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PUBLIC HEALTH REPORT

Consumer attitudes towards food labelling

Is chicken literacy a solution for campylobacteriosis?

May 2016

Preface

This report represents the culmination of our Public Health project undertaken at the University of Otago, Wellington as part of the Bachelor of Medicine and Bachelor of Surgery (MB ChB) degree. We have also prepared this report for delivery to our client, the Ministry for Primary Industries (New Zealand).

At the outset of this project, our intent was to investigate food labelling in its broadest sense, and use *Campylobacter* infection as a specific case study of an area where improvements in food labelling could have public health value. This intent remains true; however we have chosen to publish our findings in two separate reports to aid readability. This report examines labelling in the context of *Campylobacter* infection, while the other report, *"A discussion of labels as a vector for food information"* (1) investigates the wider context of food labelling. Both reports share some aspects of methodology and have been prepared in parallel. While they may be read independently, we suggest maximum benefit may be gained from reviewing both.

Wellington, May 2016

Executive Summary

Background

Campylobacteriosis is a primarily foodborne infection that gives rise to a significant human and economic burden. New Zealand experiences consistently high rates of the disease, much of which is attributable to poultry contamination, particularly from fresh chicken products. To date, much of the focus of *Campylobacter* control has been on improving industry processing of chicken. However, another potential solution is improving the safety warnings and handling instructions on retail labelling of fresh poultry products. Currently it is unknown whether poultry labels meet the expectations of consumers and the recommendations of regulatory, microbiological and poultry industry experts.

In view of this context, the **aims** of this study were fourfold:

1. Evaluate the knowledge and expectations of New Zealand consumers regarding *Campylobacter* and poultry labelling.
2. Examine current poultry labelling in New Zealand supermarkets and butchers to determine potential scope for label improvement.
3. Determine scientific, regulatory and poultry industry positions on the current state of chicken labelling and views on possible improvements.
4. Investigate public and expert views on potential advancements in labelling information and design as a means of addressing campylobacteriosis rates.

Methods

To address our study aims we employed three research methods.

Survey of shoppers

We conducted a street-intercept survey of supermarket and butchery shoppers in the Wellington region of New Zealand. Shoppers answered questions regarding chicken purchasing frequency, knowledge of poultry-borne illness and prevention, and views on chicken label content.

Chicken label analysis

To assess contemporary chicken labelling in supermarkets and butcheries, we evaluated labels from the same Wellington retailer locations as per the survey. We developed a grading system to quantitatively evaluate label content and display.

Key informant interviews

We interviewed representatives from the fields of health promotion, microbiology, consumer affairs, food marketing and food regulation in order to assess views on appropriate poultry labelling and other interventions targeting *Campylobacter*. Interviews were transcribed and thematically analysed.

Results

Survey of shoppers

We interviewed 401 shoppers during a seven day period (19-25th April 2016). The majority of survey participants reported buying, preparing and cooking fresh chicken. Knowledge levels of safe chicken handling were adequate on the whole but some uncertainty existed about certain food safety behaviours. Many consumers were unaware of the level of *Campylobacter* contamination and favoured substantial increases in the amount of information on poultry labels, particularly covering safe chicken handling and cooking and prevention of cross-contamination.

Poultry label analysis

Major gaps were identified in poultry labelling in both supermarkets and butchers. Label display and content were both found to be inadequate, with a complete absence of food safety information in some settings, although labelling met current regulation standards.

Key informant interviews

Several main themes pertaining to chicken labelling were identified from expert interviews:

- Practical information needed to be provided to consumers;

- Given the limitations of labels as a route of information transmission to consumers, specific education regarding preparing chicken also needed to happen concurrently;
- Given the limitations of consumer-focused interventions, industry-wide intervention is suggested to lower contamination levels on fresh poultry.

Conclusion

Campylobacteriosis levels remain high in New Zealand and infection from fresh, raw chicken remains a key contributor to this burden due to the fact that a high proportion of poultry is contaminated and this food is widely consumed. There is a gap between what information consumers desire on a chicken label and what is currently provided. Shoppers are aware of the risks posed from chicken but are not well informed on how to guard against it. Analysis of current poultry labels highlighted discrepancies with consumer need and also with an 'ideal' label that was generated through thematic analysis of expert interviews. Food labels can be a key communication resource for informing consumers of *Campylobacter.* Improving chicken labels could support better food handling and significantly reduce the disease burden from campylobacteriosis.

Recommendations

1. A separate, standardised, mandatory label for all poultry products, containing information on correct cooking, storage and other food safety messages.
2. A graded labelling system on poultry products stating producers' average *Campylobacter* levels.
3. Concomitant educational campaigns to educate consumers about safe chicken preparation and any changes in labelling.
4. Reduction in the allowable levels of *Campylobacter* contamination of poultry products.

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- Glen Neal, General Manager of Food Standards Australia New Zealand
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1. Introduction

1.1 Background

Campylobacteriosis is a primarily foodborne infection that consistently leads public health disease notifications in New Zealand (2). The disease and its sequelae have a significant human and economic burden, with an estimated loss of 957 DALYs (disability-adjusted life years), and economic cost of $NZD 36 million annually (3,4). Importantly, about half of these cases arise from the consumption of contaminated fresh poultry meat (5). In New Zealand, this figure is estimated to be greater than 28,000 cases per year, based on the 6,229 cases notified in 2015 (2), a multiplier of 9.3 obtained from a United Kingdom study of infectious intestinal diseases(6), and source attribution from poultry of about 50% (5). Hence, campylobacteriosis is an important disease in New Zealand with detrimental effects that may potentially be mitigated by changes to poultry processing and retail practices.

1.2 Clinical features of campylobacteriosis

Campylobacteriosis is a gastrointestinal disease caused by the bacteria *Campylobacter*. The two species most often associated with human illness are *Campylobacter jejuni* and *Campylobacter coli* (7). Here we refer to these two organisms collectively as *Campylobacter*.

With reference to foodborne infection, campylobacteriosis results from ingestion of *Campylobacter*, which colonises and inflames the intestines (8). There is usually an incubation period of 2-5 days, but it may be as long as 10 days before symptoms occur (8). Prodromal symptoms are influenza-like and include headache, fatigue, muscle pains and fever, followed later by watery or bloody diarrhoea (9). Other gastrointestinal symptoms can include stomach pain, stomach cramps and nausea (9).

While the acute effects are undeniably troublesome, of potentially greater concern are the long term sequelae of campylobacteriosis, notably reactive arthritis and Guillain–Barré syndrome (9,10). Reactive arthritis involves sterile joint inflammation but can also include skin, gastrointestinal, ocular, and cardiac symptoms which occur in 1-5% of campylobacteriosis cases, 7-10 days post-infection (11). Guillain–Barré

syndrome is an autoimmune disorder of the peripheral nervous system and is characterised by paralysis and weakness (10). Although the syndrome is rare, occurring in 0.1% of campylobacteriosis cases, only 15% of those affected recover fully. *Campylobacter* infection is estimated to cause about 25% of GBS infections in NZ (12).

1.3 Epidemiology of campylobacteriosis

New Zealand has experienced a prolonged epidemic of campylobacteriosis (13). Incidence peaked at 383.5 per 100 000 population in 2006 (14). At that point, New Zealand had the highest reported rates of *Campylobacter* infection worldwide, three times that of Australia and four times that of the United Kingdom (111.3 and 87 per 100,000 population, respectively) (15,16). Figure 1 shows the rates of campylobacteriosis in New Zealand compared with some other high-income countries.

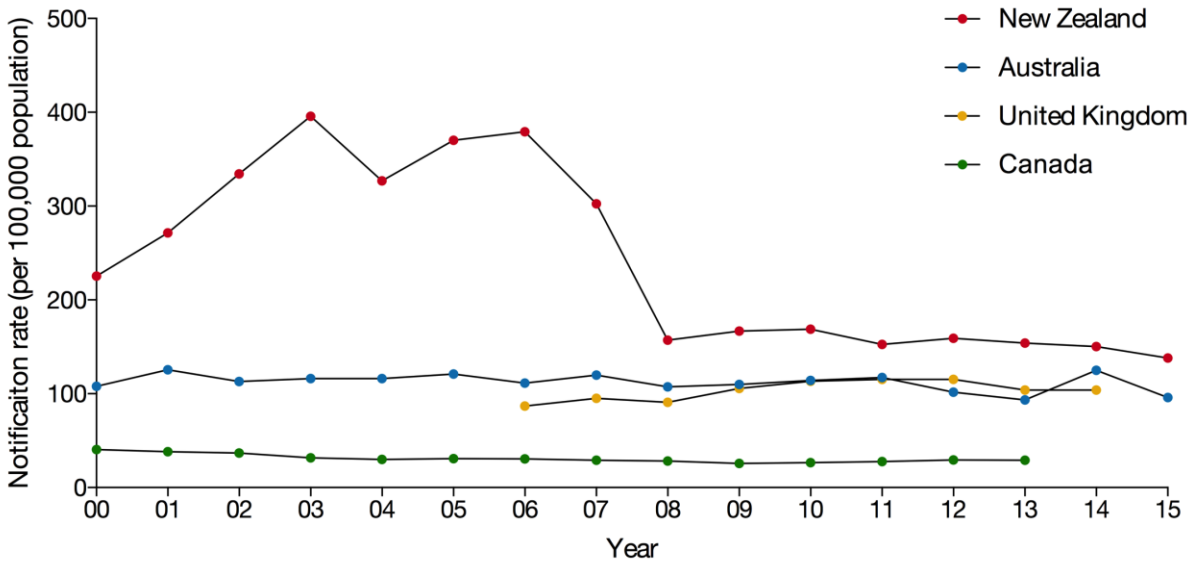

Figure 1. Campylobacteriosis notifications rates in New Zealand and selected countries
Annual campylobacteriosis notification rate for New Zealand, Australia, the United Kingdom and Canada. All available data between 2000 and 2015 are displayed.

The "*Campylobacter* Risk Management Strategy" was introduced in 2006 by the New Zealand Food Safety Authority (now part of the Ministry for Primary Industries (MPI)) in an effort to reduce the high incidence of campylobacteriosis (17). A package of industry-orientated interventions were employed to reduce *Campylobacter* loads on poultry products. These measures included setting mandatory performance targets

for reductions in *Campylobacter* counts on chicken, enhancing hygiene practices during primary processing and improvements in the chilling process (4,17). Specific changes included the use of acidified sodium chlorite for carcass disinfection treatment, additional carcass washing, intensive laboratory monitoring and testing and more extensive use of leak-proof packaging at the retail level (4).

Implementation of this strategy resulted in a rapid and significant reduction in the incidence of notified campylobacteriosis to 157 cases per 100,000 population by 2008 (5,18,19). However, following this decline incidence rates have since plateaued at 138 per 100,000 in 2015 (19,20). At this level, New Zealand remains a leader compared to other developed nations such as Australia, United Kingdom, United States of America and Canada, with 96.1, 103.9, 17.2 and 29.1 cases per 100,000 respectively (15,21–23). Figure 2 presents recent data on the global incidence of *Campylobacter*.

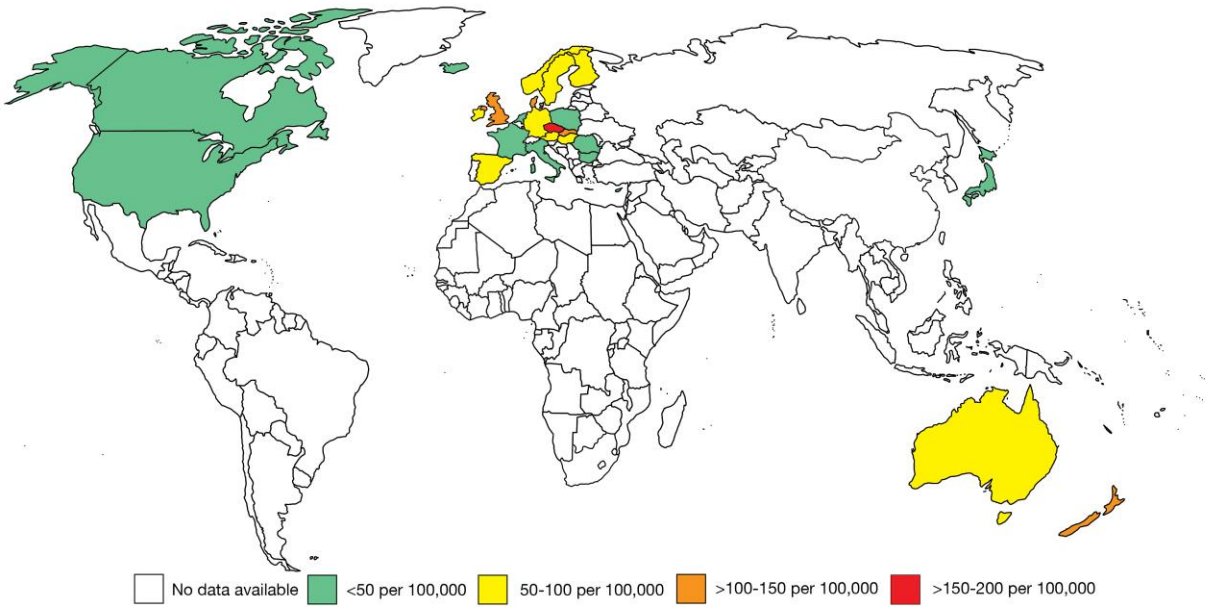

Figure 2. Campylobacteriosis incidence per 100,000 population in selected countries
Campylobacteriosis incidence per 100,000 population in North America, selected countries in Europe, Japan, Australia and New Zealand. The most recent data available are displayed (2007 or later). Note that New Zealand's 2015 incidence of 138 per 100,000 is higher than many comparable developed countries.

The figure has been generated using New Zealand data from The Institute of Environmental Science and Research (2), European data from European Centre for Disease Control and Prevention (21), Canadian data from Public Health Agency of Canada (23), United States data from the Centers for Disease Control and Prevention (22) and Singaporean data from the Ministry of Health, Singapore (24), Japanese data from Gideon Informatics Inc.

1.4 Sources of Campylobacter

Campylobacter is found in the gut of birds especially poultry, and other animals such as cattle, sheep, cats and dogs (8,9). Infection may be through ingestion of contaminated food or water, via the faecal-oral route, or through direct contact with an infected person or animal or contaminated environment (8,9,25).

A 2014 MPI report used a variety of approaches to determine campylobacteriosis source attribution (5). Epidemiological approaches showed that more than 50% of human campylobacteriosis was attributable to poultry-related variables (5). *Campylobacter* is present on the skin of raw chicken meat (26). Using a microbial subtyping approach, chicken accounted for 55-71% of human cases in 2007 (5). Before the implementation of the “Campylobacter Risk Management Strategy”, over 70% of campylobacteriosis cases were attributable to poultry. However, in the years following this intervention (2008-2010), this estimate dropped to below 50% (5). Nonetheless, contaminated chicken meat remains the single most important source of campylobacteriosis for the New Zealand population.

1.5 Labelling of poultry products

The current New Zealand regulations regarding poultry labelling differ depending on location and product type. Chicken sold in supermarkets that has been packaged on-site requires a label. Marinated or minced chicken requires a nutrition information panel but products consisting of a single ingredient for example plain breast or drumsticks, do not (27). Meat sold at butchers is not required to be labelled because it is packaged in the presence of the purchaser (28). Guidelines produced by the MPI in consultation with the New Zealand Poultry Association specify that “labels on retail packs of raw poultry products must include instructions on how to cook the product safely” (29). However as this is not mandated by Food Standards Australia New Zealand it is unable to be enforced by MPI (30).

1.6 Study aims

In an environment where food choices are increasingly complex and producer-consumer contact is limited, food labels serve an important role in informing

consumers (31). Many consumers want more information about the safety of food, but whether labels provide consumers with this information is unclear (32).

One product for which food safety labelling is potentially important is chicken products due to *Campylobacter* contamination. New Zealand has epidemic levels of campylobacteriosis (2,19), yet whether consumers are well informed of the risk from poultry products is uncertain. Well-designed food labels have been demonstrated to positively influence consumer and industry behaviour (33). It is therefore plausible that labels warning consumers of the risk of infection and informing them of safe chicken handling practices may be a useful strategy in tackling New Zealand's high rates of campylobacteriosis.

In light of this, our aims were fourfold. First, using a street-intercept survey of shoppers, we sought to evaluate the knowledge and expectations of New Zealand consumers regarding *Campylobacter* and poultry labelling. Second, we examined current New Zealand poultry product labelling in supermarkets and butchers to determine potential scope for label improvement. Third, through key informant interviews, we sought to determine scientific, regulatory and poultry industry positions on the current state of chicken labelling and views on possible improvements. Fourth, we sought public and expert views on potential advancements in labelling information and design as a means of addressing campylobacteriosis rates.

2. Methods

2.1 Survey of shoppers

Study design

We conducted a street-intercept survey of 401 food shoppers during a seven day period (19-25th April 2016). Surveying was conducted at entrances to supermarkets and butcheries in the cities of Wellington, Lower Hutt and Porirua, New Zealand. Twelve supermarkets (comprising four major New Zealand supermarket chains) and six butcheries were selected by suburb with the aim of achieving a reasonably representative distribution of ethnic and socio-economic groups (based on the

NZDep 2013 Index, which assigns a deprivation level to census area units (34)). Figure 3 displays a map of the sampling sites. Surveys were conducted throughout the shopping day (supermarkets 0900-2100 hours, and butchers 0900-1700 hours) to reflect the changing demographic composition of shoppers at different times of day (35).

Figure 3. Suburb locations where supermarket and butchers were sampled in the cities of Wellington, Lower Hutt and Porirua
Surveys were conducted at twelve supermarkets and six butcheries, located at ten suburbs across the cities of Wellington, Lower Hutt and Porirua, New Zealand. The New Zealand deprivation index value for each sampling site is displayed in parentheses following the suburb marker.

Participant recruitment

Shoppers were defined as anyone entering or leaving a supermarket or butchery. All those aged 16 years or older were eligible to participate. Potential participants were approached and offered the opportunity to take part in this study. Non-participation was defined as declining after being informed of the topic of the survey and the expected time commitment (5-10 minutes). All recruited shoppers provided written informed consent prior to study participation. Appendix 1 contains the participant information sheet and consent form. Ethical approval was granted by the University of Otago Human Ethics Committee.

Survey design and delivery

We devised a survey to assess respondents' knowledge, attitudes and practices regarding fresh chicken and labelling. The survey consisted of 36 questions, divided into 7 sections (A-G).

- Section A was comprised of general interview details and also determined if the participant was the main shopper for their household.
- Section B investigated shopper views on the necessity of certain types of information on food labels including aspects of food safety, nutrition, welfare considerations and value for money. Questions were assessed on a 1-5 Likert *necessity* scale, where 1 was unnecessary and 5 was essential (see Appendix 3).
- Section C examined participants' use of food labels, whether labels were thought to contain all necessary information, and general views on food regulation. Questions were assessed on a 1-5 Likert *agreement* scale, where 1 was strongly disagree and 5 was strongly agree (see Appendix 3).
- Section D asked participants if they bought, prepared or cooked chicken and if so, the type of chicken product. We also assessed frequency of fresh chicken preparation, awareness of bacterial contamination of chicken products (including *Campylobacter* contamination) and beliefs on safe chicken preparation.
- Section E evaluated shopper views on the necessity of certain information types on poultry labels such as correct preparation and specific *Campylobacter* warnings. The Likert *necessity* scale was also used for this section.
- Section F asked participants to select the most effective of three mock-up chicken product labels at communicating safe chicken preparation information to them. Figure 4 presents the three mock-up labels.
- Section G collected demographic information such as age group, ethnicity and suburb of residence as a proxy for socioeconomic deprivation.

This report includes data from sections A, and D-G. Results from sections B and C appear in our complementary report, *"A discussion of labels as a vector for food information"* (1). Appendix 2 contains the survey form.

Questions were read aloud by the interviewer in a prescribed format. Four showcards were provided to participants as visual aids in answering the questions. These showcards are presented in Appendix 3.

Figure 4. Chicken product label mock-ups
(A) Current label format (B) Current label with larger font and enhanced information (C) 'Pronounced' separate label from the price and/or weight label.

Note that the "Clean, Cook, Cover, Chill" information is not routine on current poultry labels, but has been mirrored on the three mock-up labels to isolate the differences in design, rather than information content.

Data analysis

Suburbs of residence were later matched to New Zealand census area units to assign a deprivation index (34). Where a suburb was partitioned into multiple census areas, we took the average deprivation index for these areas. Once averaged, we rounded the value to the nearest integer. For example, Johnsonville is separated into Johnsonville North, East and Centre with a deprivation index of 2, 3 and 5 respectively. For this study, the deprivation of Johnsonville as a whole would therefore be 3.

Likert scale data (necessity and agreement scales) were analysed by use of corresponding numerical values for word items, for example the value 1 was assigned to the item "unnecessary". Results are reported using either the numerical or word item values. Two-tailed Spearman's rank correlation coefficients were used to assess trends in labelling preferences with deprivation. To determine if these preferences differed between ethnic groups (Māori vs. non-Māori, Pacific vs. non-Pacific, Asian vs. non-Asian) we used the Mann-Whitney U test. Pacific and Asian

groups were generated by collating the corresponding country ethnicity responses from the Pacific or Asian regions respectively. We assessed differences in chicken handling knowledge between deprivation groups by the Kruskal-Wallis test, with significant results being followed by post hoc Mann-Whitney U testing. Last, we tested if chicken handling knowledge differed between ethnic groups (comparisons as above) by the chi-square test. Statistical analyses were performed using SPSS (SPSS Statistics version 23.0 for Mac OS X, IBM, Armonk, NY, USA). All data are expressed as median (interquartile range (IQR)), or as the % (number of participants/total number of responses per question) of participants, unless otherwise stated. Alpha was defined as $P \leq 0.05$. Figures were generated using Prism (GraphPad Prism version 6.0h for Mac OS X, GraphPad Software, La Jolla, CA, USA).

2.2 Poultry label analysis

Assessment of current poultry product labelling

We assessed the labelling of fresh chicken products available for purchase at supermarkets and butchers in the cities of Wellington, Lower Hutt and Porirua, New Zealand. Where possible, assessment sites were identical to survey sites, resulting in a total of nine supermarkets (comprising four major New Zealand supermarket chains) and three butcheries for label assessment. In this report, retailers have been assigned anonymous identifiers such as ‘Supermarket Chain A’. Within each site, all fresh poultry products with labels were photographed for subsequent analysis. If no information regarding handling and storage was present on the label, this was noted and photos were not collected. We categorised fresh chicken products by cut, marinated or not, bone in or out and skin on or off. Cuts examined comprised of chicken breast, thigh, leg, wing, mince, kebabs, tenderloins, sausages and whole bird. We excluded all frozen and cooked chicken products, which have significantly lower *Campylobacter* contamination (26,36).

Analysis of current poultry product labelling

We developed a grading system for analysis of the current state of poultry labelling based on current literature regarding food labelling, guidelines for safe poultry handling and expert opinions (Mary-Ann Carter, Health Promotion Agency, and a

representative from Consumer NZ, an organisation acting for consumer protection and information).

All scores were determined by two assessors. Prior to analysis, both assessors independently scored a test sample of ten labels which confirmed sufficient inter-rater reliability.

Collected photographs of labels were scored by **display** and **content**, each of which received up to 5 points, for a total score out of 10. First, for the **display score**, points were allocated as follows (score):

1. Demarcation of safety information from other text (0.5)
2. Positioning the label on the front side of the product package (0.5)
3. The use of a contrasting colour surrounding the safety information (0.5)
4. The use of graphics relating to safe handling of raw chicken (0.5)
5. The use of simple language (i.e. no jargon or potential for misinterpretation of information) (0.5)
6. Clear structure and layout of safety information (0.5)
7. Font size of the safety information wording. This was determined based on its absolute size and size relative to that of information on the label. Font size was scored as 0.5, 1.0 or 2.0. This expanded range of scores is in cognisance of small font sizes being consistently identified by consumers as a barrier to label use (37).
    a. Small font size (~3mm in height). This is the minimum size permissible according to Food Standards Australia New Zealand (38) (0.5)
    b. Moderate font size (>3mm in height but smaller than other wording on the label) (1.0)
    c. Large font size (>3mm in height *and* equivalent or larger in size than other wording on the label) (2.0)

Second, for the **content score**, we used information elements from the ‘Cook, Clean, Cover and Chill’ strategy supported by MPI. We also incorporated extra information deemed important in the safe handling of raw poultry (39,40). Content scores were allocated as follows (score):

1. The ‘Cook’ category

    a. Mentioning the need to cook the product before consumption (0.5)
    b. Detailing a set duration and temperature for suitable cooking, or the recommendation that juices from the chicken should run clear prior to consumption (0.5)
2. The ‘Clean’ category
    a. Mentioning that items or surfaces that come in contact with the raw poultry must be cleaned (0.5)
    b. Details on how to appropriately clean items or surfaces to ensure *Campylobacter* is killed (0.5)
3. The ‘Cover’ category
    a. Mention of ensuring the raw product does not come into contact with other foods (0.5)
    b. Mentioning the need to cover the raw product or place it in a container for storage (0.5)
4. The ‘Chill’ category
    a. Mentioning the need to refrigerate the raw product (0.5)
    b. Specification of a range of suitable temperatures for refrigeration (0.5)
5. Extra information regarding the safe handling of raw chicken identified as important based on our review of the literature (39,40)
    a. Description of appropriate freezing and thawing instructions (0.5)
    b. Advice against the rinsing of the raw product under the tap. This has been shown to be a common behaviour that aids the spread of *Campylobacter* across kitchens (40) (0.5)

Content scores were plotted against display scores and the resulting graph was divided into poor, moderate and excellent segments by dividing each axis into equal thirds.

2.3 Key informant interviews

Recruitment and interview

We conducted interviews with key informants to generate qualitative evidence regarding the labelling, regulation, production and safety of food. Key informants from the fields of microbiology, public health, the poultry industry, consumer affairs,

health promotion, food distributors and food labelling regulation were approached to be interviewed. Representatives from the poultry industry and major supermarket chains declined to take part or did not respond to our interview requests. Interviews were conducted with experts in health promotion, food science, microbiology, consumer affairs, food industry association and food regulation.

Interviews were conducted by an investigator using a standardised set of questions. The questions were split into two sections; 'General food labelling' and '*Campylobacter* and chicken'. Findings from the '*Campylobacter* and chicken' section inform this report, while information from the 'General food labelling' section appear in our complimentary report, *"A discussion of labels as a vector for food information"* (1). All interviews were recorded with consent either by dictaphone in the case of face-to-face interviews, or by a mobile recording app for telephone interviews. The interviewers were subsequently transcribed for analysis. Transcriptions were made available to the interviewee to allow for any corrections to be made. At the conclusion of the interview, experts were asked to complete our consumer food labelling survey discussed above (see appendix 2). This questionnaire was completed either independently or with guidance from the interviewer.

Thematic analysis

We conducted a thematic analysis of our interviews. First, interviews were transcribed, then key themes across multiple interviews were identified. These themes covered issues such as the provision of practical information to consumers, concurrent educational campaigns and industry intervention. Next, these themes were codified and assessed for concordance.

Survey analysis

We analysed the expert responses from the consumer survey independently from those of the general population. We identified common responses from the experts and compared them to the responses from the general population. A response of 1 or 2 on the necessity or agreement scales was taken to mean 'unimportant', 3 was considered 'neutral' and a response of 4 or 5 was considered 'important'. For the purposes of the expert-public comparison, this definition was also applied to consumer responses.

3. Results

3.1 Survey of shoppers

Participant characteristics

We surveyed 401 shoppers out of 584 approached, for a response rate of 69%. 397 participants completed the entire survey and contributed towards the demographic characteristics summarised in Table 1. We achieved a minimum of 396 responses for all questions, with nominal data points missing due to participant refusal to provide a response, participants leaving prior to the end of the survey, or surveying error. All available data for each question were analysed.

The median age group of participants was 40-49 years (IQR, 20-29 - 60-69 years). 61% (246/396) of shoppers surveyed were women. Our participants were mainly of New Zealand European ethnicity, comprising 76% (299/396), followed by Other, comprising 13% (50/396), then by Māori, comprising 10% (40/396). 82% were the main shopper for their household (329/399). 62% of our participants were in the deprivation index range of 1-5.

Table 1.	**Demographic characteristics**	
Age, years*		
	16-19	20 (5%)
	20-29	90 (22%)
	30-39	60 (15%)
	40-49	60 (15%)
	50-59	66 (17%)
	60-69	56 (14%)
	70-79	34 (9%)
	80+	11 (3%)
Sex*		
	Female	246 (62%)
	Refused	1 (<1%)

Ethnicity†		
	New Zealand European	299 (76%)
	Māori	40 (10%)
	Pacific‡	22 (6%)
	Asian§	27 (7%)
	Other ethnicity//	50 (13%)
	Don't know	5 (1%)
	Refused to answer	2 (<1%)
Deprivation index, 1=least deprived, 10=most deprived#		
	1	41(11%)
	2	64(17%)
	3	45(12%)
	4	23(6%)
	5	62(16%)
	6	37(10%)
	7	13(3%)
	8	54(14%)
	9	23(6%)
	10	23(6%)

Data are n (%). *n=397. †n=445. Where more than one ethnic group was reported, participants have been counted in each applicable group. However, the total responses for ethnicity (n=396) has been used to calculate %, and therefore the total % is >100%. ‡Comprises Samoan (n=12), Cook Island Māori (n=5) and Tongan (n=5). §Comprises Indian (n=14) and Chinese (n=13). // Other ethnicity may contain Pacific or Asian groups not specified in the above groupings. #n=385.

Chicken purchasing frequency and handling knowledge

Figure 4A presents the type of chicken products purchased by consumers. The majority of participants indicated that they bought, prepared or cooked chicken (89%, 356/399). The most common type of chicken product to be bought, prepared or cooked was fresh raw chicken (83% of all participants, 331/399), followed by cooked chicken with 55% (220/399) participants.

Figure 4B shows the frequency of chicken preparation by consumers. Most consumers prepared chicken 2-4 times per week (31%, 125/399), followed by once per week (29%, 114/399). The least common frequency of chicken preparation was daily (2%, 7/399).

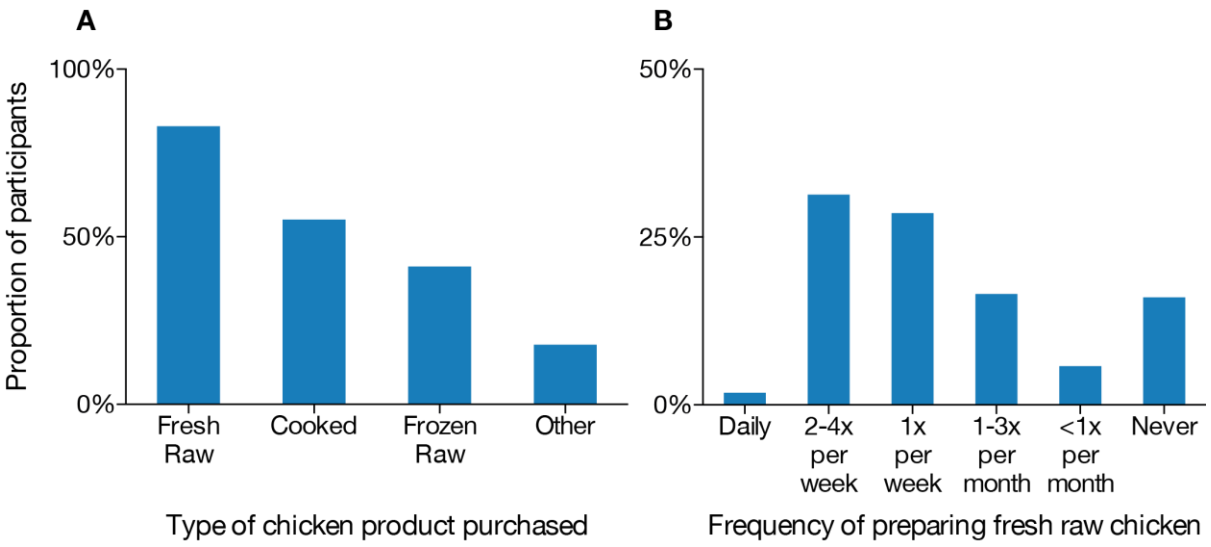

Figure 4. Types of chicken products and frequency
(A) Types of chicken products bought, prepared or cooked (n=399) (B) Frequency of preparing fresh raw chicken (n=399).

97% of participants (389/399) were aware that chicken has bacteria on it that can cause illness. The most common bacteria that was able to be recalled by our participants was *Salmonella* (45%, 181/399). This was followed by *Campylobacter* with 29% (117/399) able to name the bacteria and a further 41% (165/399) having heard of the bacteria when prompted.

The most common response to ‘how much of the fresh raw chicken for sale in New Zealand do you believe has *Campylobacter* on it’ was ‘some (10-40%)’ at 34% (133/392) while the correct answer of ‘most (60-90%)’ was selected by only 15% of participants (59/392). These results are presented in Figure 5.

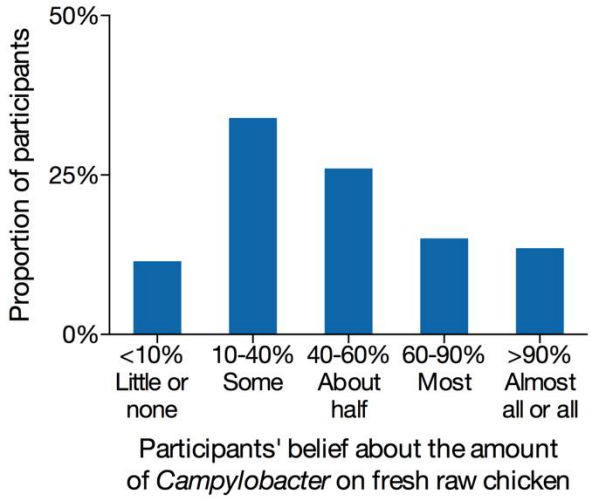

Figure 5. Belief about level of *Campylobacter* contamination
Participants' belief about the level of *Campylobacter* contamination of fresh raw chicken in New Zealand (n=392).

Figure 6 presents the results for participant views on information content of fresh chicken labels. Consumers rated all information about chicken handling, cooking, cleaning, *Campylobacter* level, features of infection and a warning label explaining the risks of *Campylobacter* as at least very necessary (4) or essential (5) with median ratings for these aspects all greater than 4. Participants believed that the most important information that a fresh chicken label should contain was 'correct handling and storage to prevent *Campylobacter* cross-contamination of other foods' with a rating of 5 (IQR 4-5) and 'details of correct cooking to kill *Campylobacter'* with a rating of 5 (IQR 4-5).

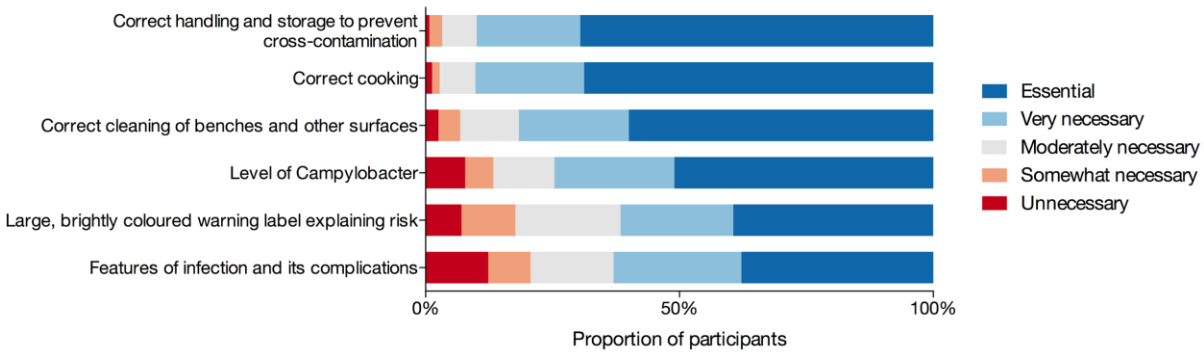

Figure 6. Views on information content of fresh chicken labels
Distribution of responses to how necessary participants felt fresh chicken labels should have certain types of information (n=397).

Figure 7 shows the results for consumer responses to safe chicken handling statements. Most consumers responded correctly to questions about cooking raw chicken (99%, 393/397), using a separate knife and chopping board from other

ingredients (97%, 386/398), cleaning and disinfecting the kitchen bench after being in contact with fresh raw chicken (95%, 379/398), and the use of hot tap water being insufficient in cleaning items after contact with fresh raw chicken (74%, 293/398). 22% (88/398) of participants incorrectly responded that 'rinsing fresh raw chicken under the tap will reduce your likelihood of getting sick from it', while a further 23% (91/398) selected 'don't know'. Lastly, only 23% (92/398) correctly stated that frozen chicken has less *Campylobacter* than fresh, while a further 43% (172/398) did not know.

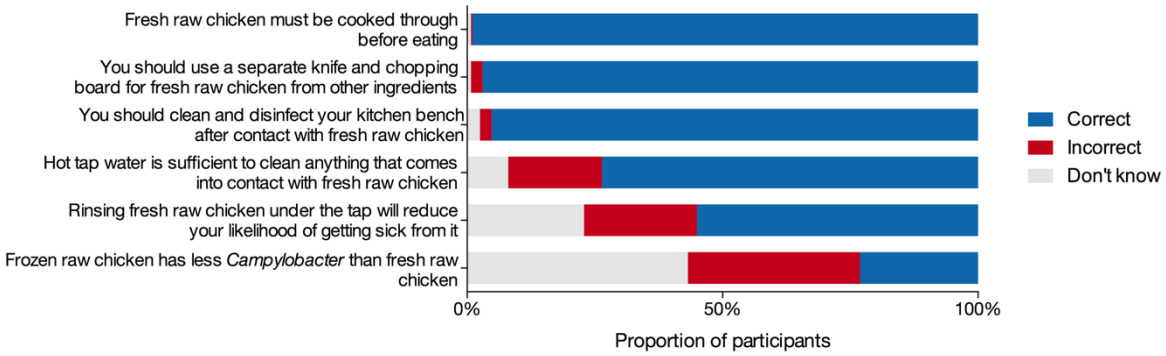

Figure 7. Responses to safe chicken preparation statements
Participants' knowledge about safe chicken preparation (n=397). Note true, false or don't know responses from the survey are presented as the proportion of correct, incorrect or don't know responses.

When consumers were asked to select the chicken label that most effectively communicated safe chicken preparation information to them, the majority picked the separate 'pronounced' label (71%, 283/396). The least popular was the current chicken label which was only selected by two participants (<1%, 2/396). Figure 8 presents these results.

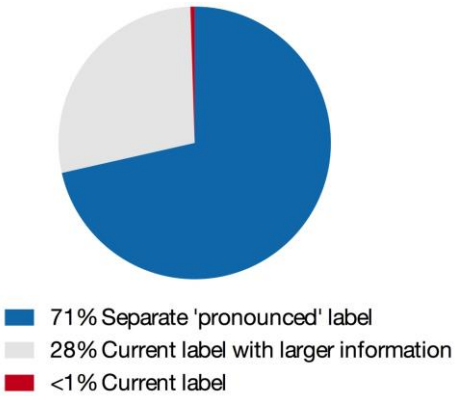

Figure 8. Fresh chicken label mock-up consumer preferences
Proportion of participants selecting the most effective chicken label for communicating safe preparation information to them (n=396).

Data above and additional analysis of consumer chicken handling knowledge and labelling preferences are shown in Appendix 4. Tables of survey data and results.

3.2 Poultry label analysis

General observations

We assessed poultry labelling at nine supermarkets and three butchers. Supermarkets had similar labels across all of their on-site packaged raw poultry products, i.e. those in cling-wrapped polystyrene trays. Labels contained various information such as price, weight, packaged-on dates and use-by dates. Information on the safe handling of raw poultry varied from non-existent to moderate.

In general, butchery poultry products were labelled with a sticker describing product type, weight and price at time of purchase. None of the three butcheries sampled had any information regarding safe chicken handling on the labels affixed to packages of chicken after purchase.

Grading of poultry labels

In total, 45 photos were analysed according to the previously discussed scoring system which awarded labels a presentation score out of 5 and a content score out of 5 giving a total score out of 10. Results of label analysis are presented in Figure 9, and tabulated results are shown in Appendix 5. Our analysis identified three major types of chicken products, that lay in the poor, moderate, excellent segments of the content vs. display graph, which were supermarket brand chicken packaged on-site, independent brands of various cuts of chicken, and independent and supermarket brand whole bagged chicken, respectively. These three categories are discussed separately below.

Each supermarket chain had similar labelling standards for on-site packaged raw poultry products, with some variation observed between different locations of the same chain. The average total score of all on-site packaged poultry was 1.8. The average display and content scores of all on-site packaged poultry were both 0.9. In general, Supermarket Chain A had the best labelling of on-site packaged raw poultry products, with scores ranging from 3.5-4.5 across three different locations.

Supermarket Chain A, Newtown scored 4.5 which was the best on-site packaged raw poultry product labelling score out of all locations and chains. Supermarket Chain C was the next best, with scores ranging from 1-1.5 across different locations. Scores for Supermarket Chain B ranged from 0-0.5. The large chain butchery Porirua scored 0, the lowest of all sampled sites. On-site fresh poultry labelling tended to be the worst labelled, with many items scoring in the poor quality zone and some in the moderate quality zone.

We sampled 20 independent brands of various cuts of chicken. These products achieved a wide spread of scores. The average total score, average display score and average content score was 3.1, 1.3 and 1.8 respectively. Brand H chicken breast and Brand K chicken roast had the lowest total scores, at 1.5 each. Brand B chicken breast achieved the highest total score, at 5.5. The majority of various brands of assorted fresh chicken products scored in the moderate zone, with some falling into the poor quality zone.

We sampled 16 different brands and variations of whole bagged fresh chicken products. These products included both independent brands and supermarkets' own in-store brands. In general, whole bagged poultry scored higher than on-site packaged raw poultry, with average total scores, average display scores and average content scores of 4.9, 2.7 and 2.3 respectively. Brands B and C each scored 7.5, which were the highest scores of all fresh raw poultry products sampled in our study. Other brands scored within a range of 4.0-6.5. Display scores were higher than content scores in every single whole bagged poultry product brand except Supermarket Chain A whole bagged chicken. Whole bagged poultry products tended to score the best, with a spread across both the moderate and excellent zones.

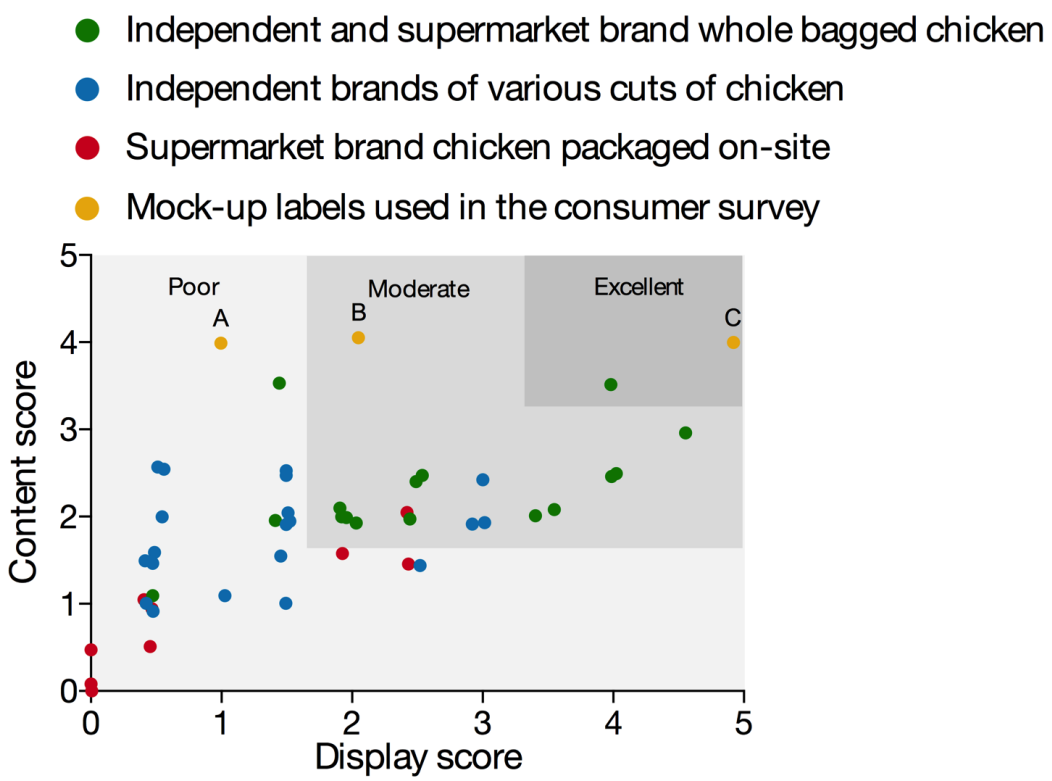

Figure 9. Poultry label scores across 9 supermarkets, 3 butcheries and our consumer survey mock-up labels
Plot of content score against display score for all analysed poultry products, and our mock-up labels used in the consumer survey. Mock-up labels are marked, (A) Current label, (B) Current label with larger information, and (C) 'Pronounced' separate label from the price and/or weight label. For the purposes of this graph, data points have been jittered to reveal overlapping points.

Lastly, none of the poultry products analysed scored above 4 in content score. In contrast, our survey mock-up labels scored 4 for content each as we aimed to highlight the differences in design rather than content to survey participants. The spread of display scores is clearly seen, with our mock-up labels A, B and C scoring 1, 2 and 5 respectively.

3.3 Key informant interviews

Conducted interviews

We interviewed the following key informants:

- Professor Timothy Blackmore (TB) - Infectious Disease Specialist, Capital and Coast DHB
- Glen Neal (GN) - General Manager, Food Standards Australia New Zealand
- Philippa Hawthorne (PH) - MPI Food Science
- Food and Grocery Council (FGC)

- Consumer NZ (CNZ)
- Mary-Ann Carter (MAC) - Manager of Nutrition and Physical Activity, Health Promotion Agency

Key informant interview themes

We identified several main specific themes pertaining to chicken labelling:

- Practical information needed to be provided to consumers;
- Given the limitations of labels as a route of information transmission to consumers, specific education regarding preparing chicken also needed to happen concurrently;
- Given the limitations of consumer-focused interventions, industry-wide intervention is suggested to lower *Campylobacter* contamination levels on fresh poultry.

Practical information needed to be provided to consumers

We asked interview participants about the kind of information needed on the label. Experts responded that labels needed to have sufficient information regarding food handling, cross-contamination and food preparation and food storage. They also recommended fuller, more practical information for the average consumer.

> *"If a label said 'use a separate board, use a separate knife, don't have any other food out when chopping the chicken and preparing for cooking', that might be a different message that will make people think" - TB*

> *"If there is going to be any education, it's not just 'wash your hands' kind of stuff. You need to chop your meat, put it into a bowl and try not to touch it again and put everything in the dishwasher" - TB*

Instructions regarding cross-contamination were emphasised as this aspect was overlooked by consumers.

> *"Have you ever been to a barbeque where someone cooks the chicken thoroughly and then puts it back into the bowl where it had originally been raw and hence contaminates it again? The* Campylobacter *is on the surface, so*

you can cook it as thoroughly as you like but if you put it back into the contaminated bowl that it came in you are re-infecting it." - TB

Information pertaining to risk was stated to be essential. However, details of the information did not need to be as precise in terms of the level of contamination which was dismissed as it was not necessarily helpful in terms of mitigating risk.

"I don't think that advising consumers about the level of Campylobacter *will make much difference. I don't think it will mean anything [unless] there's a relevant 'so what' factor for consumers what do they need to do differently as a result"- GN*

"Because, that doesn't give the consumer a method of fixing so I think…to mitigate the risk is probably more useful than …what the risk is" - PH

As mentioned previously, it was important that the information used was clear, simple and comprehensible by a broad range of consumers. For example, words such as "sanitise" could be confused and instead more direct language should be used.

"The language has to be simple, clear and easy to understand. Not all New Zealanders have the same literacy" - FGC

Consumer education is a necessary concurrent intervention

Several experts highlighted the role of labels as a trigger for consumers to remember information from concurrent educational campaigns.

"The label is only really going to be effective ever in a wrap-around campaign. A label …needs to be one tool in a number of things so putting something on a label without looking at health messages somewhere else or effective marketing or a campaign that goes with that label [is ineffective]" - PH

Industry-level intervention is an option

Given competing demands for consumer attention such as time pressure and budget constraints, it was suggested that intervention at the level of the supply chain may be more effective in decreasing the level of the *Campylobacter* contamination.

> *"Well there are definitely interventions that can be made in the supply chain…certainly the emphasis at the moment has had a lot of focus on the consumer end saying you know what to do with the chicken and what to do to store it in terms of reducing* Campylobacter *rates. Given the ongoing significance of the problem there is a need for greater intervention. Supply chain interventions would be good and we need to look at other ways of reducing it. That may include looking at labelling information or providing or limiting the supply of some types of chicken meat." – CNZ*

> *"I think it's going to be a number of things. Obviously using cooked and frozen sort of prevents it, but people are going to buy fresh and cook it themselves. Then people need to know how to handle it, and cleaning up the chicken farms. I think the best way's probably to clean up the chicken farms." – MAC*

Other interventions such as freezing chicken to reduce *Campylobacter* rates were suggested as a possible option. However, it was questioned whether frozen chicken would be a palatable intervention to the New Zealand public. Cost feasibility was also raised as an issue.

> *"The problem is there is a preference for fresh poultry, so that would be a big step." - FGC*

Although anecdotes of the successes of industry-wide intervention were praised for their success, any subsequent increase in cost could be passed onto the consumer.

> *"They certainly have a very strong economic focus. Because of the rules we make, will the overall net benefit to society outweigh the costs that have to be borne? And they're usually borne by industry so there's that conversation with industry that we have to have, in terms of how much it will cost them and whether or not that benefit to society outweighs the industry cost" – GN*

"…So we've halved the amount of Campylobacter *cases in the last few years, the question is what is the cost of taking the rate down further…So the question is, are we prepared to pay more for our chicken in order to have it cleaner? That's the reality." – GN*

Key informant surveys

We received six surveys from the key informants. Five of the six experts believed that the separate 'pronounced' label (label C) would be most effective at communicating safe chicken preparation information (see *Appendix 3, Showcard 3).* This agreed with the general population, of whom 71% picked the same label. However expert views differed from those of the general public regarding displaying features of *Campylobacter* infection and its complications on chicken labels, with five out of six experts believing this was unimportant.

Poultry industry response

While the Poultry Industry Association New Zealand (PIANZ) declined to participate in our interviews, we received the following email response from executive director Michael Brooks:

"Thank you for contacting PIANZ as part of your study on food labelling to assist consumers. I have coordinated the following overview on labelling, from an industry perspective.

1. There are many different poultry products available to consumers ranging from fresh poultry to frozen, pre-cooked or par-cooked, and different portion sizes. Understandably there are variances on the information the respective food labels would contain.
2. The appropriate regulatory authorities do not mandate cooking information on poultry products – that is up to the individual companies as to how much information they include. A standard message across all chicken products however is that they must all be cooked thoroughly.
3. All companies have storage & handling information on the labelling of chicken products that require it. These follow the fundamental principles of food safety. For example, for fresh chicken products specific handling instructions are clearly labelled with "cook until juices run clear", "store cooked foods above raw foods, etc. " etc. For bigger chicken items such as frozen or fresh whole chickens there are specific storage and handling instructions on the labels.

4. For companies with products that require specific cooking instructions (for example chicken kebabs, or par-cooked chicken nuggets) there are specific cooking instructions labelled clearly on these products
5. PIANZ also has 'Top 10 Poultry Safety tips' prominently displayed on our website, but as you can appreciate, on-product labelling varies for the appropriateness of the food safety of that particular product.

Michael Brooks
Executive Director
Poultry Industry Association of New Zealand”

4. Discussion

4.1 Summary of findings

This study assessed consumer views on poultry labelling, the current state of New Zealand poultry labels and key informant views on this topic. We found that consumers desire comprehensive labelling of chicken products, but that this want for greater information is not currently met. Analysis of contemporary poultry labels highlighted marked deficiencies in display and content. Since labelling may have positive behavioural influences on consumers (41) and the food industry (33,41,42), our findings suggest that improvements in chicken labelling is a potential strategy to tackle the high rates of campylobacteriosis in New Zealand.

4.2 Consumer understanding of safe chicken preparation

Consumer knowledge of safe chicken preparation

Changing food safety behaviour requires consumer knowledge and motivation. Our survey results suggest consumers have reasonable understanding of safe chicken preparation. However some important deficiencies remain, namely whether or not fresh chicken should be rinsed under the tap, if frozen raw chicken is less contaminated with *Campylobacter* than fresh raw chicken, and if hot tap water is sufficient to kill the bacteria. Strategies to address these knowledge deficiencies such as improvements in labelling are potentially important, as they point to practical

advice on how to safely prepare chicken. In addition to the chicken handling knowledge assessed in our survey, consumers may benefit from a basic understanding of where *Campylobacter* infection may occur. The home is a common place of foodborne infection (43), yet an American study found that half of consumers thought it was not very common for people to get foodborne illnesses from the home (43,44), which is a barrier to safe food handling practices (45). With respect to motivation, people must perceive the risk from a food product to be significant and this perception must be coupled with sufficient self-efficacy for food safety related behaviour to occur (46).

Gap between knowledge and behaviour

There exists a gap between consumers' knowledge and the behaviours they exhibit when handling chicken at home. Consumers are generally aware of food safety and amongst New Zealand consumers chicken was the food most commonly identified as a cause of food poisoning (47), but there are discrepancies between knowledge and practices. Even after having heard or read information on how washing chicken can spread bacteria, 57.2% of consumers in an American study said they would still continue to wash raw poultry (43). Potential mediators of this inconsistency could be habit and learned behaviour (40).

One study postulated that many errors in food preparation occur because individuals fail to recognise hazards in their immediate preparation situations and that this is more an issue of attention and vigilance rather than knowledge or beliefs (48). This is especially evident with practices that could lead to cross-contamination of *Campylobacter* (49). In a study from 1988 to 2010 it was noted in America that consumer-reported rates of cross-contamination behaviours during food preparation have increased over time (48). Studies in Ireland and America have shown that food preparers' hands, countertops, knives, handles and dish cloths are important and frequent sources of cross-contamination (44,50). It appears that cross-contamination events seem to be of greater importance than the risk associated with undercooking of poultry meat (51). Therefore, given cross-contamination is a prime route of infection, it is reassuring that our findings show that participants believed that it was essential for information on preventing cross-contamination to be on poultry labels.

4.3 Labels as a vector for chicken related food safety information

Perception of risk

One evident challenge with preventing campylobacteriosis is educating the public and promoting behavioural changes (44). It is suggested that this is in part because consumers' perception of their risk is influenced by sociological and psychological factors, and is not closely correlated with their objective risk (49,52,53). If they do not believe they have a high chance of personally experiencing a negative outcome this can hinder educational efforts to reduce risk behaviours (54). Most of the participants in our survey believed that only some (10-40%) of fresh raw chicken was contaminated with *Campylobacter*, which is markedly less than the actual contamination level (60-90%). Consequently, strategies aiming to change consumer behaviour should seek to elevate consumer risk perception to match reality.

Delivery of food safety messages

Effective food risk communication should aim to be personally relevant to consumers, and educate on the incidence and frequency of foodborne infection, because the perceived risk is often underestimated by the consumer (54,55). Furthermore, messages must be frequent, consistent and science-based (45). Personalised food safety messages have been shown to be successful in promoting food safety behaviours (46). Our survey did not address the role of personal experience, however participants believed it to be very necessary that details of *Campylobacter* infection and consequences were displayed on labels. This finding suggests that increased knowledge may improve consumers' sense of self-efficacy and result in more care taken in chicken preparation methods.

Current poultry labelling in New Zealand

With regards to labels on chicken products as a means to impart information there are certain requirements for this to be effective. Product labels should contain food handling information and warnings for high risk populations (45). The information should be conveyed on the label in print large enough to be read, especially as the proportion of elderly increases (45). In our own survey when given three mock-up labels to choose from the majority of participants selected the brightly-coloured

pronounced label over current labelling as most effective at communicating information about safe chicken preparation. In addition, symbols and engaging graphics to hold consumers' attention could further enhance the effectiveness of the message (40,45).

Our findings from poultry label analysis demonstrate that many different fresh chicken products available for purchase do not meet our 'gold standard' criteria for display and content. The highest average scoring product was whole bagged chicken, however its score of 4.9 was still low compared to the maximum score of 10. However, most products still complied with current regulations (56), indicating that labelling standards are a potential area for improvement. Moreover, comparison with survey findings showed consumers desire improved labelling content and presentation.

Other sources of chicken-related food safety information

Besides food labelling there are many ways in which information can be conveyed to consumers regarding chicken handling practices. In New Zealand consumers receive information on chicken-related food safety from a wide range of media sources, with television being the most common followed by newspapers, journals and magazines and radio(45,47). Consumers' purchasing behaviour is shaped by the subjective impressions of highly publicised events such as food scares and often consumers' attitudes are dependent on the type and level of media coverage(53). Periods of improved food handling practices have been shown to coincide with a high increase in levels of food safety coverage by the media(48). This being said, even with high recent exposure of *Campylobacter* in the media, our survey found that 55% of consumers named *Salmonella* as a poultry-borne cause of illness, but only 35% named *Campylobacter.* This finding is consistent with a previous NZ survey that also found that consumers were more likely to identify *Salmonella* as the bacteria responsible for infection from fresh raw chicken (47).

Educational campaigns can be a useful source of food safety information for consumers. The 'Clean, Cook, Cover, Chill' advertising campaign was implemented in New Zealand to educate consumers on safe food handling practices(57). It contained a range of information such as information to prevent cross-contamination,

safe cleaning techniques, information on meat thermometers, the types of bacteria including *Campylobacter*, proper storage techniques and information on fridge temperature (57).

4.4 The poultry industry and market

Chicken consumption is reported to have increased substantially in recent decades, with 80% of New Zealand consumers eating chicken 1-6 times per week in 2008 (47) compared with 42% of consumers in 1997 (58). The main reasons for consumer preference for chicken are taste, convenience, healthiness and value for money (47). Of the 401 participants in our survey, 89% bought, prepared or cooked chicken with fresh, raw chicken being the most popular choice (83% of all participants).This finding indicates a large proportion of shoppers are dealing with fresh raw chicken and are at risk of campylobacteriosis. Similar levels of fresh raw chicken purchased by consumers have been reported (47).

Frozen chicken has been shown to have a reduced level of *Campylobacter* as some bacteria is killed during the freezing process (59). Our survey indicated only 41% of our participants bought, prepared or cooked frozen chicken. However, a previous survey of chicken purchasers found that 84% of respondents claimed that they would still buy chicken if only the frozen type was available, however loss of convenience was seen as the major disadvantage of freezing (47). Given there is consumer acceptance of frozen chicken, efforts to expand the market share of frozen chicken may be a useful complement to labelling interventions.

As discussed earlier, changes in production brought about by the “Campylobacter Risk Management Strategy” reduced notified and hospitalised cases of campylobacteriosis by about 50%(18) [ref]. In particular, consumers view stricter farm management practices as the most acceptable means of controlling bacterial contamination of chicken, with chemical treatment being the least acceptable (47).

Similar to New Zealand, the United Kingdom has also experienced problems with persistently high *Campylobacter* contamination of fresh chicken and is currently working towards reducing these levels (60). A year-long survey from February 2014

to February 2015 was conducted by the Food Standards Agency to quantify the level of *Campylobacter* on fresh chicken. Individual results from major retailers were published online to allow consumer purchasing discretion and to increase retailer accountability (61). Retailers have implemented changes to meet targets of *Campylobacter* reduction through retailer-led implementation of food chain interventions and improved food handling messages on chicken labels (61). Results in 2015 show that 11% of chickens tested positive for the highest level of contamination, down from 19% in the previous year. The overall presence of *Campylobacter* in chickens decreased by 15% from October 2014 to October 2015 (60). Therefore, interventions that mandate producer and/or retailer transparency have the power to motivate changes in industry behaviour to reduce *Campylobacter* levels on poultry products.

4.5 Methodological considerations

This study had important strengths and limitations that should be considered when interpreting the findings.

Survey of shoppers

First, due to the street-intercept nature of the survey, we adopted a concise survey that took an average of 5 to 10 minutes to complete in order to maximise participation rates. A pilot trial was also conducted to test reception and feasibility. To achieve a degree of consistency in the delivery of the survey between surveyors, our survey was designed with standardised statements for each surveyor to read out. The validity of certain survey data (in Section C for example), may still be affected by acquiescence bias, where there is a tendency for participants to agree rather than disagree with statements read out by the interviewer (62). To help minimise and control for this particular bias, we used a balance of positively and negatively worded items which consumers responded to using a Likert Scale (62). Social desirability bias may also occur. This is when participants may feel uncomfortable providing honest answers to avoid presenting themselves in an unfavourable manner (63). This bias is unlikely to be an issue with our survey results as the topic of chicken purchase, preparation, cooking and labelling is not particularly sensitive.

Secondly, with the use of Likert Scale to measure participants' attitudes in our survey, we had to ensure certain assumptions were not being made. The assumption that intervals between values in a Likert scale are equal is incorrect (64) as Likert Scales fall within the ordinal level of measurement i.e. the response categories have a rank order. It is incorrect to assume that the intensity of feeling between "strongly disagree" and "somewhat disagree" is equivalent to the intensity of feeling between other consecutive categories in the Likert Scale, for example between "neither agree nor disagree" and "somewhat agree"(64). This feature is important to take into consideration because it affects the appropriate descriptive and inferential statistical methods to be used in the analysis and correct interpretation of our results (64). In this case, we reported the median and interquartile range as the measure of central tendency as opposed to the mean and standard deviation which is normally used for interval variables (64).

Thirdly, we aimed to minimise selection bias by approaching all shoppers entering and exiting supermarkets and butcheries in our sampling frame. Selection bias can cause problems with confounding but is unavoidable in a non-randomised survey situation. Although our surveyors approached any individual coming in/out of the supermarkets and butchers, females and New Zealand Europeans tended to consent to the survey more than other demographic groups. This situation could create potential for some selection bias (65). However, the response proportion was high for a survey of this type (69%) so selection bias is unlikely to have had a large effect on the findings.

Fourthly, we sampled our shoppers to provide a reasonably representative sample of the Wellington population to support generalisability of the results (35). By using a number of survey locations across a range of deprivation levels (Wellington City, Lower Hutt and Porirua), we attempted to get a representative sample of different types of shoppers across different times of the day (9am-9pm) and throughout the week and weekend. We completed 124 (31%) surveys in the morning (9am-1pm), 181 (45%) in the afternoon (1-5pm) and 94 (24%) in the evening (5-9pm), with fewer surveys completed in the evening session as a result of butchers being closed during this time. 78 surveys (19.5%) took place over the weekend. One limitation to generalisability was the underrepresentation of Māori in our sample with 10% of our

survey participants identifying as Māori compared with 14.9% of the total New Zealand population (2013 Census QuickStats). 62% of our participants were female which is slightly lower than the percentage of urban female main household shoppers found by Nielsen Consumer and Media Insights which was 72% (email from Nielsen Consumer and Media Insights, April 27, 2016; unreferenced).

In our survey, we assigned the socioeconomic status of participants based on their suburb of residence from which we then allocated NZDep scores. We did not attempt to assign socioeconomic status at the individual level using exact address or other determinants such as total income or level of education (66). Percentage of participants in each NZDep decile in our study ranged from 3-17% of total participants. 62% of our participants had a deprivation score from 1-5, so our sample was slightly biased towards those with lower deprivations, that is those with higher socioeconomic status.

Finally, we did have some missing data due to a few reasons. The majority of missing data in our survey was from item non-response which arose from participants refusing to answer a question or surveyors failing to ask a question or record an answer (67). We also had some missing data due to partial non-response which occurred in a few cases when participants had to leave before they completed the survey. All available data for each question were analysed, we did not use imputation for missing values. The cause of missing data largely influences the impact it has (66). Where data are missing randomly this has little effect on the result as there is no systematic difference between participants with and without data (68). When data are missing in a systematic pattern there is a possibility for bias to be introduced (68). There was very little missing data in this study so this bias is unlikely to affect the findings.

Poultry label analysis

One limitation to our analysis included the fact that criteria such as font size, which was weighted twice as much as other criteria, was analysed subjectively. This was because we used the font size of other information on labels of the product, to

compare as to whether a score of 0, 1 or 2 was given to the font size of the safety content of the fresh chicken label.

Another limitation was the refusal of several of our selected locations to allow photographs of labels to be taken, resulting in a potential selection bias of locations.

5. Recommendations

Our study demonstrates a discrepancy between what consumers want on poultry product labels and what the majority of labels currently provide. While improvements in food labelling will not be a ‘silver bullet’ solution to New Zealand’s campylobacteriosis epidemic, it is clear that labels can be effective in changing consumer and food industry behaviour. Therefore, we propose the following recommendations for chicken labelling in New Zealand.

Implications for label design

Our survey found that consumers desired an increased level of information surrounding safe chicken storage, preparation, cooking and cleaning. Evidence suggests that safe-handling labels on meat products influence consumer behaviour, with a US study finding a reported behaviour change in 43% of participants as a result of safe handling information (45).

Based on these findings we recommend a separate standardised and mandatory label for all fresh chicken products. These recommendations for ideal poultry labelling are informed by current literature regarding food labelling, guidelines for safe poultry handling and several experts’ opinions. Our proposed label would contain the display and content features recommended in the label analysis section and would be similar in design to the brightly-coloured pronounced label shown in Appendix 3 - Showcards, Label mock-up C. This label was judged to be the most appropriate to ‘effectively communicate safe chicken preparation’ by 71% of our study participants.

We suggest that the label content could reflect the ‘Clean, Cook, Cover, Chill’ message previously used in an advertising campaign by MPI (57), as the campaign

and its contents are already familiar to many consumers, so consumer acceptance and understanding of this message is likely to be increased and its introduction on mandatory labels is likely to be hastened (57). This message comprises information including:

- Information to prevent cross contamination
- Safe cleaning techniques
- The types of bacteria present on chicken, including *Campylobacter*
- Proper storage techniques
- Information on fridge temperature and chilling (57).

In addition, our survey identified specific gaps in consumer knowledge of safe chicken handling not currently covered by the 'Clean, Cook, Cover, Chill' message. As such, we recommend that the following extra information is placed on poultry labels:

- *Do not* rinse chicken under the tap. It will spread droplets of bacteria around your kitchen
- If possible, freeze chicken. Freezing kills most bacteria that can make you sick.

We suggest the following display features for a mandatory label:

- Demarcation of safety information from other text
- Positioning the label on the front side of the product package
- The use of a contrasting colour surrounding the safety information
- The use of graphics relating to safe handling of raw chicken
- The use of simple language (i.e. no jargon or potential for misinterpretation of information)
- Clear structure and layout of safety information
- Font size clearly readable

The content and display featured described here are proposed as a starting point for discussion. Any new labels would require extensive consultation with experts in foodborne disease prevention and health information communication. They would also need careful pretesting with a representative sample of consumers.

We suggest that this separate, standardised label be mandatory for all fresh chicken products sold in outlets in New Zealand in order to provide maximum impetus for poultry industry changes to reduce the *Campylobacter* load of fresh chicken. In this way labelling serves as not only a vehicle for consumer education but also an incentive for industry improvements.

Additionally, we suggest that the level of *Campylobacter* be presented on the label. Provision of this information was deemed to be either ‘very necessary’ or ‘essential’ by 75% of our study population. The data for *Campylobacter* levels would be obtained from the current monitoring system, the National Microbiological Database for poultry meat. This scheme measures levels of contamination on chicken carcasses at the seven major processing plants in New Zealand (17). The average *Campylobacter* level of carcasses at each production plant would then be stated on the corresponding fresh chicken label recommended above potentially using broad bands, for example 0-20%, 20-40% or >40% contamination. Labels could be colour-coded for different levels as a visual cue to consumers. This differential labelling system would incentivise industry interventions to decrease contamination during processing in order to receive a labelled grade more favourable to consumers.

The introduction of this mandatory label on fresh chicken products would likely be met with some opposition from several quarters. The poultry industry may be concerned about costs and damage to reputation, as was the case in the comparable example of introduction of mandatory front-of-package nutrition labelling in New Zealand. This was met by opposition by the food industry who feared decreased profit margins due to consumer rejection of unhealthy products and increased labelling costs (69). Mandatory labelling also comes with a cost for the supplier, as evidenced by an analysis of mandatory fortification of the food supply. Costs incurred through re-designing labels were estimated to cost NZ$300-$500 per stock-keeping unit (i.e. barcode) (70). Increased costs for producers would presumably need to be passed on as a downstream increase in cost to the consumer, an unintended consequence that should be considered before initiating labelling changes. Given the large volumes of fresh poultry sold in NZ, these additional costs are likely to be minimal for each product sold. Such costs would also

be insignificant compared with the costs of campylobacteriosis to the NZ economy (71).

There are several strategies that can help to address the barriers to implementation of mandatory fresh chicken labels. Consultation with the poultry industry and suppliers will help identify achievable goals that are agreed upon by industry and regulators, taking into consideration implementation costs and a reasonable 'phase-in' time for the optimal system to be implemented (69).

Changes to labelling requirements in New Zealand may have implications for the Australia New Zealand Food Standards Code administered by Food Standards Australia New Zealand (FSANZ). For example, the code specifies exclusion criteria for food that does not require a label, notably food that is made and packaged on the premises where it is sold (72). Specific stipulations for labelling of poultry products would be need to be included in the Food Standards Code to allow enforcement of these changes by the Ministry for Primary Industries.

Complementary strategies

There is evidence to suggest that food labels work synergistically with other interventions (40). Food safety education through multimedia is more effective at conveying concepts and increasing understanding than a single medium, such as labels (40). Periods of improved food handling practices have been shown to coincide with a high increase in levels of food safety coverage by the media (48).Therefore, we could consider the use of a nationwide advertising campaign in combination with increased chicken labelling. This campaign could include television advertisements reiterating the safe chicken messages found on the labels and providing a website to access more information on the risk of *Campylobacter* on fresh chicken.

While we consider that the introduction of better labelling will be the most appropriate approach, we also recommend that the maximum level of *Campylobacter* allowed on chicken, as per the *'Campylobacter* Risk Management Strategy' (17), should be further reduced. This recommendation is based on expert opinion that targeting

contaminated food is more effective and efficient than attempting to influence consumer behaviour. The previous reduction in permissible levels was followed by an approximately 50% reduction of notified and hospitalised cases of campylobacteriosis so this strategy is known to be highly effective (18).

Equity considerations in implementing recommendations

Interventions aimed at improving population health should seek to achieve equitable outcomes. The Health Equity Assessment Tool (HEAT) is a planning tool developed with the aim of reducing health inequities in New Zealand and designed to be utilised when considering the implementation of health and equity related policy, programmes or services (73). Here we use it to assess potential impacts of changes to poultry labelling.

The viewing, comprehension and subsequent behavioural changes that labels attempt to achieve are known to differ across population groups in New Zealand (74). Māori, Pacific and low-income consumers have been shown to utilise and understand labels less than other groups in New Zealand, resulting in disparities in potential for information acquisition from labels (74). Some contributors to this disparity include label complexity, lack of consumer knowledge and insufficient time to read labels. (74).

To tackle this inequity, we propose that a simple intervention could be to increase the use of culturally relevant wording and graphical use in labelling. This could include the use of *te reo Māori* or Pacific languages in labelling and advertising; for example translation of messages such as “Clean, Cook, Cover, Chill”. This approach would increase not only the inspection rates but also the comprehensiveness of labelling, by some vulnerable populations. The use of graphics would also be helpful, as it could partially bypass the language barrier between ethnically diverse population groups, especially when universally recognisable graphics are used.

Unintended consequences for this intervention might be distaste or unresponsiveness from other ethnic populations when inspecting the food label. Another complication may be that Māori and Pacific populations may not be

responsive to the intervention itself, meaning that this intervention would be less effective in reducing inequity.

Application of these strategies should be undertaken with the intention of reducing current inequities in label use and understanding, and should be supported by evidence of efficacy in disadvantaged groups as well as strengthened by active collaboration with consumers from target populations. Other interventions proposed include targeting “social marketing and education campaigns, increasing the number of low-cost foods with voluntary nutrition labels, a reduction in the price of 'healthy' food, and consideration of an alternative mandatory nutrition labelling system that uses simple imagery like traffic lights” (74).

Evaluating the effectiveness of this intervention, would require follow up studies, such as quantitative research and qualitative evidence from consumer focus groups, to assess the effectiveness and acceptance of the intervention. Using tools such as the HEAT tool to assess consequences of health interventions on equity ensures that interventions are fair, just and equitable to the whole population.

Implications for research

Source attribution methods suggest that more than 50% of human campylobacteriosis in New Zealand was attributable to poultry sources (26). However there are other potential sources of *Campylobacter* infection for example, consumption of contaminated food or water, via the faecal-oral route, certain types of sexual contact or contact with an infected animal (7,25). Therefore, because about 50% of campylobacteriosis is not accounted for by contaminated chicken products it would be beneficial to investigate other sources of *Campylobacter*.

Another implication could be research more specifically directed towards consumers chicken preparation behaviours. Consumers are generally aware of food safety and amongst New Zealand consumers, chicken was the food most commonly identified as a cause of foodborne infection(47). However, there are discrepancies between the knowledge and practices of consumers (47,49). High-quality direct observation studies may be needed to assess actual chicken preparation behaviours in

comparison to optimum behaviours that could be recommended through improved labelling on chicken products.

6. Conclusion

Poultry is a popular and highly-consumed food item in the New Zealand diet. Campylobacteriosis infection from fresh, raw chicken is a large, preventable burden on the New Zealand population, economy, and health care system and labels are a possible intervention strategy to combat this problem. This report summarises consumer views on poultry labelling, the current state of New Zealand poultry labels and key informant views on this intervention.

Our main findings show there is a large gap between consumers' desires for comprehensive safety labelling on fresh raw chicken and the current information that is provided. Furthermore, shoppers are aware of the risk posed from chicken, but are not well informed on how to guard against it. Finally analysis of contemporary poultry labels highlighted marked discrepancies with a framework for an 'ideal' label generated through thematic analysis of expert interviews. New Zealand is a world leader in controlling campylobacteriosis, but these measures have not gone far enough with our disease rates still amongst the highest in the world. Poultry products remain the dominant source. Food labels can be a key communication resource for informing consumers of *Campylobacter* and how to prevent it. They also provide an important signal to the industry itself and provide incentive to producers to lower their contamination levels. We therefore expect that improving chicken labels could significantly reduce this public health burden.

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Appendices

Appendix 1. Participant information sheet and consent

MEDICAL STUDENT RESEARCH
University of Otago, Wellington
Food Labelling

PARTICIPANT INFORMATION SHEET

Thank you for showing an interest in this project. It is entirely your choice whether or not to participate. This information sheet will help you decide if you'd like to take part. If you choose to take part, there is a consent form to fill out.

What is the aim of the project?
We are fourth year medical students, and are running a study on shopper's attitudes towards food labelling. We are particularly interested in your views on labelling of chicken products.

Who we are looking for?
Anyone age 16 years or over may participate. There are no direct benefits to taking part, however, the results from this study will be available by contacting the lead researcher.

What does the project involve?
Should you agree to take part in this project, you will be asked to participate in a street survey of approximately 5-10 minutes. We will record your answers on paper for later analysis. You may skip any questions you prefer not to answer, and may withdraw from this survey at any time without any disadvantage to yourself.

What happens to the information collected in the study?
We will be preparing a report and presentation at the conclusion of this project. Additionally, an article for publication may be written. You are welcome to request a copy of the results by contacting the lead researcher. All the data collected and reported will be anonymous. It will be stored securely for at least 5 years, and only be accessible by those involved in the project.

Who do I contact for more information, concerns, or a copy of the results?

Professor Michael Baker
Department of Public Health
University of Otago, Wellington
04 918 6802
michael.baker@otago.ac.nz

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph +643 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

CONSENT FORM

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:

1. My participation in the project is entirely voluntary;
2. I am free to withdraw from the project at any time without any disadvantage;
3. The results of the project may be reported and published, but nothing that could personally identify me will be used
4. Data collected will be securely stored for at least 5 years

I agree to take part in this project.

....
(Participant's Signature) (Date)

.....
(Printed Name)

Appendix 2. Survey form

MEDICAL STUDENT RESEARCH
University of Otago, Wellington
Food Labelling

SURVEY FORM

A. Interview details

Informed consent gained: **Yes** ☐

1. Interviewer _____
2. Location _____
3. Date _____ Time _____
4. Are you the main shopper for your household? Yes ☐ No ☐

B. Categories of information on food labels
Read: Food labels can have a variety of information displayed on them. Please look at this show card and tell me how necessary you think it is that labels have the following information:
[SHOWCARD 1]*(Necessary statements. NB. if necessary remind them that we are referring to label information)*

5. Food safety to protect from infectious diseases, e.g. proper handling and storage
   1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
6. Safety for vulnerable groups, e.g. people with nut allergies
   1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
7. Nutritional composition, e.g. percentage of sugar, salt and saturated fat
   1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
8. Energy in food, e.g. distance needed to walk to 'burn off' calories per serving
   1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
9. Additives, e.g. preservatives, colouring agents
   1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
10. Environmental impact and sustainability, e.g. greenhouse gas (carbon) footprint
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
11. Animal welfare, e.g. free range
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
12. Welfare of workers involved in production, e.g. fair trade
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
13. Information for those with specific dietary preferences & religious beliefs, e.g. vegetarian, halal
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
14. Value for money, e.g. cost per 100g or cost per kg
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

15. Country of origin labelling to help consider food safety risks and other concerns eg, animal welfare, welfare of workers
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

C. General views on food labels

Read: I'd now like to ask you about your general view on food labels. Please look at this show card and indicate your level of agreement with the following statements:
[SHOWCARD 2]*(Agreement statements)*

16. Excluding the price label, I always read food labels before buying a food product for the first time
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

17. I believe food labels currently contain all the information I need
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

18. I believe the government should prohibit certain foods from being in the market if they are, for example, unhealthy for people or bad for the environment
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

19. I believe the government should tax unhealthy foods and drinks, e.g. sugar sweetened beverages
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

20. I believe consumers should be given all the information about foods so that they can decide themselves, e.g. each product has a link to a website with this information
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

D. Knowledge of fresh chicken

Read: We now have some more specific questions to ask you about one type of food, chicken.

21. Do you buy, prepare or cook chicken? Yes ☐ No ☐

22. If yes, which of the following chicken products do you buy, prepare or cook?

    a. Fresh raw chicken Yes ☐ No ☐
    b. Frozen raw chicken Yes ☐ No ☐
    c. Cooked chicken Yes ☐ No ☐
    d. Other chicken products (specify) _____ Yes ☐ No ☐

23. How often do you typically prepare fresh raw chicken at home?
    a. Daily ☐
    b. 2-4 times per week ☐
    c. Once per week ☐
    d. 1 to 3 times per month ☐
    e. Less than once per month ☐
    f. Never ☐

24. Did you know that fresh raw chicken can carry bacteria (bugs) that can make you sick?
    Yes ☐ No ☐
    a. If yes, can you tell me the name of the bacteria (bug)?
       Specify: _____
    b. If no, or named different bacteria, have you heard about c.....r?
       Yes ☐ No ☐

25. How much of the fresh raw chicken for sale in New Zealand do you believe has c.....r on it? *(NB. Best guess)*
    a. Little or none (<10%) ☐
    b. Some (10-40%) ☐
    c. About half (40-60%) ☐
    d. Most (60-90%) ☐
    e. Almost all or all (>90%) ☐

26. For the following statements about safe chicken preparation please tell me which ones you think are true or false, or are ones you 'don't know'?

    a. You should use a separate knife and chopping board for fresh raw chicken from other ingredients
       T ☐ F ☐ Don't know ☐

    b. Hot tap water is sufficient to clean anything that comes into contact with fresh raw chicken
       T ☐ F ☐ Don't know ☐

    c. Fresh raw chicken must be cooked through before eating
       T ☐ F ☐ Don't know ☐

    d. Rinsing fresh raw chicken under the tap will reduce your likelihood of getting sick from it
       T ☐ F ☐ Don't know ☐

    e. You should clean and disinfect your kitchen bench after contact with fresh raw chicken
       T ☐ F ☐ Don't know ☐

    f. Frozen raw chicken has less campylobacter than fresh raw chicken
       T ☐ F ☐ Don't know ☐

E. Views on content of labelling of fresh chicken
Read: I now want to ask you about your views on labelling of fresh chicken. Just to let you know, most fresh raw chicken products sold in New Zealand are contaminated with campylobacter. Please look at this show card and tell me how necessary you think it is that labels on fresh chicken have the following information features:
[SHOWCARD 1]*(Necessary statements. NB. If asked, "most" is 60-90%)*

27. The level of campylobacter on that particular product
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

28. Features of campylobacter infection and its complications
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

29. Correct cooking to kill campylobacter
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

30. Correct handling and storage to prevent campylobacter cross-contamination of other foods
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

31. Correct cleaning to kill campylobacter on benches and other surfaces
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

32. Large, brightly coloured warning labels on chicken products to explain the risk of campylobacter
    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

F. Fresh chicken label mock-ups
Read: We have a current typical label and prepared sample mock-ups of possible fresh raw chicken labels to show you. Please look at this show card and tell me which you think is most effective at communicating safe chicken preparation information to you:
[SHOWCARD 3]*(Mock-ups. NB. Read out options on showcard)*

A. Current label ☐
B. Current with extra information ☐
C. Separate 'pronounced' label ☐

G. Participant details
Read: We just need a few details about you:

33. Age group: 16-19 20-29 30-39 40-49 50-59 60-69 70-79 80+

34. Sex: M ☐ F ☐

35. Which suburb do you live in?: _____

36. Which ethnic group do you belong to? Indicate the group or groups which apply to you
    [SHOWCARD 4]*(Ethnicity. NB. Multiple responses are possible)*

    a. New Zealand European b. Māori
    c. Samoan d. Cook Island Māori
    e. Tongan f. Niuean
    g. Chinese h. Indian
    i. Other such as DUTCH, JAPANESE, TOKELAUAN. Please state:_____
    j. Don't know k. Refused

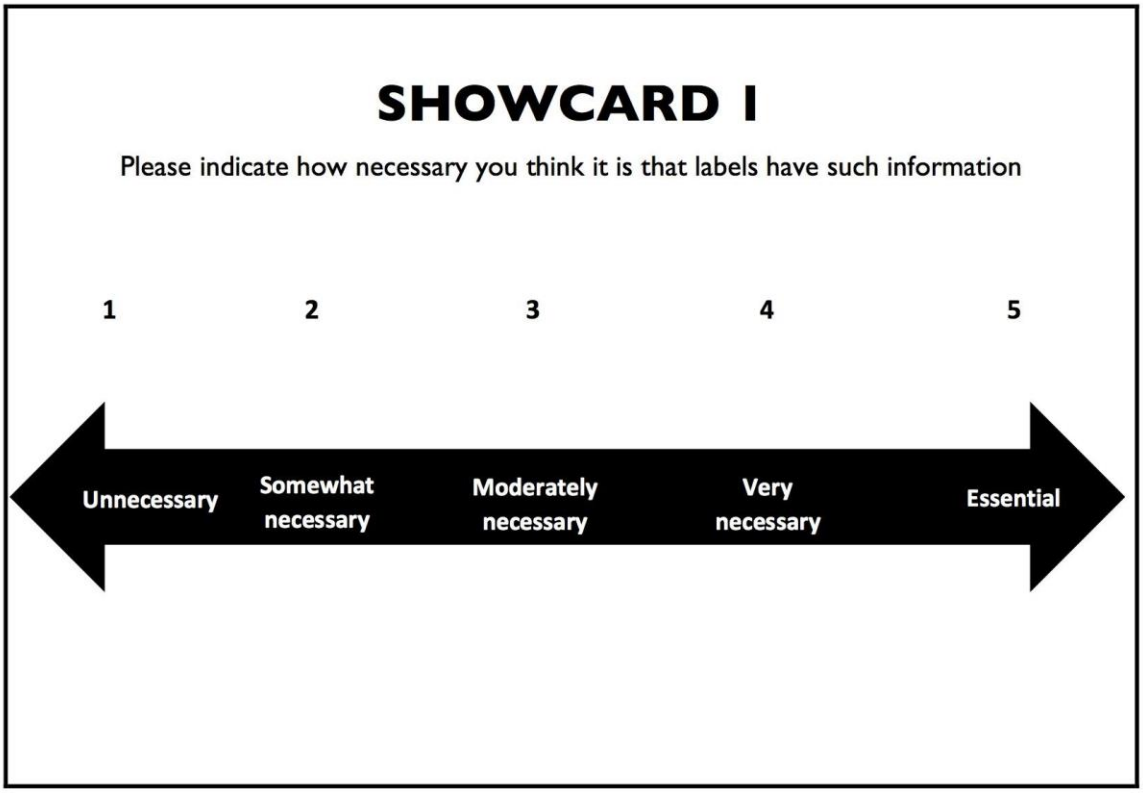
Read: That is the end of the survey. Do you have any comments or questions?

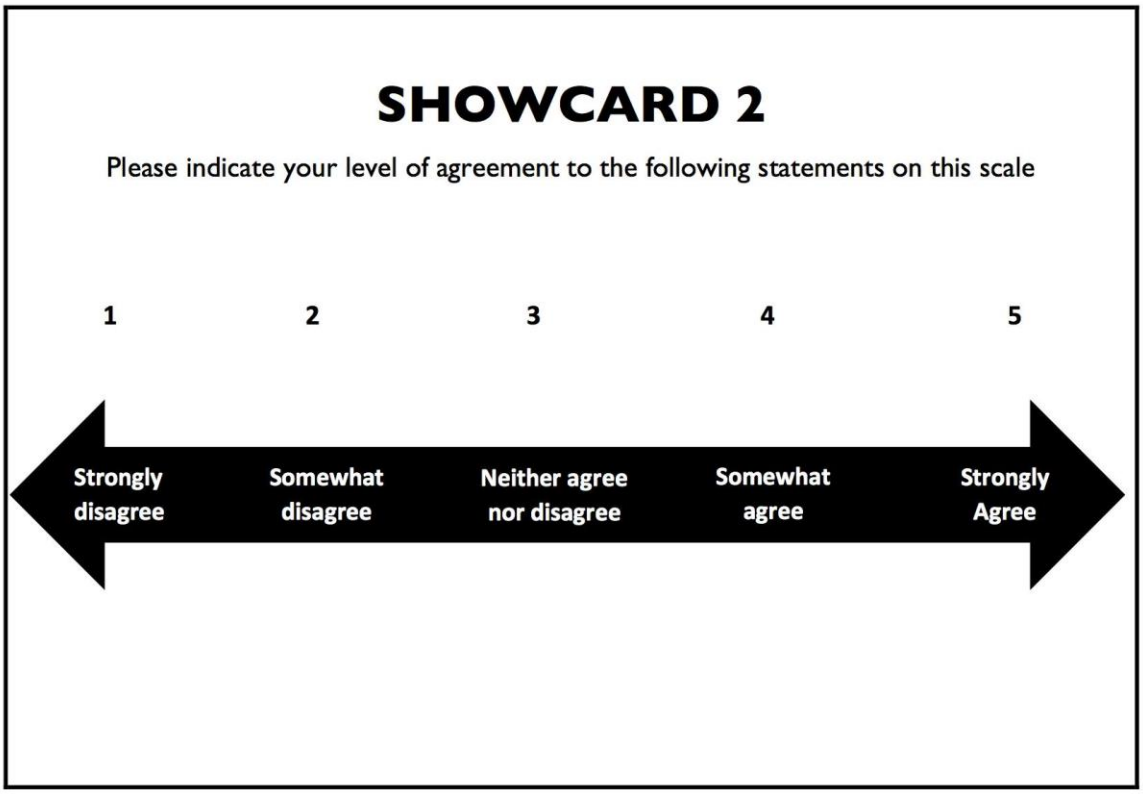
Notes:_____

_____

Survey Ends

Appendix 3. Survey showcards





SHOWCARD 3

Please tell us which you think is most effective at communicating safe chicken preparation information to you

A

- Current label

B

- Current label with information larger

C

- Information on a separate label

SHOWCARD 4

Which ethnic group do you belong to? Indicate the group or groups which apply to you.

a. New Zealand European

b. Māori

c. Samoan

d. Cook Island Māori

e. Tongan

f. Niuean

g. Chinese

h. Indian

i. Other such as DUTCH, JAPANESE, TOKELAUAN. Please state

Appendix 4. Tables of survey data and results

Table 1.	Knowledge of fresh chicken		
			Frequency
Chicken Product			N=356
	Fresh		331
	Frozen		164
	Cooked*		220
	Other		71
Frequency of exposure			N=399
	Daily		7
	2-4/Week		125
	1/Week		114
	1-3/Month		66
	>1/Month		23
	Never		64
Knowing Chicken as Source			N=399
	Yes		389
		Named Campylobacter	117
Heard of Campylobacter			277
	Yes		165
Proportion With Campylobacter			N=392
	<10%		45
	10-40%		133
	40-60%		102
	60-90%		59
	>90%		53
Cooked through			N=397
	Correct		393
	Incorrect		1
	Don't know		3
Separate utensils			N=398
	Correct		386
	Incorrect		9
	Don't know		3
Cleaning surfaces			N=398
	Correct		379
	Incorrect		9
	Don't know		10
Hot tap water			N=398
	Correct		293
	Incorrect		73
	Don't know		32

Rinsing chicken		N=398
	Correct	219
	Incorrect	88
	Don't know	91
Frozen vs fresh		N=398
	Correct	92
	Incorrect	134
	Don't know	172

* Total response only 355

**SD=Standard Deviation

Table 2. Knowledge of fresh chicken for each Deprivation level

		Frequency(%)										Kruskal -Wallis
		Dep 1	Dep 2	Dep 3	Dep 4	Dep 5	Dep 6	Dep 7	Dep 8	Dep 9	Dep 10	p-value
Cooked through		N=41	N=64	**N=45	N=23	N=62	N=37	N=13	N=54	N=23	N=23	
	Correct	40(98%)	63(98%)	43(98%)	23(100%)	62(100%)	37(100%)	13(100%)	54(100%)	23(100%)	22(96%)	
	Incorrect	1(2%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	
	Don't know	0(0%)	1(2%)	1(2%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	1(4%)	0.296
Separate utensils												
	Correct	41(100%)	63(98%)	44(98%)	22(96%)	59(95%)	37(100%)	11(85%)	52(96%)	21(91%)	23(100%)	
	Incorrect	0(0%)	1(2%)	1(2%)	0(0%)	2(3%)	0(0%)	2(15%)	1(2%)	2(9%)	0(0%)	
	Don't know	0(0%)	0(0%)	0(0%)	1(4%)	1(2%)	0(0%)	0(0%)	1(2%)	0(0%)	0(0%)	0.341
Cleaning surfaces												
	Correct	38(93%)	64(100%)	42(93%)	22(96%)	56(90%)	34(92%)	13(100%)	53(98%)	21(91%)	23(100%)	
	Incorrect	2(5%)	0(0%)	2(4%)	0(0%)	4(6%)	1(3%)	0(0%)	0(0%)	0(0%)	0(0%)	
	Don't know	1(2%)	0(0%)	1(2%)	1(4%)	2(3%)	2(5%)	0(0%)	1(2%)	2(9%)	0(0%)	0.362
Hot tap water												
	Correct	34(83%)	49(77%)	34(76%)	18(40%)	50(81%)	17(46%)	7(54%)	41(76%)	16(70%)	11(48%)	
	Incorrect	5(12%)	9(14%)	9(20%)	1(4%)	9(15%)	11(30%)	3(23%)	8(15%)	5(22%)	11(48%)	
	Don't know	2(5%)	6(9%)	2(4%)	4(17%)	3(5%)	9(24%)	3(23%)	5(9%)	2(9%)	1(4%)	0.024*
Rinsing chicken												
	Correct	22(54%)	36(56%)	27(60%)	10(43%)	40(65%)	23(62%)	4(31%)	32(59%)	14(61%)	8(35%)	
	Incorrect	9(22%)	14(22%)	7(16%)	8(35%)	10(16%)	10(27%)	4(31%)	9(17%)	5(22%)	9(39%)	
	Don't know	10(24%)	14(22%)	11(24%)	5(22%)	12(19%)	4(11%)	5(38%)	13(24%)	4(17%)	6(26%)	0.688
Frozen vs fresh												
	Correct	9(22%)	13(20%)	5(11%)	2(7%)	19(31%)	10(27%)	5(38%)	12(22%)	6(26%)	6(26%)	
	Incorrect	13(32%)	23(36%)	17(38%)	10(43%)	18(29%)	12(32%)	4(31%)	14(26%)	9(39%)	8(35%)	
	Don't know	19(46%)	28(44%)	23(51%)	11(48%)	25(40%)	15(41%)	4(31%)	28(52%)	8(35%)	9(39%)	0.393

Table 3. Knowledge of fresh chicken handling by ethnicity

	Frequency (%)											
	Māori	Non-Māori	Pearson Chi-Square p-value	Pacific	Non-Pacific	Pearson Chi-Square p-value	Asian	Non-Asian	Pearson Chi-Square p-value	NZ European & Other	Don't Know	Refused
Cooked through**	N=36	N=360		N=26	N=370		N=32	N=364		N=302	N=5	N=2
Correct	36(100%)	355(99%)		25(96%)	366(99%)		31(97%)	360(99%)		299(99%)	5(100%)	2(100%)
Incorrect	0(0%)	1(>1%)		0(0%)	1(>1%)		1(3%)	0(0%)		0(0%)	0(0%)	0(0%)
Don't know	0(0%)	3(1%)	0.817	1(4%)	2(1%)	0.167	0(0%)	3(1%)	0.003♮	2(1%)	0(0%)	0(0%)
Separate utensils												
Correct	36(100%)	348(97%)		26(100%)	358(97%)		30(94%)	354(97%)		292(97%)	5(100%)	2(100%)
Incorrect	0(0%)	9(3%)		0(0%)	9(2%)		2(6%)	7(2%)		7(2%)	0(0%)	0(0%)
Don't know	0(0%)	3(>1%)	0.539	0(0%)	3(1%)	0.647	0(0%)	3(1%)	0.256	3(1%)	0(0%)	0(0%)
Cleaning surfaces												
Correct	35(97%)	342(95%)		26(100%)	351(95%)		31(97%)	346(95%)		285(94%)	5(100%)	2(100%)
Incorrect	0(0%)	9(3%)		0(0%)	9(2%)		1(3%)	8(2%)		8(3%)	0(0%)	0(0%)
Don't know	1(3%)	9(3%)	0.629	0(0%)	10(3%)	0.496	0(0%)	10(3%)	0.606	9(3%)	0(0%)	0(0%)
Hot tap water												
Correct	27(75%)	265(74%)		9(35%)	283(76%)		20(63%)	272(75%)		236(78%)	5(34%)	2(100%)
Incorrect	7(19%)	65(18%)		13(50%)	59(16%)		10(31%)	62(17%)		42(14%)	0(0%)	0(0%)
Don't know	2(6%)	30(8%)	0.837	4(15%)	28(8%)	0.000♮	2(6%)	30(8%)	0.135	24(8%)	0(0%)	0(0%)
Rinsing chicken												
Correct	18(50%)	200(56%)		14(54%)	204(55%)		16(50%)	202(55%)		170(56%)	3(60%)	1(50%)
Incorrect	7(19%)	81(22%)		9(35%)	79(21%)		14(44%)	74(20%)		58(19%)	2(40%)	1(50%)
Don't	11(31%)	79(22%)	0.499	3(12%)	87(24%)	0.177	2(6%)	88(24%)	0.003♮	74(25%)	0(0%)	0(0%)

know												
Frozen vs fresh												
Correct	9(25%)	83(23%)		9(35%)	83(22%)		9(28%)	83(23%)		65(22%)	2(40%)	0(0%)
Incorrect	10(28%)	123(34%)		8(30%)	125(34%)		13(41%)	120(33%)		102(34%)	3(60%)	1(50%)
Don't know	17(47%)	154(43%)	0.741	9(35%)	162(44%)	0.352	10(31%)	161(44%)	0.364	135(45%)	0(0%)	1(50%)

* Total response only 355

**Non-Māori has N=359, Non-Pacific has N=369, Non-Asian has N=363, NZ European has N=301

♮Significant at the 0.01 level

Table 4. Views on content labelling of fresh chicken

Views on label content*	Frequency						
	Unnecessary-1	Somewhat Unnecessary-2	Moderately Necessary-3	Somewhat Necessary-4	Essential-5	Median(IQR**)	
Handling and Storage	3	10	27	81	276	5(4-5)	N=397
Cooking info	5	6	28	85	273	5(4-5)	N=397
Cleaning info	10	17	46	86	238	5(4-5)	N=397
Campylobacter Level	31	22	48	94	203	5(3-5)	N=398
Large, brightly coloured label	28	42	82	88	156	4(3-5)	N=396
Features of campylobacteriosis	49	33	65	100	150	4(3-5)	N=397

*Categories from section E of survey

**IQR=Interquartile Range

Table 5. Views on content labelling of fresh chicken for each Deprivation level

Views on label content*	Median response for Deprivation (IQR**)										Spearman's ρ
	Dep 1	Dep 2	Dep 3	Dep 4	Dep 5	Dep 6	Dep 7	Dep 8	Dep 9	Dep 10	(p-value)
Handling and Storage	5(5-5)	5(4-5)	5(4-5)	5(4-5)	5(4-5)	5(4-5)	5(3-5)	5(4-5)	5(4-5)	5(4-5)	-0.091(0.074)
Cooking info	5(4-5)	5(4-5)	5(4-5)	5(4-5)	5(4-5)	5(5-5)	5(3-5)	5(4-5)	5(4-5)	5(4.5-5)	-0.01(0.851)
Cleaning info	5(4-5)	5(4-5)	5(4-5)	5(4-5)	5(4-5)	5(4-5)	4(3-5)	5(4-5)	4(3.5-5)	5(4-5)	-0.068(0.185)
Campylobacter Level	4(4-5)	4(3-5)	4(4-5)	5(3.5-5)	4(3-5)	5(4-5)	5(4-5)	5(4-5)	4(3-5)	5(4-5)	0.094(0.065)
Large, brightly coloured label	4(3-5)	4(3-5)	4(3-5)	4(3-5)	4(3-5)	5(3-5)	4(3-5)	4(3-5)	4(3-5)	5(3-5)	0.007(0.894)
Features of Campylobacteriosis	4(4-5)	4(3-5)	4(3-4)	4(3-5)	4(3-5)	4(3-5)	4(2-4)	4(3-5)	3(3-5)	4(3.5-5)	-0.03(0.552)

*Categories from section E of survey

**IQR=Interquartile Range

Table 6. Views on content labelling of fresh chicken

Views on label content*	Median response by Ethnicity* (IQR**)											
	Māori	Non-Māori	Mann-Whitney p-value	Pacific	Non-Pacific	Mann-Whitney p-value	Asian	Non-Asian	Mann-Whitney p-value	NZ European & Other	Don't Know	Refused
Handling and Storage	5(4-5)	5(4-5)	0.123	5(5-5)	5(4-5)	0.176	5(4-5)	5(4-5)	0.692	5(4-5)	4(4-5)	4.5(4-5)
Cooking info	5(4-5)	5(4-5)	0.034♮	5(5-5)	5(4-5)	0.304	5(4-5)	5(4-5)	0.431	5(4-5)	5(4-5)	4.5(4-5)
Cleaning info	5(3-5)	5(4-5)	0.32	5(4-5)	5(4-5)	0.5	5(4-5)	5(4-5)	0.977	5(4-5)	4(4-5)	4(3-5)
Campylobacter Level	4(3-5)	5(4-5)	0.544	4.5(3-5)	5(4-5)	0.91	5(4-5)	5(3-5)	0.513	5(4-5)	4(3-5)	1.5(1-2)
Large, brightly coloured label	3(2.75-5)	4(3-5)	0.1	4(3-5)	4(3-5)	0.832	4(3-5)	4(3-5)	0.289	4(3-5)	3(2-4)	5(5-5)
Features of Campylobacteriosis	4(2-5)	4(3-5)	0.4	4(4-5)	4(3-5)	0.148	5(3-5)	4(3-5)	0.064	4(3-5)	4(2-4)	5(5-5)

*Categories from section E of survey

**IQR=Interquartile Range, Min-Max for Refused

♮-significant at the 0.05 level

Appendix 5. Results of poultry label analysis

Table 1: Supermarket on-site packaged fresh raw poultry labels: Display, Content and Total scores

Sample location (n=9)	Display score(out of 5)	Content score (out of 5)	Total score (out of 10)
Supermarket chain A Kilbirnie	2.5	1.5	4
Supermarket chain A Newtown	2.5	2	4.5
Supermarket chain A Petone	2	1.5	3.5
Supermarket chain B Hutt	0	0.5	0.5
Supermarket chain B Porirua	0	0	0
Supermarket chain C Miramar	0.5	1	1.5
Supermarket chain C Thorndon	0.5	0.5	1
Supermarket chain C Island Bay	0.5	1	1.5
Large chain butchery Porirua	0	0	0

Table 2: Different brands of bagged fresh whole poultry labels: Display, content and total scores

Brand and cut (n=16)	Display score (out of 5)	Content score (out of 5)	Total score (out of 10)
Supermarket chain A bagged whole chicken	1.5	3.5	4
Supermarket chain A bagged whole chicken flavoured variant	2	2	4
Supermarket chain A bagged whole chicken value variant	2	2	4

Brand A bagged whole chicken	2.5	2.5	5
Brand A bagged whole chicken flavoured variant	4	2.5	6.5
Brand B bagged whole chicken	4	3.5	7.5
Brand C bagged whole chicken	4.5	3	7.5
Brand D bagged whole chicken	4	2.5	6.5
Brand D bagged whole flavoured chicken	2.5	2.5	5
Brand E bagged whole chicken	3.5	2	5.5
Brand F bagged whole chicken	3.5	2	5.5
Brand F bagged whole flavoured chicken	1.5	2	3.5
Brand G Chicken roast	0.5	1	1.5
Brand H bagged whole chicken	2	2	4
Brand I bagged whole chicken	2	2	4
Brand J bagged whole chicken	2.5	2	4.5

Table 3: Other branded fresh chicken product labels: Display, content and total scores

Brand and cut (n=20)	Display score (out of 5)	Content score (out of 5)	Total score (out of 10)
Brand A chicken mince	0.5	1	1.5
Brand B chicken breast	0.5	2.5	3

Brand B chicken kebabs	3	2	5
Brand B chicken mince	1.5	1	2.5
Brand B chicken schnitzel	0.5	2	2.5
Brand C chicken breast	3	2	5
Brand C chicken mince	0.5	1.5	2
Brand C chicken sausages	1.5	2	3.5
Brand C chicken sausages	1.5	2.5	4
Brand F bagged whole flavoured chicken	1.5	2.5	4
Brand F chicken kebabs	0.5	1.5	2
Brand F chicken kebabs	0.5	2.5	3
Brand F chicken wings	1.5	2	3.5
Brand H chicken breast	0.5	1.5	2
Brand H chicken leg	3	2.5	5.5
Brand I chicken breast	0.5	1	1.5
Brand I chicken kebabs	2.5	1.5	4
Brand K chicken roast	1.5	2	3.5
Brand K chicken sausages	1	1	2
Brand L chicken kebabs	1.5	1.5	3