

Dietary Changes arising from Listeriosis Awareness among Pregnant Women in the Loddon-Mallee Region of Victoria¹

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Listeriosis is a rare but serious food-borne illness with particular implications for pregnant women. The study investigated changes in dietary habits due to awareness of Listeria among recent mothers in the Loddon-Mallee region of Victoria. The study also aimed to determine the effectiveness of Listeria educational material and to gauge the degree of behaviour change among this group. A postal survey of all mothers in the Loddon-Mallee region who gave birth in the month of June 2003 was conducted. There were 303 women who had live singleton births in the region in June 2003. Of these, 129 consented to be contacted and 83 responded. Nineteen women had never heard of Listeria and seven heard only after their pregnancy. Knowledge and awareness of Listeria in post-partum women in the region is poor and dietary behaviour changes, while acceptable, were not consistent or well understood. Women in rural areas are not well informed about many aspects of Listeria and its consequences.

Key Words: Listeria; Pregnancy; Loddon-Mallee; Dietary Behaviour; Infection Awareness; Immunity; Food Safety; Pathogenesis

Listeriosis is a rare, food-borne, gastrointestinal disease, but one with high public health significance. Listeriosis is caused by ingestion of the *Listeria* bacterium. The study examined a small cohort of women in the Loddon-Mallee region of Victoria. The research was a retrospective, cross-sectional survey. All women who gave birth in the region during June 2003 were approached to participate in a survey exploring their knowledge of listeriosis and their dietary behaviour during pregnancy.

Listeriosis is a serious, but relatively rare food-borne disease to which neonates, pregnant women, the immunocompromised and the elderly are particularly susceptible. Infection during pregnancy can be transmitted to the foetus. Infants may be stillborn, born with septicaemia or develop meningitis in the neonatal period (Roche et al. 2001). *Listeria* infection or listeriosis is an illness usually

caused by eating food contaminated with the bacterium known as *Listeria monocytogenes* (Department of Human Services [DHS] 1996). The causative agent, *L. monocytogenes*, is a Gram-positive rod-shaped bacterium and human infections are usually caused by serovars I/2a, I/2b and 4b (Chin 2000; DHS 1996; Donnelly 2001).

The symptoms of listeriosis can take a few days or even weeks to appear and can be mild, thus pregnant women might not even know they have it. Therefore, it is very important to take appropriate dietary and food safety precautions during pregnancy. It is vital that pregnant women become apprised of the dangers of *Listeria* infection and the precautions that should be taken as early as possible during the pregnancy or, preferably, before becoming pregnant. However, Woteki (2001) reports that many women are not properly advised about the risks of *L. monocytogenes*, even

when they have specifically asked their health care provider for information. Only Torvaldsen et al. (1999) have made any assessment of the dietary habits of pregnant women because of the risk of listeriosis. The study concluded, among other things, that rural women were less likely to have knowledge of *Listeria* or to initiate appropriate dietary changes during pregnancy.

Listeria monocytogenes is commonly found in the environment and would be impossible to eradicate. Some exposure to the bacteria is unavoidable, though most people are at low risk of infection. In others, symptoms include minor complaints such as headache, tiredness, aches and pains, vomiting and diarrhoea. As a food-borne disease, listeriosis is a relatively new and emerging condition, which has not yet achieved high public recognition or understanding.

Characteristics of *Listeria monocytogenes*

Listeria monocytogenes is common in soil and water and a normal inhabitant of the gastrointestinal tracts of many animals and up to 5% of healthy human adults (Wing & Gregory 2002). However, contaminated foods are the usual method of *Listeria* infection (US Department of Health and Human Services and Department of Agriculture [USDHHS & USDA] 2001). Unlike most food-borne pathogens, *L. monocytogenes* grows well in low temperature environments and relatively high salt concentrations (Chin 2000; Wing & Gregory 2002). Hence *L. monocytogenes* can grow well at refrigeration temperatures and in foods that are preserved in brine, such as soft cheeses and ready-to-eat foods (DHS 2000b). Such foods are commonly the vehicles for *Listeria* infection. Recently, foods such as salads, smoked salmon, pâtés, fruit salads, spinach, sandwiches,

corn, broccoli, coleslaw, hot dogs, pasteurised milk, unpasteurised milk, processed meats and pre-cooked chilled foods have been implicated in listeriosis infections.

Listeria during pregnancy

Pregnant women have 20 times the risk of acquiring listeriosis when compared to normal, healthy humans (Donnelly 2001). Listeriosis occurs most often during the third trimester of pregnancy, resulting in one of three outcomes: an asymptomatic maternal infection and an infected infant; a severely ill mother who enters labour prematurely and delivers a stillborn or severely ill infant, or an unaffected foetus but the mother usually dies. Mylonakis et al. (2002) also reported that maternal listeriosis often resulted in a non-specific febrile illness that rarely was diagnosed pre-partum. Serious illness was rarely noted in a study group of pregnant women. Infection, however, often resulted in spontaneous abortion, stillbirth, death of the newborn within hours after birth, or neonatal sepsis (Mylonakis et al. 2002). In Western countries, listeriosis has the highest mortality rate of any food-borne pathogen.

Outbreaks of Listeriosis

Food is now well known to be a vehicle for *Listeria* transmission and it has received much attention since a 1981 Canadian outbreak (Bell & Kyriakides 1998; Donnelly 2001). The outbreak affected 41 individuals and had a 27% mortality rate. Coleslaw was shown to be the vehicle responsible. Other outbreaks, including one in Massachusetts (1983) and another in Los Angeles (1985), relating to pasteurised milk and Mexican-style soft cheese, respectively, confirmed the risk of ingesting contaminated foods (Fleming et al. 1985; Linnan et al. 1988). There have been outbreaks in seafood, marine

and shellfish. This includes raw seafood from oysters, sashimi and salmon, as well as the sushi and sandwiches made from these ingredients (Motes 1991). The disease also occurs in smoked salmon (Tauer et al. 2007). Contamination of fruits or vegetables can be a problem (Kathariou 2002). Foods placed in a buffet or salad line are problematic as the bacteria can multiply quite quickly (Li et al. 2002; Penteadó & Leitao 2004). Listeriosis in Italy was associated with consumption of a corn salad that was contaminated with *L. monocytogenes*, with many of the cases in that outbreak presenting as gastroenteritis in healthy individuals (Aureli et al. 2000).

In other instances, the organism might have adapted to a microenvironment within the plant, such as a drain, a crevice in a floor, or a roller on an assembly line, that is inaccessible or difficult to clean and disinfect thoroughly as part of standard sanitation (Tompkin 2002).

Outbreaks continue to be reported around the world but are relatively uncommon in Australia. In 1990, a Listeriosis outbreak was reported in Western Australia involving 10 pregnant women who had six stillbirths (Watson & Ott 1990). Small outbreaks have continued to occur in Australia and in the period 1998-2000, there were five outbreaks, three of them in healthcare settings

(Kirk et al. 2003). For a more detailed discussion of Listeriosis outbreaks refer to Jackson et al. (2005).

Public health significance and occurrence

Listeriosis is an uncommon disease in humans. Mean rates in Australia for 1998-2000 were three per million (Kirk et al. 2003). Listeriosis in Victoria is a laboratory notifiable condition under the *Health (Infectious Diseases) Regulations 1990*. Listeriosis notifications in Australia have been steadily increasing over the last 15 years and in 1999 there were 63 cases reported (DHS 2000a). Table 1 summarises the listeriosis notifications and deaths in Victoria from 1996 to 2000.

Listeria awareness

Only one study (Torvaldsen et al. 1999) has been found regarding the awareness of *Listeria* among pregnant women. That study also investigated the factors causing women to change their dietary behaviour during pregnancy. Torvaldsen et al. (1999) reported that women who had heard of *Listeria* were asked whether they changed their dietary behaviour in pregnancy and 90% reported that they had avoided certain foods, even though most reported some difficulty in doing so. It has also been reported that whilst the general awareness

Table 1: Listeriosis notifications and deaths, by category, Victoria, 1996-2000 (Perinatal Data Collection Unit 2001)

Year	Materno-foetal cases		Other Cases		Total cases	
	Notifications (Deaths) ^a	Case fatality rate %	Notifications (Deaths)	Case fatality rate %	Notifications (Deaths)	Case fatality rate %
1996	3 (1)	33	17 (9)	53	20 (10)	50
1997	4 (1)	25	11 (3)	27	15 (4)	27
1998	5 (4)	80	10 (3)	30	15 (7)	47
1999	5 (3)	60	7 (1)	14	12 (4)	33
2000	2 (1)	50	9 (6)	66	11 (7)	64
Total	19 (10)	53	54 (22)	41	73 (32)	44

^a Materno-foetal deaths include stillbirths, neonatal deaths and miscarriages and deaths of the mother.

of listeriosis is poor, the perception of the risks associated with *Listeria*, is that the risks are high or severe (Fife-Schaw & Rowe 1996).

Reservoir and sources

Listeria monocytogenes is ubiquitous in the environment, and human exposure is frequent. The organism is commonly isolated from sewage, silage, sludge, birds, wild and domestic animals (DHS 1996, 2001). Cattle, sheep, and goats are also well-recognised carriers of *L. monocytogenes*, and these ruminants acquire listeriosis primarily through consumption of contaminated silage. However, silage is not commonly fed to these animals in Australia (S. Fenwick, personal communication, 24 November 2003). *L. monocytogenes* can be soil-borne, can persist in soil for extended time periods, and can contaminate plant material grown in its presence. Fresh produce such as cabbage, potatoes, asparagus, broccoli, cauliflower, corn, green beans, lettuce, and radishes have been shown to be sources of *L. monocytogenes*, and products upon which *L. monocytogenes* can grow and proliferate (Bell & Kyriakides 1998; DHS 2000b).

An outbreak of listeriosis in the Hunter Valley of New South Wales involved a contaminated batch of fruit salad (Food Science Australia [FSA] 2002; Mansberg 2003). Fruit salad had not previously been associated with *Listeria* contamination and therefore had not been considered a 'high risk' food. From January 1998 to January 1999, six cases of listeriosis, five of which were fatal, occurred in the Hunter Valley. No pregnancy-associated infections were involved. The fatal cases were all residents of aged care facilities or patients of health care institutions. The NSW Health Department linked four of the cases to contaminated fruit

salad (FSA 2002). Prior to this outbreak there were no listeriosis cases associated with raw fruit or fresh fruit salad reported in the scientific literature. Consequently, fruit salad, not previously considered a risk food, was not examined in this research.

Methodology

The aim of the research was to determine to what extent pregnant women change their dietary behaviour when aware of the consequences of listeriosis. The study examined a small, cross-sectional cohort of women in the Loddon-Mallee Region of Victoria. All women who gave birth to a live singleton infant in the Region during June 2003 were approached to participate and of these 83 agreed to participate in the survey. Participants were asked to complete a five-page, self-paced, paper survey consisting of 24 questions which was designed to gather quantitative data relating to *Listeria* awareness during pregnancy. The survey also collected information on dietary behaviours and changes during pregnancy in response to listeriosis risks and any difficulties experienced in changing dietary behaviours.

It collected information on dietary behaviours and changes during pregnancy in response to listeriosis risks and any difficulties experienced in changing dietary behaviours. Participants were asked to complete the questionnaire at their own pace and to return it by post.

The women in this survey had some knowledge of the DHS pamphlets (*Listeria: The Facts 2001*; *Listeria monocytogenes in Ready-to-eat Foods 2000b*) but little knowledge of other pamphlets given out by various authorities in Victoria.

A more detailed explanation of the methodology is given in Jackson et al. (2005).

Results

A total of 303 women gave birth to live singleton infants in the Loddon-Mallee region in June 2003. Consent was obtained from 129 women (43%) and of these, there were 83 (64%) who responded. Thus 27% of the target population completed the questionnaire.

Of the 83 women who responded, ages ranged from 18-42 with a median of 31 years. All women reported English as the language normally spoken at home and only one reported having been born overseas.

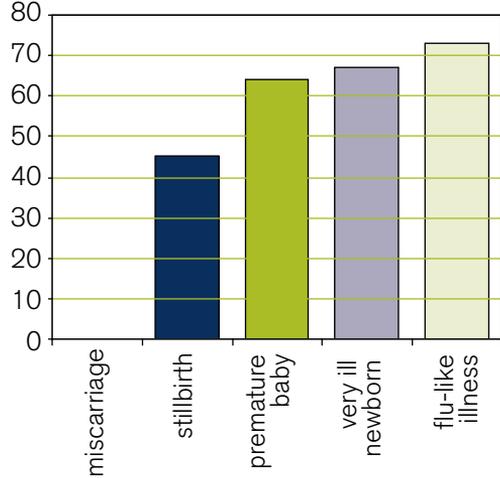
Of the 83 respondents, 19 (23%) had not heard of *Listeria*. Of the remaining 64 who had heard of *Listeria*, 7 (13%) heard about it only after their pregnancy. Of the 64 respondents who had heard about *Listeria*, most (69%) had heard about *Listeria* prior to their pregnancy.

Of the 28 women who reported having seen the pamphlet, 25 found it very useful or useful. Two women found it neither helpful nor unhelpful and one woman could not remember. When asked to comment on what further information could be included in the *Listeria* pamphlet, five women commented that they would like more information on topics such as risk foods, food preparation, symptoms in the mother, symptoms and illness in the foetus and infection transmission times.

Knowledge of transmission and outcomes of Listeria infection

Women who had heard of *Listeria* were asked to identify the possible outcomes of *Listeria* infection during pregnancy and were asked to select any appropriate responses. Only 2 (3%) women, out of 64, correctly identified all 5 correct responses and no incorrect ones. There were 20 women (31%) who did not know and 42 (66%) who answered incorrectly or partially correctly (see Figure 1). Of those who selected one or more symptoms,

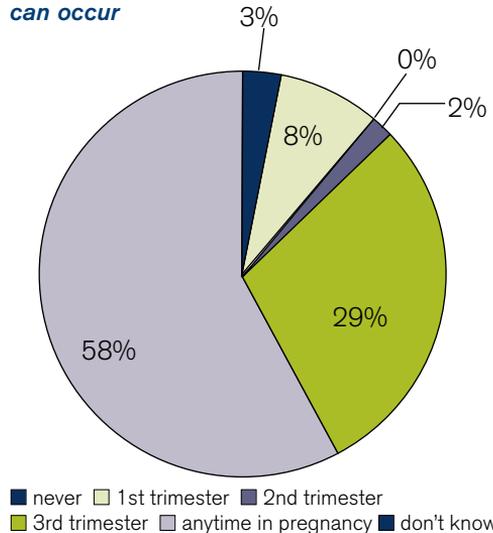
Figure 1: Percentage of mothers who failed to identify key symptoms of Listeria infection during pregnancy



all correctly identified miscarriage as an outcome, but 45% failed to identify stillbirth, 64% failed to identify premature birth, 67% failed to identify a very ill newborn baby and 73% failed to identify flu-like symptoms.

Women were also asked to identify the stage in pregnancy at which *Listeria* infection could be transmitted from the mother to the child (Figure 2). Only 18 (29%) of the 64 women correctly identified that transmission could occur at any time during pregnancy.

Figure 2: Knowledge of new mothers about when during pregnancy Listeria infection can occur



Dietary habits and changes in activities pertaining to avoidance of *Listeria* infection during pregnancy

Women who had heard of *Listeria* were asked if they had, because of the risk of *Listeria*, avoided foods during their pregnancy that they might usually have consumed. Forty-six (72%) of the respondents reported that they had avoided certain foods, and of these 46, 7 (15%) reported that they often had difficulty avoiding certain foods, 26 (57%) sometimes had difficulty and 13 (28%) said they never had difficulty. Women who had difficulty avoiding certain foods were asked to nominate reasons for the difficulty (see Figure 3). Respondents were asked to choose all boxes that applied. The most common reasons cited were: couldn't be sure of the history of the food (17), didn't know which foods were safe (16) and missed the taste (15). Ten women reported difficulty due to lack of alternatives at home or when out. Other reasons were given by three of the women. One woman stated that she was uncertain about the safety of using leftover foods so she often threw them out, one just forgot, and the third "craved salami 24 hours a day, every day for the entire nine months of the pregnancy".

Those 18 women who did not change their dietary behaviour were asked to give their reasons. Multiple responses were permitted. Four women reported that they ate what they liked because they did not realise there were foods to be avoided, six said they thought the risk of *Listeria* was low, and one stated that it was just too difficult to avoid all high-risk foods. Five women gave other reasons, all of which related to them being on strictly controlled diets under the supervision of various health practitioners.

Knowledge of which foods should be avoided by pregnant women

All participants were asked to identify those foods which should not be eaten by pregnant women due to the risk of *Listeria* infection (see Figure 4) from a list of 10 items. Of the 10 items listed there were six correct items: smoked salmon, soft cheese, ham sandwich bought from a sandwich bar or deli, chicken liver pate, coleslaw from a salad bar, and fresh corn, green beans or broccoli. Also included were four incorrect items: peanuts, sausages, eggs and hamburgers.

All participants were asked to complete this question. No one from either group who had or had not heard about *Listeria* was able to get all correct items and

Figure 3: Reasons for difficulties of pregnant women in avoiding high-risk foods associated with *Listeria* infection

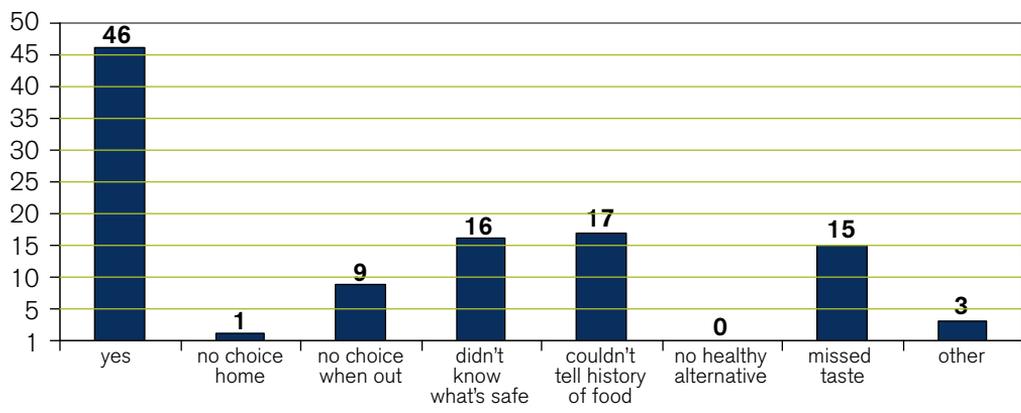


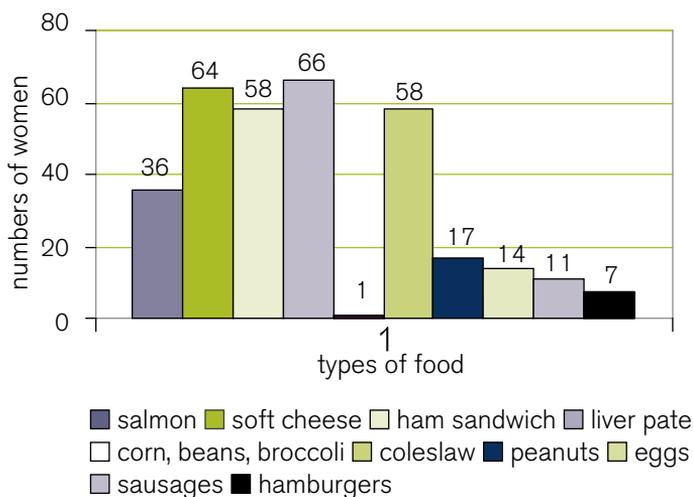
Table 2: Knowledge of new mothers regarding foods associated with *Listeria* infection which pregnant women are advised not to eat.

Potential risk food	N(%) of those who had heard of <i>Listeria</i> (n=64) who selected this item	N(%) of those who had not heard of <i>Listeria</i> (n=19) who selected this item	Unadjusted odds ratio for having heard of <i>Listeria</i> (95% CI)
Correct responses			
Smoked salmon	30 (47)	6 (32)	1.9 (0.6-6.5)
Soft cheeses	53 (83)	11 (58)	3.5 (1.0-12.4)
Ham sandwich bought from sandwich bar or deli	48 (75)	10 (53)	2.7 (0.8-8.9)
Chicken liver pate	57 (89)	9 (47)	9.5 (2.4-36.0)
Fresh corn, green beans or broccoli	0 (0)	1 (5)	Undefined
Coleslaw from a salad bar	44 (69)	14 (74)	0.8 (0.2-2.8)
Incorrect responses			
Peanuts	14 (22)	3 (16)	1.5 (0.4-14.1)
Eggs	12 (19)	2 (10)	2.0 (0.4-14.1)
Sausages	4 (6)	0 (0)	Undefined
Hamburgers	3 (5)	4 (21)	0.2 (0- 1.1)

none of the incorrect items. Most of the women who had a majority of the correct responses did not identify corn, green beans or broccoli as potential risk foods. Seventy-six (92%) of the women were able to identify at least one risk food. Five women, all from the group which had heard of *Listeria*, did not respond.

The responses of the two groups of women, those who had heard of *Listeria* and those who had not, were compared for each of the correct and incorrect responses (see Figure 4). Those women who had heard of *Listeria*, generally, had a higher likelihood of selecting from a list of the correct foods and not selecting

Figure 4: Foods identified as 'to be avoided by pregnant women' because of the risk of *Listeria* infection



the incorrect foods. In most cases, the differences were not statistically significant. For coleslaw, peanuts, eggs and sausages, the non-aware group performed better, but the differences were only slight. A significantly greater percentage (83% c.f. 58%) of women who had heard of *Listeria* correctly identified soft cheeses compared to those who had not heard of *Listeria* (OR 3.5, 95% CI 1.0-12.4). Women who had heard of *Listeria* were also significantly (89% c.f. 47%) more likely to identify chicken liver pate as a food to be avoided (OR 9.5, 95% CI 2.4-36.0).

Discussion

Awareness of Listeria

Almost one quarter (23%) of the surveyed women had never heard of *Listeria*, yet Torvaldsen et al. (1999) found that overall, only 11% of new mothers in Western Australia were unaware of *Listeria*. However, Torvaldsen et al. (1999) also concluded that rural women had a higher likelihood (OR 4.6, 95% CI 2.5-8.6) of not having heard of *Listeria*. Results in this present study confirm that finding for rural women.

Younger women and women with lower education levels were found to be less likely to have heard of *Listeria*. In particular women under 25, when compared with the referent group of women over 29, were almost six times more likely to have not heard of *Listeria*. This has important consequences as these women are, therefore, less able to control dietary risks associated with *Listeria* infection.

Knowledge of times when Listeria transmission can occur during pregnancy

An understanding of the stages during which transmission of *Listeria* infection can occur, by those new mothers who had heard of *Listeria*, was poor. Over half (58%) of the new mothers selected

“don't know” and another 13% gave an incorrect answer which indicates there are low levels in the understanding of this issue. Sound knowledge of transmission times would seem to be vital in this high-risk group.

The levels of knowledge indicated were in stark contrast to the findings of Torvaldsen et al. (1999) that 83% of new mothers knew that transmission could occur at any time during pregnancy. As has previously been stated, this has important implications for behaviour throughout a pregnancy (Torvaldsen et al. 1999). Future campaigns should, therefore, be structured so as to emphasise this aspect because of its importance in shaping the dietary habits of pregnant women throughout the entire course of the pregnancy. It is possible that this lack of knowledge of transmission times is related to the general sources of information utilised by this group. It may be that sources such as magazines, newspapers, friends and relatives would be more focused on the often dramatic outcomes of *Listeria* infection than on the less ‘technical’ aspects such as transmission times.

Knowledge of symptoms and outcomes of Listeria infection

Only two new mothers among those who had heard of *Listeria* were able to identify all correct possible outcomes of *Listeria* infection in pregnancy and did not indicate any of the incorrect ones. However, all others who selected one or more boxes were able to nominate at least one of the correct symptoms. This is critical as far as the public health and behaviour implications are concerned because the recognition or understanding by pregnant women that there are potential adverse outcomes from *Listeria* infection in pregnancy might lead to the appropriate dietary and behaviour adjustments necessary to minimise the

risks. Although 20 (31%) of the women acknowledged having no knowledge of the symptoms of *Listeria* infection during pregnancy, it was encouraging that all of the other women recognised miscarriage as an outcome. Recognition of the other symptoms was less sound. Of some concern is that 73% of the women failed to recognise that flu-like symptoms in the pregnant women could be a sign of *Listeria* infection. As this is often the only noticeable indication of *Listeria* infection for a pregnant woman, it is important for them to be able to recognise and report it to their medical practitioner. It is of course vital that medical practitioners also recognise this as a possible sign of *Listeria* infection.

Difficulties in changing dietary behaviour during pregnancy

The reasons for food choices are not always clear. Food choices tend to be personal or left to trusted relatives. Many food choices are habitual and decisions about the selection of particular products might have been made at some considerable time in the past. Eating is not generally perceived as hazardous, except in times of food alarms (Fife-Schaw & Rowe 1996). It has also been found that individuals 'perceive personal risk to be lower than the risk for either other people or society – independent of the hazard characteristics – and in line with a theory of optimistic bias' (Frewer et al. 1993, p. 23).

The difficulties encountered by women in avoiding certain foods that might be associated with a risk of *Listeria* infection were reasonably common and the reasons were primarily uncertainty, lack of alternatives or desire for certain foods. Torvaldsen et al. (1999) pointed out that women in rural areas indicated that lack of choice was an issue and this is supported by the findings in this study. Provision

of education and support in the areas of alternative, safe and nutritious foods and cooking for these women should be considered in any future *Listeria* strategies. This could be complementary to the education about other dietary practices, such as folic acid intake, that need to be followed by pregnant women. The education of partners and other family members regarding *Listeria* infection might also assist pregnant women in avoiding high-risk foods.

It is concerning that a number of women indicated they did not avoid high-risk foods because of the belief that the risk was low or it was just too difficult to avoid these foods. That these women were prepared to take the chance in the light of the knowledge that there was a risk, indicates a need for a stronger message about potential adverse outcomes.

Seventy-six of the women were able to identify at least one risk food. This has important public health significance as it indicates that most women have some awareness of the need to monitor dietary intake during pregnancy, even if they are not sure of the exact reason. No one was able to identify all the risk foods, but as most omitted the 'corn, green beans, broccoli' group, this is not of serious consequence as these items have only recently been implicated in *Listeria* outbreaks and are not yet mentioned in much of the publicly available literature. There also appears to be some overlap from warnings about foods which are considered hazardous for other reasons. A number of women incorrectly identified eggs and peanuts as being risk foods for *Listeria*.

Conclusion

The hypothesis that *Listeria* is not well understood by young mothers has been supported by this research in so far as there is a notable lack of understanding by

this group of a number of pertinent areas. Areas of knowledge that are unsatisfactory in this group include: adverse outcomes of *Listeria* infection, times of transmissibility of *Listeria* infection, and appropriate dietary behaviour during pregnancy. The findings of Torvaldsen et al. (1999) were confirmed in that dietary behaviour change during pregnancy was common and that the message about *Listeria* risk foods is reasonably well understood in the community.

When compared to countries such as the United States, England and France, the number of *Listeria* cases in Australia has been relatively low for many years. There is some evidence that they have even been declining in recent years. Whether this is due to the success of educational and awareness programs, or is due to higher standards in food processing industries leading to reduced exposures, or to other reasons is difficult to ascertain. One factor that could be impacting on the number of

Listeria outbreaks is the use of convenience foods. Usage of pre-cooked chilled foods is far lower in Australia than many other countries and it is these foods that are very often implicated in major outbreaks overseas. If this is correct, then as the use of these types of foods grows in Australia then there may be an increase in the number of *Listeria* outbreaks in the future. It would seem to be imperative then for agencies such as DHS to increase its role in the promotion of *Listeria* awareness and to be more proactive in delivering the message to the general public and to at risk populations.

Recommendations

Any further study should have specific emphasis placed upon assessing rural women's access to education programs, sources of information about *Listeria* and the availability of medical practitioners and other health service providers.

Endnote

This article is a companion article to 'Listeriosis awareness among pregnant women in the Loddon-Mallee region of Victoria' (2005) by Jackson, Sheldon and Katscherian and published in *Environmental Health*, vol. 5, no. 2. A more extensive coverage of the characteristics of *Listeria monocytogenes*, the study methodology and study results are included in that article.

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