Key messages

- Large, widespread international outbreaks of foodborne disease may result when faults occur in modern food production processes
- International surveillance networks can strengthen infection control
- When a foodstuff is contaminated it is important to examine as many batches as possible to show the duration of the production fault

difficult as snacks may be eaten outside the home and parents may not be aware of consumption.

Contaminated snacks were manufactured on at least seven separate dates over four months, indicating that the production fault was prolonged. The degree of contamination was expected and found to be low.[6]

The *S agona* outbreak demonstrates the importance of communication and collaboration between health officials locally, nationally, and internationally. Sharing of information led to voluntary recalling of the product in North America and in England and Wales, as well as to the identification of the source of a major outbreak in Israel.[5] With the modern worldwide distribution of food products, the Salm-Net surveillance network has a crucial role in rapid case finding and information exchange within Europe and further afield.[1 7]

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International epidemiological and microbiological study of outbreak of *Salmonella agona* infection from a ready to eat savoury snack—II: Israel

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Abstract

***Objectives*—To explain an increase in the incidence of salmonellosis caused by *Salmonella agona* in Israel between October 1994 and January 1995 in the light of an outbreak of *S agona* phage type 15 infection in England and Wales caused by consumption of a ready to eat savoury snack produced in Israel.**

***Design*—Epidemiology of *S agona* in 1994-5 was analysed and two consecutive, case-control studies of 32 and 26 case-control pairs were performed. Phage typing and molecular methods were used to characterise strains of *S agona* isolated from cases and samples of the snack in Israel and England and Wales.**

***Results*—The increase in the incidence of *S agona* between October 1994 and January 1995 was countrywide. Cases of infection with group B salmonella increased from 60% to 80% in children under 5 years old. In both case-control studies, cases consumed more of the snack than did controls (4.25 *v* 2.94 packets per week in the first study (P=0.086) and 4.04 *v* 2.37 packets per week in the second study (P=0.034)). When the two studies were combined there was a significant dose-response relation for the number of packets consumed weekly. Compared with consumption of less than two packets, the odds ratio was 1.43 for between two and six packets and 3.37 for seven or more packets (χ^2 for trend=5.27, P=0.02) *S agona* phage type 15 was isolated from a packet of the snack sold in Israel, and the strain was identical with those isolated from packets and cases in Israel and England and Wales.**

***Conclusions*—This outbreak of *S agona* was caused by the contamination of a snack produced in Israel. Even under modern operating conditions, large, widespread international outbreaks of foodborne disease can occur. The success of this investigation resulted from excellent international collaboration between public health authorities.**

Introduction

During October 1994 to January 1995 there was a sharp increase in the incidence of *Salmonella agona*, a group B salmonella, in Israel.[1] The increase was countrywide, and epidemiological investigations failed to identify a source. On the 14 February 1995 a report was received of a small outbreak of *S agona* infection in England and Wales that was associated with contamination of a ready to eat, kosher, savoury snack manufactured in Israel.[2 3] We began a study to determine whether consumption of the same snack was responsible for the outbreak in Israel.

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Subjects and methods

SOURCES OF DATA ON SALMONELLA ISOLATES

Annual data on the incidence of salmonellosis and *S agona* infection were obtained from the central reference laboratory that receives most isolates for confirmation of serogroup and serotype characterisation. To estimate age specific rates of salmonellosis by serogroup, data were obtained from the central laboratory of one health maintenance organisation, which serves about 10% of the population.

CASE-CONTROL STUDIES

Two matched case-control studies were carried out to identify food items that may have been associated with an increased risk of disease. The first was done at the beginning of March 1995 and included cases that occurred during November and December 1994. To examine possible continued consumption of contaminated food, a second case-control study was carried out during April and May 1995 to include children who had been ill during February and March.

The implicated snack is eaten by nearly all young children in Israel so we used the number of packets consumed a week as the measure of exposure. The sample size necessary for detecting a minimum difference of one packet per week between the two groups, with alpha = 0.05 and beta = 0.20, was about 25 pairs.

We constructed a questionnaire on food consumption that included 38 food items likely to be associated with salmonellosis and ready to eat snacks commonly consumed by children. Information was also sought on recent diarrhoeal disease in other family members. The parents of all cases and controls were interviewed by telephone. At the end of the interviews they were asked whether they had read about the possible contamination of the snack in the news media.

CASES AND CONTROLS

At the time of the first study, laboratory results for about 80 cases that occurred during November and December 1994 were documented at the central reference laboratory. The parents of the first 34 cases with complete data were selected for the study, and 32 were successfully contacted. In the second study 30 parents of all the cases identified by the laboratory of the health maintenance organisation were contacted and 26 were successfully interviewed. The main reason for non-response in both studies was failure to locate the respondent. No one refused to be interviewed. Although the cases in the studies were not selected strictly at random, there is no reason to suspect that they differed from all other cases in their consumption of snacks.

Controls were selected at random from lists of children registered at family health centres that provide preventive services to the whole population. They were matched with cases by age (within about 10% of their age in months) and area of residence. In the first study 45 controls were selected and 32 parents were interviewed. In the second study 38 parents were selected and 26 interviewed. The reasons for non-response were absence from home at the time of telephoning; only one parent refused. In addition, some children were not included because they had diarrhoea at the time of the interview.

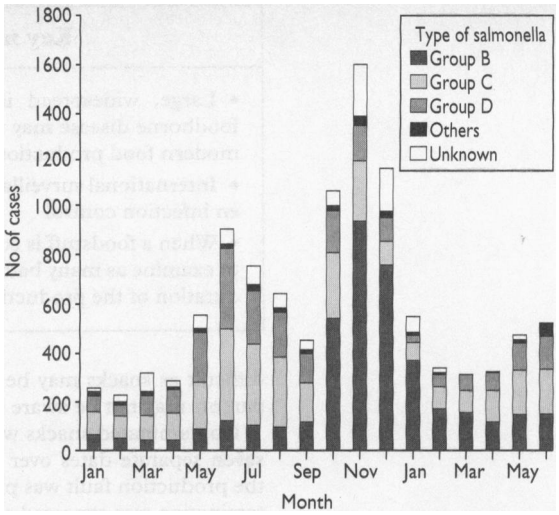

Fig 1—*Monthly incident cases of microbiologically proved salmonellosis in Israel by serogroup during 1994 and from January to June 1995*

MICROBIOLOGY

Samples of the snack were subjected to bacteriological examination at the district food laboratories. Repeated swabs from all parts of the production line, systematic samples of ingredients, and stool samples from all production workers were tested microbiologically. Phage typing was carried out in the Laboratory of Enteric Pathogens, Central Public Health Laboratory in England on isolates from the snack and from patients in England and Wales and in Israel. Phage typing was also carried out on *S agona* isolates from chickens and turkeys from 1995 stocks and from human and animal feed isolates from the years 1974 to 1985. Pulsed field gel electrophoresis was used in the Laboratory of Enteric Pathogens to characterise further the isolates from the snack and from patients from England and Israel.

Results

THE OUTBREAK

A steep rise in the incidence of group B salmonellas began in October 1994 and peaked in November and December (fig 1). The increase in *S agona* isolates from humans was countrywide, and at the same time there was no change in the number or percentage of isolates from chickens. The percentage of salmonella B isolates

Table 1—*Mean (SE) numbers of specific food items consumed in previous week by cases and controls*

	First case-control study				Second case-control study				Combined case-control studies			
Food item	Cases (n=32)	Controls (n=32)	Difference	P value	Cases (n=26)	Controls (n=26)	Difference	P value	Cases (n=58)	Controls (n=58)	Difference	P value
Packets of savoury snack	4.25 (0.63)	2.94 (0.49)	1.31 (0.81)	0.086	4.04 (0.75)	2.37 (0.40)	1.67 (0.81)	0.034	4.16 (0.48)	2.68 (0.32)	1.47 (0.57)	0.008
Servings of chicken	3.81 (0.44)	3.36 (0.43)	0.45 (0.58)	0.236	1.88 (0.22)	2.50 (0.26)	−0.61 (0.38)	0.184	2.95 (0.29)	2.97 (0.27)	−0.02 (0.37)	0.644
No of eggs	1.78 (0.42)	2.07 (0.33)	−0.29 (0.55)	0.758	2.21 (0.44)	2.89 (0.46)	−0.68 (0.56)	0.402	1.97 (0.30)	2.44 (0.28)	−0.46 (0.39)	0.774
Servings of vegetable salad	5.50 (0.46)	5.70 (0.42)	−0.20 (0.65)	0.740	4.79 (0.52)	6.58 (0.24)	−1.79 (0.54)	0.004	5.18 (0.35)	6.09 (0.26)	−0.91 (0.44)	0.042

Two tailed Student's *t* test for paired observations was used to evaluate differences in consumption of individual items (after logarithmic transformation).

in children under the age of 5 years increased from 60% to 80% in September 1994. This pattern persisted until January 1995, declining in February to the previous levels.

CASE-CONTROL STUDIES

For the combined studies there were no significant differences between cases and controls in mean age (42.2 months for cases and 42.6 months for controls). None of the parents interviewed had heard of the possible contamination of the snack. Overall, 54 (93%) of the cases and 51 (88%) of the controls consumed the snack (yielding a combined odds ratio of 1.85 (95% confidence interval of 0.45-8.09)).

In the first study, cases consumed an average of 1.3 packets of snack a week more than controls (P=0.086) (table 1). In the second study cases consumed 1.67 packets a week more than the controls (P=0.034). The controls in this study consumed significantly more fresh salads (P=0.004). When the two studies were combined cases consumed an average of 1.47 packets a week more than controls (P=0.008). There was a dose-response relation. Compared with consumption of less than two packets a week, the odds ratio was 1.43 for between two and six packets and 3.37 for seven or more packets (χ^2 for trend=5.27, P=0.020).

LABORATORY INVESTIGATIONS

Out of 450 snack packets examined that were produced from the end of December to February 1995, two were contaminated with salmonella. One packet produced from 6 February contained *S agona* and one packet produced on 21 February contained *S enteritidis*. The phage type of *S agona* isolated from the snack samples in England and Wales and Israel was phage type 15 and was identical with those isolated from children with salmonellosis in each country. When tested together using pulsed field gel electrophoresis at the Laboratory of Enteric Pathogens in England all isolates of *S agona* phage type 15 from the snack packets and from cases in Israel and England and Wales were indistinguishable.[4] A collection of *S agona* strains isolated in Israel from humans and from animal feeds were examined at the laboratory, and none of the isolates before 1995 were phage type 15.

Before the outbreak routine microbiological examinations were performed daily on a sample of the finished product, and none were found to be contaminated. The snack contains corn grits, hydrogenated soya bean oil, antioxidants, encapsulated vitamins, salt, and a peanut butter coating. *S agona* was not isolated from any of the swabs taken from the production line, samples of ingredients, or stool samples from workers, which were tested as part of the investigation. *S enteritidis* was isolated from a reusable plastic bag in which the snack was stored for 48 hours before packaging.

Discussion

Our findings show that the outbreak of *S agona* during late 1994 and early 1995 was due largely to contamination of a commonly consumed snack. Until this time *S agona* was rarely isolated in Israel since its first appearance in 1969,[5,6] representing less than 5% of the isolates per year.[1] The more than 2200 cases reported in five months is particularly impressive, considering the underreporting of salmonellosis.[7] This is most likely a consequence of the popularity of the snack among children in Israel.

Officials from the ministry of health's food service examined all potential points of contamination of the snack but were unable to locate the specific source. Extensive control measures were introduced. Reusable bags were changed to single use bags, and the frequency and extent of microbial examinations of raw materials were increased. Instructions for handling of raw materials and cleaning of all equipment were revised, and microbiological examinations of the finished products were extended and carried out more frequently. Products are not released from the plant until results of the microbiological tests are received. Since February 1995 the incidence of *S agona* in Israel has remained at the level before the outbreak and no further salmonella organisms have been isolated from the snack samples tested.

In this outbreak the almost universal consumption of the contaminated snack by children in Israel considerably hampered efforts to identify the source. There are several lessons to be learnt.

Firstly, enormous outbreaks of gastrointestinal disease can occur if modern food processes break down.

Secondly, it can be extraordinarily difficult to recognise the source of large outbreaks due to a commonly consumed food.

Thirdly, delays in recognition of the source may be due to slowness in obtaining the specific serotype of the salmonella.

The investigation of this outbreak has shown the importance of international communicable disease surveillance to reveal deficiencies in food production processes. Modern communications allowed rapid and effective scientific collaboration between investigators in several countries which led directly to successful public health action.

Key messages

- It is not easy to recognise the source of an outbreak if a commonly consumed food item is contaminated, even if the outbreak is large
- Surveillance and control of an outbreak of salmonella infection is compromised by any delay in obtaining data on salmonella serotypes
- Effective ongoing communication between public health authorities in different countries can play a key part in the prompt identification of the source of unusual outbreaks

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