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Nordic Expert Survey on Future Foodborne and Waterborne Outbreaks

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Sammanfattning

Under perioden december 2011 till maj 2012 genomfördes en nordisk expertenkät på internet om livsmedelsburna och vattenburna utbrott i framtiden. Syftet var att undersöka expertuppfattningar och nationella perspektiv på framtida utbrottsrisker. Vi testade också en ny metod att validera experters riskskattningar (Belief Score J). Inbjudningar skickades till 248 experter på hälsorisker med livsmedel och dricksvatten i Danmark, Finland, Norge och Sverige. Enkäten besvarades av 110 respondenter, dvs. en svarsfrekvens på 44,4 %. Analyserna inriktades på samband mellan svarsfrekvenser med hjälp av Pearsons Chi-square.

Sammanfattningsvis förväntade sig respondenterna att livsmedelsburna och vattenburna utbrott kommer att öka till antalet med omkring 10-20 % under perioden 2011-2020 i jämförelse med 2001-2010. Respondenter med lång professionell erfarenhet av riskvärderingar förväntade sig en större ökning än respondenter med en mer begränsad erfarenhet. Uppfattningarna om orsaker och drivkrafter till framtida ökningar var både generella och varierande beroende på professionell erfarenhet av riskanalys, utbildningsbakgrund och nationalitet. Den generella bilden av en potentiell framtida ökning av antalet livsmedelsburna utbrott kan sammanfattas med följande scenario:

> *Importerade livsmedel, i synnerhet råa grönsaker, förorenade med oreglerade ämnen, virus eller bakterier, tillagade i offentliga miljöer där kunskapen om livsmedelssäkerhet brister, serverade till grupper med hög andel äldre personer.*

Experternas uppfattningar varierade till viss del beroende på professionell erfarenhet av riskanalys, utbildningsbakgrund och nationalitet. Lång erfarenhet av riskhantering var kopplad till starkare förväntningar på virus som livsmedelsburna agens, samt grönsaker som utbrottskälla. En bakgrund inom mikrobiologi var vidare kopplad till starkare förväntningar på importerade varor som utbrottskälla. Svenska respondenter valde oftare än andra respondenter örter och kryddor som trolig källa, kanske på grund av erfarenheterna av Ehec-utbrottet i Tyskland och Frankrike. Finska respondenter såg oftare fisk som utbrottskälla, något som kan bero på en större import av fiskprodukter i Finland.

Även om undersökningen visade på demografiska skillnader var likheterna (scenariot ovan) starkare än skillnaderna. Skillnaderna var dock tillräckliga för att väcka frågor om hur våra riskbedömningar påverkas av vår bakgrund. Till viss del är demografiska faktorer sammanflätade. Vem som anses vara en expert på framtida risker beror på institutionella och organisatoriska frågor som till viss del är specifika för varje land. Hur det fungerar i praktiken förblir en obesvarad fråga, men som bör belysas i framtida forskning om risker och beslutsfattande.

Vem är egentligen expert på framtida risker? När vi siar om framtiden ställs vi alla inför osäkerhet, såväl experter som lekmän. Allas våra bedömningar färgas av personliga erfarenheter och värderingar, i någon mån. Inte ens en större grupp experter kan förändra situationen. En rad kända och okända faktorer samverkar

och påverkar riskuppfattningar och bedömningar. Det är skäl nog att belysa och jämföra expertbedömningar inom och mellan länder.

Summary

An expert internet-based survey on future foodborne and waterborne outbreaks was conducted from December 2011 to May 2012 in Denmark, Finland, Norway and Sweden. Invitations were sent to 248 experts in the management and assessment of food-related hazards and diseases. The survey was completed by 110 respondents (Denmark: 21; Finland: 21; Norway: 34; Sweden: 34), resulting in a response rate of 44.4%. The analyses consisted primarily of response frequencies and Pearson's Chi-square ($\chi 2$) statistics. A novelty was a new method of ranking likelihood, enabling evaluation of probability judgments.

Overall, the respondents expected the numbers of foodborne and waterborne outbreaks to increase by 10-20% in 2011-2020 compared with 2001-2010. Respondents with long professional experience of risk assessment tended to expect a larger increase than respondents with more limited experience. The opinions on the causes and drivers of such change showed general patterns, as well as variations depending on professional experience of risk analysis, education and nationality. The general view of a future increase in the number of foodborne outbreaks related to the following scenario:

> *Imported food, particularly raw vegetables, contaminated with unregulated agents, viruses or bacteria, prepared in public food service facilities with deficient food safety knowledge, served to a population with an increasing share of elderly people.*

The sources and causes selected as likely also varied depending on professional experience of risk analysis, as well as nationality and educational background. A background in microbiology was associated with stronger expectations of imported goods as vehicles. Long experience of risk management experience went with stronger expectations of viruses as foodborne agents and of vegetables as vehicles. Swedish respondents selected more often than other respondents herbs and spices as likely vehicles of foodborne transmission, perhaps due to recent experience of the severe EHEC outbreak in Germany and France. In contrast, Finnish respondents selected more often than others fish as likely vehicles, perhaps due a larger share of imported fish products.

While the survey demonstrated some differences between professions and countries, the commonalities (the scenario above) were stronger than the differences. However, the variation that exists raises questions about the relative contributions of professional experience and nationality to judgments of future risks. To some extent, these factors appear intertwined. The professions considered to be expert on future risks may also depend on institutional and organisational issues that are specific to each country. This is too often a neglected issue that needs to be addressed in future research and policy making on future risks.

When estimating potential changes in the future, we face uncertainty and must to some extent rely on personal knowledge and experiences. However, It is still not clear how a limited pool of experts can be used to disentangle the many interacting factors that influence our perception of future risks. To evaluate the contributions of nationality, education and professional experience to expert risk perceptions, we need large and representative samples of experts in the food sector, which may in fact not exist. Who is actually an expert on future risks?

Background

The main objective of food safety authorities is to ensure healthy food commodities on the market. Their work involves the task of tracking and assessing future changes in food safety risks, i.e. identifying so-called “emerging risks”. Within the European Union (EU), part of this task falls under the emerging risk unit (EMRISK) of the European Food Safety Authority (EFSA). At the national level, official organisational structures and resources for identifying “emerging risks” are usually lacking.

> “Only a few countries have developed a dedicated horizon scanning or foresight program to identify future risks and opportunities for food and feed safety”. (1)

Emerging risk identification is more often than not an informal and distributed task among experts in risk analysis, i.e. risk assessment, risk management and risk communication. It involves everyday intelligence work in diverse domains, e.g. food production and distribution, microbiology, toxicology and chemistry. The two organisational levels, i.e. EMRISK and national experts, are bridged by the Emerging Risks Exchange Network (EREN), which consists of member state representatives exchanging information on emerging issues and risks. Within this institutional framework, the representatives of the Nordic countries (Denmark, Finland, Norway and Sweden) decided to conduct an expert survey on future foodborne and waterborne outbreaks, the aim being to develop and test methods for identification of emerging risks, and to map and compare national and professional differences in the perception of emerging risks.

> “Overall, our experience shows that ERI [Emerging Risks Identification] requires a high level of expertise due to major data gaps and uncertainties in the evaluation process”. (2)

Expert knowledge and judgments are considered essential for emerging risk identification (ERI), i.e. identifying new or increased threats against or within the food chain. Identification is then strongly related to scientific validation, subordinating ERI to separate scientific domains. This makes it difficult to integrate and compare risk observations across different fields of expertise, or to carry out broad trend analysis of emerging risks. To get a broader picture of uncertain futures, we must go beyond given facts and rely on systematic pooling of expert opinions and perceptions (3).

The purpose of the Nordic expert survey was to map and compare expert opinions and perceptions on future foodborne and waterborne outbreaks. Instead of relying on scientific classifications of hazards, threats or agents, we allowed the survey to be guided by a topic of general concern, i.e. future foodborne and waterborne outbreaks of disease. A number of reasons directed our choice of topic. First, it is an important and relevant emerging issue for food safety authorities and the general public. Second, in contrast to long-term food safety issues, e.g. cancer, the topic refers to single events, outbreaks, making it easier to rely on everyday observations and experiences. Third, the topic goes beyond any single area of expertise, motivating a survey among experts in different areas of expertise. Thus, it is a good starting point for developing and testing a Nordic panel on emerging issues and risks.

Method

Selection of experts

Designing an expert survey may come close to being a paradox. A survey is often meant to capture representative opinions or perceptions among people in a larger population, but experts are neither a homogeneous population nor a large population. In fact, it is far from clear who actually belongs to the group "food safety experts". The group represents a loosely defined professional culture, rather than a well-defined population. Therefore, expert surveys should not be confused with statistical samples. Care must be taken in extrapolating to other experts beyond the selection of experts in question.

Another difficulty in using experts for comparative studies is the national differences that exist in institutional and organisational structures. On the one hand, an optimal selection of experts would be one that controls for national differences in professional roles and structures. On the other hand, being interested in national differences, we should allow for differences in experts, and account for the national variation by background questions.

In the current study, the selection of experts involved two sampling strategies, expert sampling and snowball sampling, with expert sampling dominating in Norway and Finland and snowball sampling in Denmark and Sweden, particularly in Sweden. Expert sampling involves the selection of people according to well-defined knowledge criteria, i.e. belonging to a specific list or group of experts, e.g. an outbreak expert group. In contrast, snowball sampling involves step-by-step recruitment, by having experts already recruited recommend other experts to be invited.

In Denmark, survey invitations were sent to the Central Outbreak Management Group (COMG), which is made up of representatives from the Danish Veterinary and Food Administration, the National Food Institute, the Technical University of Denmark and Statens Seruminstitut. This sampling was supplemented with snowball sampling of central, regional and local experts in foodborne and waterborne hazards, i.e. the selected participants in the COMG were asked to recommend one or more other experts relevant for enrolment in the study.

In Finland, the national representative opted to select experts one by one based on their knowledge of, and experience in, foodborne and waterborne diseases, which resulted in a restricted pool of experts.

In Norway, the food safety authority makes use of an external science committee, with experts in science and medicine. We sent survey invitations by mail to all members of this science committee.

In Sweden, snowball sampling was the main approach used. Experts on foodborne hazards and disease outbreaks at several state agencies were invited to recommend experts relevant for the survey. The choice of initial experts was made on the basis of expertise concerning foodborne hazards and diseases, including drinking water.

Questionnaire and platform

During autumn 2011, we developed an internet-based expert questionnaire in English on the platform SurveyMonkey, addressing the issue of potential changes in future outbreaks of human foodborne and waterborne diseases. The future in this case referred to the decade 2011-2020, compared with the previous decade, 2001-2010. The questionnaire is fully reproduced in the Appendix. It consisted of 19 questions covering expert beliefs about outbreak trends, the outbreak characteristics of a potential positive trend, the drivers of such a potentially increasing number of outbreaks, and background questions on nationality, education and professional experience of risk management, risk assessment and risk communication. The overall structure was: (1) Likely outbreak trends, (2) likely outbreak ingredients and characteristics, and (3) likely global drivers and forces. The questionnaire began with two questions about the respondents' personal beliefs concerning the future number of foodborne outbreaks. It then proceeded to questions about likely causes, agents and vehicles. This was followed by similar questions about waterborne outbreaks. Finally, forces and drivers of change were addressed with questions about more complex factors and requests for explanations for increasing numbers of outbreaks.

The questionnaire was designed to capture and represent what respondents believe are likely future scenarios of increasing numbers of outbreaks. Even if an expert did not believe in a positive trend, he or she was asked about what would create such a trend. In principle, the number of future scenarios is unlimited. In practice, it was limited due to various considerations. The time needed to complete the questionnaire was one important factor, since when dealing with experts' time is highly limited. The time frame was set to 20-30 minutes, allowing for 20-30 questions. To secure efficient coding of answers, the question format was mostly closed, but additional free comments were allowed. Answer options to a single survey question were presented in random order.

The specific design of questions and answer options was guided by the concept of risk and its three components: (1) Hazards, e.g. foodborne or waterborne agents, (2) forms of exposure, i.e. quantitative and qualitative patterns of consumption, e.g. agent concentrations in different vehicles, and (3) susceptibility of different age and consumer groups to different hazards. Our starting hypothesis was that future changes in outbreak frequencies are primarily perceived as extrinsic rather than intrinsic, i.e. causes and drivers are foreign rather than domestic, e.g. new agents and vehicles rather than an increasingly susceptible ageing population. However, the study was primarily explorative, rather than being directed by specific hypotheses.

The final questionnaire was the result of a process of deliberation over time involving discussions and pilot testing, with the aim of representing general outbreak characteristics, causes and drivers of change. Inspiration was also derived from previous research reports on expert elicitation (4, 5, 6, 7, 8, 9, 10, 11, 12). The survey was initially tested on pilot scale and then revised. The final version was ready in January 2012. Answers were collected until May 2012.

Statistical analyses

The questionnaire included four questions about the direction and magnitude of future change in the number of foodborne and waterborne outbreaks (Q.1, 2, 9 and 10). Two of these questions were qualitative in nature (Q.1 and 9) and the other two were quantitative (Q.2 and 10). To enable comparisons between the different types of answers, we constructed a metric that transformed the two qualitative questions (Q.1 and 9) into a single measure of expert belief in change. The qualitative questions comprised three parts (A, B and C in Table 1), with five answer options to each part (Most likely, Likely, Possible, Unlikely, Most unlikely). The answers to the three question parts were then combined and integrated into a single belief score ‘J’ using the equation:

$$J = (A+C)*B$$

Table 1. A metric for transforming answers to Q.1 and 9 into single belief scores J

Question parts / Answer options	Most likely	Likely	Possible	Unlikely	Most unlikely
A. Yes, the number of outbreaks will increase by at least 10%.	+2	+1	±0	-1	-2
B. No, the number of outbreaks will change by no more than 10%.	1/4	1/2	1	2	4
C. Yes, the number of outbreaks will decrease by at least 10%.	-2	-1	±0	+1	+2

The values for the question parts A and C, ‘An increase by at least 10%’ and ‘A decrease by at least 10%’, were added and multiplied by the values for the question part B, ‘No change’. At one extreme, we had a strong belief in an increased number of outbreaks (+2), which was added to a strong disbelief in a decrease in the number of outbreaks (+2). The sum was multiplied by a strong disbelief in no change (4), resulting in a maximum score of +16 for a belief in a positive outbreak trend. The reverse, i.e. maximum disbelief in an increase, maximum belief in a decrease and maximum disbelief in the status quo, resulted in a minimum score of -16. Between these two extremes, there were weaker beliefs and higher uncertainty regarding future outbreak trends. By correlating belief scores and expert estimates of future change, we were able to check for consistency.

We conducted an ANOVA (Analysis of Variance) of the J scores, using country name, experience group (high or low experience in risk management, risk assessment and risk communication) and educational background as factors. Due to the limited number of participants and factor correlations we did not include all factors at once, but conducted an ANOVA on each country and then controlled for each experience group and educational background in turn.

For the remaining outbreak questions, we summarised the answers in the form of frequency tables. Due to the limited number of respondents, we avoided rendering the results as percentages. For the purpose of testing associations between variables (questions) using Chi-square statistics, the number of answer options is often reduced, merging the responses 'Most likely' and 'Likely' into one class 'Likely', and the responses 'Possible', 'Unlikely' and 'Most unlikely' into another class 'Not likely'. This re-coding is meant to stress the contrast between beliefs versus non-beliefs. Re-coding the option 'Possible' together with 'Likely' and 'Most likely' would instead put the emphasis on the contrast between doubt ('Unlikely' and 'Most unlikely') versus non-doubt.

To allow for cross-tabulations, answers to one background question, i.e. the number of years of professional experience of risk analysis, were re-coded into high and low experience. The median was used as the coding criterion. For each variable – risk management, assessment and communication – a respondent was classified as 'high' or 'low' in experience depending on whether his or her estimate was above or below the median of the variable in question. We then used these categorisations rather than the original categories. In general, we used cross-tabulation and Chi-square statistics to analyse associations between discrete variables and correlation and ANOVA to analyse associations between continuous variables. The presentation of test results is limited to the strongest associations for each question, to avoid too many details.

Results

Demographics

Invitations were sent to 248 experts in Denmark, Finland, Norway and Sweden. By the end of May, 110 respondents had completed the questionnaire, giving a response rate of 44.4%. The rate varied among countries, with a higher rate for Finland and a lower rate for Norway (Table 2). This variation may in part be explained by the different recruitment strategies. In Norway, we turned to a broad group of risk assessors in the science committee, for which the relevance of outbreak issues is not transparent. In Finland, invitations were more selective, from one expert to another, which may have increased the relevance of the study for prospective participants.

Table 2. Number of participants, number of invitations issued, and response rate for each of the four countries in the survey

Country	No. of Participants	No. of Invitations	Response rate
Denmark	21	51	41.2%
Finland	21	38	55.3%
Norway	34	86	39.5%
Sweden	34	73	46.6%

The average number of years of professional experience of risk analysis reported by the respondents is shown in Table 3. However, this is a rather unclear estimate, as we did not know how the respondents interpreted 'Years of experience' and what it implies in practice. Nevertheless, any large difference in professional experience between countries provides a frame of reference for interpreting other national differences.

As Table 3 indicates, the Norwegian respondents had longer experience of risk assessment than risk management, unlike the other nationalities. The opposite tendency applied for the Finnish respondents. ANOVA revealed that the difference in experience of risk management and assessment was statistically significant, $F(3,106)=7.505$, $p<0.001$. A more detailed analysis showed that the difference was only significant for Norway. The variation among respondents was large. There was no significant difference between countries in professional experience of risk communication, $F(3,106)<1$.

The educational background of the respondents added to the contrast between Finland and Norway, with the educational profile for Finland comparatively characterised by veterinary medicine and the profile for Norway by nutrition, biology and toxicology (Tables 4 and 5). A background in microbiology characterised the Swedish respondents, whereas food technology was relatively strong among the Danish respondents. Consequently, any national differences in expert opinions on future outbreak risks may be due to different professional experiences of risk analysis or educational background among respondents, rather than true general differences.

Table 3. Professional experience of risk analysis in the different countries (standard error of the mean in brackets – SEM)

Country	Professional experience of risk analysis (mean number of years)		
	Management	**Assessment**	**Communication**
Denmark	11.6 (1.5)	9.0 (1.1)	8.8 (1.1)
Finland	12.9 (1.8)	6.6 (1.3)	8.4 (1.2)
Norway	4.9 (1.4)	12.1 (2.3)	7.2 (1.3)
Sweden	7.4 (1.5)	6.9 (1.2)	4.0 (1.0)
All countries	8.4 (0.8)	9.0 (0.9)	6.9 (0.6)

Table 4. Educational background of respondents I (multiple choices possible for each respondent)

Country	Water Techno-logy	Food Techno-logy	Nutrition	Chem-istry	Toxico-logy	Micro-biology
Denmark	1	5	5	2	1	8
Finland	1	2	1	1		11
Norway	1	2	12	7	14	13
Sweden	5	5	2	5		20
Sum	8	14	20	15	15	52

Table 5. Educational backgrounds of respondents II (multiple choices possible for each respondent)

Country	Biology-Ecology	Agro-nomy	Veterin-ary	Epidem-iology	Public Health
Denmark	2		7	8	6
Finland			15	5	10
Norway	8	2	11	12	11
Sweden	3	3	14	15	15
Sum	13	5	47	40	42

In the remaining presentation of results, the response data and the analyses of each question are described in turn, from Question 1 to Question 16.

Change in foodborne outbreaks

Question 1. Will the number of foodborne outbreaks change in your country for the period 2011-2020 compared with the period 2001-2010?

The general opinion of the respondents on the change in the number of outbreaks was slightly in favour of an increase (Table 6). The number of 'Most likely' and 'Likely' responses was higher for an increase than for a decrease and the number of 'Most unlikely' and 'Unlikely' responses was clearly higher for a decrease than for an increase.

Table 6. Response frequencies for future changes in foodborne outbreaks

Answer options chosen by: no. of respondents	Most likely	Likely	Possible	Unlikely	Most unlikely	Sum
No, the number of outbreaks will change by no more than 10%.	9	39	45	16	1	110
Yes, the number of outbreaks will increase by at least 10%.	5	31	47	25	2	110
Yes, the number of outbreaks will decrease by at least 10%.	0	8	26	61	15	110

The belief score J combined and integrated the respondents' answers to the three question parts. It was defined to produce a single measure of the respondents' belief in change (see the Method section for an operational definition). The majority of the respondents (n=63, 57.3%) had J scores > 0, indicating an opinion in favour of an increase in the number of foodborne outbreaks. Table 7 shows the mean score per country. The score was higher for Norway, in particular compared with Denmark, although the variation (SEM) was high. Among Norwegian respondents, 23 had J scores larger than 0 (67.6%). The corresponding figure among Danish respondents was 8 (38.1%).

ANOVA of the J scores identified one significant factor, experience of risk assessment ($F(1,108)=4.83$, $MSE=3.93$, $p=0.03$). High experience of risk assessment was accompanied by higher J scores. The trend for Norway was close to being statistically significant, but the experience factor explained the variance better than the country factor. The same results were obtained by Chi-square tests of frequency tables for the responses 'Most likely' and 'Likely' to the statement

"*Yes, the number of outbreaks will increase by at least 10%*", cross-tabulated by country and experience ('high' versus 'low').

Table 7. Belief score J for foodborne outbreaks according to respondents from the different countries

Country	Mean J	SEM*
Denmark	0.46	0.32
Finland	0.95	0.31
Norway	1.59	0.48
Sweden	1.03	0.26
All	1.08	0.19

*Standard Error of the Mean

Estimation of foodborne outbreaks

Question 2. Please give your estimate of the change in the number of foodborne outbreaks in your country.

Four respondents did not provide any estimate. Furthermore, some answers were probably due to a misunderstanding of the question format, i.e. estimation of the relative change in the number of outbreaks. The J score allowed the consistency of the estimates provided to be checked. In Figure 1, the estimates are plotted against the belief scores J. The correlation was modest (0.34), indicating a need for closer evaluation.

Two respondents appeared to have given their estimates in percentage terms, instead of relative numbers as required. Furthermore, six respondents gave estimates that were impossible to reconcile with their answers to question 1. For example, despite having evaluated an increase as unlikely and a decrease as likely, one respondent estimated the relative increase as 5 (500%). In cases where a mistake was obvious, we treated the estimate as a missing value. In one case, we adjusted an estimate in agreement with the belief score J, from 10 to 1.1. After these adjustments, the correlation between estimates and J scores rose from 0.34 to 0.62. Another 20 estimates were incompatible with the J scores, but not inconsistent in direction, e.g. judging all scenarios as equally likely, giving 0 in J score, but still estimating the change as 1.05. Incompatible estimate and J score values were left unadjusted.

The overall mean of adjusted estimates was 1.17, i.e. an increase of 17%. The contrast between Norway and Denmark was weaker for estimates (Table 8) than for J scores (Table 7), but the variance was also lower for estimates. When conducting ANOVAs of estimates, Norway was the only significant factor ($F(1,98)=10.04$, $MSE=0.064$, $p=0.002$). Neither education nor experience of risk analysis made a difference when controlling for country. Without control, a background in toxicology was related to higher estimates, $\beta=0.195$, $t(98)=2.46$, $p=0.016$.

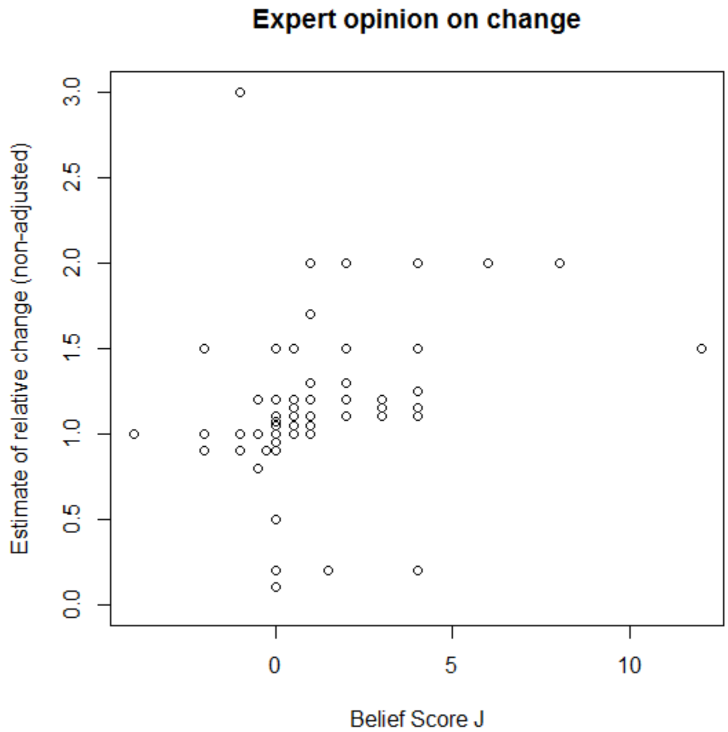

Figure 1. Expert opinion on change. Two measures of the change in the future number of foodborne outbreaks, i.e. estimate of relative change with respect to belief score J.

Table 8. Estimates of relative numbers of foodborne outbreaks made by respondents in the different countries

Country	**No. of Estimates**	**Mean**	**SEM***
Denmark	18	1.07	0.04
Finland	17	1.12	0.04
Norway	29	1.3	0.07
Sweden	34	1.15	0.04
All	98	1.17	0.03

*Standard Error of the Mean

Causes of foodborne outbreaks

Question 3. Which causes are likely or unlikely to lead to an increase in the number of foodborne outbreaks in your country?

Increasing exposure to known agents, followed by new agents, were more often considered likely causes for an increasing number of outbreaks (Table 9). Exhaustive Chi-square tests of frequency tables of response counts with respect to belief and demographics (country, experience level and educational background) did not reveal any co-variation.

Table 9. Response frequencies for prospective causes of a change in foodborne outbreaks

Number of affirmative responses per answer option	Likelihood level					
	Most likely	Likely	Possible	Unlikely	Most unlikely	Sum
Increasing exposure to known foodborne disease agents.	15	51	34	10	0	110
The emergence of new foodborne disease agents, or new variants of known agents.	14	44	43	9	0	110
Increasing susceptibility to known foodborne disease agents.	9	15	28	51	7	110

Foodborne pathways

Question 4. Which exposures are likely or not to contribute to an increasing number of foodborne outbreaks in your country during 2011-2020 compared with 2001-2010?

The spread of non-regulated agents through new food vehicles was more often considered a likely route (Table 10). Finnish respondents selected regulated agents in new vehicles more often as a likely pathway, whereas Norwegian respondents chose this alternative more often as unlikely, $\chi^2(3)= 10.2$, $p=0.017$ (Table 11). Finally, a background in microbiology favoured unregulated agents in known vehicles as a likely pathway, $\chi^2(1)= 7.12$, $p=0.008$ (Table 12).

Foodborne agents

Question 5. Which agents of foodborne diseases are likely to contribute to a significant increase in the number of outbreaks in your country during 2011-2020 compared with 2001-2010?

Bacteria and viruses were more often than other agents indicated as likely agents of an increasing number of outbreaks (Table 13). Swedish respondents selected parasites more often as likely agents, $\chi^2(3)= 12.2$, $p=0.007$, while

Norwegian respondents selected viruses less often as likely, $\chi^2(3)= 17.8$, $p<0.001$, and mycotoxins more often as likely, $\chi^2(3)= 11.9$, $p=0.008$ (Table 14). Management experience was related to more likely responses to viruses, $\chi^2(1)= 7.25$, $p=0.007$ (Table 15).

Table 10. Response frequencies for prospective exposure pathways

Number of affirmative responses per answer option	**Likelihood level**			
	Likely	**Possible**	**Unlikely**	**Sum**
Increased exposure through new food vehicles to agents not subject to food safety regulations.	48	48	9	105
Increased exposure through known food vehicles to agents not subject to food safety regulations.	38	59	9	106
Increased exposure through new food vehicles to agents subject to food safety regulations.	34	57	15	106
Increased exposure through known food vehicles to agents subject to food safety regulations.	28	49	29	106

Table 11. Response frequencies for the pathway "Regulated agents and new vehicles" by country

Country	**Not likely**	**Likely**	**No answer**	**Sum**
Denmark	14	7		21
Finland	9	11	1	21
Norway	27	4	3	34
Sweden	22	12		34

Table 12. Response frequencies for the pathway “Unregulated agents and known vehicles” by background

Microbiology	Not likely	Likely	No answer	Sum
No	43	13	2	58
Yes	25	25	2	52

Table 13. Response frequencies for prospective foodborne agents

Agent	Likely	Possible	Unlikely	Sum
Bacteria	77	29	4	110
Viruses	73	33	4	110
Allergens	33	45	32	110
Parasites	32	43	35	110
Microbial toxins in food	30	65	14	109
Mycotoxins	28	46	36	110
Marine toxins	18	62	29	109
Plant toxins	16	42	52	110
Environmental chemicals	12	45	53	110
Processing chemicals	10	44	56	110
Infectious proteins (prions)	2	27	80	109
Other foodborne agents	6	72	22	100

Table 14. Opinions on prospective agents by country

Country	Parasites		Viruses		Mycotoxins	
	Not likely	Likely	Not likely	Likely	Not likely	Likely
Denmark	19	2	5	16	19	2
Finland	17	4	5	16	19	2
Norway	25	9	21	13	19	15
Sweden	17	17	6	28	25	9

Table 15. Opinions on prospective viruses by management experience

Management experience	Viruses		
	Not likely	Likely	Sum
Low	26	30	56
High	11	43	54

Vehicles of foodborne outbreaks

Question 6. Which food commodities are likely disease agent vehicles for an increasing number of foodborne outbreaks in your country during 2011-2020 compared with 2001-2010?

The majority of respondents indicated vegetables and herbs as a likely vehicle for a future increase in the number of foodborne outbreaks (Table 16). About half the respondents opted for meat and seafood as likely vehicles. Several national differences were noted.

Table 16. Response frequencies for food commodities as carriers of diseases

Food commodities	Likely	Possible	Unlikely	Sum
Vegetables and vegetable products	76	31	2	109
Herbs, spices and condiments	68	34	7	109
Fish and other seafood	55	50	4	109
Meat and meat products	53	47	9	109
Fruit and fruit products	45	36	27	108
Legumes, nuts and oilseeds	33	56	19	108
Composite foods	28	57	23	108
Eggs and egg products	21	47	41	109
Products for special nutritional use	18	44	47	109
Fruit and vegetable juices	17	49	43	109
Snacks, desserts, and other foods	16	54	38	108
Grains and grain-based products	14	50	45	109
Milk and dairy products	14	61	33	108
Starchy roots and tubers	7	47	53	107
Animal and vegetable fats and oils	4	33	71	108
Non-alcoholic beverages	4	34	71	109
Food for infants and small children	3	51	55	109
Sugar and confectionary	2	24	81	107
Alcoholic beverages	1	13	95	109
Other food commodities	4	69	17	90

Vegetables evoked fewer ‘Likely’ responses among Norwegians, $\chi^2(1)= 5.49$, p=0.019 (Table 17), but management experience was an equally strong explanatory factor, $\chi^2(1)= 5.95$, p=0.015 (Table 18), with more ‘Likely’ responses among respondents with long experience. This is in line with Norwegian respondents having longer assessment experience, but shorter management experience. Furthermore, Swedish respondents considered herbs more often as a likely vehicle, whereas Norwegian respondents did the opposite, ticking herbs less often as a likely vehicle, $\chi^2(3)$= 15.7, p=0.001. Finnish respondents selected fish more often as a likely vehicle, $\chi^2(3)$= 15.0, p=0.002. An educational background in toxicology reduced the number of likely responses to herbs as vehicles, $\chi^2(1)$= 7.77, p=0.005 (Table 19).

Table 17. Opinions on vegetables, herbs and fish as prospective carriers by country

Country	Vegetables		Herbs		Fish	
	Not likely	**Likely**	**Not likely**	**Likely**	**Not likely**	**Likely**
Denmark	6	15	7	14	15	6
Finland	4	17	8	13	5	16
Norway	16	18	21	13	22	12
Sweden	7	26	5	28	12	21

Table 18. Opinions on prospective vegetable carriers by management experience

Management experience	Vegetables		
	Not likely	**Likely**	**Sum**
Low	23	32	55
High	10	44	54

Table 19. Opinions on prospective herb carriers by background in toxicology

Education in toxicology	Herbs		
	Not likely	**Likely**	**Sum**
No	30	64	94
Yes	11	4	15

Critical points in the food chain

Question 7. Which points in the food chain are likely or unlikely points of agent proliferation generating an increasing number of foodborne outbreaks in your country during 2011-2020 compared with 2001-2010?

A clear majority of the respondents selected imports and food service facilities (restaurants and catering) as likely points of agent proliferation (Table 20). Only one demographic factor interacted with the likelihood estimations. A background in microbiology favoured households as points of proliferation, $\chi^2(1)$= 5.88, p=0.015 (Table 21).

Table 20. Response frequencies for likely critical points of agent proliferation

Critical point	Likely	Possible	Unlikely	Sum
Imports	86	24	0	110
Primary production	38	60	11	109
Food processing industry	32	62	15	109
Food transport	17	56	36	109
Restaurants and catering	72	37	1	110
Health care institutions	24	54	32	110
Households	47	54	9	110
Other critical point	2	64	17	83

Table 21. Opinion on households as prospective points of proliferation by background in microbiology

Education in microbiology	Households		
	Not likely	Likely	Sum
No	40	18	58
Yes	23	29	52

Control measures in the food chain

Question 8. Which control measures in food production are likely or unlikely to enable mitigation of an increasing number of foodborne outbreaks in your country during 2011-2020 compared with 2001-2010?

Food safety knowledge was most frequently selected as a likely measure for mitigation (Table 22). All respondents with background in water technology considered a change in processing technology to be a likely measure of hazard control, $\chi^2(1)=7.97$, $p=0.005$ (Table 23). A veterinary background favoured the purchase of raw material as a likely measure for mitigation, $\chi^2(1)=6.48$, $p=0.011$.

Table 22. Response frequencies for future effective hazard controls

Hazard controls	Likely	Possible	Unlikely	Sum
Food safety knowledge	78	22	9	109
Water, soil and air management	52	40	16	108
Purchase of raw material	52	50	7	109
Food storage	51	49	9	109
Change of processing technology	50	55	4	109
Other control measures	11	65	7	83

Table 23. Opinions on resource management and raw material as likely control measures by background

Education in water technology	**Processing technology**		**Education in veterinary medicine**	**Raw material**	
	Not likely	**Likely**		**Not likely**	**Likely**
No	59	42	No	40	23
Yes	0	8	Yes	17	29

Change in waterborne outbreaks

Question 9. Will the number of waterborne outbreaks change in your country for the period 2011-2020 compared with the period 2001-2010?

The responses to future changes in waterborne outbreaks demonstrated similar patterns to the responses regarding future changes in foodborne outbreaks. Thus the responses favoured an increase in the number of waterborne outbreaks (Table 24), but national contrasts were weaker (Table 25), with no significant differences in J scores. Matched-pair t-tests of the difference in J scores for foodborne and waterborne outbreaks showed that this was not significant. Educational background in nutrition provided the only significant factor, favouring higher J scores, i.e. a stronger belief in an increasing number of outbreaks, $\beta=1.34$, $t(108)=2.44$, $p=0.016$.

Table 24. Response frequencies for future changes in the number of waterborne outbreaks

Answer option / no. of responses	**Most likely**	**Likely**	**Possible**	**Unlikely**	**Most unlikely**	**Sum**
Yes, the number of outbreaks will increase by at least 10%.	8	31	33	32	6	110
No, the number of outbreaks will change by no more than 10%.	13	30	52	14	1	110
Yes, the number of outbreaks will decrease by at least 10%.	2	4	32	59	13	110

Table 25. Belief score J for waterborne outbreaks

Country	Mean J	SEM*
Denmark	0.99	0.38
Finland	0.67	0.24
Norway	1.04	0.52
Sweden	1.38	0.37
All	1.06	0.22

*Standard Error of the Mean

Estimaton of waterborne outbreaks

Question 10. Please give your estimate of the change in the number of waterborne outbreaks in your country.

As for foodborne outbreaks, we used the J scores for waterborne outbreaks to adjust the estimates of relative change in the number of waterborne outbreaks. The correlation between J scores and estimates was 0.39 before adjustment and 0.44 after adjustment.

The mean estimate of the relative change in the number of outbreaks was 1.22, i.e. an increase of 22% (Table 26). The only demographic factor that made a difference in estimates of change was an educational background in chemistry, favouring higher estimates, $\beta=0.26$, $t(105)=2.13$, $p=0.036$. The difference in estimates of change between foodborne and waterborne outbreaks was not significant (matched-pair t-test).

Table 26. Estimates of relative numbers of waterborne outbreaks

Country	# Estimates	Mean	SEM*
Denmark	21	1.18	0.09
Finland	20	1.09	0.06
Norway	32	1.22	0.09
Sweden	34	1.33	0.08
All	107	1.22	0.04

*Standard Error of the Mean

Causes of waterborne outbreaks

Question 11. Which causes are likely or unlikely to lead to an increase in the number of waterborne outbreaks in your country?

Compared with the causes selected for foodborne outbreaks, the cause “New agent” was not chosen as frequently in the attribution of waterborne outbreaks, $\chi^2(1)=5.60$, $p=0.018$. More often it was the second choice of cause, “Increasing exposure to previously known agents", that was chosen, $\chi^2(1)=3.87$, $p=0.049$ (Tables 9, 27 and 28).

Table 27. Response frequencies for causes of change in waterborne outbreaks

Number of affirmative responses per answer option	Likelihood level					
	Most likely	Likely	Possible	Unlikely	Most unlikely	Sum
Increasing exposure to known foodborne disease agents.	38	42	19	9	2	110
The emergence of new foodborne disease agents, or new variants of known agents.	5	27	49	28	1	110
Increasing susceptibility to known foodborne disease agents.	6	12	32	51	9	110

Table 28. Response frequencies for causes of future foodborne and waterborne outbreaks

Foodborne agent likely cause	Waterborne agent likely cause			Food exposure likely cause	Water exposure likely cause		
	No	Yes	Sum		No	Yes	Sum
No	43	9	52	No	17	27	44
Yes	35	23	58	Yes	13	53	66
Sum	78	32	110	Sum	30	80	110

The causes selected for an increasing number of waterborne outbreaks interacted with nationality, with Swedish and Norwegian respondents more often selecting new agents as likely causes, $\chi^2(3)=10.5$, $p=0.015$ (Table 29). Respondents with a background in microbiology more often selected increasing exposure, $\chi^2(1)=4.03$, $p=0.045$ (Table 30).

Table 29. Response frequencies for new agents as likely causes of change in waterborne outbreaks

Country	**Not likely**	**Likely**	**Sum**
Denmark	18	3	21
Finland	19	2	21
Norway	19	15	34
Sweden	22	12	34

Table 30. Opinions on increasing exposure as a likely cause of change in waterborne outbreaks by education in microbiology

Education in microbiology	**Increasing exposure**		
	Not likely	**Likely**	**Sum**
No	21	37	58
Yes	9	43	52

Waterborne agents

Question 12. Which agents of waterborne diseases are likely or unlikely to contribute to a significant increase in the number of outbreaks in your country during 2011-2020 compared with 2001-2010?

The two most likely agents of an increasing number of waterborne outbreaks were the same as the two most likely agents of foodborne outbreaks, e.g. bacteria and viruses, although in reverse order (Tables 13 and 31). Parasites and environmental chemicals were also more frequently selected as likely agents of waterborne outbreaks. Compared with Danish and Finnish respondents, Swedish and Norwegian respondents more often selected parasites as likely agents, $\chi^2(3)=22.26$, $p<0.001$ (Table 32). Furthermore, Norwegian respondents selected viruses less often as likely agents, $\chi^2(3)=9.60$, $p=0.022$, whereas Danish respondents more often opted for environmental chemicals as likely agents, $\chi^2(3)=9.61$, $p=0.022$ (Table 33). A background in epidemiology increased the frequency of likely responses to parasites, $\chi^2(1)=5.24$, $p=0.022$ (Table 34).

Table 31. Response frequencies for waterborne agents

Agent	Likely	Possible	Unlikely	Sum
Viruses	71	30	9	110
Bacteria	61	45	4	110
Parasites	57	40	13	110
Environmental chemicals	21	52	36	109
Marine toxins	13	33	62	108
Microbial toxins	9	47	51	107
Plant toxins	3	29	76	108
Mycotoxins	2	23	84	109
Processing chemicals	2	40	67	109
Allergens	1	25	81	107
Infectious proteins (prions)	0	12	96	108
Other foodborne agents	2	49	32	83

Table 32. Opinions on parasites as likely waterborne agents by country

Country	Not likely	Likely	Sum
Denmark	17	4	21
Finland	15	6	21
Norway	12	22	34
Sweden	9	25	34

Table 33. Opinions on viruses and environmental chemicals as likely waterborne agents by country

Country	Viruses		Environmental chemicals	
	Not likely	Likely	Not likely	Likely
Denmark	7	14	12	9
Finland	5	16	19	2
Norway	19	15	28	5
Sweden	8	26	29	5

Table 34. Opinions on parasites as likely waterborne agents by education in epidemiology

Education in epidemiology	Parasites as likely agents		
	Not likely	Likely	Sum
No	40	30	70
Yes	13	27	40
Sum	53	57	110

Drivers of change in outbreak numbers

Question 13. Which environmental, social or economic changes are likely or unlikely drivers of an increasing spread of foodborne or waterborne diseases in your country during 2011-2020 compared with 2001-2010?

Global trade, human travel and new patterns of food consumption were most frequently selected as likely global drivers of change (Table 35). Danish respondents also considered weather-climate change as a likely driver, $\chi^2(3)=8.23$, $p<0.042$, whereas Finnish respondents more often selected types of food production as a likely driver, $\chi^2(3)=22.26$, $p<0.001$ (Table 36). An educational background in water technology favoured more ‘Likely’ responses to water consumption as driver, $\chi^2(1)=7.48$, $p<0.006$ (Table 37). However, the last result should not be overstated considering the limited number of respondents with the background in question (n=8).

Table 35. Response frequencies for global drivers of change in foodborne or waterborne diseases

Global drivers of change	Likely	Possible	Unlikely	Sum
Global trade/transportation	76	26	8	110
Human travel/migration	74	30	6	110
Weather or climate	65	32	13	110
New patterns of food consumption	62	36	12	110
New patterns of food production	39	47	23	109
Fraud and crime	16	55	39	110
New water consumption	14	40	56	110
New water production	8	50	51	109
Other changes	8	65	14	87

Table 36. Opinions on weather-climate and food production as drivers of change by country

Country	Weather or climate		Food production	
	Not likely	Likely	Not likely	Likely
Denmark	4	17	16	5
Finland	13	8	7	14
Norway	13	21	23	10
Sweden	15	19	24	10

Table 37. Opinions on water consumption as a driver of change by background

Education in water technology	**Water consumption as driver**		
	Not likely	**Likely**	**Sum**
No	92	10	102
Yes	4	4	8
Sum	96	14	110

Population change

Question 14. Which changes in the consumer population are likely or unlikely explanations for an increasing human susceptibility to foodborne and waterborne diseases?

The majority of the respondents considered food consumer behaviour and an ageing population likely factors in changing human susceptibility to foodborne and waterborne diseases (Table 38). Education in public health was associated with a tendency to select environmental stress as a likely driver of increasing susceptibility, $\chi^2(1)=7.48$, $p<0.006$ (Table 39).

Table 38. Response frequencies for changes in consumer populations as drivers of susceptibility

Changes in consumer populations	**Likely**	**Possible**	**Unlikely**	**Sum**
An ageing consumer population	62	36	12	110
Changes in food consumer behaviour	61	38	11	110
Health issues in specific consumer groups	40	57	13	110
Increasing environmental stress on public health	28	52	30	110
Population growth	16	40	54	110
Other changes	3	66	9	78

Table 39. Opinions on environmental stress as a driver of change by background

Education in public health	**Environmental stress as driver**		
	Not likely	**Likely**	**Sum**
No	57	11	68
Yes	25	17	42
Sum	82	28	110

Consumer behaviour

Question 15. Which changes in food consumer behaviour are likely or unlikely to contribute to an increase in the number of foodborne and waterborne outbreaks in your country during 2011-2020 compared with 2001-2010?

A clear majority of the respondents considered increased consumption of imported and raw food to be a likely source of an increasing number of outbreaks in the future (Table 40).

Table 40. Response frequencies for changes in consumer behaviour as drivers of outbreak numbers

Changes in consumer behaviour	**Likely**	**Possible**	**Unlikely**	**Sum**
Increased import of foreign food	85	23	2	110
Increased consumption of raw food	70	33	7	110
Deteriorating food hygiene	34	55	21	110
Increased consumption of ready meals	32	53	25	110
Increased consumption of mixed foods	29	62	18	109
Other changes	2	64	0	66

Respondents with a background in microbiology were more prone to consider imported goods as a likely contributor to the change, $\chi^2(1)=5.87$, p=0.015. Respondents with a background in public health more often selected mixed foods as a source of the change, $\chi^2(1)=5.63$, p=0.018 (Table 41).

Table 41. Opinions on imports and mixed foods as sources of increasing outbreak numbers by background

Education in Microbiology	**Imported food consumption**		**Education in Public Health**	**Mixed food consumption**	
	Not likely	**Likely**		**Not likely**	**Likely**
No	19	39	No	55	12
Yes	6	46	Yes	25	17

Drivers of change in consumption

Question 16. Which are the more likely or unlikely explanations for changes in food consumer behaviours that may contribute to an increasing number of foodborne and waterborne outbreaks?

There was high uncertainty regarding likely contributors to changes in food consumer behaviours. No explanation was considered likely by a majority of the respondents. Consumer preferences and an ageing population were more often considered likely than other explanations (Table 42). An ageing population was more frequently selected by Finnish respondents, $\chi^2(1)=14.42$, $p=0.002$ (Table 43).

Table 42. Response frequencies for drivers of change in consumer behaviour as drivers of outbreak numbers

Drivers of change in consumer behaviour	Likely	Possible	Unlikely	Sum
Food consumer preferences	48	52	9	109
An ageing consumer population	41	45	24	110
Economic conditions of food production	35	59	16	110
Population change due to migration	31	61	18	110
Other changes	3	68	10	81

Table 43. Opinions on an ageing population as a driver of change by country

Country	Not likely	Likely	Sum
Denmark	17	4	21
Finland	6	15	21
Norway	24	10	34
Sweden	22	12	34

Discussion

The survey respondents considered an increasing number of foodborne and waterborne disease outbreaks to be a more likely scenario than not. However, the respondents used multiple formats when estimating the relative increase in 2011-2020 compared with 2001-2010 and the estimates they gave did not always agree with the qualitative judgments of change (Question 1). The belief score J provided support for evaluating the expert estimates. It can be considered a ranking of expert beliefs in change. The initial multiple qualitative judgments of change were transformed into a single measure of change, allowing for validation and adjustment of the expert estimates. Thus, the belief score bridged two types of expert judgments of change, qualitative and quantitative. More research is needed to explore its potential as a qualitative control in expert judgments of probability. One line of inquiry is to use it in studies of biases in estimates of probability (13).

After adjustment, the expert estimates indicated a 10%-20% increase in foodborne and waterborne outbreaks of disease. The remaining questions, with the exception of demographics, concerned likely causes, drivers and explanations of change. Taken together, the answers to these questions can be re-phrased as a scenario of likely factors and forces that will lead to a future increase in the number of outbreaks.

> *Imported food, particularly raw vegetables, contaminated with unregulated agents, viruses or bacteria, prepared in public food service facilities with deficient food safety knowledge, served to a population with an increasing share of elderly people.*

This set of factors could provide us with a scenario template in future research on crisis planning. By collecting data of relevance for the template, we can elaborate it into multiple crisis scenarios that examine e.g. which countries of origin are of concern, which viruses and bacteria and which types of food service facilities. These questions need to be addressed to transform the scenario template into an operational scenario for analysis and planning that can serve in crisis preparedness and management.

Besides these general patterns of expert opinion and perception, the survey also revealed variations depending on demographics. Nationality influenced appraisals of outbreak agents and vehicles. For example, parasites and herbs were more frequently selected as likely options among Swedish respondents. The causes of prospective outbreaks selected by Norwegian respondents were less in tune with mainstream answers. The Norwegian respondents also gave significantly higher estimates of the relative increase in outbreak numbers.

The reason for the variations observed is unclear. One hypothesis is that national differences in professional experience of risk analysis and educational background influenced the answers, rather than nationality. The Norwegian respondents had longer experience of risk assessment and represented a broader area of expertise. This non-homogeneous mixing of nationality, analytical experience and education makes it difficult to disentangle the factors and this must be left to future research.

In particular, it is important to determine whether the observed differences between countries in organisational structures of food safety experts also represent cultures and risk perceptions, or whether the national differences in risk perceptions in the current survey can be reduced to professional and/or educational differences, e.g. microbiologists stressing changes in agent exposures and public health professionals stressing changes in lifestyle factors.

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Appendix

The internet-based questionnaire has been reproduced in full in appendix.

BACKGROUND

This is a survey of expert perceptions of future foodborne and waterborne outbreaks. It is addressed to a selected group of experts in Denmark, Finland, Iceland, Norway and Sweden.

The survey is a joint venture by the Nordic food authorities. The purpose is to identify common and different concerns.

The survey takes about 30 minutes to complete. It must be carried out during a single online session.

Please share your beliefs.

CONFIDENTIALITY

We ask you to share your opinions and judgements for statistical purposes only. The survey is confidential.

The statistical analysis will be carried out by Tom Andersson at the National Food Agency in Sweden. Only he and the head of the Division for Evaluation, Cecilia Svärd, will have access to digital response files.

To receive a copy of the results, we kindly ask you to provide us with an e-mail address at the end of the survey.

After separating the e-mail address from the response file, the original server file will be deleted to make it impossible to trace answers back to individuals.

For further information or questions, please contact Tom Andersson: tom.andersson(at)slv.se.

1. Number of foodborne outbreaks

Will the number of foodborne outbreaks change in your country for the period 2011-2020 compared with the period 2001-2010?

A 'foodborne outbreak' is here defined as at least two cases of disease due to food contamination, excluding drinking water contamination.

Please specify your beliefs by marking one of the five choices 'most likely', 'likely', 'possible', 'unlikely' or 'most unlikely' for each outcome.

This question is mandatory to complete the survey.

	Most likely	Likely	Possible	Unlikely	Most unlikely
Yes, the number of outbreaks will decrease by at least 10%.	◯	◯	◯	◯	◯
Yes, the number of outbreaks will increase by at least 10%.	◯	◯	◯	◯	◯
No, the number of outbreaks will change by no more than 10%.	◯	◯	◯	◯	◯

2. Your estimate

Please give your estimate of the change in the number of foodborne outbreaks in your country.

Please specify a number representing the proportion (ratio) of number of outbreaks for 2011-2020 compared with 2001-2010. Use decimal points for decimal numbers.

For example, '2' represents twice the number of outbreaks. '0.5' represents half the number. '1' represents no change.

3. Cause of change

Irrespective of previous questions and answers, let us assume that the number of foodborne outbreaks will increase by at least 10% during 2011-2020 compared with 2001-2010.

Which causes are likely or unlikely to lead to an increase in the number of foodborne outbreaks in your country?

Please specify your beliefs by marking one of the five choices 'most likely', 'likely', 'possible', 'unlikely' or 'most unlikely' for each outcome.

This question is mandatory to complete the survey.

	Most likely	Likely	Possible	Unlikely	Most unlikely
Increasing exposure to known foodborne disease agents.	◯	◯	◯	◯	◯
The emergence of new foodborne disease agents, or new variants of known agents.	◯	◯	◯	◯	◯
Increasing susceptibility to known foodborne disease agents.	◯	◯	◯	◯	◯

4. Exposure to known disease agents

Let us assume that your country is facing a significant increase in the number of foodborne outbreaks due to increasing exposure to known disease agents.

Which exposures are likely or not to contribute to an increasing number of foodborne outbreaks in your country during 2011-2020 compared with 2001-2010?

Please specify your beliefs regarding the likelihood of the four types pf exposure by marking them as 'likely', 'possible' or 'unlikely'.

	Likely	Possible	Unlikely
Increased exposure through known food vehicles to agents subject to food safety regulations.	○	○	○
Increased exposure through new food vehicles to agents subject to food safety regulations.	○	○	○
Increased exposure through known food vehicles to agents not subject to food safety regulations.	○	○	○
Increased exposure through new food vehicles to agents not subject to food safety regulations.	○	○	○

5. Foodborne disease agents

Which agents of foodborne diseases are likely to contribute to a significant increase in the number of outbreaks in your country during 2011-2020 compared with 2001-2010?

Please specify your beliefs regarding the likelihood of the disease agents by marking them as 'likely', 'possible' or 'unlikely'.

For clarification, the term 'microbial toxins in food' refers here to toxins generated before consumption.

	Likely	Possible	Unlikely
Allergens	◯	◯	◯
Microbial toxins in food	◯	◯	◯
Marine toxins	◯	◯	◯
Mycotoxins	◯	◯	◯
Plant toxins	◯	◯	◯
Bacteria	◯	◯	◯
Viruses	◯	◯	◯
Infectious proteins (prions)	◯	◯	◯
Environmental chemicals (pesticides, residues and metals)	◯	◯	◯
Parasites	◯	◯	◯
Processing chemicals (additives and packaging materials)	◯	◯	◯
Other foodborne agents	◯	◯	◯

If you have other or specific agents in mind, please specify.

6. Food commodities

Which food commodities are likely disease agent vehicles for an increasing number of foodborne outbreaks in your country during 2011-2020 compared with 2001-2010?

Please specify your beliefs regarding the likelihood of the following commodities by marking them as 'likely', 'possible' or 'unlikely'.

	Likely	Possible	Unlikely
Meat and meat products (including edible offal)	◯	◯	◯
Herbs, spices and condiments	◯	◯	◯
Alcoholic beverages	◯	◯	◯
Fruit and vegetable juices	◯	◯	◯
Non-alcoholic beverages (excepting milk based beverages)	◯	◯	◯
Composite foods (including frozen products)	◯	◯	◯
Products for special nutritional use	◯	◯	◯
Snacks, desserts, and other foods	◯	◯	◯
Grains and grain-based products	◯	◯	◯
Food for infants and small children	◯	◯	◯
Fish and other seafood (including amphibians, reptiles, snails and insects)	◯	◯	◯
Vegetables and vegetable products (including fungi)	◯	◯	◯
Starchy roots and tubers	◯	◯	◯
Legumes, nuts and oilseeds	◯	◯	◯
Eggs and egg products	◯	◯	◯
Milk and dairy products	◯	◯	◯
Sugar and confectionary	◯	◯	◯
Animal and vegetable fats and oils	◯	◯	◯
Fruit and fruit products	◯	◯	◯
Other food commodities	◯	◯	◯

If you have other or specific commodities in mind, please specify.

7. Critical points

Which points in the food chain are likely or unlikely points of agent proliferation generating an increasing number of foodborne outbreaks in your country during 2011-2020 compared with 2001-2010?

Please specify your beliefs regarding the likelihood of the following critical points by marking them as 'likely', 'possible' or 'unlikely'.

	Likely	Possible	Unlikely
Imports	◯	◯	◯
Health care institutions	◯	◯	◯
Restaurants and catering	◯	◯	◯
Primary production	◯	◯	◯
Food processing industry	◯	◯	◯
Food transport	◯	◯	◯
Households	◯	◯	◯
Other critical point	◯	◯	◯

If you have other or specific critical points in mind, please specify.

8. Hazard control

Which control measures in food production are likely or unlikely to enable mitigation of an increasing number of foodborne outbreaks in your country during 2011-2020 compared with 2001-2010?

Please specify your beliefs regarding the likelihood of the following control measures by marking them as 'likely', 'possible' or 'unlikely'.

	Likely	Possible	Unlikely
Food storage – equipment and practice	◯	◯	◯
Change of processing technology	◯	◯	◯
Purchase of raw material	◯	◯	◯
Water, soil and air management	◯	◯	◯
Food safety knowledge	◯	◯	◯
Other control measures	◯	◯	◯

If you have other or specific control measures in mind, please specify.

9. Number of waterborne outbreaks

Here we pass into some questions regarding outbreaks due to contamination of drinking water (tap water).

Will the number of waterborne outbreaks change in your country for the period 2011-2020 compared with the period 2001-2010?

A 'waterborne outbreak' is here defined as at least two cases of disease due to drinking water contamination.

Please specify your beliefs by marking one of the five choices 'most likely', 'likely', 'possible', 'unlikely' or 'most unlikely' for each outcome.

The question is mandatory to complete the survey.

	Most likely	Likely	Possible	Unlikely	Most unlikely
Yes, the number of outbreaks will decrease by at least 10%.	◯	◯	◯	◯	◯
No, the number of outbreaks will change by no more than 10%.	◯	◯	◯	◯	◯
Yes, the number of outbreaks will increase by at least 10%.	◯	◯	◯	◯	◯

10. Your estimate

Please give your estimate of the change in the number of waterborne outbreaks in your country.

Please specify a number representing the proportion (ratio) of number of outbreaks for 2011-2020 compared with 2001-2010. Use decimal points for decimal numbers.

For example, '2' represents twice the number of outbreaks. '0.5' represents half the number. '1' represents no change.

11. Cause of change

Irrespective of previous questions and answers, let us assume that the number of waterborne outbreaks will increase by at least 10% during 2011-2020 compared with 2001-2010.

Which causes are likely or unlikely to lead to an increase in the number of waterborne outbreaks in your country?

Please specify your beliefs by marking one of the five choices 'most likely', 'likely', 'possible', 'unlikely' or 'most unlikely' for each outcome.

This question is mandatory to complete the survey.

	Most likely	Likely	Possible	Unlikely	Most unlikely
The emergence of new waterborne disease agents, or new variants of known agents.	◯	◯	◯	◯	◯
Increasing exposure to known waterborne disease agents.	◯	◯	◯	◯	◯
Increasing susceptibility to known waterborne disease agents.	◯	◯	◯	◯	◯

12. Waterborne disease agents

Which agents of waterborne diseases are likely or unlikely to contribute to a significant increase in the number of outbreaks in your country during 2011-2020 compared with 2001-2010?

Please specify your beliefs regarding the likelihood of the disease agents by marking them as 'likely', 'possible' or 'unlikely'.

For clarification, the term 'microbial toxins' refers here to toxins generated before consumption.

	Likely	Possible	Unlikely
Parasites	◯	◯	◯
Mycotoxins	◯	◯	◯
Marine toxins	◯	◯	◯
Microbial toxins	◯	◯	◯
Plant toxins	◯	◯	◯
Viruses	◯	◯	◯
Environmental chemicals (pesticides, residues and metals)	◯	◯	◯
Allergens	◯	◯	◯
Infectious proteins (prions)	◯	◯	◯
Processing chemicals (additives and packaging materials)	◯	◯	◯
Bacteria	◯	◯	◯
Other foodborne agents	◯	◯	◯

If you have other or specific agents in mind, please specify.

13. Drivers of change

Let us now take a broader view on the forces of change in future foodborne and waterborne outbreaks.

Which environmental, social or economic changes are likely or unlikely drivers of an increasing spread of foodborne or waterborne diseases in your country during 2011-2020 compared with 2001-2010?

Please specify your beliefs regarding the likelihood of the following factors by marking them as 'likely', 'possible' or 'unlikely'.

	Likely	Possible	Unlikely
Fraud and crime	◯	◯	◯
New water consumption and/or consumer patterns	◯	◯	◯
Human travel and/or migration	◯	◯	◯
Weather or climate	◯	◯	◯
New food consumption and/or consumer patterns	◯	◯	◯
Global trade and/or transportation	◯	◯	◯
New food production practices and/or technology	◯	◯	◯
New water production practices and/or technology	◯	◯	◯
Other changes	◯	◯	◯

If you have other or specific changes in mind, please specify.

14. Population change

Irrespective of previous questions and answers, let us assume that your country is facing a significant increase (at least 10%) in the number of foodborne or waterborne outbreaks during 2011-2020 due to increasing human susceptibility to foodborne or waterborne diseases.

Which changes in the consumer population are likely or unlikely explanations for an increasing human susceptibility to foodborne and waterborne diseases?

Please specify your beliefs regarding the likelihood of the following changes by marking them as 'likely', 'possible' or 'unlikely'.

	Likely	Possible	Unlikely
Health issues in specific consumer groups	○	○	○
Changes in food consumer behaviour	○	○	○
Increasing environmental stress on public health	○	○	○
An ageing consumer population	○	○	○
Population growth	○	○	○
Other changes	○	○	○

If you have other or specific changes in mind, please specify.

15. Consumer behaviour

Which changes in food consumer behaviour are likely or unlikely to contribute to an increase in the number of foodborne and waterborne outbreaks in your country during 2011-2020 compared with 2001-2010?

Please specify your beliefs regarding the likelihood of the following changes by marking them as 'likely', 'possible' or 'unlikely'.

	Likely	Possible	Unlikely
Increased consumption of raw food	◯	◯	◯
Increased import of foreign food	◯	◯	◯
Increased consumption of ready meals	◯	◯	◯
Increased consumption of mixed foods	◯	◯	◯
Deteriorating food hygiene	◯	◯	◯
Other changes	◯	◯	◯

If you have other or specific changes in mind, please specify.

16. Behavior change

Which are the more likely or unlikely explanations for changes in food consumer behaviours that may contribute to an increasing number of foodborne and waterborne outbreaks?

Please specify your beliefs regarding the likelihood of the following changes by marking them as 'likely', 'possible' or 'unlikely'.

	Likely	Possible	Unlikely
Economic conditions of food production	○	○	○
Food consumer preferences	○	○	○
An ageing consumer population	○	○	○
Population change due to migration	○	○	○
Other changes	○	○	○

If you have other or specific changes in mind, please specify.

17. Professional experience

Please specify the number of years of education and professional experience you have in the following areas of expertise.

Please enter a positive number in each field.
If necessary, please use a decimal point: '.'

Risk management and control (food safety)	
Risk assessment (food safety)	
Risk communication (food safety)	

18. Educational background

Please specify your educational background of relevance for water and food safety.

- [ ] Water technology
- [ ] Food technology
- [ ] Nutrition
- [ ] Chemistry
- [ ] Toxicology
- [ ] Microbiology
- [ ] Biology-Ecology
- [ ] Agronomy
- [ ] Veterinary
- [ ] Epidemiology
- [ ] Public Health

Other (please specify)

19. Home country

Please specify your home country.

- ◯ Denmark
- ◯ Finland
- ◯ Iceland
- ◯ Norway
- ◯ Sweden

20. E-mail address

Please provide your e-mail address if you want us to send you a copy of the final report of the survey results. The report will be published at the end of April 2012.

Thank you for participating!

Rapporter som utgivits 2011

1. Lunch och lärande – skollunchens betydelse för elevernas prestation och situation i klassrummet av M Lennernäs.
2. Kosttillskott som säljs via Internet – en studie av hur kraven i lagstiftningen uppfylls av A Wedholm Pallas, A Laser Reuterswärd och U Beckman-Sundh.
3. Vetenskapligt underlag till råd om bra mat i äldreomsorgen. Sammanställt av E Lövestram.
4. Livsmedelssvinn i hushåll och skolor – en kunskapssammanställning av R Modin.
5. Riskprofil för material i kontakt med livsmedel av K Svensson, Livsmedelsverket och G Olafsson, Rikisendurskodun (Environmental and Food Agency of Iceland).
6. Proficiency Testing – Food Microbiology, January 2011 by C Normark and I Boriak
7. Proficiency Testing – Food Chemistry, Nutritional Components of Food, Round N 47.
8. Proficiency Testing – Food Chemistry, Trace Elements in Food, Round T-22 by C Åstrand and Lars Jorhem.
9. Riksprojekt 2010. Listeria monocytogenes i kyld ätfärdig mat av C Nilsson och M Lindblad.
10. Kontroll av restsubstanser i levande djur och animaliska livsmedel. Resultat 2010 av I Nordlander, Å Kjellgren, A Glynn, B Aspenström-Fagerlund, K Granelli, I Nilsson, C Sjölund Livsmedelsverket och K Girma, Jordbruksverket.
11. Proficiency Testing – Food Microbiology, April 2011 by C Normark, I Boriak, M Lindqvist and I Tillander.
12. Bär – analys av näringsämnen av V Öhrvik, I Mattisson, A Staffas och H S Strandler.
13. Proficiency Testing – Drinking Water Microbiology, 2011:1, March by T Slapokas, C Lantz and M Lindqvist.
14. Kontrollprogrammet för tvåskaliga blötdjur – Årsrapport 2009-2010 – av av I Nordlander, M Persson, H Hallström, M Simonsson, Livsmedelsverket och B Karlsson, SMHI.
15. Margariner och matfettsblandningar – analys av fettsyror av R Åsgård och S Wretling.
16. Proficiency Testing – Food Chemistry, Nutritional Components of Food, Round N 48.
17. Kontroll av bekämpningsmedelsrester i livsmedel 2009 av A Jansson, X Holmbäck och A Wannberg.
18. Klimatpåverkan och energianvändning från livsmedelsförpackningar av M Wallman och K Nilsson.
19. Klimatpåverkan i kylkedjan – från livsmedelsindustri till konsument av K Nilsson och U Lindberg.
20. Förvara maten rätt så håller den längre – vetenskapligt underlag om optimal förvaring av livsmedel av R Modin och M Lindblad.
21. Råd om mat för barn 0-5 år. Vetenskapligt underlag med risk- och nyttovärderingar och kunskapsöversikter.
22. Råd om mat för barn 0-5 år. Hanteringsrapport som beskriver hur risk- och nyttovärderingar, tillsammans med andra faktorer, har lett fram till Livsmedelsverkets råd.
23. Proficiency Testing – Food Chemistry, Trace Elements in Food, Round T-23 by C Åstrand and L Jorhem.
24. Proficiency Testing – Food Chemistry, Vitamins in Food, Round V-9 by A Staffas and H S Strandler.
25. Nordiskt kontrollprojekt om nyckelhålsmärkning 2011 av I Lindeberg.
26. Rapport från GMO-projektet 2011. Undersökning av förekomsten av GMO i livsmedel av Z Kurowska.
27. Fat Quality – Trends in fatty acid composition over the last decade by I Mattisson, S Trattner and S Wretling.
28. Proficiency Testing – Drinking Water Microbiology, 2011:2, September by T Slapokas and M Lindqvist.
29. Kontrollen roll skiljer sig mellan livsmedelsbranscherna av T Ahlström, G Jansson och S Sylvén.
30. Kommuners och Livsmedelsverkets rapportering av livsmedelskontrollen 2011 av C Svärd och L Eskilsson.
31. Proficiency Testing – Food Microbiology, October 2011 by C Normark and I Boriak.

Rapporter som utgivits 2012

1. Fisk, skaldjur och fiskprodukter – analys av näringsämnen av V Öhrvik, A von Malmborg, I Mattisson, S Wretling och C Åstrand.
2. Normerande kontroll av dricksvattenanläggningar 2007-2010 av T Lindberg.
3. Tidstrender av tungmetaller och organiska klorerade miljöföroreningar i baslivsmedel av J Ålander, I Nilsson, B Sundström, L Jorhem, I Nordlander, M Aune, L Larsson, J Kuivinen, A Bergh, M Isaksson och A Glynn.
4. Kompetensprovning av laboratorier: Mikrobiologi – Livsmedel, Januari 2012 av C Normark, I Boriak och L Nachin.
5. Mögel och mögelgifter i torkad frukt av E Fredlund och J Spång.
6. Mikrobiologiska dricksvattenrisker ur ett kretsloppsperspektiv – behov och åtgärder av R Dryselius.
7. Market Basket 2010 – chemical analysis, exposure estimation and health-related assessment of nutrients and toxic compounds in Swedish food baskets.
8. Kompetensprovning av laboratorier: Mikrobiologi – Livsmedel, April 2012 av L Nachin, C Normark, I Boriak och I Tillander.
9. Kontroll av restsubstanser i levande djur och animaliska livsmedel. Resultat 2010 av I Nordlander, Å Kjellgren, A Glynn, B Aspenström-Fagerlund, K Granelli, I Nilsson, C Sjölund Livsmedelsverket och K Girma, Jordbruksverket.
10. Råd om fullkorn 2009 – bakgrund och vetenskapligt underlag av W Becker, L Busk, I Mattisson och S Sand.
11. Nordiskt kontrollprojekt 2012. Märkning av allergener och "kan innehålla spår av allergener" – resultat av de svenska kontrollerna av U Fäger.
12. Kompetensprovning av laboratorier: Mikrobiologi – Dricksvatten, 2012:1, mars av T Šlapokas, M Lindqvist och K Mykkänen.
13. Länsstyrelsens rapportering av livsmedelskontroll inom primärproduktionen 2010-2011 av L Eskilsson och K Bäcklund Stålenheim.
14. Vetenskapligt underlag för råd om mängden frukt och grönsaker till vuxna och barn av H Eneroth.
15. Kommuners och Livsmedelsverkets rapportering av livsmedelskontrollen 2011 av L Eskilsson.
16. Sammanställning av resultat från en projektinriktad kontrollkurs om skyddade beteckningar 2012 av P Elvingsson.
17. Nordic Expert Survey on Future Foodborne and Waterborne Outbreaks by T Andersson, Å Fulke, S Pesonen and J Schlundt.

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