4 Foodborne disease and climate change
(See also section 4.2 of 2001/2002 report)

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Summary

- New scientific evidence confirms the effect of temperature on salmonellosis.
- The role of temperature in *Campylobacter* transmission remains uncertain.
- The effect of warmer summers on foodborne disease incidence will depend on future food hygiene behaviour and the relative contribution of different pathogens, as well as changes in temperature.

Recommendations

- Vulnerability to the effects of climate change could be reduced by continuing efforts to improve the microbiological standards of food at all stages in the food chain, including production, distribution, storage and preparation.
- There may be a case for educating and warning food producers and the public about the particular risks associated with hot weather.
- The existence of lags between high temperatures and effects on humans offers the possibility of instituting a warning system.
4.1 Introduction

The previous review noted that food poisoning is an important cause of morbidity in the general population associated with significant costs of treatment and loss of working time. The 1990s had seen a large increase in incidence for reasons that remain controversial, but may include changes in methods of food production such as the shift towards intensive rearing of poultry and other animals, changing patterns of retailing and catering as well as changing behaviour of consumers.

The recognition of the seasonality of food poisoning incidence and of the various ways in which weather conditions might affect the microbiological safety of food had led to the suggestion that climate change could increase food poisoning risk (McMichael et al., 1996). However, at the time of the previous review there was only a very limited body of published evidence on which an assessment of the potential impacts of climate change on food poisoning could be based.

In recent years there have been major changes in the number of cases of food poisoning in England and Wales and in the relative importance of different pathogens. The number of food poisoning notifications increased steadily during most of the 1990s to reach a peak in 1998. Since then there has been a marked decline, with notifications for the most recent year (2004) being about 25% lower than at the peak with especially large reductions being evident for infections from *Salmonella* which decreased by 60% between their peak (in 1997) and 2004.

4.2 Current impacts of climate and weather

The existence of a pronounced seasonal pattern, with a higher incidence in the summer, points to a role for weather and climate in the aetiology of food poisoning. High temperatures favour the multiplication of some pathogenic micro-organisms in food, including the *Salmonellas* that are an important source of food poisoning in the UK. High temperatures may also have an influence on human health risks by affecting infection rates in food animals, for example by the multiplication of bacteria in animal feed. Other indirect influences on human risks could include a weather-influenced shift towards dietary items or forms of food preparation (e.g. barbecues) that are associated with increased risk.

Since the previous review, several empirical studies have been published on the relationship between environmental temperatures and the incidence of foodborne illness. Bentham and Langford (2001) analysed the association between weekly notification of food poisoning and temperatures in England and Wales for the period 1974–96. This confirmed the findings of earlier studies (Bentham and Langford, 1995; Bentham, 1997) of a positive association between food poisoning and temperature, with the strongest effects being for conditions 2–5 weeks earlier. A significant limitation of this study is that the data used do not record which pathogens are responsible for the notified cases. This is important because the different common types of food poisoning pathogens are known to respond differently to environmental temperatures. The rate of multiplication of *Salmonella* is strongly related to temperature in the range from approximately 7°C to 37°C, providing opportunities for ambient temperatures to affect the numbers of bacteria in food at various stages in the food chain. *Campylobacter*, on the other hand, replicates most readily at temperatures between 37°C and 42°C in a low-oxygen environment. This makes it well adapted to the guts of birds and other animals, but multiplication in food at typical ambient temperatures is unlikely. Simple direct relationships with environmental temperatures are therefore less likely than for *Salmonella*, although more complex effects of temperature on
the ecology of animal reservoirs or on patterns of human behaviour leading to exposure are possible.

**Salmonella**

D’Souza et al. (2003) investigated the association between monthly salmonellosis notifications and temperature in five Australian cities. They found a significant positive association between mean temperature of the previous month and the number of salmonellosis notifications in the current month, with the estimated increases for a 1°C increase in temperature ranging from 4% to 10% depending on the city. Kovats et al. (2004) analysed the association between laboratory-confirmed cases of salmonellosis and monthly temperatures in 10 European countries. The estimated change in incidence above a common 6°C threshold ranged from 0.3% in Denmark to 12.5% in England and Wales. The strongest effects were found for temperatures 1 week before the onset of illness rather than the longer lag of 1 month found in the Australian study.

**Figure 4.1 Modelled association between temperature and number of reported cases of salmonellosis in England and Wales (adjusted for outbreaks, seasonal factors and holidays)**

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**Campylobacter**

At the time of the earlier review, information was sparse on the relationship between environmental temperatures and human disease resulting from infection by *Campylobacter*, but since then new evidence has been published. In a study of *Campylobacter* infection in Denmark, Patrick et al. (2004) found a significant positive association with temperature, the
The strongest effects being for lags of 4 weeks. The study also showed that the prevalence of *Campylobacter* infection in broiler flocks at slaughter was positively associated with temperatures 3 weeks earlier. In Denmark consumption of poultry is an important risk factor for campylobacteriosis in humans. Increasing *Campylobacter* carriage rates in chicken meat following warm weather may therefore be one of the factors underlying the association between incidence and temperature in humans. A positive association between rates of campylobacteriosis in humans and temperature (unlagged) has also been reported for England and Wales (Louis *et al.*, 2005). However, a limitation of both these studies is that they did not adjust for seasonal factors that could confound the association between campylobacteriosis and temperature. Influences on the seasonality of campylobacteriosis in 13 countries has been investigated by Kovats *et al.* (2005). Although most of these countries showed seasonal patterns, the study was unable to find a strong effect of temperature variability on *Campylobacter* transmission. Unlike *Salmonella*, a simple direct relationship between temperature and *Campylobacter* infections is therefore not likely. However, what cannot be excluded is the possibility of more complex effects of weather and climate via their influence on factors such as the size of animal reservoirs of infection (Skelly and Weinstein, 2003) or the ease of transmission to humans, for example by vectors such as flies (Nicholls, 2005).

### 4.3 Future impacts of climate change

One study (Bentham, 1997) had used regression analysis to develop statistical models of the relationship between the monthly incidence of food poisoning and temperatures in England and Wales for the period 1975–95. The resulting regression model of the association between temperature and food poisoning notifications (adjusted for trend and seasonal factors) was then used to estimate the impact on food poisoning notifications of scenarios of +1°C, +2°C and +3°C temperature increases. This produced estimates of increases in food poisoning notifications of 4.5%, 9.5% and 14.8% respectively. If applied to the total of 94,000 notified cases of food poisoning for 1998, these would represent absolute increases of ~4,000, ~9,000 and ~14,000. It was emphasised that because of the under-recording of food poisoning the real number of additional cases might be considerably higher. It was concluded that higher temperatures as a result of climate change might exacerbate the food poisoning problem which is already a significant threat to public health. However, it was emphasised that the estimated changes were small relative to the large increases that had occurred over the previous 20 years as a result of other factors.

The 2001/2002 report concluded that a 1°C increase in temperature might result (ceteris paribus) in about a 4.5% increase in food poisoning. Subsequent published studies have strengthened the evidence that environmental temperatures affect the risk of food poisoning by *Salmonella*, with Kovats *et al.* (2004) yielding an estimated effect of +12.5% per 1°C increase in temperature. This could be taken to indicate that the earlier estimate is too low. However, the impacts on total incidence of food poisoning resulting from all pathogens will clearly depend also on the temperature sensitivity of disease caused by other pathogens, especially *Campylobacter*. Unfortunately, in spite of the new data that have become available, the published evidence remains insufficient to estimate reliably the potential effect of changes in temperature on campylobacteriosis. Another important factor is that in recent years both the absolute and the relative contributions of *Salmonella* infections to the total burden of food poisoning have declined. The fraction of food poisoning cases for which there is clear evidence of a direct relationship with temperature is therefore likely to have fallen. On balance, there appear to be no strong grounds for changing the estimate of the earlier review that a 1°C increase in temperature might result in about a 4.5% increase in food poisoning. The absolute numbers of additional cases will depend on the scenarios for temperature and the baseline number of cases of food poisoning.
References


