Health Promotion International Advance Access published August 14, 2013

Health Promotion International
doi:10.1093/heapro/dat051

INVITED REVIEW

Domestic food preparation practices: a review of the reasons for poor home hygiene practices

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SUMMARY

New Zealand has a much higher rate of reported campylobacteriosis cases than the rest of the developed world. It has been suggested that New Zealanders have worse home hygiene practices during food preparation than the citizens of other developed countries. Thus, it is necessary to recognize and understand the reasons for consumer's poor practices in order to help develop a more effective message to improve New Zealanders' practices in the domestic environment. This could in turn lead to a reduction in the number of campylobacteriosis cases. The objective is to review cited literature on consumer practices which is related to food poisoning and to attempt to list the factors related to poor consumer practice. There are many internationally identifiable reasons for the poor practices of consumers. These reasons include psychological, demographic and socioeconomic variables; personal interest in new information; prior knowledge; cultural influence; educational background; perception of risk, control and liability; and attitude towards the addressed practices or hazards. The results have indicated that 'optimistic bias', the 'illusion of control', habits and lack of knowledge concerning food safety during domestic food preparation are prevalent among consumers. The research indicated the influence of demographic factors (age, gender, level of education, income, work hours, race, location, culture), as they play a potential role in determining domestic food safety behaviour. It appears that all these factors are applicable for New Zealand consumers and should be addressed in any future education strategy aimed at improving New Zealanders' food handling practices.

Key words: Consumer poor practice; food preparation; optimistic bias; demographic and socio-economic factors

INTRODUCTION

Internationally, cross-contamination during food preparation is considered to be the main factor in the transmission of campylobacteriosis (Mylius *et al.*, 2007). New Zealand has a much higher rate of reported campylobacteriosis cases than the rest of the developed world (Baker *et al.*, 2006; Kennington *et al.*, 2010). In 2006, there were 15 873 notified cases for this disease at 384 cases per 100 000 population (NZPHO, 2007). It has been suggested that New Zealanders have worse home hygiene practices during food preparation than citizens of other developed countries (Coddington, 2007; McKenzie, 2007; Al-Sakkaf, 2012), and this could allow cross-contamination during food preparation in the kitchen. Despite the efforts of food safety authorities and health organizations in education and promotional campaigns, food handling practices

remain a major risk factor for food-borne disease in New Zealand and the rest of the world (Redmond and Griffith, 2003). Therefore, it is necessary to investigate the reasons for consumer poor practice.

The aim of health professionals and risk managers is generally to encourage consumers to perform desirable and safe practices and to discourage improper or unsafe practices. The measuring of consumers' knowledge, attitudes and behaviour can help in designing an effective health promotion initiative. Traditionally, the communication process was a transfer of information, or an educative process, with a one-way flow of objective scientific information from experts (government, academia, authorized organization or industry) to the public applying their knowledge in order to increase consumer knowledge and improve practice by following the advice of knowledgeable experts (Rowan, 1996; Gurabardhi *et al.*, 2005). This is based on the principles that the provision of the educational information of knowledge must precede behaviour change (Medeiros *et al.*, 2004) and the awareness of the consequences of unsafe practice can increase consumer motivation to change their practices (Bruhn, 1997). This approach did not take into account the consumer's perception of the expert educational advice, and the public then became more unwilling to accept the experts' advice and appeared to become disillusioned about the types of risk information they were provided with, which lacked important facts from their perspective (Trautman, 2001).

There are many reasons that may affect public receptivity to expert advice, such as demographic and socioeconomic variables, personal interest in new information, prior knowledge, cultural influence, educational background, perception of risk, control and liability and attitude towards the addressed practices or hazards (Redmond and Griffith, 2005).

The objective of this study is to investigate the reasons for consumer poor practice in order to help in developing a new more effective message to improve New Zealanders' practice in the domestic environment. This will lead to a reduction in campylobacteriosis cases in New Zealand, which has the highest rate of campylobacteriosis in the developed world. The validity of these reasons, which are identified internationally as reasons for consumers' poor practices, will be tested with regard to New Zealand consumers.

METHODOLOGY

An extensive search of Scopus, ISI web of knowledge, and Google scholar databases was conducted for peer reviewed publications regarding consumers and factors influencing the practices of consumers. Different wordings and phrases have also been used to capture more articles and subsequent refining steps were conducted when necessary. The phrases 'domestic food preparation', 'food preparation practice', 'reasons for poor home hygiene', 'causes of cross contamination in home', 'consumer food preparation practice' and 'factors for poor domestic poor hygiene' along with other similar words and phrases were used to retrieve articles from the databases. The citations of the retrieved papers enriched the search with additional relevant articles. The review covered studies up until 2009, as this review was part of a PhD study, which covered more aspects of the New Zealand campylobacteriosis public health problem. An update of the review is planned to be conducted in the near future. The numerous papers retrieved (entailing more than 300) have been screened, appraised and summarized. The study included high quality and relevant papers as much as was possible and was guided by the common checklist (Heller *et al.*, 2008; Young and Solomon, 2009).

Valuable data were also gained through attendance at international conferences (The New Zealand Institute of Food Science and Technology, NZIFST 2008; The International Association for Food Protection, IAFP 2008; International Workshop on Campylobacter, Helicobacter and Related Organisms, CHRO 2009, IAFP 2010).

The available data provided an understanding of current consumer behaviour and the possible reasons for their deviation from safe food handling practice. This could be then used to plan effective education strategies.

RESULTS AND DISCUSSIONS

To the best of our knowledge, it has been shown that there is a lack of studies in this area in New Zealand. The broad nature of the review in investigating all the reasons (personal and environmental) prevented the researcher from performing a meta-analysis of the studies. However, it has also been shown that the systematic reviews and meta-analysis have their limitations and

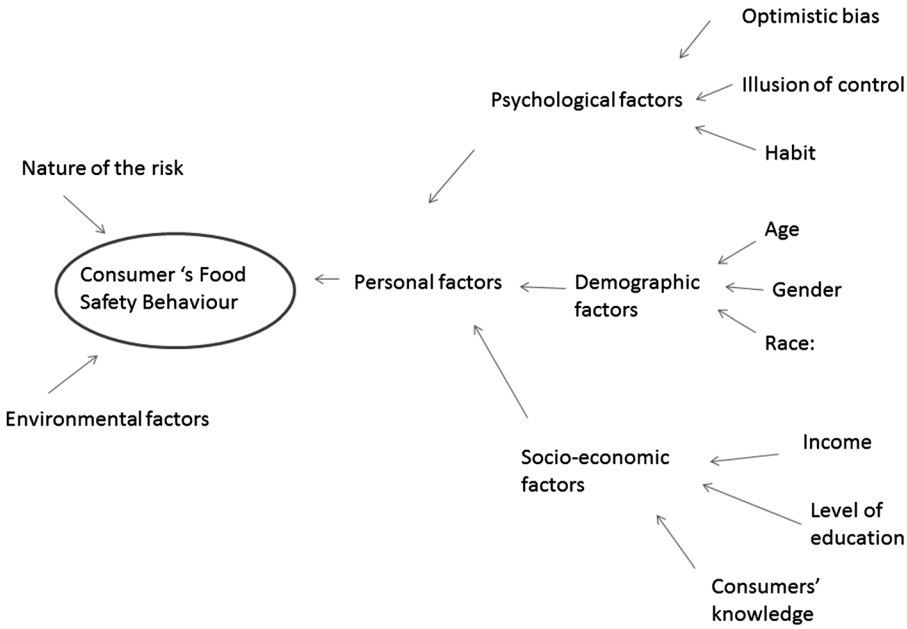

Fig. 1: Factors influences domestic food safety behaviour.

weaknesses as detailed in the literature (Lau *et al.*, 1998; Garg *et al.*, 2008; Chiappelli, 2010).

The literature revealed that there are many factors influencing consumer behaviour at home. In order to simplify and better understand these factors, in our study, they were categorized into three categories (Figure 1), as there were also discrepancies in the literature regarding the classification of the factors in each category aside from the inclusion or the exclusion of factors in each category. This study includes the most important and relevant factors for food safety behaviour as were attainable.

The three categories are personal factors, environmental factors and the nature of risk, which are explained as follows.

Personal factors

These are considered as the main factors, which influence consumers' behaviour and can be categorized further into psychological, demographic and socio-economic factors.

Psychological factors

There is a lack of papers internationally regarding the psychological factors influencing food safety behaviour. However, some studies (Ajzen and Fishbein, 2000; Fischer *et al.*, 2005) have confirmed the importance of psychological factors, which effect the consumer's ability to adopt and continue recommended safe practices. These psychological factors include optimistic bias, illusion of control and habit.

Optimistic bias. This is defined as the tendency of individuals to believe that they are less likely to experience negative events when compared with other people (Frewer *et al.*, 2003; Miles and Scaife, 2003). Consumers always underestimate the risk of food poisoning from the preparation of food in their kitchens (Miles and Scaife, 2003; Redmond and Griffith, 2003; Redmond and Griffith, 2004) and they think that they are less likely to be affected by any poor practice compared with other people (Frewer *et al.*, 1994; Raab and Woodburn, 1997; Parry *et al.*, 2004; Redmond and Griffith, 2004). Moreover, Frewer *et al.* reported that the perceived risk from food poisoning by food prepared at home was the lowest among 10 hazards that were studied (Frewer *et al.*, 1994). Most outbreak investigation studies or surveys state that patients may have a bias to more easily recall poultry meals eaten away from home and blaming the food prepared by friends or restaurants as the main cause of their food poisoning cases (Frewer *et al.*, 1994; Fein *et al.*, 1995). Similarly, other studies reported that consumers consider food factories

or food processing plants the most likely places for food contamination (Williamson *et al.*, 1992; Mataragas *et al.*, 2010). Thus, consumers will be less motivated to change their poor practices in order to protect themselves (Fischer and Frewer, 2008). Evidentially, up to 80% of food poisoning cases were acquired at home (Fein *et al.*, 1995; Humphrey *et al.*, 2001; Cogan *et al.*, 2002; Beumer and Kusumaningrum, 2003; Redmond and Griffith, 2003; van Asselt *et al.*, 2009).

Illusion of control. Illusion of control is defined as the tendency of individuals to believe that they can control, or at least influence, outcomes that they demonstrably have no influence over. Langer (Langer, 1975) added that people frequently behave as if chance events are manageable by personal control. Many researchers do not differentiate between the illusion of control and optimistic bias, as the illusion of control can be explained also by people's optimistic bias (McKenna *et al.*, 1991). However, McKenna (McKenna, 1993) later indicated that optimism refers to a comprehensive anticipation of positive events independent of the source of events, whereas the illusion of control locates the source of the expected events in terms of personal control. Thus, in a few studies, this is known as the locus of control, which is a measure of to whom an individual attributes control of events that affect him/her. There is an 'internal locus of control' by individuals and also an 'external locus of control' by fate or the environment (Judge *et al.*, 1998). For example, an individual with a high internal locus of control reflects his individual belief that he can control important events of his life and is inclined to use food safety information, whereas individuals with a low level of internal locus of control are disinclined to use food safety information and an individual with a high external locus of control reflects a fatalistic interpretation of life (Fischer and Frewer, 2008). Illusion of control and optimistic bias have also previously been linked to automobile accidents, disease and crime (Weinstein, 1987).

Habit. The automatic routines of behaviour that are repeated regularly and without thinking are called habits. The individual may not be paying attention to, or be aware of, the behaviour. Individuals have a tendency to establish habitual behaviour in order to reduce the cognitive effort required to conduct a specific behaviour (James, 1950). Food preparation for many individuals can be described as a habitual behaviour because it is a frequently repeated behaviour (Fischer and De Vries, 2008). If the behaviour target and its associated practice have recurred so regularly as to turn out to be 'automatic', individuals tend to respond without thinking in-depth about their behaviour. As a consequence, for individuals who have high goal behaviour linked to an associated action, their practice automatically follows their behaviour goal without further deliberation (Aarts and Dijksterhuis, 1999). Aarts and Dijksterhus indicated that a practice becomes a habit when 'the behaviour has been performed many times in the past, future behaviour becomes increasingly under control of an automated process' (Aarts and Dijksterhuis, 2000). Many cooks may exhibit bad habits regarding food-handling practices. Thus, habits are considered an obstacle for changing individual behaviour. However, frequent exposure to risk should guide improvement in safety behaviour later on (Anonymous, 2010). A New Zealand study revealed that New Zealanders need to improve their hand-washing habits in order to reduce the rate of campylobacteriosis (Al-Sakkaf, 2012).

Demographic factors

Previous research indicates the influence of demographic factors in predicting food safety behaviour, as these factors play a potential role in determining domestic food safety behaviour (Christensen *et al.*, 2005; Kennedy *et al.*, 2005b; Mahon *et al.*, 2006; McCarthy *et al.*, 2006; McCarthy *et al.*, 2007; Fischer and Frewer, 2008; Kennedy *et al.*, 2008). These studies indicated that the hygiene level during food preparation varied significantly between individuals due to demographic factors such as age, gender and race.

Age. It was reported that age is one of the most important factors in determining the public understanding of food safety practices (De Boer *et al.*, 2005; Kennedy *et al.*, 2005b; McCarthy *et al.*, 2005; Mahon *et al.*, 2006). Studies reported that older people were more concerned about food safety practices and hazards (Meer and Misner, 2000; Brennan *et al.*, 2007; McCarthy *et al.*, 2005; Towns *et al.*, 2006). Older people cook more safely than younger people (Kennedy *et al.*, 2005b). Young consumers have less food safety

knowledge and their practices need urgent improvement (Sanlier, 2009). Older people probably learned cooking in school as part of the educational curriculum in the past (Fischer and Frewer, 2008). Hudson and Hartwell indicated that older people were the group who suffered least from food poisoning (Hudson and Hartwell, 2002). Moreover, young adults (18–29 years) are considered to be the most vulnerable individuals to food poisoning (Klontz *et al.*, 1995; Altekruse *et al.*, 1999; Li-Cohen and Bruhn, 2002; Patil *et al.*, 2005). The reasons for this may be that more mothers are working and have less time to cook and so purchase ready or semi-ready meals for the family. This prevents their children from learning food handling practices by directly observing their mothers (Anderson, 1998). Also, food safety as traditionally taught has recently become rare or elective in the school curriculum in the United States (Byrd-Bredbenner *et al.*, 2007). However, a few studies have reported that there is no difference in food hazards between different age groups (Jussaume and Judson, 1992; Jussaume and Higgins, 1998). Other studies (Kennedy *et al.*, 2005b; Brennan *et al.*, 2007; McCarthy *et al.*, 2007; Kennedy *et al.*, 2008) linked age to other demographic and/or socio-economic factors such as, gender, level of education, race, culture, income, the presence of a child in the home and the segmentation of society into subgroups (Kennedy *et al.*, 2005b; Brennan *et al.*, 2007; McCarthy *et al.*, 2007; Kennedy *et al.*, 2008).

However, New Zealand surveillance data indicated that children between the ages of 1 and 4 were most frequently affected by *Campylobacter*. This is followed by children under 1 year of age, and after this was the young adults group, aged between 20 and 29 (NZPHO, 2010). However, these figures may not reflect the actual figure of young adults who suffered from campylobacteriosis, as many adults do not visit the GP when they experience diarrhoea. In contrast, children below 5 years of age do visit the GP after diarrhoea, as their parents are concerned about the health of their children as children have a lower immunity than the adult group (20–29 years). Yet, it is the adult group who possibly increase the risk for their children to contract campylobacteriosis through their poor hygiene practices (Al-Sakkaf, 2012). For example, it is possible that the adult parents in the group aged 20–29 did not wash their hands properly during feeding or preparation of the feed/food or accidently cross-contaminated the feed/food of their children. This would increase the number of children who became susceptible to campylobacteriosis.

Gender. Lin indicated that gender plays a significant role in risk perception (Lin, 1995). Women tend to judge health risks as having a higher potential of danger than men because women are socialized to be mothers and nurturers (Finucane *et al.*, 2000; Dosman *et al.*, 2001). Studies (Bruhn and Schutz, 1999; Dosman *et al.*, 2001; Brennan *et al.*, 2007; Byrd-Bredbenner *et al.*, 2007; Unusan, 2007; Nesbitt *et al.*, 2009) have reported that females scored better than males in food safety knowledge or reported food handling practices. Males in the age group 17–26 specifically were reported as being more at risk than females (Unklesbay *et al.*, 1998; Byrd-Bredbenner *et al.*, 2007). Other studies associated gender with race (Flynn *et al.*, 1994; Knight and Warland, 2004; Knight and Warland, 2005) and reported that White women and Blacks (males and females) were more likely to be highly concerned about food safety than White men and young people. Another study associated gender with income and compared both variables for three countries (the USA, Japan and Canada), concluding that women have higher risk perception for food safety in the USA and Canada but risk perception is lower for individuals with a higher income for all three countries (Tonsor *et al.*, 2009). A few studies have combined gender with the level of education (Kennedy *et al.*, 2008). Kennedy *et al.* have identified males with a higher level of formal education and aged below 45 as a high-risk group of consumers (Kennedy *et al.*, 2008). New Zealand surveillance data revealed that males are more at risk than females, and the notification rate for the years 2009 and 2010 was 188 and 191 per 100 000 population for males, respectively, and 142 and 143, respectively, for females.

Race. Lin indicates that race has not played a significant role in food hazards (Lin, 1995). However, other studies (Flynn *et al.*, 1994; Finucane *et al.*, 2000; Johnson, 2004; Knight and Warland, 2004; Patil *et al.*, 2005) have reported that race plays a role in perception and reaction to hazards. The fact that White males were less concerned about food hazards was reported by most of these studies. Also, a few studies have found that race and gender have an interactive

relationship. However, Kwon *et al.* found that the food safety knowledge and the reported practices of White participants were better than those of Black participants and Hispanic participants (Kwon *et al.*, 2008). Johnson considered race as an important factor when exploring differences or similarities in views of risk within and among ethnic groups, mainly when such distinction leads to differences in actual hazard levels that could otherwise be avoided (Johnson, 2004).

A New Zealand surveillance report (NZPHO, 2010) indicated that Europeans were the community most affected by campylobacteriosis, and this is followed by Asians and then Maori, with indicated rates of 200, 117 and 82, respectively. This may be due to the overall representation of Europeans in the New Zealand population (79%). Surprisingly, although Asians constitute only 7% of the New Zealand population, they suffered more from campylobacteriosis than the Maori ethnic group (~14%). Thus, the reason for the higher rate of reported campylobacteriosis cases among Europeans and Asians may be that these ethnic groups have better access to the public health system. Maori, particularly, young adults are more reluctant to visit the GP after experiencing diarrhoea. Also, as Europeans and Asians have better access to public health in New Zealand and as they are more concerned about their health, they are more likely to visit their GP after suffering diarrhoea.

Socio-economic factors

The socio-economic factors below are considered to play an important role in consumer safety behaviour.

Income. A few studies show that there is a link between income and food hazard perception and that individuals with a higher income are less worried about food safety, engage in more unsafe practices or have lower risk perception or attitudes than those with a lower income (Altekruse *et al.*, 1999; Patil *et al.*, 2005; Nesbitt *et al.*, 2009; Tonsor *et al.*, 2009). It has been suggested by Nesbitt *et al.* (Nesbitt *et al.*, 2009) that proper food handling skills may be obtained through practice and experience with handling food. For example, in his study, if individuals with higher income levels did not prepare meals as regularly as those with lower income levels did, it is possible that more risky behaviours would be observed among the higher income individuals (Yang *et al.*, 1998; Roseman and Kurzynske, 2006). Moreover, Roseman and Kurzynske (Roseman and Kurzynske, 2006) and Shiferaw *et al.* (Shiferaw *et al.*, 2000) reported that low-income consumers performed better than higher income individuals in reported food safety practices. However, Kwon *et al.* (Kwon *et al.*, 2008) and Towns *et al.* (Towns *et al.*, 2006) contradicted all the above studies in their findings, as they indicated that more risky behaviours would be observed among low-income individuals. New Zealand data from hospital discharge records indicated that most of the patients with infectious diseases were children from low-income households (Maani *et al.*, 2006).

Level of education. One study (De Boer *et al.*, 2005) has considered the level of education and age as the most important factors in determining public understanding of food safety practices (De Boer *et al.*, 2005). Interestingly, consumers without high-school education were safer food handlers, especially in preventing cross-contamination and in proper cooking and heating, than individuals with a high-school level of education or above (Patil *et al.*, 2005). Several studies also reported that individuals with a higher level of education were less worried about food hazards or less safe in terms of their cooking skills (Jordan and Elnagheeb, 1991; Fischer and Frewer, 2008). Miles and Scaife (Miles and Scaife, 2003) interpreted this finding that individuals with a high education level also have lower food safety concerns or practices as either resulting from a high internal locus of control (Green, 2004) or that these individuals were more optimistic about their skills in conducting a requested task (Benkendorf *et al.*, 1997) or that they habitually cooked less as someone else prepared the food for them in restaurants, takeaways or delis, department stores etc. (Fischer and De Vries, 2008). However, several studies also reported that individuals with a high level of education were more concerned about food hazards (Lin, 1995; Altekruse *et al.*, 1999; Towns *et al.*, 2006; Kwon *et al.*, 2008; Nesbitt *et al.*, 2009). Moreover, Patil *et al.* indicated that individuals without a high -school education had the least amount of knowledge of the various safe handling practices (Patil *et al.*, 2005). Also, Wandel reported that consumers with a lower education were less interested than other consumers in the general

question that food could be unsafe to health (Wandel, 1994). Other studies could not find a significant association between food safety perception and level of education (Jussaume and Judson, 1992; Jussaume and Higgins, 1998; Knight and Warland, 2004; Roseman and Kurzynske, 2006; Nesbitt *et al*., 2009).

Consumers' knowledge. This is defined as exposure to information sources and personal effort in obtaining information (McIntosh *et al.*, 1994). Researchers have identified a gap or a decrease in consumers' knowledge regarding food poisoning (Griffith *et al.*, 1995). McIntosh *et al*. and Kennedy *et al*. indicated that consumer knowledge is correlated with current practices, which can affect willingness to change current practices if it is taught that current practices are safe (McIntosh *et al*., 1994; Kennedy *et al*., 2005b). Many other studies also pointed out that many consumers were unaware of the basic rules of food hygiene (Raab and Woodburn, 1997; Redmond and Griffith, 2003). However, recent surveys in developed countries indicated that consumers who acquire the necessary food safety practices do not necessarily implement them (Jay *et al.*, 1999; Miles *et al.*, 1999; Redmond and Griffith, 2003). In New Zealand, the lack of consumer knowledge about food safety and poor practices in the home have been identified as possible contributing factors to the high rate of campylobacteriosis (Al-Sakkaf, 2012).

Life style. A few studies have considered that current lifestyle influences the way in which food is purchased and prepared. Factors which affect consumers' behaviour at home or their risk perception include work status or increased working hours and the increase in the number of women who work (Jussaume and Judson, 1992; McCarthy *et al*., 2005; Fischer *et al.*, 2006; Brennan *et al*., 2007). Brennan *et al.* found that work status played a significant role and added that time investment or current lifestyle prevents consumers from following best practice (Brennan *et al*., 2007). Generally, increased working hours or the increased number of women working reduced significantly the time spent at home and in food preparation.

Nature of the risk

Risk is defined as the likelihood that undesirable adverse effects may occur as a result of human activities (Kates *et al.*, 1985; Fischer *et al*., 2005). Human activities can alter the consequences of an event by changing the initial poor behaviour or by mitigating the impact of the event. There has been increased attention in the media in recent years on food safety risks, and microbial food poisoning is considered as a predominant risk in the food supply chain. The nature of the food risk affects consumer perception about risk, which may lead to a change in consumer behaviour. The psychometric paradigm has been used to investigate risk perception (Sandman, 1993), where it is indicated that every hazard has its own unique pattern of psychologically determined features that are related to perceptions of risk. These characteristics are severity, dread and concern. When these characteristics become more serious, they are classified into dimensions of severity where the risk is known to those exposed; the risk is known to science and the risk has unknown dimensions. For example, *Listeria* and *Salmonella* caused a higher concern than more generic bacterial contamination terms (Sparks and Shepherd, 1994). In general, consumers may change their attitude and behaviour to some foods and ignore the risk caused by other foods (Anonymous, 2010).

Environmental factors

The influence of environmental factors, cultural, economical and regulatory and the media, in changing consumers' behaviour has been proven by researchers for a long time (Anonymous, 2010). For example, cultural factors reflect various traditions and influence food preparation methods and consumers to ignore good food safety practices. For example, drinking unpasteurized raw milk or making cheese from unpasteurized raw milk in many countries, eating raw or partially treated meat or raw fish in some countries and some food of indigenous people. Economical factors have a direct impact on consumer behaviour, as an increase in unemployment and limited resources can force the consumer into unsafe storage or preparation of food. Economic factors can also hinder investment in food research, education of consumers, and changes or improvements in legislation. The media has great influence on consumer food safety behaviour via the communication of various types of risk message and the interpretation of those risk messages. The media also plays a role in consumer negativism, as the message content, message presentation and

delivery, and the credibility of the information determine whether consumers try to understand the message and react accordingly (McCarthy *et al.*, 2008). This confusion over guidelines provided by the media or by different sources managing or dealing with consumer food safety practices has been considered to be another reason for the poor practices of consumers and is highlighted in other studies as well (McCarthy *et al.*, 2006; Redmond and Griffith, 2006).

The household environment also has an influence on consumer behaviour, as those who live in a family tend to prepare food more safely than those living in a single-person household (Anonymous, 2010), and the presence of children in the house will increase the concern of individuals regarding food hazards. Some studies (Jussaume and Judson, 1992; Lin, 1995) have found that the presence of at least one child increases the concern about food hazards. However, other studies were been unable to support this finding (Nayga, 1996; Jussaume and Higgins, 1998).

CONCLUSIONS

Cumulatively, the results from this review have revealed that 'optimistic bias', the 'illusion of control', habits and lack of knowledge concerning food safety during domestic food preparation are prevalent among consumers, and over-optimistic biases and habits during the evaluation of personal health risks are considered to be common (Bennett, 1998; Redmond and Griffith, 2004; Fischer *et al.*, 2006; Redmond and Griffith, 2006; Fischer and Frewer, 2008). It is possible that these psychological factors may have also influenced New Zealand consumers and may have hindered them in improving their food safety practices at home.

It was identified that age was probably the most important factor in determining the public understanding of food safety (De Boer *et al.*, 2005; Kennedy *et al.*, 2005a; McCarthy *et al.*, 2005; Mahon *et al.*, 2006; McCarthy *et al.*, 2007). Some studies (Kennedy *et al.*, 2005b; McCarthy *et al.*, 2005; Brennan *et al.*, 2007; McCarthy *et al.*, 2007; Kennedy *et al.*, 2008) have succeeded in segmenting consumers according to demographic and socio-economic characteristics aimed at the identification of high-risk groups in order to further investigate their unsafe practices and to work to improve their practices by a tailored education programme. All the above factors, along with socio-economic/demographic factors, may contribute to the continued implementation of unsafe food-handling behaviour (Redmond *et al.*, 2004) associated with microbial risks during domestic food preparation in New Zealand. They may also hinder educational efforts to improve risk-reducing behaviours internationally as well as in New Zealand (Miles *et al.*, 1999; Knight and Warland, 2004; Brennan *et al.*, 2007; Fischer and Frewer, 2008; Nesbitt *et al.*, 2009). The details of how to design an effective education strategy in New Zealand in order to improve food safety practice are discussed in another study (Al-Sakkaf, submitted for publication), since the scope of this study does not cover this issue.

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