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PAPER

Food preparation, risk communication and the consumer

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An observational method for estimating the risk of food poisoning following domestic food preparation is described. A total of 108 consumers prepared one of four recipes and the results are of use in risk assessment. Whilst some consumers (4.6%) fully implemented appropriate food safety control measures, 3.7% prepared food in a way which seriously violated critical control points and exposed them to a high level of risk. The vast majority of consumers (95.4%) failed to implement one or more basic hygiene practices due to lack of knowledge or failure to implement known food safety procedures. Some of these meals could have posed a risk of food poisoning if eaten. The findings have implications for when and how food hygiene is taught and if extrapolated to food preparation in general indicates a potential for further increases in food poisoning notifications. The results are discussed within the context of risk communication. © 1998 Elsevier Science Ltd. All rights reserved

INTRODUCTION

Foodborne illnesses have been described as one of the most widespread problems of the contemporary world (Notermans *et al.*, 1994) and their notified incidence has increased world wide (Todd, 1989; Maurice, 1994). In England and Wales notified cases of food poisoning and of Campylobacteriosis have increased significantly in the past 15 years although it is recognized that real morbidity is unknown and the incidence is relatively under-reported.

Additionally, the range of organisms capable of causing illness is now recognized as being more extensive (Notermans *et al.*, 1994) with the inclusion of organisms sometimes referred to as emerging pathogens. Of particular concern has been the increase, since the mid-1980s, of enteropathogenic *Escherichia coli* as well as Rotavirus and Small Round Structured Virus (SRSV) infections (Sockett *et al.*, 1993). The costs of food poisoning may be social and economic (Griffith *et al.*, 1995) and the latter represents a significant burden to the economy. Using Public Health Laboratory criteria (Mifsud *et al.*, 1994), food poisoning should be viewed as a communicable disease requiring high priority.

Strategies for achieving a reduction in food poisoning have been the subject of debate for some time (Gilbert, 1983; Charles, 1982). A dual approach (Todd, 1989; Gilbert, 1983) has been advocated based upon legislation and education. New food safety legislation started to be introduced into the UK in 1990 and September 1995 saw the advent of the new Food Hygiene Regulations based upon the EC hygiene directive. The latest legislation requires owners of food businesses to identify relevant hazards and points critical to ensuring food safety. This implicitly requires some form of risk assessment.

Evidence suggests that many cases of food poisoning may be associated with the home (Griffith

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et al., 1994) but legislation does not apply to the home, unless it is being used as a food business. Education, the other half of the dual strategy, can be used proactively to improve food safety at all stages in the food chain including the home. Of importance in education are both the message and the way in which the message is communicated and recent publications (Griffith *et al.*, 1994; Griffith *et al.*, 1995) have stressed the value of considering behavioural aspects of the educational process.

The likely success of both strategies will be improved if based upon scientific principles and accurate data. Within this context Risk Assessment, defined as determining the risk associated with a hazard, is important and of increasing public interest (Advisory Committee on Dangerous Pathogens, 1996). Microbiological hazards should be managed against a background of sound knowledge of risk avoidance practices although there is a frequent lack of appropriate data (Advisory Committee on Dangerous Pathogens, 1996). The application of risk assessment to food safety is now new (Mossel, 1989) although its application to domestic food preparation is underutilized (Worsfold and Griffith, 1995).

Risk assessment, a component of risk analysis (*Figure 1*), can be quantitative or qualitative, can be highly structured in approach (FAO/WHO, 1995) and elements of risk assessment have been, or may be, applied to foodborne illness in a number of ways (Mossel, 1989; Bryan, 1988). All forms of risk assessment involve some form of quantification and this may include detailed mathematical calculations derived from highly controlled epidemiological or laboratory studies and may be more applicable to some (eg chemical) aspects of food safety than others. Whilst many microbial hazards have been identified, dose–response and other data are more limited and variable. An alternative is to use more qualitative expressions such as high, medium and low risk. In an ideal world highly quantitative approaches may be preferred although the more qualitative approaches, perceived by some as less scientific and inaccurate, may be more acceptable to the public (Advisory Committee on Dangerous Pathogens, 1996).

Data from risk assessment are useful in health education and in controlling the exposure of human populations to food hazards. One application to domestic food preparation could be to try to quantify the risk of importing pathogens into the kitchen. This can be via food items (*Table 1*) or non-food items such as pets, pests, soil, nappies, human contamination, etc. Another application could be to try to determine the risk of an individual suffering from food poisoning (*Table 2*). The problem with this calculation is that the true number of cases notified is known to represent the tip of the iceberg and it has become practice (Lacy, 1993) to use a multiple of 10 to try to estimate actual incidence. This type of approach allows an estimate of the number of suspected cases of food poisoning and such data could be of benefit in risk communication and are a component of some health education models advocated for use within hygiene education (Ackerley, 1994). Perceived susceptibility and severity are likely to be especially important for people categorized as 'ultra cautious' (Ackerley, 1994). A third approach is an attempt to identify food handler practices or factors that can contribute to an increased risk of food poisoning (Bryan, 1988; Weingold *et al.*, 1994; Ryan *et al.*, 1996). Potentially, this information is important for risk management and risk communication.

In conducting risk assessment the quantity and quality of information are considered important. Data from targeted studies, which may involve cross-sectional surveys, are ranked highly (Advisory Committee on Dangerous Pathogens, 1996). One problem with much of the available data on domestic food handling is that they are based upon self-reporting and this may be quite different from actual practices (Worsfold and Griffith, 1995). An additional problem is that food poisoning often requires an accumulation of errors or malpractices associated with specific foods and this is not usually determined in self-reporting. Direct observational studies, whilst not without disadvantages, offer a more reliable data source (Worsfold and Griffith, 1997). Planned observations of individuals help to provide a sense of perspective and a better understanding of the natural history of a disease as well as helping in the design and evaluation of preventative measures (Royal Society, 1992).

The aim of the present study was to observe domestic food handling practices in order to provide data on likely exposure assessment to foodborne pathogens following domestic food preparation. One component of exposure assessment examines the frequency of exposure (Morris, 1996) and can be interpreted as the probability of consumption of a pathogen, this in turn is dependent on the food preparation practices used (FAO/WHO, 1995). The meal preparation represents the exposure pathway — the mechanism by which an inividual is exposed to the hazard (McKone, 1996).

MATERIALS AND METHODS

A risk-based observational auditing approach was used to assess the likelihood of illness after 108 meal preparations, containing ingredients commonly implicated in outbreaks of food poisoning. The participants were recruited from the Women's Institute, church and retirement groups, and venues such as community centres and a supermarket consumer advice area. The study focused on a small range of selected food products prepared according to standardized recipes. These included (*Table 3*) a baked egg product, a cold chicken snack, a minced beef sauce

and a fried chicken and ham dish. These dishes were utilized as they contained ingredients commonly implicated in food poisoning, perishable ingredients requiring correct storage, and commonly used handling techniques which were potentially hazardous.

A Temptrak (Hanna Instruments) data logger was used for time–temperature monitoring of the food during transport and refrigerated storage. The interior temperature of the food at the end of cooking was determined using a Comark 9009 digital thermometer. The data logger and thermometer were both accurate within 0.5°C.

The success of food handling practices, designed for each recipe to control identified hazards (*Table 4*) which awarded demerit marks for control measures not implemented, thus the higher the score the more cumulative food hygiene errors made or the fewer the control measures used. A food operations risk (FOR) based on handling practices is produced, which is then adjusted to consider the food risk (based upon epidemiological data). The resultant food safety risk score (FSR) is therefore a summative score of the number of demerit marks, expressed as a percentage of the maximum possible, that a person has accumulated. This is then modified by the potential of the food to cause illness. The FSR thus provides an indication of the potential risk for illness following the preparation of that particular dish.

Statistical analysis was performed using SPSS/PC.

RESULTS

The subjects recruited were evenly distributed over three age bands (*Table 5*) and the mean FSR score for each age band was very similar. The socio-economic profile of the subjects (*Table 6*) was predominantly groups B, C1 and C2 and for these groups mean FSR scores were relatively consistent. One hundred of the 108 participants were female. The sample bias was partly due to the method of recruitment, although it is accepted that women are the primary domestic food producers.

Minor variation in FSR scores occurred between recipes (*Table 7*). Although the recipes shared common preventive measures they required different

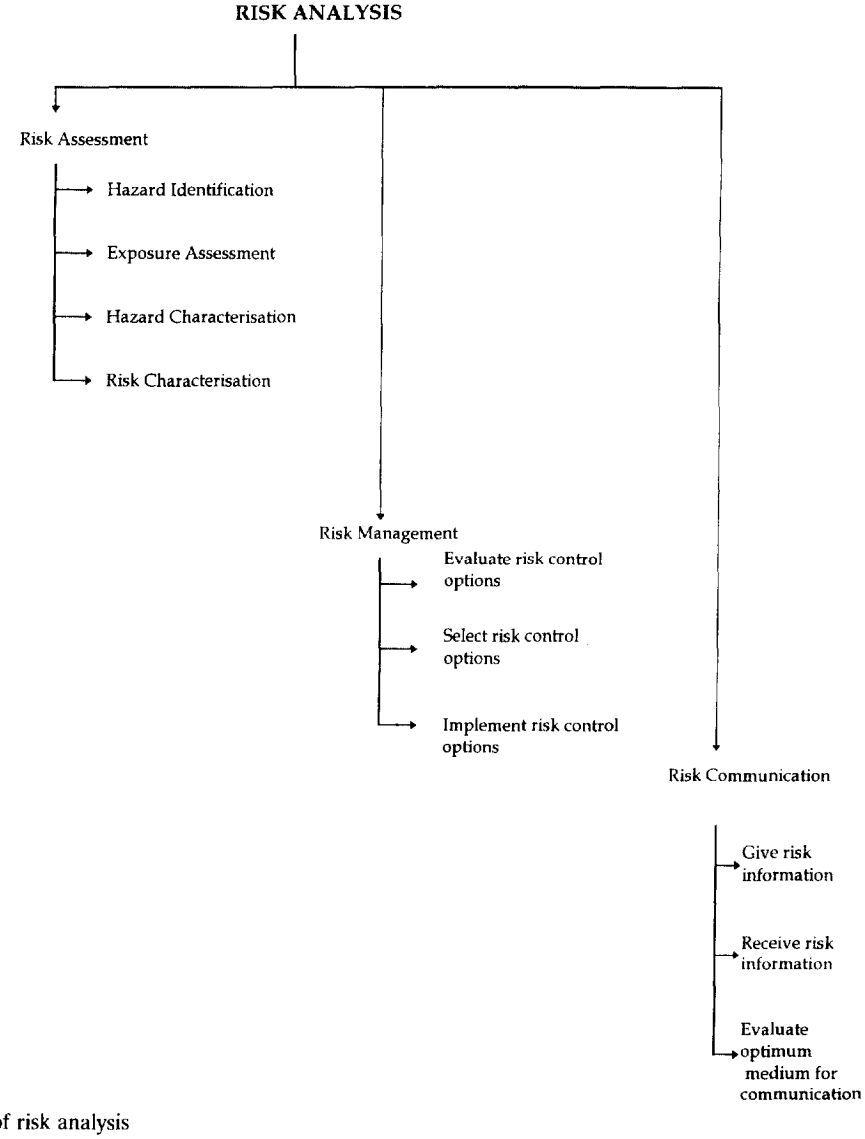

Figure 1 Components of risk analysis

Table 1 Probability of food contaminated with *Salmonella*

Number tested	Number tested positive for *Salmonella*	Risk of contamination
Probability of poultry contaminated with *Salmonella*[a]		
562	207	1 in 2.7
Probability of eggs contaminated with *Salmonella*[b]		
7730	17	1 in 455

[a]Calculated from Department of Health data contained in the MAFF Food Safety Information Bulletin, 13 February, 1995.
[b]Calculated from data by de Louvois (1994).

food handling and cooking techniques and this probably accounts for some of the FSR store recipe variations.

Table 8 illustrates the percentage of subjects found in FSR bandings of 4.9% difference. The FSR scores ranged from 0 to 64.9% with a modal band of 5→9.9%. Of the subjects observed, 48% had an FSR score below 20%. Approximately 90% of consumers had an FSR score below 40%. Nearly 14% of subjects were in the lowest FSR band and five of the participants (4.6% of the total) scored a zero mark. Of more concern was that 7.5% of the participants had an FSR between 40 and 59.9 with 3.7% of the subjects having an FSR above 60%. This latter group mostly prepared recipe 1 and seriously violated critical control measures during cooking, cooling, holding and re-heating.

The range of food handling malpractices observed and the frequency of their occurrence are listed in *Table 9*. These included practices about which there would appear to be considerable awareness (Walker, 1996). The majority of these malpractices occurred prior to cooking although 15% of the participants did not cook the food to a sufficiently high temperature to ensure safety. More than 60% of the subjects delayed consuming the food, 35% failed to cool it quickly and 19% failed to refrigerate the product correctly after cooking.

DISCUSSION

Absolute food safety or 'zero risk' is an impossible goal and it is more realistic to think in terms of insignificant or acceptable risk (Griffith *et al.*, 1995). This requires risk assessment which also acts as a framework for organizing epidemiological and food handling data as well as allocating responsibility (FAO/WHO, 1995). Within risk assessment a variety of models can be used to reach conclusions (FAO/WHO, 1995) and the experimental method described, resulting in a food safety risk score (FSR), is useful in the identification of risk factors and in exposure assessment.

In the present study, based on observations of food preparation, there was no correlation between FSR and socio-economic group or age. Thus no distinct group showed, by virtue of its preparation practices, a potentially higher risk of foodborne illness. This is in contrast to data (FDF, 1996), based upon questionnaires and interviews, which indicated that older people were more likely to cook food correctly and younger people were less likely to store food correctly. The same data, based upon the respondents' own answers (FDF, 1996), indicated food poisoning was consistently spread across the population by gender and social group although it was claimed that food poisoning was more common amongst younger people.

In the present study 4.6% of participants scored zero, ie complete implementation of the control measures, with 13.8% having a very low FSR. These data indicate that the control measures used to guide the observation were realistic and not a theoretical ideal. Of concern was the small number that obtained high FSR scores. Food poisoning depends upon a series of events to take place, starting with contamination of the food, followed by survival and/or growth of the contaminant organism and the FSR considers the potential for these to take place. It is not possible, however, to state a maximum FSR score below which the consumer should achieve in order to produce a safe dish. Nevertheless, the higher the FSR

Table 2 Probability of food poisoning in the UK

1. Probability of a person having food poisoning in 1994 using FDF data[a]		
Number of people asked	Number claiming to have had food poisoning	Risk of having food poisoning
2122	149	1 in 14
2. Probability of a person having food poisoning in 1994 using OPCS data[b]		
Number of people notified having food poisoning (provisional data)	Population of England and Wales	Risk of having food poisoning
82,591	51,500,000	1 in 623
Number of people having food poisoning assuming 1:10 reported		
825,910	51,500,000	1 in 62.3

[a]Food and Drink Federation National Food Survey Report, 1996.
[b]Data contained in Griffith *et al.*, 1995.

score the greater the risk of food poisoning following consumption of the food.

Risk assessment is likely to be increasingly applied to food safety at all points in the food chain from farm to fork, but there is uncertainty and variability in the process. One area of uncertainty within risk assessment concerns population behaviour (FAO/WHO, 1995); when applied to food safety this may be interpreted as 'how safely do consumers handle and prepare foods in the home?'. This involves an evaluation of the degree of intake likely to occur and the present investigation attempts to provide relevant information on this subject.

For example, with recipe 1, which contained chicken, it would be reasonable to assume that food prepared with an FSR in excess of 60% would carry a relatively high risk of foodborne illness. Given that one in 2.7 chickens is likely to be contaminated with salmonella and an estimated 700 million chickens sold (Anon, 1995) this could mean an estimated 259 million salmonella-infected chickens are handled per year. If figures from the present investigation were extrapolated (assuming 3.7% poorly handled the food) then 9.58 million salmonella-infected chickens could be badly handled per year. This represents a substantial risk and indicates potential for further increases in notified cases of food poisoning, especially if sales of chicken increase as predicted (Anon, 1995). Such data do not, however, correlate with consumers' perceptions of the food safety of food prepared in the home (Frewer *et al.*, 1994). Further work is required to refine the estimate of risk including determining the likely numbers of salmonella in the badly prepared foods.

The data also pose a dilemma for government and industry. In practical terms there is an increasing requirement for government and industry to inform the population about relevant risks to which they

Table 3 Recipes

Recipe 1	Chicken Surprise
Recipe 2	Mexican Beef
Recipe 3	Egg, Leek and Prawn Gratinee
Recipe 4	Tropical Chicken

Table 4 The Food Safety Risk Score for Recipe 1

1. Food Risk (FR)	
Recipe	**Coefficient**
Contains chicken and ham	5
2. Food Operation Risk (FOR)	
Process step	**Demerit points**
Procuring	
• Damaged packaging	5
• Older than 'use-by' date	5
• Temperature abuse during transport	10
Total	(20)
Storage	
• Ham, chicken stored above 5°C	10
• Food stored longer than 2 days	10
Total	(20)
Handling and preparing raw foods	
• Chicken packaging contaminates work surface	1
• Washes chicken	2
• Handler does not wash hands after handling raw chicken	10
• Parsley not washed	2
• Ham cut on dirty board	10
• Chicken cut in large uneven pieces	5
Total	(30)
Cooking	
• Product not cooked to internal temperature of at least 74°C	
Total	(50)
Cooling	
• Product is not cooled rapidly to 21° within 90 min	
Total	(50)
Room temperature storage	
• Product is kept at room temperature for period longer than 3 h but less than 6 h	30
• Product is kept at room temperature for period longer than 6 h but less than 12 h	60
• Product is kept at room temperature for period longer than 12 h	90
Total	(90)
Refrigeration	
• Product is stored in refrigerator which does not maintain a temperature of 5°C or less	10
• Cooked food is stored in refrigerator longer than 3 days	10
Total	(20)
Reheating	
• Product not cooked to internal temperature of at least 74°C	
Total	(50)
Handling after re-heating	
• product is re-heated more than once, with intervening holding periods at room temperature	
Total	(40)

Food operation risk (FOR): Maximum score = 370; Minimum score = 0.
Maximum food safety risk (FSR) = food risk (FR) × food operation risk (FOR) = 5 × 370 = 1850.

Table 5 FSR scores by age groups

Age group	Number of subjects	Mean FSR score
16–34	35	19.1 (SD 15.6)
35–54	35	18.9 (SD 17.5)
55+	38	18.7 (SD 12.4)

Number of subjects – 108.

might be exposed (Royal Society, 1992). Such communications should have the goal of encouraging particular behaviour, eg thorough cooking to minimize risk; however, this needs to be done in such a way that the consumer is not alarmed into boycotting the relevant food. The risk communication messages therefore need to reassure the consumer that the risk from the food is tolerable and controllable while at the same time warning the consumer and making it relevant to them and providing them with the means to control the hazard. This dilemma is sometimes referred to as the reassurance–arousal paradox.

The key to the food safety message is that risks should be controllable and perceived as relevant and tolerable. The Health and Safety Executive (Royal Society, 1992) interpret tolerability to include the monitoring of risks balanced against possible benefits (eg for poultry this may include nutritional healthy eating and cost). This assumes that efforts will be made by industry to implement reasonable practical precautions to minimize risk: the ALARP (as low as reasonable practicable) principle. This should be achieved by industry fully implementing the HACCP approach. A barrier to consumer perception of the relevance of food safety information may be caused by optimistic bias. This occurs when people believe that they are at less risk from food poisoning than an average member of society. It is of importance because the potential risk from microbiological hazards may be ignored if personal risk from food poisoning is discounted (Frewer *et al.*, 1994) and such individuals are more likely to engage in risky behaviour.

Risk valuation integrates social, economic and political considerations with risk assessment. The level of risk in relation to food safety is increasingly important in risk valuation to both consumers (Frewer *et al.*, 1994) and food manufacturers in the design of HACCP plans. The data presented may also prove beneficial to health professionals in the education of consumers. Risk valuation forms the link between risk characterization and risk manage-

Table 6 FSR scores and socio-economic group

Socio-economic group	Number of subjects	Mean FSR score
A	8	14.6 (SD 10.8)
B	24	18.4 (SD 14.4)
C1	41	18.2 (SD 13.4)
C2	29	21.9 (SD 18.5)
D and E	6	21.8 (SD 14.2)

Number of subjects = 108.

Table 7 FSR scores by recipe

Recipe	Mean FSR score
Recipe 1	19.3
Recipe 2	15.6
Recipe 3	21.7
Recipe 4	19.5

Table 8 Percentage of subject within each FSR score range

FSR score range (%)	Percentage of subjects
0–4.9	13.8
5–9.9	25.0
10–14.9	6.5
15–19.9	12.9
20–24.9	11.1
25–29.9	6.5
30–34.9	8.3
35–39.9	5.6
40–44.9	3.7
45–49.9	2.8
50–54.9	0.0
55–59.9	0.0
60–64.9	3.7

Number of subjects = 108.

Table 9 Food handling practices

Process step	Percentage of occurrences
Transport	
Temperature abuse during transport	45
Storage	
Chilled ingredients stored above 5°C	58
Food stored longer than 2 days	0
Handling and preparing raw foods	
Handler does not wash hands before work	66
Packaging contaminates work surface	18
Washes raw poultry/offal	33
Handler does not wash hands after handling raw meat/poultry	58
Vegetables not washed	41
Ingredients cut on dirty board	25
Single board used for all cutting tasks	60
Cooking	
Product not cooked to internal temperature of at least 74°C	15
Cooling	
Product is not cooled rapidly to 21°C within 90 min	35
Post-cooking handling	
Cooked food cut on dirty board	8
Cooked food handled directly	9
Post-cooking storage	
Product is kept at room temperature for period longer than 3 h but less than 6 h	12
Product is kept at room temperature for period longer than 6 h but less than 12 h	7
Product is kept at room temperature for period longer than 12 h	0
Re-heating	
Product not cooked to internal temperature of at least 74°C	11
Product is re-heated more than once	6

Number of subjects = 108.

ment (McKone, 1996) and the data presented should help in risk management. It should assist governmental agencies in cost–benefit studies and consumers in risk–benefit decisions. A proportion of consumers will practice appropriate food handling measures if the risk of food poisoning is perceived to be sufficiently high. Central to these actions regarding food handling is the degree of control that consumers feel they have over food safety. To some extent the evidence on this is conflicting, although UK data (Frewer *et al.*, 1994) indicate that consumers feel they have relatively high control over the prevention of food poisoning in the home. Lowest personal risk was associated with 'home produced food', with food poisoning from food prepared by others being more likely (Frewer *et al.*, 1994). However, the consumers also felt that their knowledge of hazards was greater than other people, giving rise to an 'illusion of knowledge'.

Industry has possibly not taken as active a role as it should have within risk communication. Recent events concerning beef and BSE combined with dramatic headlines by the mass media have resulted in a significant international fall in beef sales. The mass media is keen to sensationalize food scares and this indicates that the food insutry needs to be more aware and proactive in risk communication. Furthermore, they should not simply dismiss public fears and concerns as irrational (Soby *et al.*, 1994). The process of risk communication is far more complex and should involve physical, psychological, social and political dimensions and should involve behavioural scientists (Griffith *et al.*, 1995; Soby *et al.*, 1994). The best risk communicators are rarely technical experts, government spokespersons or 'men in white coats'. The background of the risk communicators is important with consumer organization and parts of the mass media being highly trusted with government and industry less trusted (Frewer *et al.*, 1994). Communicators should be prepared to discuss the risk message, including the non-attainability of zero risk, at various levels or tiers (Soby *et al.*, 1994). They should be prepared to enter into dialogue with the public who need to be made aware that their food-handling practices are important and that they do have personal control over food safety outcomes. Risk communicators should also enter into an effective dialogue with the media and be proactive and this should receive greater consideration by the food industry. Better use of the mass media and television personalities may be particularly beneficial in the process of food safety risk communication (Griffith *et al.*, 1994).

Food safety is the responsibility of everyone in the food chain, including the consumer, and educating them about the risk and severity of food poisoning is important in health education. The present study indicates that whilst many people practised food hygiene appropriately, a small minority did not. Given the contamination rates of some foods, this gives rise to an important risk of illness. The data produced in this study are of the type required to help in the estimation of exposure assessment. Data are available concerning consumer food safety awareness (Walker, 1996) and further work is required to determine why this is not translated into improved food-handling practices.

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REFERENCES

Ackerley, L. (1994) *Consumer Awareness of Food Hygiene and Food Poisoning*. Environmental Health. 1–4 March

Advisory Committee on Dangerous Pathogens (1996) *Microbiological Risk Assessment: An Interim Report*. HMSO, London

Anon (1995) Chicken volumes continue to rise while meats tumble. *Frozen and Chilled Foods*, 4 April

Bryan, F. L. (1988) Risks of practices, procedures and processes that lead to outbreaks of foodborne disease. *Journal of Food Protection* **51**, 663–673

Charles, R. H. G. (1982) Prevention and control of Salmonella food poisoning: education of the food handler and the consumer. *Health and Hygiene* **4**, 49–53

FAO/WHO (1995) Application of risk analysis to food standards issues. *Report of the Joint FAO/WHO Expert Consultation*. World Health Organisation, Geneva, Switzerland

FDF (1996) *National Food Safety Report: Foodlink*. Food and Drink Federation, London

Frewer, L. J., Shepherd, R. and Sparks, P. (1994) The Interrelationship between perceived knowledge control and risk associated with a range of food-related hazards targeted at the individual, other people and society. *Journal of Food Safety* **14**, 19–40

Gilbert, R. J. (1983) Foodborne infections and intoxifications recent trends and prospects for the future. In *Food Microbiology Advances and Prospects for the Future*, ed. T. A. Roberts and F. A. Skinner. Academic Press, London

Griffith, C. J., Mathias, K. A. and Price, P. E. (1994) The mass media and food hygiene education. *British Food Journal* **96**, 16–21

Griffith, C. J., Mullan, B. and Price, P. E. (1995) Food safety: implications for food medical and behavioural scientists. *British Food Journal* **97**, 23–28

Lacy, R. (1993) Food poisoning: the rise continues. *British Food Journal* **95**, 25–31

de Louvois, J. (1994) Salmonella contamination of stored hens' eggs. *PHLS Microbiology Digest* **11**, 203–205

McKone, T. E. (1996) Overview of the risk analysis approach and terminology: the merging of science, judgement and values. *Food Control* **7**, 69–76

Mifsud, A. J., Patel, B. C. and Wall, P. G. (1994) Public Health Laboratory Service overview of infections and communicable disease. *PHLS Microbiology Digest* **11**, 230–232

Morris, M. E. (1996) Risk assessment terms and definisions. *Journal of Food Protection Supplement* 6–9.

Mossel, D. A. A. (1989) Food safety and the need for public reassurance. *Food Science and Technology Today* **3**, 2–10

Notermans, S., Zwietering, M. H. and Mead, G. C. (1994) The HACCP concept: identification of potentially hazardous microorganisms. *Food Microbiology* **11**, 203–214

Royal Society (1992) Risk analysis, perception and management. Royal Society, London

Ryan, M. J., Wall, P. G., Gilbert, R. J., Griffin, M. and Rowe, B. (1996) Risk factors for outbreaks of infections intestinal disease linked to domestic catering. *CDR Review* **6**, 179–183

Soby, B. A., Simpson, A. C. D. and Ives, D. P. (1994) Managing food related risks: integrating public and scientific judgements. *Food Control* **5**, 9–19

Sockett, P. N., Cowden, J. M., Le Bargue, S., Aduk, G. F. and Evans, E. (1993) Foodborne disease surveillance in England and Wales 1989–1991. *CDR Review* **3**, 150–173

The rise and rise of food poisoning, (1994) *New Scientist* **17**, 28–33

Todd, E. C. D. (1989) Costs of acute bacterial foodborne disease in Canada and the USA. *International Journal of Microbiology* **9**, 313–326

Walker, A. (1996) Food safety in the home: a survey of public awareness. Office for National Statistics Social Survey Division, HMSO, London

Weingold, S. E., Guzewich, J. J. and Fudala, J. K. (1994) Use of foodborne disease data for HACCP risk assessment. *Journal of Food Protection* **57**, 820–830

Worsfold, D. and Griffith, C. J. (1995) A generic model for evaluating consumer food safety behaviour. *Food Control* **6**, 357–363

Worsfold, D. and Griffith, C. J. (1997) An assessment of the standard of consumer food safety behaviour. *Journal of Food Protection* **60**, 1–9