A national case-control study of risk factors for listeriosis in Australia

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SUMMARY

Listeriosis is a foodborne disease associated with significant mortality. This study attempts to identify risk factors for sporadic listeriosis in Australia. Information on underlying illnesses was obtained from cases' treating doctors and other risk factors were elicited from the patient or a surrogate. We attempted to recruit two controls per case matched on age and primary underlying immune condition. Between November 2001 and December 2004 we recruited 136 cases and 97 controls. Of perinatal cases, living in a household where a language other than English was spoken was the main risk factor associated with listeriosis (OR 11·3, 95% CI 1·5–undefined). Of non-perinatal cases we identified the following risk factors for listeriosis: prior hospitalization (OR 4·3, 95% CI 1·0–18·3), use of gastric acid inhibitors (OR 9·4, 95% CI 2·4–37·4), and consumption of camembert (OR 4·7, 95% CI 1·1–20·6). Forty percent of cases with prior hospitalization were exposed to high-risk foods during hospitalization.

Key words: Foodborne infections, *Listeria*, public health.

INTRODUCTION

Listeriosis is a serious foodborne infection with a mortality rate of about 10–44% in foodborne outbreak cases [1]. Cases occur predominantly in the elderly, immunocompromised, and pregnant women and their neonates. Neonatal infection follows maternal sepsis and chorioamnionitis and can result in abortion, stillbirth, premature delivery or neonatal meningitis in those developing illness in the weeks after delivery. Common manifestations of listeriosis in adults include meningoencephalitis and a wide range of focal infections in organ systems and prostheses [2].

In Australia, the incidence of listeriosis is low with about 2·5–3·6 cases per million population per annum. Doctors and laboratories notify about 50–60 non-perinatal and 5–10 materno-fetal infections to health

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departments annually [3]. Multiple risk factors and high-risk foods have been identified from outbreak investigations, case-control studies, and risk assessments overseas. High-risk foods include ready-to-eat foods, which are often of animal origin, and 'delicatessen style' processed foods such as processed meats, soft cheeses and smoked seafood, and a wide range of fruit and vegetable products [4]. Food safety authorities worldwide use these findings to develop advice for populations particularly vulnerable to listeriosis, such as the immunocompromised, pregnant women, and the elderly, and to guide food safety programmes. Most cases of listeriosis in Australia appear to be sporadic and local evidence for risk factors for listeriosis are limited to investigations of six clusters over the last 30 years that have been associated with mussels, processed meats, sandwiches and fruit salad [5, 6]. The aim of this case-control study was to identify dietary, medical and behavioural risk factors for invasive listeriosis in Australia and describe the spectrum of illness in patients with listeriosis.

METHODS

From November 2001 to December 2004, Australian State and Territory health departments attempted to interview all notified cases of listeriosis within 1 month of collection of a specimen that was positive by culture for *Listeria monocytogenes*. Listeriosis is a laboratory notifiable condition in all states and territories of Australia based on the culture of *L. monocytogenes* from a normally sterile site. Perinatal cases were defined as illness in a pregnant woman, fetal loss, or illness in a baby aged <3 months with isolation of *L. monocytogenes* from at least one of the materno-fetal pair from any of the following sites: the placenta or products of conception, fetal gastrointestinal contents, or a normally sterile site from a pregnant woman, fetus or baby. Pregnant women were recruited to case status for the purpose of identifying risk factors for infection. Non-perinatal cases were defined as all other cases with *L. monocytogenes* isolated from blood, cerebrospinal fluid or other normally sterile site. Cases were excluded if they were: (1) asymptomatic, except for perinatal mothers, (2) part of an outbreak associated with an identified food vehicle, (3) unable to be contacted within 4 weeks of culture date, and (4) where the treating doctor or family member refused participation.

We attempted to recruit two controls per case, except in Victoria where only cases were recruited to the study. For non-perinatal cases, we attempted to recruit two age-matched controls per case from clinics specializing in the treatment of the case's primary underlying immune condition. Where there was no known immunocompromising condition, age-matched controls were selected from a general practitioner's clinic. Perinatal controls were recruited from hospital-based antenatal clinics and had gestational attainment within 4 weeks of the matched case at the time of the positive culture. All controls were recruited within 4 weeks of conducting the case interview.

Interviewers conducted telephone interviews with cases, or their surrogates, and controls using a standard questionnaire. Information on the case's major underlying immunocompromising condition was obtained from the treating doctors, while other risk factors were elicited from the patient or a surrogate. Participants were asked about consumption of 43 food items, considered to be high risk for listeriosis in previous studies, that were consumed in the 4 weeks prior to specimen collection date for cases and the corresponding 4 weeks for perinatal controls and the 4 weeks prior to interview date for non-perinatal controls. Information on the frequency of consumption (weekly, 2–3 times per month, or monthly), place of preparation, site of purchase or consumption, and, where appropriate, whether eaten raw or cooked were collected for each item. Prior hospitalization was defined as 7–28 days prior to specimen collection date for cases or interview date for controls.

Descriptive, univariate and multivariate logistic regression analyses were conducted using Stata Intercooled version 10 (Stata Corp., USA) for both perinatal and non-perinatal cases and controls. All case-control analyses were matched. Conditional logistic regression was used for non-perinatal data and all variables with P values $\leqslant 0.25$ were included in multivariate models for further assessment. Final multivariate models were derived using a forwards stepwise approach. Model specification was assessed using the link test. Exact (matched) logistic regression was used for the perinatal data.

Within each jurisdiction, ethics approval was gained through the relevant State or regional ethics committees.

RESULTS

We recruited 136 cases from 1 November 2001 to 31 December 2004. Cases were recruited in all States and
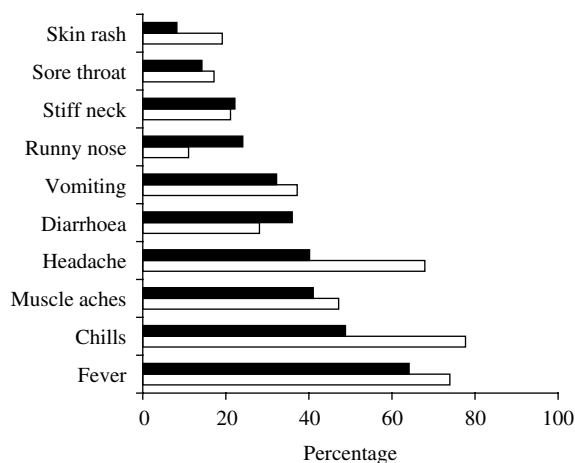
Fig. 1. Prevalence of symptoms in non-perinatal (■) and perinatal (□) cases in the 4 weeks before specimen collection, Australia 2001–2004.

Territories with 113 (83%) recruited cases resident in NSW (53), Victoria (34), Western Australia (26). Cases in other jurisdictions were as follows: Queensland (14), South Australia (5), ACT (2), Northern Territory (1) and Tasmania (1). Jurisdictions began recruiting at different times; however, we recruited 136 (71%) of the 193 incident cases that were notified once jurisdictions had commenced the study. When all jurisdictions were participating 52/69 (75%) cases notified nationally in 2003 and 47/67 (70%) cases notified in 2004 were recruited. No outbreaks were detected during the study period.

There were 19 (14%) perinatal cases of which *L. monocytogenes* was isolated from the materno-fetal pair in 10 cases, from the mother only in two cases and from the fetus only in seven cases. Median fetal gestational age at diagnosis was 35 weeks (range 18–40) with a total of four deaths between 18 and 32 weeks for a fetal case-fatality rate of 21%.

Of the 117 non-perinatal cases, 55 (47%) were female, 87 (74%) were aged ⩾60 years and 47 (40%) were aged ⩾75 years. The site of culture was blood for 92 (79%), cerebrospinal fluid for 18 (15%), and other sites for seven (6%) cases. Twenty-two cases died giving a non-perinatal case-fatality rate of 19%.

Fever, chills, and headache were reported more frequently in pregnant women than non-perinatal cases, and diarrhoea was more often reported by non-perinatal cases (Fig. 1).

Of all cases for whom information was available, 50/129 (39%) cases came from households where a Language Other Than English (LOTE) was spoken and 42/88 cases (48%) were born in countries other than Australia. The geographic region of birth for

Table 1. *Primary underlying immunocompromising condition for non-perinatal listeriosis cases as reported by the case's treating doctor, Australia, 2001–2004*

Primary condition	Number	Proportion (%)
Cancer – haemotological	30	26
Cancer – solid	21	18
Diabetes	10	9
Renal disease	8	7
Heart disease	6	5
Arthritis	4	3
Liver disease	4	3
Organ transplant	4	3
Inflammatory bowel disease	3	3
HIV/AIDS	2	2
Lung disease	2	2
Lupus	1	1
Other	2	2
None identified	20	17
Total	**117**	**100**

foreign-born cases was Europe (30 cases, predominantly Western and Southern Europe), Asia (eight cases), Middle East (one case) and Oceania (two cases) with missing data for one. The region of birth for 37 cases identified as living in households where a LOTE was spoken were Western Europe (15, 41%), Central Eastern Europe (5, 14%), Asia (6, 16%), Oceania (2, 5%) and Australia (9, 24%). Nine of 136 (7%) cases were from rural areas, and 15/131 (12%) were Aboriginal.

Treating doctors nominated the following conditions as the primary immunocompromising condition in the non-perinatal patients, haematological malignancy (26%), solid cancers (18%) diabetes (9%), and renal disease (7%) (Table 1).

The most common immunocompromising medications used by non-perinatal cases in the 4 weeks prior to onset were antibiotics (37%), corticosteroids (36%), chemotherapy (26%), and gastric acid inhibitors (22%). Fifteen cases (13%) were residents of aged care institutions where meals were provided for them. Thirty-nine cases (33%) were admitted to hospital in the period 7–28 days prior to specimen collection.

Eighty-five controls were recruited for the 117 non-perinatal controls, 51 cases were matched to a control, 17 with one control each and 34 with two controls each. Twelve controls were recruited for the 19 perinatal cases, six cases were matched to two

Table 2. *Case-specific risk factors for non-perinatal and perinatal listeriosis, Australia, 2001–2004*

Risk factor	Non-perinatal						Perinatal					
	Cases exposed		Controls exposed				Cases exposed		Controls exposed			
	n	%	*n*	%	mOR	95% CI	*n*	%	*n*	%	Exact (mOR)	95% CI
Aboriginal or Torres Strait Islander	11/117	9·4	5/85	5·9	2·0	0·6–7·4	4/19	21·0	4/12	33·3	1·0	0·0–97·9
LOTE	37/117	31·6	6/85	7·1	3·2	1·1–9·4	13/19	68·4	1/12	8·3	11·3†	1·5–undefined
Overseas born	33/117	28·2	15/85	17·7	1·7	0·7–4·1	9/19	47·4	1/12	8·3	7·7†	0·8–undefined
Resident ACF	15/117	12·8	4/85	4·7	2·6	0·6–11·1	0/19	0·0	3/12	25·0	0·4†	0·0–5·1
Prior medications												
Prednisolone	42/117	35·9	20/85	23·5	3·7	1·3–10·9	0/19	0·0	0/12	0·0	*	
Antibiotics	43/117	36·8	18/85	21·2	3·1	1·3–7·5	1/19	5·3	0/12	0·0	*	
Antacids	21/117	18·0	22/85	25·9	1·1	0·5–2·7	4/19	21·1	4/12	25·0	0·4	0·0–8·1
Gastric acid suppressants	26/117	22·2	11/85	12·9	6·2	2·0–18·6	0/19	0·0	0/12	0·0	*	
Prior hospitalization (7–28 days)	39/117	33·3	9/85	10·6	4·4	1·6–12·2	0/19	0·0	1/12	8·3	*	

mOR, Matched odds ratio; CI, confidence interval; LOTE, language other than English; ACF, aged care facility.

* Unable to calculate as numerator or denominator = 0 in matched analysis.

† Median unbiased estimates.

controls each. Controls for non-perinatal cases were recruited from NSW (55, 65%), Queensland (13, 15%), Western Australia (13, 15%), and South Australia (4, 5%). Controls for perinatal cases were recruited from NSW (8, 67%), and Western Australia (4, 33%). A higher percentage of non-perinatal cases (47%) than non-perinatal controls (38%) were female. A similar percentage of cases (74%) and controls (71%) were aged ⩾60 years.

In univariate analysis, risk factors for non-perinatal listeriosis cases included living in a household where a LOTE was spoken; prior hospitalization; and any one of antibiotic, prednisolone or gastric acid inhibitor administration in the 4 weeks prior to admission (Table 2), and consumption of liverwurst (Table 3). No food history was available for five of the non-perinatal cases.

Multivariate analysis of non-perinatal cases identified the following risk factors for listeriosis: prior hospitalization (OR 4·3, 95% CI 1·0–18·3), use of gastric acid inhibitors (OR 9·4, 95% CI 2·4–37·4), and consumption of camembert (OR 4·7, 95% CI 1·1–20·6). Model specification was assessed using the link test and found to be acceptable. Analysis of risk factors for perinatal cases identified living in a household where a LOTE was spoken as the only risk factor associated with listeriosis (OR 11·3, 95% CI 1·5–undefined). No association was found between the frequency of consumption of any other individual foods and perinatal or non-perinatal listeriosis (data not shown). Many other case-specific and food-specific risk factors were examined but no meaningful associations with *Listeria* infection were identified (see Appendix Tables 1 and 2).

Of LOTE cases, only 1/8 (13%) perinatal cases and 1/19 (5%) non-perinatal cases reported that a health-care worker had warned them to avoid specific foods to prevent *Listeria* prior to their illness with listeriosis. This compares with 3/5 (60%) perinatal cases and 10/61 (16%) non-perinatal cases in non-LOTE households.

Of the patients that were hospitalized or made clinic visits in the 2 months prior to their listeriosis diagnosis, the following high-risk foods were reportedly consumed during their visit, lettuce 11/39 patients (28%), diced chicken sandwiches 5/39 (13%), ham sandwiches 15/40 (38%), fresh fruit salad 8/39 (21%), soft cheese 4/39 (10%) rockmelon (cantaloupe) or strawberries 9/39 (23%). Eighteen of 45 (40%) cases consumed at least one of these high-risk foods during hospitalization. For these 18 cases, the following immunocompromising conditions were identified: age >75 years (1), haematological cancer (8), solid cancer (3), HIV/AIDS (1), heart disease (2), organ transplant (1), renal impairment (1), and mixed connective tissue disease (1).

Table 3. *Food-specific risk factors for non-perinatal and perinatal listeriosis*

| Risk factor – foods | Non-perinatal | | | | | | Perinatal | | | | | |
| | Cases exposed | | Controls exposed | | | | Cases exposed | | Controls exposed | | | |
	n	%	n	%	mOR	95% CI	n	%	n	%	Exact (mOR)	95% CI
Rockmelon/cantaloupe	50/112	44·6	32/85	37·7	2·1	1·0–4·7	8/19	42·1	3/12	25·0	4·0	0·2–236·0
Ready-to-eat fruit salad	12/112	10·7	11/85	12·9	1·6	0·5–4·5	3/19	15·8	1/12	8·3	2·0†	0·0–78·0
Ready-to-eat other salad	3/112	2·7	16/85	18·8	0·2	0·0–0·9	2/19	10·5	5/12	41·7	0·3	0·0–4·3
Chopped liver/liverwurst	7/112	6·3	1/85	1·2	11·1	1·3–92·5	1/19	5·3	0/12	0·0	*	
Camembert	14/112	12·5	7/85	8·2	2·5	0·9–7·4	0/19	0·0	2/12	16·7	0·8†	0·0–10·7
Blue-veined cheese	11/112	9·8	5/85	5·9	1·9	0·5–7·2	0/19	0·0	0/12	0·0	*	
Fetta	16/112	14·3	7/85	8·2	1·9	0·6–5·7	3/19	15·8	2/12	16·7	0·8†	0·0–10·7
Mussels	6/112	5·4	4/85	4·7	2·2	0·5–10·0	1/19	5·3	0/12	0·0	*	

mOR, Matched odds ratio; CI, confidence interval.

* Unable to calculate as numerator or denominator = 0 in matched analysis.

† Median unbiased estimates.

DISCUSSION

This first national case-control study of listeriosis in Australia provides evidence to support existing listeriosis prevention policies but also highlights the need for an increased focus on preventing listeriosis in non-English speaking people and their families and increased attention to safety of food service in hospitals.

The associations between perinatal infections and living in a household where a LOTE was spoken and the tendency to report lower rates of being warned about the risks of listeriosis in this group suggest that a focus should be placed on preventing illness in non-English speaking pregnant mothers. Speaking a LOTE cannot, of itself, be a risk factor for listeriosis. It may be a surrogate for lack of information on how to prevent listeriosis infection or a cultural marker for the consumption of high-risk foods. The low number of controls reporting living in a household where a LOTE is spoken is probably due in part to bias introduced through lack of adherence to a systematic selection of controls leading to an artificially low rate in the controls. It is possible that clinics may have broken the protocol and preferentially approached potential controls with a good command of English leading to an overestimate of LOTE as a risk factor. Nevertheless, 68% of cases reported living in a household where a LOTE is spoken compared to only 21% of the community reporting speaking a LOTE in the 2006 Census which suggests a real association, perhaps through a surrogate pathway, between speaking a LOTE and listeriosis [7]. This supports the need for review of food safety warnings in languages other than English. The Food Standards Australia and New Zealand (FSANZ) website only provides a brochure on listeriosis and food in English [8]. Languages used in State and Territory brochures vary widely with some only including English while others provide up to 14 languages other than English. While the lower frequency of reporting prior *Listeria* prevention messages by LOTE cases compared to non-LOTE cases is not significant it is still a concerning finding and is consistent with lower availability of educational material in languages other than English.

The increased usage of gastric acid inhibitors in the month before illness in listeriosis cases compared to controls in our study is consistent with findings from other studies identifying acid suppression as a risk for bacterial enteric infection [9, 10]. While the association with gastric acid inhibitors may have been confounded by comorbid factors that were not appropriately controlled for in the matching process, at least one study found that current users, but not former users, of H2 antagonists were at increased risk for salmonellosis infection [9]. Additionally, antacid and cimetidine administration were associated with listeriosis infection in case-control studies that attempted to control for comorbid conditions [11]. Long-term H2 antagonist therapy has been associated with an increased risk of faecal carriage of *L. monocytogenes* and animal studies have confirmed that decreasing gastric acidity in rats increases the risk of *L. monocytogenes* infection [12, 13].

Eighteen hospitalized patients with immunocompromising conditions consumed high-risk foods that Australian food safety agencies recommend should be avoided by persons at risk for listeriosis. Surveys of long-term care facilities in the USA have identified that high-risk foods are often served to residents aged >65 years [14]. In October 2007, a new national food safety standard was gazetted that requires businesses and institutions that provide food service to vulnerable persons, such as in hospitals and aged care institutions, to implement a documented and audited food safety programme by October 2008 [15].

It is very difficult to provide robust food safety information to immunocompromised people, as they are not a homogeneous group and clinicians and patients cannot easily predict risk of infection in individuals. Pregnancy is an ideal time to provide counselling on the risk of *Listeria* infection and this complements counselling on healthy eating in pregnancy in antenatal clinics and classes. One study conducted in Australia found that only 13% of English-speaking pregnant women were able to identify all six high-risk foods in a survey and women from a non-English speaking background were 12 times more likely to select 'don't know' when asked about a range of high-risk foods [16].

Apart from the associations found with camembert and chopped liver/liverwurst consumption this study did not identify any other particular food as a substantial contributor to listeriosis. Identifying high-risk foods in a case-control study that spans multiple years is more challenging than in a single outbreak incident as the rate of contamination of even high-risk foods may vary widely over time. Subtyping of the *Listeria* isolates with comparison to food isolates may increase the chance of identifying high-risk foods with subtype concordance and efforts to uniformly subtype isolates from each jurisdiction are in progress. However, in Australia subtyping for listeriosis is usually only performed when outbreaks are identified. In future studies consideration should be given to the use of case-case comparison assisted by routine subtyping of all isolates – as used in the study by Varma *et al.* [17]. In the USA, PulseNet provides a national system for the uniform subtyping, comparison and archiving of *L. monocytogenes* strains [18]. Such a system would assist the recognition and investigation of outbreaks and development of a standardized national database of clinical *L. monocytogenes* isolate subtypes in Australia should be a priority.

Our study may have had limited power to detect high-risk foods due to small numbers, particularly for perinatal cases, where we only recruited 19 cases and 12 controls.

The study conducted by Varma *et al.* [17] identified a significant association with melons consumed in a commercial establishment and hummus prepared in a commercial establishment. No link with acid-suppressing medication was identified. In this study an association with rockmelon or cantaloupe approached significance in the univariate analysis but not the multivariate analysis. Place of consumption was not collected for rockmelon, nor was hummus exposure.

There are many other limitations to this study. We had difficulty recruiting controls from busy clinics. Food recall over multiple weeks is difficult, and it is likely that this study examines usual food preferences rather than exact exposures. The use of proxies for deceased cases may have led to exposure misclassification.

Hospitals and aged care institutions should ensure that food safety programmes for food service to vulnerable persons comply with the new standard, particularly in regard to the exclusion of high-risk foods. Auditing of the programmes should pay special attention to exclusion of potentially hazardous foods where the facility may not have the capacity to identify, validate and monitor hazard control interventions for those foods. This study identified that listeriosis prevention messages need to be disseminated in multiple languages and primary-care practitioners should ensure that patients from households speaking a LOTE receive counselling on listeriosis prevention.

This study adds to the concern associated with acid suppression removing a barrier to bacterial infection. There may be a place for counselling of patients taking such medications or a warning on the product insert regarding the potential increased risk of bacterial enteric infection.

Listeriosis is a serious and preventable foodborne infection for which vulnerable populations and high-risk foods have been known for many decades. While surveillance can be further enhanced to develop food safety policy into the future, it is important that both the well established vulnerable populations and newly recognized LOTE groups are protected as soon as possible. The effectiveness of the implementation of the new food safety programmes for food service to vulnerable persons should be carefully evaluated to ensure optimal protection of this group.

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DECLARATION OF INTEREST

None.

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Appendix Table 1. *Additional case-specific risk factors for non-perinatal and perinatal listeriosis, Australia, 2001–2004*

Risk factor	Non-perinatal Cases exposed		Controls exposed				Perinatal Cases exposed		Controls exposed			
	n	%	n	%	mOR	95% CI	n	%	n	%	Exact (mOR)	95% CI
Gender – male	61/117	52·1	53/85	62·4	0·7	0·3–1·9	0/19	0·0	0/12	0·0	*	
Age					1·1	1·0–1·1					1·0	0·9–1·2
Rurality												
Inner city urban	26/117	22·2	5/85	5·9	Ref.		3/19	15·8	1/12	8·3	Ref.	
Suburban	73/117	62·4	70/85	82·4	0·5	0·1–2·3	13/19	68·4	9/12	75·0	0·5	0·0–39·3
Town	11/117	9·4	7/85	8·2	1·2	0·2–8·8	1/19	5·3	2/12	16·7	1·0†	0·0–39·0
Rural or remote	7/117	6·0	3/85	3·5	1·6	0·2–13·3	2/19	10·5	0/12	0·0	1·0	0·0–undefined
Education level												
Primary school	7/117	6·0	9/85	10·6	Ref.		0/19	0·0	0/12	0·0	Ref.	
Secondary school	32/117	27·4	32/85	37·7	1·2	0·3–4·6	5/19	26·3	6/12	50·0	*	
Apprenticeship	3/117	2·6	2/85	2·4	2·2	0·2–23·2	1/19	5·3	0/12	0·0	1·0	0·0–undefined
Certificate or diploma	14/117	12·0	18/85	21·2	1·3	0·3–5·7	0/19	0·0	3/12	25·0	1·0†	0·0–13·0
University degree	18/117	15·4	21/85	24·7	1·0	0·2–4·1	5/19	26·3	3/12	25·0	4·4	0·3–236·2
Other/missing/ refused/don't know	43/117	36·8	3/85	3·5	3·9	0·5–27·6	8/19	42·1	0/12	0·0	1·0	0·0–undefined
Income level (AUS$)												
<25000	40/117	34·2	41/85	48·2	Ref.		3/19	15·8	3/12	25·0	Ref.	
25000–50000	12/117	10·3	16/85	18·8	0·7	0·2–2·4	5/19	26·3	4/12	33·3	2·0	0·0–195·8
>50000–100000	10/117	8·6	9/85	10·6	0·8	0·2–3·9	1/19	5·3	2/12	16·7	1·6	0·0–130·8
>100000	2/117	1·7	0/85	0·0	*	*	1/19	5·3	1/12	8·3	10·0†	0·0–390·0
Missing/refused/ don't know	53/117	45·3	19/85	22·4	0·9	0·3–2·6	9/19	47·4	2/12	16·7	1·4	0·01–195·4
Prior medications												
Cyclosporine	4/117	3·4	4/85	4·7	*	*	0/19	0·0	0/12	0·0	*	
Chemotherapy	30/117	25·6	20/85	23·5	1·7	0·6–5·0	0/19	0·0	0/12	0·0	*	
Radiation therapy	9/117	7·7	5/85	5·9	0·8	0·1–4·4	0/19	0·0	0/12	0·0	*	
Antidiarrhoeal agent	15/117	12·8	7/85	8·2	3·4	0·8–14·6	0/19	0·0	0/12	0·0	*	
Other medication	62/117	53·0	49/85	57·7	1·3	0·6–2·8	3/19	15·8	0/12	0·0	4·8†	0·4–undefined

mOR, Matched odds ratio; CI, confidence interval.

* Unable to calculate as numerator or denominator =0 in matched analysis.

† Median unbiased estimates.

Appendix Table 2. *Additional food-specific risk factors for non-perinatal and perinatal listeriosis*

| Risk factor – foods | Non-perinatal | | | | | | Perinatal | | | | | |
| | Cases exposed | | Controls exposed | | | | Cases exposed | | Controls exposed | | Exact | |
	n	%	n	%	mOR	95% CI	n	%	n	%	(mOR)	95% CI
Self-serve salad bar	7/112	6·3	13/85	15·3	0·7	0·2–2·0	2/19	10·5	3/12	25·0	1·4	0·1–21·7
Lettuce	70/112	62·5	62/85	72·9	1·1	0·5–2·7	12/19	63·2	8/12	66·7	1·0	0·1–59·0
Prepacked bagged coleslaw	7/112	6·3	10/85	11·8	0·8	0·2–2·7	2/19	10·5	0/12	0·0	*	
Strawberries	42/112	37·5	35/85	41·2	0·9	0·4–2·0	9/19	47·4	4/12	33·3	1·6	0·2–12·7
Alfalfa/pea sprouts	10/112	8·9	15/85	17·7	0·4	0·1–1·5	2/19	10·5	2/12	16·7	0·8†	0–10·7
Any fresh juice	11/112	9·8	19/85	22·4	0·3	0·1–1·0	4/19	21·1	0/12	0·0	2·0†	0·1–undefined
Any fresh juice – high risk	7/112	6·3	11/85	12·9	0·5	0·1–2·6	3/19	15·8	0/12	0·0	2·0†	0·1–undefined
Organic produce	11/112	9·8	11/85	12·9	0·6	0·2–2·0	3/19	15·8	1/12	8·3	2·0	0·0–157·0
Ready to eat coleslaw	12/112	10·7	27/85	31·8	0·3	0·1–0·9	3/19	15·8	2/12	16·7	1·0	0·0–98·0
Deli meat or cold cuts of meat	84/112	75·0	73/85	85·9	0·6	0·2–1·6	16/19	84·2	12/12	100·0	0·5†	0·0–19·5
Deli meat/cold cuts – high risk	83/112	74·1	71/85	83·5	0·6	0·3–1·6	15/19	79·0	12/12	100·0	0·5†	0·0–19·5
Barbequed chicken	33/112	29·5	35/85	41·2	0·6	0·3–1·4	11/19	57·9	8/12	66·7	1·0	0·1–16·0
Devon/luncheon meat/ luncheon loaf	8/112	7·1	5/85	5·9	0·6	0·1–3·4	1/19	5·3	2/12	16·7	0·8†	0·0–10·7
Ham	63/112	56·3	55/85	64·7	0·6	0·3–1·3	8/19	42·1	11/12	91·7	0·1†	0·0–1·0
Pepperoni	15/112	13·4	12/85	14·1	0·9	0·3–2·5	3/19	15·8	3/12	25·0	1·4	0·1–21·7
Pate	4/112	3·6	3/85	3·5	0·6	0·1–5·4	1/19	5·3	0/12	0·0	*	
Other meat	29/112	25·9	21/85	24·7	1·4	0·7–3·2	4/19	21·1	2/12	16·7	1·0	0·0–19·2
Other meat – high risk	20/112	17·9	13/85	15·3	2·2	0·8–5·6	3/19	15·8	0/12	0·0	2·0†	0·1–undefined
Frankfurter/hot dog	14/112	12·5	15/85	17·7	0·9	0·3–2·3	3/19	15·8	2/12	16·7	0·8†	0·0–10·7
Any cheese	67/112	59·8	38/85	44·7	1·8	0·9–3·6	10/19	52·6	5/12	41·7	0·6	0·0–13·4
Brie	11/112	9·8	11/85	12·9	0·9	0·3–2·6	0/19	0·0	0/12	0·0	*	
Cream cheese	13/112	11·6	8/85	9·4	1·4	0·5–4·2	1/19	5·3	0/12	0·0	2·0†	0·1–undefined
Ricotta	12/112	10·7	4/85	4·7	1·3	0·3–6·1	0/19	0·0	0/12	0·0	*	
Mozarella	12/112	10·7	5/85	5·9	1·6	0·2–10·1	3/19	15·8	0/12	0·0	*	
Other soft cheese	10/112	8·9	9/85	10·6	0·4	0·1–2·0	2/19	10·5	0/12	0·0	*	
Raw or unpasteurized milk	1/112	0·9	0/85	0·0	*	*	1/19	5·3	0/12	0·0	*	
Prawns	24/112	21·4	28/85	32·9	0·8	0·4–1·8	3/19	15·8	2/12	16·7	0·8†	0–10·7
Oysters	8/112	7·1	8/85	9·4	0·7	0·2–2·7	1/19	5·3	2/12	16·7	0·8†	0–10·7
Smoked salmon/lox	12/112	10·7	11/85	12·9	1·3	0·4–4·4	0/19	0·0	0/12	0·0	*	
Other smoked fish	8/112	7·1	11/85	12·9	0·5	0·1–1·8	0/19	0·0	0/12	0·0	*	

mOR, Matched odds ratio; CI, confidence interval.

* Unable to calculate as numerator or denominator = 0 in matched analysis.

† Median unbiased estimates.