EPIDEMIOLOGY OF HUMAN *YERSINIA ENTEROCOLITICA, CAMPYLOBACTER JEJUNI/ COLI* AND *SALMONELLA TYPHIMURIUM* O:4,12 INFECTIONS IN NORWAY.

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Meat is world-wide recognized as an important vehicle for transmission of pathogens to man. Campylobacteriosis is linked to the consumption of poultry, yersiniosis to pork consumption and salmonellosis to eating poultry, beef or pork. The agents causing these diseases are, however, also frequently found in the environment, and contaminated drinking water supplies are important for the transmission of these diseases.

In Norway about 50 % of all the recorded cases of human infections with *Campylobacter jejuni/ coli* and more than 80% of human salmonellosis are acquired abroad. In contrast, less than 2% of the human *Yersinia enterocolitica* infections are acquired outside Norway.

In order to identify the risk factors involved in human infections with *S. typhimurium* O:4,12, *C. jejuni/ coli* and *Y. enterocolitica* in Norway, we have conducted three case-control studies. Furthermore, we are in the process of completing a study with the aim of identifying risk factors in the introduction of *Campylobacter jejuni/ coli* into broiler chicken flocks.

MATERIALS AND METHODS

Case-control studies.

Cases were patients from the south-eastern part of Norway with *Y. enterocolitica* (63 cases) and *C. jejuni/ coli* (58 cases) isolated from stool samples, who had not travelled abroad the weeks before the onset of disease. Each case was matched with two population controls of the same sex, age and area of residence. Cases and controls were interviewed using a standard questionnaire. A similar study was conducted on sporadic infections of *S. typhimurium* O:4,12, where cases (n=24) and controls were interviewed by telephone.

Broiler chicken study

All broiler producers (n=200) in an area in south-eastern Norway were included in the study. The farms were randomly selected once in the one year study period. From each selected flock, 28 chickens were examined at slaughter for *C. jejuni/ coli* by cloacal swabs. The owners were interviewed about their hygienic and husbandry practices. Production and meat inspection data were recorded.

Statistical analysis

Data from the case-control studies were analyzed by univariate matched analysis using the statistical program Epi-Info (CDC/WHO, version 5, 1990). Broiler data were analyzed without matching with the same package. Preliminary multiple regression analysis was undertaken using the statistical program EGRET (SERC 1990).

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RESULTS

Although pork consumption was found to be the main risk factor for human yersiniosis, consumption of non-disinfected drinking water was also a significant risk contributor (Table 1).

For sporadic cases of infections with *S. typhimurium* O:4,12, private drinking water supply was identified as the main risk factor (Table 1).

The detected risk factors for campylobacteriosis illustrates a more complex pattern (Table 1). Poultry consumption was a clear risk factor, but most of this effect could be explained by the occasional import of poultry meat from neighboring countries. Contact with dogs and eating meat at a barbecue were also important factors.

The prevalence of *C. jejuni/ coli* in broiler chicken flocks was 19 %, with a strong geographical (Figure 1a) and seasonal (Figure 1b) variation. No hygienic or husbandry practices were found to be important risk factors in the introduction of the bacterium into the flocks. Feeding the chicken with non-disinfected water appeared to be main risk factor, with a population attributable fraction of 0.60 (Table 2).

DISCUSSION

Our results support other findings pointing to meats as important risk factors for campylobacteriosis and yersiniosis. The results further indicate that drinking water is a main source of infections caused by *Y. enterocolitica*, *C. jejuni/ coli* and *S. typhimurium* O:4,12 in Norway. Water as a risk factor reflects the connection between animal carriers, the environment and man. The broiler study also confirmed the importance of the environment for the introduction of *Campylobacter* into broiler flocks. *Salmonella* is nearly non-existent in animal husbandry in Norway, in contrast to the situation in most other countries. Some strains of *Salmonella* have, however, been established in the environment. Numerous outbreaks of salmonellosis of birds caused by *S. typhimurium* O:4,12 illustrates this phenomena. The same type caused a major outbreak in children when chocolate infected by local birds was spread throughout the country.

Approximately 50 % of the Norwegian population is provided with water which has not passed any kind of disinfection process. Most domestic animals are kept in areas where disinfection of drinking water is uncommon. Previous studies have shown that *C. jejuni/ coli* can be regularily detected in Norwegian surface waters, peaking in spring and late summer. Still, Norwegian broilers have a low prevalence of *C. jejuni/ coli* compared to other countries, pointing to the low intensity and small unit production as a possible factor in reducing risk.

In our case-control studies, more controls were drinking non-disinfected water than in the general population. The measured effects linked to water might therefore represent an underestimation of the real health hazards linked to the drinking of non-disinfected water in Norway.

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Table 1. Main risk factors for human infections with *Yersinia enterocolitica*, *Campylobacter jejuni/ coli* and *Salmonella typhimurium* O:4,12. Univariate matched analysis of data from case-control studies

Variable	Cases	Controls	Matched OR (95% CI)	p-value
Y. enterocolitica				
Eating pork	56/63	83/123	5.4 (1.8-16.0)	<0.01
Drinking non-disinfected water	24/62	27/114	2.8 (1.2-6.4)	0.03
C. jejuni/ coli				
Eating poultry	39/57	52/115	3.1 (1.4-6.7)	<0.01
Eating Norwegian poultry	28/58	47/117	1.4 (0.7-2.8)	0.37
Eating imported poultry	11/57	6/115	9.0 (1.8-44.3)	<0.01
Drinking non-disinfected water	27/51	34/103	2.4 (1.1-4.9)	0.02
Contact with dogs	35/56	45/112	3.8 (1.6-9.2)	<0.01
Eating meat at barbecue	1/57	14/115	6.7 (2.3-19.8)	<0.01
S. typhimurium				
Drinking non-disinfected water	13/23	16/45	2.9 (0.8-10.4)	0.13
Public drinking water supply	14/24	44/48	0.11 (0.02-0.7)	<0.01

Table 2. Main risk factors in the introduction of *Campylobacter jejuni/ coli* into broiler flocks. Univariate analysis of data from a one year field study.

Variable	RR (95 % CI)	RR_{pop}	AR	AF	AR_{pop}	AF_{pop}
Feeding chicken non-disinfected water	3.3 (1.2-9.0)	2.5	0.18	0.70	0.11	0.60
Feeding chicken surface water	3.1 (1.6-5.6)	1.3	0.32	0.73	0.04	0.23

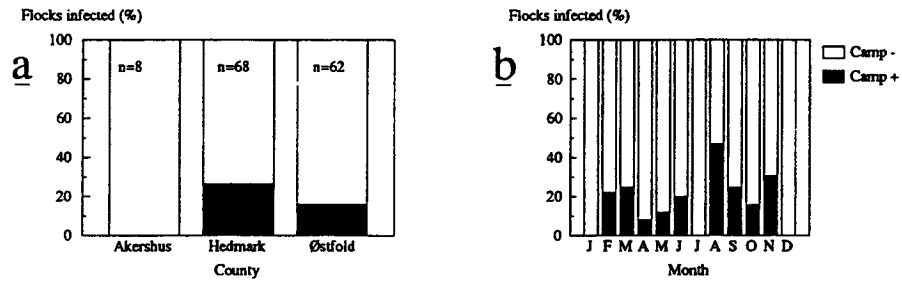

Figure 1. Distribution of *Campylobacter jejuni/ coli* infected broiler flocks by county (a) and month of slaughter (b).

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