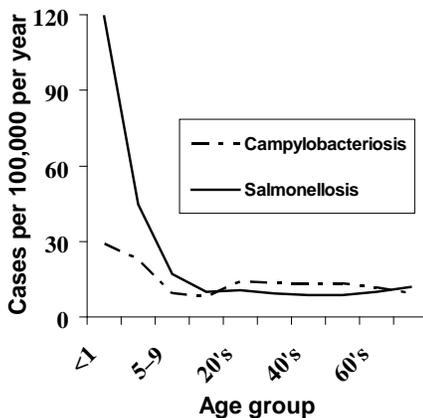


OREGON PUBLIC HEALTH DIVISION • DEPARTMENT OF HUMAN SERVICES

SALMONELLOSIS AND CAMPYLOBACTERIOSIS IN INFANTS

Salmonellosis and campylobacteriosis are the most common foodborne diseases, and they affect infants disproportionately (Figure). In adults both *Salmonella* and *Campylobacter* infections have been linked to contaminated foods, water, raw milk, animal contact, and person-to-person transmission. Much of what is known of risk factors in older populations comes from investigations of foodborne outbreaks, which typically have included few infants. In one review of 91 outbreaks involving more than 3300 people, only 14 (0.4%) were infants.<sup>1</sup> We think that most salmonellosis and campylobacteriosis in adults comes from food.<sup>2</sup> Risk factors in infants are probably very different, because of the limited diets of most children under one year of age.

Figure. Ten year average incidence of campylobacteriosis and salmonellosis by age group, FoodNet 1998–2007



Few data have been published regarding risk factors for either *Salmonella* or *Campylobacter* infections in infants. Some studies looked for associations with family diet, shopping habits, family size, use of sitters, eating meals outside, presence of pets or domestic animals, and the home slaughter of food animals; but no FoodNet is CDC's Foodborne Diseases Active Surveillance Network

statistically significant differences between cases and controls were demonstrated for these putative risk factors. Infant salmonellosis has been associated with drinking high-iron formula<sup>3</sup>, having a close contact with diarrhea<sup>4,5</sup> and *Salmonella* contamination of home vacuums.<sup>6</sup> Breast feeding was found to protect against salmonellosis.<sup>7</sup>

Investigators in New Zealand have studied the epidemiology of campylobacteriosis in children over a 10-year period. They suggested that contact with dogs, a rural residence, association with live animals and handling raw meat were associated with infection.<sup>8</sup> A study of 89 cases of campylobacteriosis among children <5 years of age in Great Britain identified contact with puppies as a risk factor.<sup>9</sup>

The study described below was designed to identify behavioral, dietary and medical risk factors for *Salmonella* and *Campylobacter* infections among infants, and to calculate the proportion of disease risk attributable to these risk factors.

STUDY DESIGN

This multi-state study was done over a 24-month period from 2002 to 2004. Study participants were residents of eight states\* in the catchment area of the CDC's Foodborne Diseases Active Surveillance Network (FoodNet). Cases were infants (i.e., <365 days old), from whom *Campylobacter* or any non-Typhi serotype of *Salmonella* was isolated from stool or a normally sterile body site. Cases were excluded if we couldn't communicate with their parent or guardian by telephone in English or Spanish, or if they were part of a recognized outbreak in which the vehicle was identified. Cases were interviewed as quickly as possible, but no later than 45 days after the specimen collection date. Controls were frequency-matched based on the incidence of infant *Salmonella* and

\*California, Colorado, Connecticut, Georgia, Minnesota, New York, Tennessee and the Beaver State

*Campylobacter* infections in participating sites during 1998–2000. Parents were interviewed about exposures during the 5 days before the onset of illness, (or, for controls, before the interview).

RESULTS

**Campylobacteriosis.** A total of 123 cases and 928 controls were enrolled.<sup>10</sup> (The 928 controls were used as comparisons for both the campylobacteriosis and salmonellosis studies.) The mean age of the cases was 7 months, and 51% were female. Eighty-nine (72%) cases were treated with an antibiotic for their illness; 14 (11%) were admitted overnight. There were no deaths. In a multivariate regression analysis, *Campylobacter* infection was associated with drinking well water, eating fruits and vegetables prepared at home, having a pet in the home with diarrhea, visiting or living on a farm, riding in a shopping cart next to meat or poultry, and traveling outside the United States. Cases were significantly less likely to be breastfed (Table, verso).

**Salmonellosis.** A total of 442 cases were enrolled; 25% of them had been hospitalized. Their responses were compared with those of the same 928 controls gathered for the campylobacteriosis study.<sup>11</sup> In multivariate regression analysis, case infants were significantly more likely than controls to have traveled outside the U.S., to have attended day care with a child with diarrhea, to have ridden in a shopping cart next to meat or poultry, or to have had exposures to reptiles. Infection was also associated with consumption of meat and concentrated liquid infant formula (Table, verso). Breastfeeding was protective. Infant mobility and preparation of raw meats within the home in the previous 5 days were associated with lower risk of illness.

DISCUSSION

We now have some insight as to how infants, who eat little solid food, contract diseases that we think of as



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largely foodborne. Meat and poultry consumption is known to carry risk for *Salmonella* and *Campylobacter* infection in older children and adults — but infants may be more likely to encounter these pathogens from riding in a shopping cart next to the meat or poultry. This is a novel finding. They might also become infected by touching contaminated shopping cart and then putting their hand in their mouth or via the meat packages or hands of caretakers who handled packaged meats. A study in the United Kingdom showed that the outsides of packages of meats and poultry can be contaminated with *Salmonella* and *Campylobacter*.<sup>12</sup>

Our study confirmed some findings from previous studies: reptile pets pose a significant risk of salmonellosis in households with infants, and other pets can spread campylobacteriosis. Travel outside the United States was a risk factor for both infections.

Breastfeeding, already known to decrease the risk of several other diseases,<sup>13</sup> was found to be protective both for *Salmonella* and *Campylobacter* infections.

**CONCLUSION**

Infants are at high risk for *Salmonella* and *Campylobacter* infection. Advise parents of young children that high percentages of reptiles carry *Salmonella*. Infants — including those going shopping with mom or dad — should be kept far away from that drippy package of chicken or beef. And if you needed another reason to advocate for breast feeding, be confident that it is strongly protective against these infections.

**Table. Risk factors for infant salmonellosis and campylobacteriosis (multivariate analysis)**

Campylobacteriosis	OR (95% CI)	PAF (%)
Eating fruits and vegetables prepared at home	2.0 (1.1–3.6)	28.1
Visiting or living on a farm	4.1 (1.9–8.9)	15.5
Drinking well water	2.6 (1.3–5.3)	13.7
Riding in a shopping cart next to meat or poultry	2.2 (1.1–4.6)	7.1
Having a pet with diarrhea in the home	5.3 (1.8–15.5)	5.9
Traveling outside the United States	19.3 (4.5–82.1)	5.4
Breast feeding	0.3 (0.2–0.6)	—
Salmonellosis		
Being exposed to a reptile	5.2 (3.4–7.9)	17.4
Consuming concentrated formula	2.0 (1.4–2.8)	13.0
Riding in shopping cart next to meat or poultry	3.2 (2.1–5.1)	11.3
Consuming any meat	1.7 (1.1–2.7)	8.3
Attending day care with another child with diarrhea	4.4 (1.8–10.7)	3.3
Travelling outside the U.S.	8.9 (2.6–30.9)	2.6
Breast feeding	0.5 (0.3–0.6)	—

OR: odds ratio. CI: confidence interval. PAF%: population attributable fraction — i.e., the percentage of reported cases attributable to the risk factor

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