns* published. The *unknown unknowns* are what cause the fear in some people, possibly because they feel that anything harmful should already have been discovered by the scientists and dealt with. To others these *unknown unknowns* are nothing to worry about since, as one public participant stated, "...if you don't know about it, it can't scare you." *Attribute framing* may therefore have a much larger effect on risk perception than *availability* and *affect*, since the major differences in opinion in the focus groups related to the *unknown* and acrylamide.

Trust

A third theme in which comments were more heavily weighted to one group was in *trust*. The mistrust of food preparers by the public participants was given as the main reason, but there are also examples throughout the focus group discussions of mistrust in the large corporations and government. *Trust* relative to food safety is a well-studied concept, especially during the BSE crisis in the United Kingdom in the

1990s, where mistrust in the government occurred because of mismanaged risk communication to the public around the link between consumption of BSE-infected meat and human disease (Kirk *et al.*, 2002; Green *et al.*, 2003). The findings in the current research related to *trust* are in line with a recent study by Lang and Hallman (2005). In their work, they determined through factor analysis that along with grocers and farmers, industry was the least trusted when public participants were asked about genetically-modified (GM) foods in the United States. Government was least correlated with the factors and so the results of this study could not conclude whether government is actually trusted or to what degree. Green *et al.* (2003) asserted that there is an insulating effect of many social environments whereby a person does not have to make risk management decisions in day-to-day activities. Once *trust* breaks down, however, a person is then left to determine their own best course of action. Relying on this idea from Green *et al.* (2003) our results would indicate that most of our participants were in this insulating environment and therefore not in a general mistrusting situation. Thus, while *trust* as a theme was discussed in the focus groups it did not appear to play a definitive role in decision-making for our research. Supporting this conclusion, the majority of responses to the question of who is responsible for the safety of food in Canada were that everyone, including the consumer, has a role to play. Nearly 75% of the public survey respondents also stated that everyone has some responsibility. It was inferred that because of this responsibility being spread across all persons, *trust* in any one player should not differ significantly and therefore the ranking choices should not have relied on *trust* as a major contributor.

Lowest-ranked food safety issues

An evaluation of the lowest rankings lead to conclusions that were almost opposite of the highest rankings, which intuitively is sensible. That is to say, the attributes of each food safety issue that struck the participants as meaningful were the same as for the highest rankings, but for the opposite reasons. The *low prevalence and severity* of agent was the most often chosen theme when it came to ranking an issue low-risk. As was the case in the highest rankings, *numeracy*, *affect* and *availability* likely played roles in an individual's choices. The effect of *numeracy* would depend on how numerate a person is and so this effect may have to be investigated in a more specific study of *attribute framing* with respect to food safety issues. The *availability* heuristic, while perhaps explaining why *Salmonella* and *E. coli* were not chosen as low-risk, does not help in explaining the ranking of BSE as low. Certainly in Alberta this is a high-profile issue, due to confirmed cases in Alberta cattle over the past four years.

Optimistic bias

It may be that *optimistic bias* is another factor that likely played a role in decisions to rank a food safety issue as low. This tendency to downplay a person's own susceptibility to a hazard is common (Parry *et al.*, 2004; Redmond & Griffith, 2004) and examples were provided by focus group participants when describing their reasoning for low-ranked issues:

> I can openly admit I've got an iron stomach. I can like chow down on anything. And even if it's like half cooked or not half cooked...it goes right through.
>
> [Public participant #3]

These attitudes were found mainly in the *personal control* and *risk understanding versus scientific knowledge* themes. Some participants stated that they were not in a high-risk group therefore they had no concerns. Being exposed to certain hazards may result in severe consequences, regardless of health status. Both the high-risk individuals and anyone else may end up having severe consequences if exposed to a particular hazard (e.g. *E. coli* O157:H7), since it takes a small exposure to certain agents to cause deleterious effects. Geographical location was given as another reason not to be concerned for some of the food safety issues. This idea was touched on in the Results. The fact that the food supply is global seemed to be overlooked by some of the participants and this relates directly to *optimistic bias*:

> Living in the prairies I'm not about to become a shellfish nut.
> [Public participant #16]

Potential Issues Identified in the Research Design

There were some issues identified with the experimental design, with respect to participant selection for the expert and public groups, the numbers of participants, and the use of the same model for both groups. Experts were selected by the researchers. There was an inherent selection bias built into this process, but the experts were chosen out of a relatively small pool of talent that makes it difficult to use random selection techniques. With only 29 public participants and 21 experts in the focus groups, the statistical significance of the initial individual rankings may come into question. However, for the most frequently chosen high-ranked food safety issues, there was a clear separation among chosen food safety issues. Although Mann-Whitney tests indicated significance with respect to the ranking of acrylamide, the primary reason for this exercise was to provide a starting point for discussion and not let the numbers 'speak for themselves'. The selection of the public participants by a third party company also was a source of bias: Individuals that were on the third party company's list were already willing to participate in focus groups. The selection of participants therefore was not random.

To provide quantitative support, the public survey was used to supplement the results and give more support to the choices made by the public groups. The survey was conducted using a random digit dialing procedure. An inherent bias of this method is that it will only capture those potential participants that are at home at a given time. Selection bias was a concern with this method since those individuals without a phone, those who screen their phone calls, those with only cellular phones and those with multiple phone numbers may have been discounted.

Some of the language in the RSS was technical and there were questions raised about this. This technical language initially appeared to be a factor in decision-making with some of the public participants, indicated by questions during the individual exercise and a few during the focus groups. It is entirely probable that some participants did not feel comfortable bringing up questions in a group setting and so did not completely understand some of the terminology. This may have impacted a decision on which food safety issue to rank highest. However, the results suggested the notion that participants made decisions based on reasoning other than a complete understanding of terminology. Some expert participants also asked for clarification on RSS terminology. We assumed therefore that these misunderstandings of the terminology did not significantly impact the basic understanding of the material presented on each issue.

There were also concerns with the order of the food safety issues given in both the individual ranking exercise and the public survey. Especially because of the effect of *availability* it was important to note that those issues presented first may influence the ranking choices of the participants. To mitigate this effect the same order was chosen for all exercises. The initial order of RSS was random and maintained thereafter for all data collection exercises.

Participant influence

Because the focus group participants indicated a great deal of conviction in their rankings, the combined effects of *affect*, *availability* and *numeracy* were strengthened. If there were a lot of influence from other participants in changing other's rankings then perhaps other effects would be warranted. The one exception to this was found in the acrylamide ranking. There were both public and expert participants who would change their acrylamide rank higher than they did if given the chance. The most often reason was because of the *unknown* factor. This reasoning speaks to the *attribute framing* discussed previously.

Additional issues

The list of additional food safety issues that participants indicated should have been included in the ranking exercise shows that all participants were very interested in their food supply. The list also shows that the participants were aware of much more with respect to food safety than what was presented in this research. That there were, for the most part, similar lists generated by both public and expert participants suggested that the two groups are not that far apart when it comes to what concerns them most with respect to food.

6 Conclusions

When deciding what food safety issues require the most resources, decision-makers are constantly looking for new ideas. Public consultation, expert elicitation and judgments by panels or committees are a few of the concepts that have been experimented with. In all cases there are biases by the participants, even though the participants, be they public or government, feel they have the best interests of the public at heart. This work was undertaken to determine two things: First, that a risk ranking model could be validated using both experts and public participants. This validation was important so that the process of gathering various players' input could be done in a consistent and user-friendly manner. The successful use of the model in individual exercises supports the validity of the model. Second, the reasons behind the rankings by the expert and public groups were compared so that it could be determined if there were significant differences between the two. While there were differences, the findings of this research indicated that they were due to subtleties in the presentation of risk attributes.

Intuitively it is known that whether we are an expert or a layperson, we are all consumers and fit into one of many publics. That a small sample of the Alberta population chose acrylamide as a high-risk food safety issue means little in the greater context. The format of the risk information could explain some of the choices made. Indeed, when a larger, random sample of the Alberta population was ranking the same food safety issues, acrylamide was very low on the list. When presenting risk messages, the effect of *attribute framing* is an important consideration. While there is no single format that will be interpreted by all receivers of the message in the same way, the format should be consistent. If something is presented as a percentage one day and a probability the next, there may be confusion and potential mistrust of the message and of future messages. Further research in this area should focus on both public and expert evaluations of food safety risks for which there is little information available. There are many food issues that are not as easily recognized as most of those presented in this research. By conducting this type of research, richer information as to the reasoning of both groups will provide insight into what really drives personal decision making with respect to the safety of the food supply. As one participant stated:

> We get to express our opinion…and then you realize, we're all kind of concerned about the same things. Everybody is sort of on the same wavelength.
>
> [Public participant #17]

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"Mad Cow Disease" (Bovine Spongiform Encephalopathy – BSE)

Summary [1]:

BSE or "Mad Cow Disease" is a transmissible, fatal disease of the central nervous system of cattle. The disease is part of a group of diseases called transmissible spongiform encephalopathies (TSEs) that also affect other mammals. Scrapie in sheep, chronic wasting disease (CWD) in deer and elk, and Creutzfeldt-Jakob disease (CJD) in humans are all TSEs. Other TSEs have been found in domestic cats and minks. It is thought that a protein called a prion is responsible for the disease. To date there is no vaccine or treatment that can be given to prevent or cure prion infections. Information given below is for the **human** form of the BSE variant CJD (vCJD).

Cases per year	Five (2005, worldwide)
Fatalities per year	152 total (1990-2005)
Likelihood of fatality	certain
Likelihood of contracting disease	Minimal / rare
Injury other than fatality	None known
High risk groups	None specified
Types of food agent is found in	Central Nervous tissue from cattle (predominantly ground beef products, sausage and mechanically recovered meat)
Geographic area agent is found	United Kingdom is the major area, elsewhere throughout world
Prevention measures in place	Removal of Specified Risk Materials (SRMs) from carcasses at slaughter prior to meat & products entering food supply; feed bans, import restrictions
Time between exposure and health effects	Several years to several decades
Scientific knowledge	Medium to high
Ability to prevent exposure	high

Other information:

BSE was discovered in the United Kingdom (UK) in 1986. The vast majority of BSE has been detected in the UK with the peak occurring in about 1992. BSE has subsequently been diagnosed in many other countries. Since this was a new disease of cattle, there was little concern that it could infect humans. However, a human form of the disease (vCJD) was discovered in 1996 and much research focused on treating and preventing this human form of BSE. A link was made between consumption of beef products and the human form of the disease. By the time scientists made this link there were almost 1 000 000 infected cattle, most of which ended up in the human food chain. Measures were subsequently put into effect to eliminate the amplification and spread of the BSE agent and minimize the risk of human exposure.

Like BSE, vCJD is not contagious (person to person). A person must be exposed to the agent by ingesting infected materials. Research on transmission by blood transfusions and other medical procedures has been inconclusive. Cattle must also be exposed in a similar way to become infected. Since the discovery of where this agent resides in cattle, the numbers of infected cattle have decreased markedly, as a result of the measures outlined below which have been implemented.

What is being done to control BSE [1]:

1. BSE is a notifiable disease and as such, any case discovered must be reported, both to the Canadian Food Inspection Agency (CFIA) and to the world animal health organization. In Canada the following measures have been taken (info from CFIA website http://www.inspection.gc.ca/english/anima/heasan/disemala/bseesb/bseesbindexe.shtml:

- Surveillance programs in which the brains of high-risk cattle are tested.
- Banning the feeding of rendered materials from ruminants (cattle, sheep, goats, bison, elk or deer) to other ruminants.
- BSE has been a reportable disease since 1990.
- Creation of the Canadian Cattle Identification Program in 2001 for cattle and bison, in order to track animals from origin to point of slaughter.
- Controlling the importation of products that have a high risk of introducing BSE into Canada. Canada only allows the importation of live ruminants and their meat and meat products from countries that Canada considers to be free of BSE.
- Canada has not imported ruminant-derived meat and bone meal for the purpose of livestock feeding from Europe for more than a decade. In December 2000, the CFIA suspended the importation of rendered

animal material of any species from any country that Canada did not recognize as free of BSE.

- Removal of certain cattle tissues, known as specified risk materials (SRMs), from all cattle slaughtered for human consumption. SRMs are tissues that may contain the prion, such as the brain. It is estimated that the removal of SRMs from cattle at slaughter effectively removes 99.99% of any potential BSE infectious prion protein.

Major references used:

1. Canadian Food Inspection Agency (CFIA) website: http://www.inspection.gc.ca/english/anima/heasan/disemala/bseesb/bseesbindexe.shtml

2. Department for Environment, Food and Rural Affairs (DEFRA) website: http://www.defra.gov.uk/animalh/bse/index.html

3. Harvard Center for Risk Analysis: http://www.hcra.harvard.edu/publications.html

Escherichia coli O157:H7

Summary:

Escherichia coli O157:H7 is a specific type of *E. coli* bacteria that resides in the gut of some animals such as cattle. While the non-pathogenic *E.coli* are a normal part of the gut microbes, including the human gut, the O157:H7 type is dangerous and can lead to serious illness and death. The organism gained notoriety when outbreaks of hemorrhagic colitis (bloody diarrhea) were associated with consumption of undercooked ground beef. Although it is a rare type of *E.coli*, O157:H7 has been found in other foods besides ground beef. Only a relatively few *E. coli* O157:H7 bacteria are needed to cause disease, thus there are challenges in the preparation of raw foods that may be contaminated this pathogen.

Cases per year	73, 000 (US)
Fatalities per year	61 (US) 3-5% for hemolytic uremic syndrome (HUS)
Likelihood of fatality	Low to Medium
Likelihood of contracting disease	Medium
Injury other than fatality	Acute: severe bloody diarrhea, cramps Chronic: HUS – kidney failure
High risk groups	Immunocompromised, elderly, infants (especially those under 5 years of age)
Types of food agent is found in	Undercooked or raw hamburger, alfalfa sprouts, unpasteurized juices, lettuce, unpasteurized dairy products
Geographic area agent is found	Ubiquitous
Prevention measures in place	Proper handling and cooking of food products; testing
Time between exposure and health effects	Acute – <24 hours Chronic – days to weeks
Scientific knowledge	High
Ability to prevent exposure	Medium to high

Other information:

E.coli O157:H7 infections are generally self-limiting and most patients will recover in 5-10 days. Antibiotic treatments are normally not used. Approximately 30% of HUS victims will need dialysis treatments due to kidney damage. Elderly persons having HUS plus fever and neurologic symptoms may have thrombotic thrombocytopenic purpura (TTP). The death rate in the elderly can be up to 50%.

Many of the food recalls due to this organism have been exceptionally large, with some having millions of kilograms of products (ground beef in most cases) being removed from the food supply.

Contaminated foods do not smell or look any different than non-contaminated foods. As well, the organism does not cause illness in cattle and so determining whether an animal is a carrier is more challenging than usual methods of inspecting food animals for disease.

What is being done to control *E.coli* O157:H7:

- Consumer education on food handling
- Many resources are available on proper handling of foods to ensure that cross-contamination is minimized during food preparation
- Research on the organism and potential controls to prevent *E. coli* O157:H7 from entering the food supply
- Regulatory / testing of food products – both the US and Canada have a zero-tolerance for *E.coli* O157:H7 found in meat products. When a positive test occurs, that product is removed from the food supply and an investigation is done into possible sources.

Major references:

1. Canadian Food Inspection Agency (CFIA): http://www.inspection.gc.ca/english/corpaffr/foodfacts/mythe.shtml
2. Food and Drug Administration (FDA) and Center for Food Safety and Applied Nutrition (CFSAN): http://www.cfsan.fda.gov/~mow/chap15.html
3. Centers for Disease Control and Prevention (CDC): http://www.cdc.gov/ncidod/dbmd/diseaseinfo/escherichiacoli_g.htm

Salmonella

Summary:

Salmonella bacteria reside in the gut of poultry (chicken, turkey) and swine (pigs), as well as in the environment. During slaughter procedures the gut of the animals can be broken open, releasing bacteria onto the food products. Ingestion of the contaminated food products may then cause infection. Persons and animals can also be carriers of the bacteria and infection can occur by close contact. Although the most common form of salmonellosis is a self-limiting disease, it can be very serious in young, elderly and immuno-comprised people. Salmonellosis is the most frequently reported cause of foodborne disease in Canada. Each year, approximately 6,000-12,00 cases of salmonellosis are reported in Canada.

Cases per year	2-4 million (US)
Fatalities per year	Less than 1% of infections (US)
Likelihood of fatality	low
Likelihood of contracting disease	Low to medium
Injury other than fatality	Acute: nausea, vomiting, diarrhea, cramps, headache Chronic: reactive arthritis (Reiter's syndrome)
High risk groups	Immunocompromised, elderly, infants
Types of food agent is found in	Poultry & poultry products (including eggs) and pork & pork products, beef, raw fruits / vegetables, unpasteurized dairy products, many other foods
Geographic area agent is found	Ubiquitous; higher in northeastern US
Prevention measures in place	Proper handling and cooking of food products; testing
Time between exposure and health effects	Acute (6-48 hours) Chronic (3-4 weeks)
Scientific knowledge	high
Ability to prevent exposure	high

Other information:

Salmonellae are common bacteria and can be spread from person to person. While the illness from these bacteria is not likely to be fatal, there is a huge public health concern because the at-risk groups of people can have prolonged illness or infection that may result in death. There have been more than 120 outbreaks of *S. enteritidis,* mostly in restaurants and institutions, according the Centers for Disease Control (CDC). Many infections are not reported as people may feel they have the flu or some other infection.

What is being done to control *Salmonella*:

- Consumer education
- Many resources are available on proper handling of foods to ensure that cross-contamination is minimized during food preparation
- Removal of infected flocks from egg supply
- Improved sanitation measures
- Testing of food products
- Quality Control Program: On Farm Food Safety Program and HACCP (a processing food safety program) at processing plant

Major references:

1. Canadian Food Inspection Agency (CFIA): http://www.inspection.gc.ca/english/corpaffr/foodfacts/salmonellae.shtml
2. Food and Drug Administration (FDA) and Center for Food Safety and Applied Nutrition (CFSAN): http://www.cfsan.fda.gov/~mow/chap1.html
3. Centers for Disease Control and Prevention (CDC): http://www.cdc.gov/ncidod/dbmd/diseaseinfo/salment_g.htm

Botulism
(*Clostridium botulinum*)

Summary:

Botulism is the name given to a rare paralyzing illness that is the result of consumption of food containing a nerve toxin produced by a bacterium, *Clostridium botulinum.* Raw foods, including raw vegetables, may contain *C. botulinum* spores. It is the toxin produced by *C. botulinum* that can cause botulism, a serious foodborne illness. Botulism is a very rare disease in Canada and can be treated if caught early. This bacterium can be found in the soil and in water sources. It may also be found in canned food in which there is low acidity, such as canned vegetables.

Proper heat processing destroys *C. botulinum* in canned food, and it can also be controlled by keeping moisture low in dried foods.

Cases per year	110 (US)
Fatalities per year	Approximately 8-10%
Likelihood of fatality	Approximately 10% of cases, if untreated
Likelihood of contracting disease	rare
Injury other than fatality	nausea, vomiting, fatigue, dizziness, headache, double vision, dryness in the throat and nose, respiratory failure, and paralysis duration of illness may be 2 hours to 14 days, although some symptoms may linger much longer.
High risk groups	Infants, elderly (if ingesting high-risk foods), aboriginal populations
Types of food agent is found in	Home-canned, low-acid foods (e.g. corn, green beans, mushrooms), raw or parboiled meats from marine mammals, fermented salmon eggs, honey, vacuum-packed foods, seafood, herbal cooking oils

Geographic area agent is found	ubiquitous
Prevention measures in place	Proper canning procedures, cooking of foods, storing of foods
Time between exposure and health effects	4 to 36 hours after ingesting.
Scientific knowledge	high
Ability to prevent exposure	high

Other information:

Clostridium botulinum bacteria could be in a food product, yet the food appears and smells safe to eat. Bulging cans are a sign that the bacteria may be present, and the food should not be consumed.

Symptoms of botulism include dry mouth, double vision, nausea, vomiting, and diarrhea. Weakness, muscle paralysis, and breathing problems may also develop. Victims who seek immediate treatment may recover fully, and death is rare. However, it can take from one week to one year to recover.

What is being done to control botulism:

- The processing industry adds salt and nitrites to many foods. These ingredients enhance flavour and colour, and also reduce the growth of *C. botulinum*
- Proper home canning of all low-acid products (for example, vegetables)
- Proper preparation of infused-oil products

Major references used:

1. Canadian Food Inspection Agency (CFIA) website: http://www.inspection.gc.ca/english/corpaffr/foodfacts/botulisme.shtml

2. FDA / CFSAN: http://www.cfsan.fda.gov/~dms/a2z-c.html

3. Centers for Disease Control and Prevention: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/botulism_g.htm

Paralytic Shellfish poisoning

Summary:

Shellfish poisoning is caused by toxins accumulated in the shellfish through their feeding. While there are many different types of shellfish toxins, most of them have similar effects on humans once ingested. The toxins generally result in neurological effects along with gastrointestinal effects. Although death is rare, the effects of the toxins may last from days to several years. Research on these toxins has indicated that there are certain times of the year that they are more prevalent, and so fishing in affected areas is limited during these times.

Cases per year	30 (US) are reported, although misdiagnosis is common, so the number may be higher
Fatalities per year	1 death in every four years is estimated
Likelihood of fatality	rare
Likelihood of contracting disease	Unknown, due to under-reporting
Injury other than fatality	Mainly neurological and include tingling, burning, numbness, drowsiness, incoherent speech, and respiratory paralysis. Some toxins result in a mild gastrointestinal disorder (nausea, vomiting, diarrhea, and abdominal pain accompanied by chills, headache, and fever Other toxins: vomiting, diarrhea, abdominal pain) and neurological problems (confusion, memory loss, disorientation, seizure, coma).
High risk groups	All persons are susceptible, but the elderly may be more so to some toxins. Persons with liver disease may be severely affected.
Types of food agent is found in	Most shellfish are potentially toxic. Mainly mussels, clams, cockles, scallops, and oysters

Geographic area agent is found	Throughout coastal areas world wide. Typically, in North America, the Gulf of Mexico, Atlantic seaboard and some Pacific coastal areas of US.
Prevention measures in place	Advisories posted for affected areas / times of year. Prohibition of fishing during these times.
Time between exposure and health effects	Between a few minutes to two days, typically. Fatalities to date have involved elderly patients.
Scientific knowledge	High
Ability to prevent exposure	Medium to high

Other information:

Prevention of shellfish harvesting is the first line of defense against shellfish poisoning. In the 1987 outbreak in Canada, the source was a single location in Prince Edward Island. Four persons died during this outbreak, but since routine testing of shellfish began in 1988, there have been no known fatal cases.

In most cases of shellfish poisoning the afflicted person will recover after a few days. There are few treatments available for persons with shellfish poisoning. In extreme cases respirators may be needed if the toxin has affected breathing. Long-term consequences of ingestion of certain types of these toxins may include short-term memory loss.

Shellfish poisoning is a broad term for illnesses caused by marine toxins. There are many types of toxin and the effects of each can vary. Heating does not destroy the toxins and so care must be taken in selecting shellfish for consumption.

What is being done to control shellfish poisoning:

- The CFIA regularly monitors shellfish to provide early warning of the toxins in bivalve molluscan shellfish. Shellfish harvesting is halted in areas having the presence of the toxins.
- Proper storage of shellfish (temperature control)
- Education of consumers on heeding warnings for known affected areas

- Department of Fisheries and Oceans officers patrol areas having warnings for the presence of the toxins, in order to control fishing of contaminated shellfish

Major references used:

1. Canadian Food Inspection Agency (CFIA) website: http://www.inspection.gc.ca/english/corpaffr/foodfacts/aspdae.shtml
2. US Centers for Disease Control and Prevention: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/marinetoxins_g.htm
3. US Food and Drug Administration / CFSAN: http://www.cfsan.fda.gov/~mow/chap37.html

Acrylamide

Summary:
Acrylamide is a chemical compound that is used for repair of sewer lines and manufacture of some plastics. It can also form in some foods that are heat-processed. The compound has been shown to be carcinogenic in animals and also cause neurological symptoms. There has been much research on acrylamide since a 2002 discovery of it forming in certain foods. The World Health Organization (WHO) has stated that it may be a health concern in food, but also states that the actual risk to human health is not known at this time. Studies on exposure to acrylamide in foods have shown that the Canadian consumer's exposure is about the same as in other countries. French fries and potato chips seem to contain the highest amounts of acrylamide. Acrylamide ingestion does not result in a specific, measurable disease, and so the information given below is somewhat incomplete.

Cases per year	unknown
Fatalities per year	unknown
Likelihood of fatality	unknown
Likelihood of contracting disease	unknown
Injury other than fatality	Neurological effects, possible tumour formation
High risk groups	None specified
Types of food agent is found in	potato chips, french fries, cookies, breakfast cereals, bread, as well as other foods that are also processed at high temperatures such as coffee, roasted almonds, and grain-based coffee substitutes.
Geographic area agent is found	ubiquitous
Prevention measures in place	Improvement of food processing technologies to reduce levels
Time between exposure and health effects	unknown
Scientific knowledge	Medium to high

Ability to prevent exposure	medium

Other information:

The mechanism by which acrylamide is formed in food is now better understood. This is an important first step towards reducing the amount of the compound in foods.

The promotion of healthier eating habits and food choices is supported by health agencies in reducing exposure to acrylamide. Avoiding large quantities of foods having the potential to contain acrylamide lowers the intake of the compound. While it is acknowledged that a safe limit of acrylamide is not easily determined for humans, there are occupational exposure limits set, based on animal models.

What is being done to control the agent:

- Reducing acrylamide in prepared and packaged foods is a primary step in reducing exposure to acrylamide.
- Research on how acrylamide is formed in some foods, so that levels may be reduced

Major references used:

1. Health Canada website: http://www.hc-sc.gc.ca/fn-an/securit/chem-chim/acrylamide/acrylamide_and_food-acrylamide_et_aliment_e.html

2. US Food and Drug Administration: http://www.fda.gov/bbs/topics/news/2005/NEW01161.html

3. World Health Organization (WHO): http://www.euro.who.int/eprise/main/who/progs/fos/Chemical/20020725_2

Faculty of Agriculture, Forestry, and Home Economics
Human Research Ethics Board
Approval

is hereby granted to:

Cindy Jardine, Principal Investigator for

05-60 An application of a formal risk ranking model in determining priorities for food safety policy

for a term of one year, provided there is no change in experimental procedures. Any changes in experimental procedures must be submitted in writing to the HREB.

Granted: March 6th, 2006

for Debra Davidson, Chair, AFHE REB

Appendix H – Information Sheet

INFORMATION SHEET for the University of Alberta Research Project:

An Application of a Formal Risk Ranking Model in Determining Priorities in Food Safety Policy

Purpose: This research project seeks to understand the similarities and differences between how the public and governments view food safety risks. By having both groups rank a number of commonly known food safety issues it can be determined whether the priorities for both parties are similar.

Background: The ranking of food safety risks is merely a starting point for discussion on how food safety issues should be prioritized. Risk ranking has been developed in many jurisdictions in the hope of effectively managing limited resources. The model used in this research utilizes risk summary sheets that are detailed enough to include all relevant information necessary to perform rankings. For this reason they are considered user-friendly for the ranker.

This research is being funded in-kind by Alberta Agriculture, Food & Rural Development (AAFRD).

Methods: In this data collection stage, we will be asking you to rank food safety issues in order of most concern to least concern.

We will be describing the model to be used and then ask you to use this model in the ranking of six food safety issues detailed in the risk summary sheets for each issue. First the rankings will be performed individually, and then again in small groups. We anticipate that the task will take one to two hours to complete, including instruction and discussion at the end. After the ranking exercise we will discuss why choices were made in the rankings. We will return our initial summary of the results to you for verification of our interpretation before the information is incorporated in any report or paper resulting from this research.

Confidentiality:

With your permission, the focus group discussion will be recorded on audiotape. This will ensure that we have an accurate record of your responses when we summarize and interpret the information you provide. If you wish to share a personal perspective that you feel might compromise your position in any way, please inform us this is the case. Such information will then not be used without your permission and will not be specifically attributed to you. We also ask that you not repeat the comments of other participants outside of the focus group, so that we respect the privacy of all participants.

Benefits: The process of public participation in risk decision-making has implications for both the public and those involved in the development of public policies for health protection. It is important to ensure that the perspectives and issues of concern of all parties be taken into account so that the resulting recommendations from this research study reflect all viewpoints. These focus groups will allow you the opportunity to provide your input. Hopefully they will also ensure that the results contribute to a better understanding of how to effectively utilize public participation in the development of appropriate and accepted food safety policies.

Risks: There are no direct risks to participating in this study. However, you may feel at risk from reprisal from your place of employment if you are critical of agency procedures or practice. As we neither use information nor personally identify you in such circumstances without permission, this risk should be negligible.

Withdrawal from the Study: Even after you have agreed to do the interview you can decide at any point you do not wish to continue. Up to one month following the focus groups you may decide that you do not want what you said to be used. The researchers then cannot use this information.

Use of the Information: The results from this research will provide a basis upon which to assess the role of the public and governments in risk management, resulting in recommendations on appropriate policy options. The results may also be used for academic presentations and peer-reviewed publications.

Contacts: The Principal Investigator for this study is Dr. Cindy Jardine of the University of Alberta. Drs. Lynn McMullen and Sean Cash of the University of Alberta are co-investigator. Kevin Webster, with the Dept. of Agricultural, Food & Nutritional Science at the University of Alberta, will be conducting much of the research as part of the requirements for his master's research. You can contact the researchers via Dr. Jardine at (780) 492-2626 or at cindy.jardine@ualberta.ca.

Additional Contacts: If you have any complaints or concerns about this research that you feel you cannot discuss with the researchers you can contact:

Georgie Jarvis, Secretary to the Human Research Ethics Board
2-14 Ag/For Centre, University of Alberta, Edmonton AB T6G 2P5
Ph. (780) 492-4931, Fax (780) 492-0097

CONSENT FORM

to Participate in the University of Alberta Research Project:

An Application of a Formal Risk Ranking Model in Determining Priorities for Food Safety Policy

Principal Investigator:

Dr. Cindy Jardine, Asst. Professor
Dept. of Rural Economy
University of Alberta
(780) 492-2626

Researcher:

Kevin Webster, MSc Candidate
Dept. of Agricultural, Food & Nutritional Science
(780) 4922626

Do you consent to being audiotaped?	Yes	No
Do you understand that you have been asked to be in a research study?	Yes	No
Have you read and received a copy of the attached Information Sheet?	Yes	No
Do you understand the benefits and risks involved in taking part in this research study?	Yes	No
Have you had an opportunity to ask questions and discuss this study?	Yes	No
Do you understand that you can quit taking part in this study at any time? You do not have to say why.	Yes	No
Has the issue of confidentiality been explained to you?	Yes	No
Do you understand that at any time you wish to speak off record, the audio recorder will be turned off and this information will not be used in the study?	Yes	No
Do you understand who will have access to the records from these discussions?	Yes	No
Do you give us permission to use the data and the information that you provided for the purposes specified in the information sheet?	Yes	No
Do you give us permission to share the data and the information that you provided with associated researchers with the researchers listed above?	Yes	No
Can we use this information for presentations and publications?	Yes	No

This study was explained to me by: ______________________________

I agree to take part in this study.

______________________________ ______________ ____________________
Signature of Research Participant Date Printed Name

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

______________________________ ____________________
Signature of Investigator Date

Appendix J - Demographics

DEMOGRAPHICS
These questions will give us a better idea of who took part in this study.

AGE
Would you please tell me what your age was on January 1, 2006?

1	18 – 25
2	26 – 30
3	31 – 35
4	36 – 40
5	41 – 45
6	46 – 50
7	51 – 55
8	56 – 60
9	61 – 65
10	Over 65
0	No response/ Refused

OCCUPATION

Pick ONE response that describes your current situation.

1	Full-Time
2	Part-Time
3	Self-Employed
4	Other ______________________________
5	Unemployed and looking for work
6	Retired
7	Looking after the household
0	No response/ Refused

EDUCATION
What is your highest level of completed education?

1	No Schooling
2	Elementary
3	Junior High
4	High School
5	Vocational/Technical
6	Community College
7	University - Diploma
8	University - Bachelor's Degree
9	University – Professional Degree (doctor, dentist, lawyer, vet)

10 University – Master's Degree

11 University - Doctorate

0 No response/ Refused

ADULT

Including yourself, how many ADULTS (18 years or older) live in your household?

____

0 No response/ Refused

CHILD

How many CHILDREN under the age of 18 years live in your household?

____

0 No response/ Refused

INCOME

What is the total family income (income of ALL the members of your household) for the past year BEFORE taxes and deductions? Please indicate the appropriate category.

1 Under $9,999
2 $10,000 to $19,999
3 $20,000 to $29,999
4 $30,000 to $39,999
5 $40,000 to $49,999
6 $50,000 to $59,999
7 $60,000 to $69,999
8 $70,000 to $79,999
9 $80,000 to $89,999
10 $90,000 to $99,999
11 More than $100,000

12 Don't Know
0 No Response/ Refused

Appendix K – Request for summary of results

Request for summary of results for:

An Application of a Formal Risk Ranking Model in Determining Priorities for Food Safety Policy

Name: ______________________________

Address: ______________________________

e-mail: ______________________________

Risk Ranking Sheet

Please use this sheet to rank the food safety issues in the risk summary sheets. A "1" indicates what you feel is the highest risk and a "6" is the lowest risk.

Food Safety Issue	Ranking	Additional comments
1		
2		
3		
4		
5		
6		

Appendix M – Individual rankings (public participants)

			Food Safety Issue			
Ranker #	BSE	*Escherichia coli* O157: H7	*Salmonella*	Botulism	Paralytic Shellfish Poisoning	Acrylamide
1	6	1	2	3	4	5
2	2	4	5	6	3	1
3	5	2	1	3	6	4
4	3	1	2	5	4	6
5	2	1	4	3	6	5
6	4	1	5	2	6	3
7	3	2	4	6	5	1
8	6	4	5	3	2	1
9	5	1	2	3	6	4
10	3	1	2	4	4	5
11	6	3	2	5	4	1
12	6	3	1	2	5	4
13	1	2	2	4	4	5
14	4	1	2	5	6	3
15	4	2	3	5	6	1
16	3	1	3	3	5	3
17	2	4	5	3	6	1
18	6	2	1	3	5	4
19	4	1	2	3	6	5
20	3	1	2	4	5	6
21	2	1	3	4	5	6
22	4	2	1	5	6	3
23	5	2	1	3	4	6
24	5	2	3	4	6	1
25	4	2	1	3	6	5
26	6	2	5	3	4	1
27	3	1	2	5	6	4
28	3	2	6	5	4	1
29	3	2	5	6	4	1

Appendix N – Individual rankings (expert participants)

	Food Safety Issue					
Ranker #	BSE	*Escherichia coli* O157: H7	*Salmonella*	Botulism	Paralytic Shellfish Poisoning	Acrylamide
1	5	1	2	3	4	6
2	5	2	3	4	1	6
3	3	1	5	2	6	4
4	6	2	1	3	4	5
5	5	2	1	3	4	6
6	6	1	3	4	5	2
7	6	1	2	3	4	5
8	6	1	3	2	4	5
9	5	2	1	3	4	6
10	4	1	2	3	5	6
11	4	2	1	3	5	6
12	4	2	1	3	6	5
13	5	2	4	1	2	5
14	5	1	2	4	3	6
15	6	2	1	3	4	5
16	6	1	3	2	4	5
17	6	2	1	3	4	5
18	6	2	1	3	4	5
19	4	2	1	3	5	6
20	3	2	1	4	5	6
21	3	2	1	5	6	4

Appendix O - Correlations (highest-ranked food safety issues)

Correlations

		more_than_highschool	urban	Salmonella most concern	PSP most concern	Acrylamide most concern	E.coli most concern	Botulism most concern	BSE most concern
more_than_highschool	Pearson Correlation	1	.098 (**)	-.052	.000	.021	.111(**)	-.029	-.094(**)
	Sig. (2-tailed)		.001	.086	.999	.489	.000	.345	.002
	N	1200	1200	1081	1081	1081	1081	1081	1081
urban	Pearson Correlation	.098(**)	1	-.032	-.016	-.007	.037	.008	-.008
	Sig. (2-tailed)	.001		.293	.587	.813	.227	.786	.791
	N	1200	1207	1085	1085	1085	1085	1085	1085
Salmonella most concern	Pearson Correlation	-.052	-.032	1	-.099(**)	-.096(**)	-.666(**)	-.210(**)	-.217(**)
	Sig. (2-tailed)	.086	.293		.001	.002	.000	.000	.000
	N	1081	1085	1085	1085	1085	1085	1085	1085
PSP most concern	Pearson Correlation	.000	-.016	-.099(**)	1	-.018	-.127(**)	-.040	-.041
	Sig. (2-tailed)	.999	.587	.001		.547	.000	.188	.175
	N	1081	1085	1085	1085	1085	1085	1085	1085
Acrylamide most concern	Pearson Correlation	.021	-.007	-.096(**)	-.018	1	-.123(**)	-.039	-.040
	Sig. (2-tailed)	.489	.813	.002	.547		.000	.200	.186
	N	1081	1085	1085	1085	1085	1085	1085	1085
E.coli most concern	Pearson Correlation	.111(**)	.037	-.666(**)	-.127(**)	-.123(**)	1	-.270(**)	-.278(**)
	Sig. (2-tailed)	.000	.227	.000	.000	.000		.000	.000
	N	1081	1085	1085	1085	1085	1085	1085	1085
Botulism most concern	Pearson Correlation	-.029	.008	-.210(**)	-.040	-.039	-.270(**)	1	-.088(**)
	Sig. (2-tailed)	.345	.786	.000	.188	.200	.000		.004
	N	1081	1085	1085	1085	1085	1085	1085	1085
BSE most concern	Pearson Correlation	-.094(**)	-.008	-.217(**)	-.041	-.040	-.278(**)	-.088(**)	1
	Sig. (2-tailed)	.002	.791	.000	.175	.186	.000	.004	
	N	1081	1085	1085	1085	1085	1085	1085	1085

** Correlation is significant at the 0.01 level (2-tailed).

Appendix P - Correlations (lowest-ranked food safety issues)

Correlations

		more_than_ highschool	urban	Salmonella least concern	PSP least concern	Acrylamide least concern	E.coli least concern	Botulism least concern	BSE least concern
more_than_ highschool	Pearson Correlation	1	.098 (**)	-.091(**)	.047	.024	-.026	-.016	-.007
	Sig. (2-tailed)		.001	.003	.133	.433	.396	.613	.827
	N	1200	1200	1030	1030	1030	1030	1030	1030
urban	Pearson Correlation	.098(**)	1	-.022	.010	.044	.046	.018	-.052
	Sig. (2-tailed)	.001		.474	.744	.159	.143	.566	.094
	N	1200	1207	1034	1034	1034	1034	1034	1034
Salmonella least concern	Pearson Correlation	-.091(**)	-.022	1	-.152(**)	-.088(**)	-.032	-.058	-.189(**)
	Sig. (2-tailed)	.003	.474		.000	.005	.302	.063	.000
	N	1030	1034	1034	1034	1034	1034	1034	1034
PSP least concern	Pearson Correlation	.047	.010	-.152(**)	1	-.268(**)	-.098(**)	-.176(**)	-.577(**)
	Sig. (2-tailed)	.133	.744	.000		.000	.002	.000	.000
	N	1030	1034	1034	1034	1034	1034	1034	1034
Acrylamide least concern	Pearson Correlation	.024	.044	-.088(**)	-.268(**)	1	-.057	-.102(**)	-.335(**)
	Sig. (2-tailed)	.433	.159	.005	.000		.068	.001	.000
	N	1030	1034	1034	1034	1034	1034	1034	1034
E.coli least concern	Pearson Correlation	-.026	.046	-.032	-.098(**)	-.057	1	-.037	-.122(**)
	Sig. (2-tailed)	.396	.143	.302	.002	.068		.231	.000
	N	1030	1034	1034	1034	1034	1034	1034	1034
Botulism least concern	Pearson Correlation	-.016	.018	-.058	-.176(**)	-.102(**)	-.037	1	-.220(**)
	Sig. (2-tailed)	.613	.566	.063	.000	.001	.231		.000
	N	1030	1034	1034	1034	1034	1034	1034	1034
BSE least concern	Pearson Correlation	-.007	-.052	-.189(**)	-.577(**)	-.335(**)	-.122(**)	-.220(**)	1
	Sig. (2-tailed)	.827	.094	.000	.000	.000	.000	.000	
	N	1030	1034	1034	1034	1034	1034	1034	1034

** Correlation is significant at the 0.01 level (2-tailed).

Appendix Q - Focus group participant

Appendix R - Regression outputs (highest-ranked issues)

BSE

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.155	.027		5.636	.000
	more_than_highschool	-.086	.028	-.095	-3.121	.002
	urban	.005	.018	.009	.297	.766

Dependent Variable: BSE most concern

BSE Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.095(a)	.009	.007	.27119

a Predictors: (Constant), urban, more_than_highschool

***Escherichia coli* O157:H7**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.285	.050		5.678	.000
	more_than_highschool	.181	.051	.109	3.563	.000
	urban	.022	.032	.021	.694	.488

Dependent Variable: *Escherichia coli* O157:H7 most concern

***Escherichia coli* O157:H7 Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.113(a)	.013	.011	.49609

a Predictors: (Constant), urban, more_than_highschool

Salmonella

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.429	.048		8.935	.000
	more_than_highschool	-.078	.048	-.049	-1.606	.108
	urban	-.026	.031	-.026	-.845	.399

Dependent Variable: *Salmonella* most concern

***Salmonella* Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.058(a)	.003	.002	.47433

a Predictors: (Constant), urban, more_than_highschool

Botulism

Appendix R - Regression outputs (highest-ranked issues)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.099	.027		3.620	.000
	more_than_highschool	-.027	.028	-.030	-.979	.328
	urban	.006	.017	.011	.355	.722

Dependent Variable: Botulism most concern

Botulism Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.031(a)	.001	-.001	.26941

a Predictors: (Constant), urban, more_than_highschool

Paralytic Shellfish Poisoning (PSP)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.021	.014		1.530	.126
	more_than_highschool	.001	.014	.002	.065	.948
	urban	-.005	.009	-.017	-.561	.575

Dependent Variable: PSP most concern

PSP Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.017(a)	.000	-.002	.13492

a Predictors: (Constant), urban, more_than_highschool

Acrylamide

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.011	.013		.799	.424
	more_than_highschool	.010	.013	.022	.727	.467
	urban	-.003	.008	-.010	-.335	.738

Dependent Variable: Acrylamide most concern

Acrylamide Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.023(a)	.001	-.001	.13155

a Predictors: (Constant), urban, more_than_highschool

Appendix S - Regression outputs (lowest-ranked issues)

BSE

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.459	.054		8.500	.000
	more_than_highschool	-.004	.054	-.002	-.069	.945
	urban	-.055	.033	-.052	-1.671	.095

Dependent Variable: BSE least concern

BSE Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.053(a)	.003	.001	.49350

a Predictors: (Constant), urban, more_than_highschool

***Escherichia coli* O157:H7**

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.025	.015		1.599	.110
	more_than_highschool	-.015	.015	-.031	-.983	.326
	urban	.014	.009	.048	1.533	.125

Dependent Variable: *Escherichia coli* O157:H7least concern

***Escherichia coli* O157:H7 Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.055(a)	.003	.001	.14132

a Predictors: (Constant), urban, more_than_highschool

Salmonella

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.110	.023		4.766	.000
	more_than_highschool	-.066	.023	-.090	-2.893	.004
	urban	-.004	.014	-.009	-.283	.777

Dependent Variable: *Salmonella* least concern

***Salmonella* Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.091(a)	.008	.006	.21021

a Predictors: (Constant), urban, more_than_highschool

Appendix S - Regression outputs (lowest-ranked issues)

Botulism

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.070	.027		2.637	.008
	more_than_highschool	-.015	.027	-.017	-.556	.578
	urban	.010	.016	.019	.595	.552

Dependent Variable: Botulism least concern

Botulism Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.024(a)	.001	-.001	.24344

a Predictors: (Constant), urban, more_than_highschool

Paralytic Shellfish Poisoning (PSP)

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.244	.051		4.791	.000
	more_than_highschool	.075	.051	.046	1.478	.140
	urban	.007	.031	.007	.215	.830

Dependent Variable: PSP least concern

PSP Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.047(a)	.002	.000	.46527

a Predictors: (Constant), urban, more_than_highschool

Acrylamide

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.093	.037		2.490	.013
	more_than_highschool	.025	.037	.021	.671	.502
	urban	.028	.023	.039	1.241	.215

Dependent Variable: Acrylamide least concern

Acrylamide Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.046(a)	.002	.000	.34077

a Predictors: (Constant), urban, more_than_highschool