2017-05-16

Knowledge of Food Safety and Food Handling Practices amongst Food Handlers in the Republic of Ireland

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Recommended Citation

Nora M. A., Priyadarshini, A. & Jaiswal, A.K. (2017). Knowledge of food safety and food handling practices amongst food handlers in the Republic of Ireland. *Food Control*. doi:10.1016/j.foodcont.2017.05.020

Accepted Manuscript

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PII:	S0956-7135(17)30263-3
DOI:	10.1016/j.foodcont.2017.05.020
Reference:	JFCO 5626
To appear in:	*Food Control*
Received Date:	29 March 2017
Revised Date:	14 May 2017
Accepted Date:	15 May 2017

Please cite this article as: Nora A. Moreb, Anushree Priyadarshini, Amit K. Jaiswal, Knowledge of Food Safety and Food Handling Practices amongst Food Handlers in the Republic of Ireland, *Food Control* (2017), doi: 10.1016/j.foodcont.2017.05.020

Highlights

- Food safety knowledge amongst Irish residents was explored.
- 1069 participants from across Ireland contributed to the study.
- Knowledge of food handling and food poisoning observed was critically low.
- Gender, age, place of residence and education level impacted the knowledge level.
- Per capita income had no influence on the knowledge level.

Knowledge of Food Safety and Food Handling Practices amongst Food Handlers in the Republic of Ireland

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Abstract

Food safety concerns have existed for a long time, as millions of people across the globe suffer from food borne disease every year. Contamination of food owing to limited knowledge of food safety practices primarily increases the risk of food borne illnesses. In the present study, quantitative research was carried out to gauge the level of food safety knowledge amongst people living in Ireland. A total of 1069 participants from all over the Republic of Ireland contributed to the survey (of which 821 were included in this research). Results showed that the residents of Ireland overall had an average level on knowledge of food safety practices (67.0% passing rate). They had an average level of knowledge in food storage (52.8% passing rate), usage and maintenance of the kitchen facilities (59.0% passing rate), and personal hygiene (61.0% passing rate). Conversely, they had a critically low level of knowledge in food handling (10.8% passing rate) and food poisoning (20.1% passing rate). The results of the present study also showed that, the level of knowledge of food safety practices varies amongst the residents based upon their gender, age, place of residence, education level, and marital status, while no significant difference in the knowledge level was observed based upon their per capita income. The study thus, highlights that there is scope for improvement for the residents to advance their knowledge of food safety practices. Therefore, it can be recommended that researchers, educators, food safety communicators, and the media can engage in educating the population, to help the residents advance their food safety knowledge to safer food practices.

Keywords: Food safety; Food handling; Food hygiene; ; Knowledge; Practice

1 Introduction

Foodborne illnesses are a burden globally to public health and to a nation's economy (Copenhagen, 2015; Young, & Waddell, 2016). In the Republic of Ireland, the numbers of foodborne cases have been rising for the fifth consecutive year in 2015 according to data collected nationally as part of the EU Zoonoses regulation (Health Protection Surveillance Center [HPSC], 2016). Vulnerable groups are the most exposed to the risks of foodborne illnesses (World Health Organization [WHO], 2015a & WHO, 2014), because their immune systems are not fully capable of fighting off infections (Food and Drug Administration [FDA], 2016a & FoodSafety.org). A large percentage of the population in Ireland can be categorised as vulnerable, with older adults "65 years old and older" and younger children of "14 years old and younger" (13.38% and 22.24%, respectively), compared to the general population (Central Statistics Office [CSO], 2016) increasing the risk of foodborne incidents.

Research has shown that the increase in foodborne illnesses could be linked to improper food safety practices in homes, as home environments can harbour an array of foodborne pathogens (Langiano et al., 2012; Mountjoy, 2014; Young & Waddell, 2016), such as bacteria, viruses and fungi (Byrd-Bredbenner et al., 2013; National Health Services [NHS], 2014). Furthermore, due to home kitchen being used as a "multipurpose area" for more than just food preparation; this increases the risk of food contamination, proliferation, and possible foodborne illnesses (Byrd-Bredbenner et al., 2013 & NHS, 2014). According to WHO, Campylobacter, Salmonella and *E. Coli* are the most common foodborne pathogens that affect millions in the world (WHO, 2015b), including in the Republic of Ireland (HPSC, 2016). While prior research shows that improper handling, preparation, and storage of food can cause foodborne illness (USDA, 2016a), evidences support that in most cases, proper cooking or processing can eliminate the risk of foodborne illnesses (USDA, 2013). The most common source of food in Ireland are home cooked meals made from scratch using fresh

ingredients increasing the importance of being vigilant about knowledge of food safety practices (Healthy Ireland Survey, 2015).

Recent studies have investigated people's knowledge of food safety in many countries around the world, while in Ireland in 2001, a study was conducted testing the pathogenic foodborne bacteria in domestic kitchens within 25 homes. A total of 325 sampling sites, which included sampling before and after preparing chicken and six sites around the house, results showed that contamination was still found after the preparation of meals, increasing the need for consumer awareness and knowledge in food handling and hygiene (Gorman et al., 2002). Another study that was conducted in Ireland was in 2005, the study was to test the knowledge of 1025 participants from the Irish residents using a questionnaire, the findings of the research is that the majority of the Irish residents have a good base of food safety knowledge, however, that did not translate to the adherence to food safety practices, and knowledge on food poisoning was at a low level (McCarthy et al, 2007). Lastly, in Ireland in 2006 a study that tested the knowledge of food safety amongst 200 of chefs and catering manager was conducted through face to face interviews, the results showed that although they were aware of basic knowledge in order to deliver safe food that followed the law, they still needed extra training to further their knowledge to implement food safety effectively (Bolton et al., 2008). While the number of foodborne incidents are still increasing (HPSC, 2016), current studies to assess the public's knowledge in the Republic of Ireland does not exist.

Therefore, the aim of this study is to contribute to the existing knowledge to tackle the reasoning behind the increasing foodborne incidents by giving an updated insight on the assessment of knowledge of people living in the Republic of Ireland on food safety and their practices on preparing food at home. The study will compare demographics based on their level of knowledge of food safety practices and also to determine common areas of weakness.

This research can help practitioners and researchers in identifying the areas of weakness of the residents for furthering research in the areas needed. It can also aid the educators, food safety policy makers and food safety communicators on where the knowledge is lacking in the Irish residents. The study will achieve the objective by surveying the residents in multiple regions and analysing and comparing the results.

2 Materials and Methods

2.1 Questionnaire Design

A questionnaire was designed with multiple-choice questions to survey the public in the Republic of Ireland for their knowledge of food safety practices. It follows a validated questionnaire (Gong et al., 2016) developed and used for conducting similar studies. Appropriate modifications were made to the questionnaire to fit the popular habits and traditions of consumers in Ireland. It was also simplified to make it easier for the participant to answer, as according to McLeod (2014), questionnaires should be simple and easy for the surveyor to understand and aimed to address the concerns of the research.

The questionnaire comprised of 32 multiple-choice questions. It was divided into two sections. The first section consisted of six questions that covered the demographics of the individuals being surveyed, such as gender, age, place of residence, per capita annual income (in Euros), educational level and marital status. The second section tested their knowledge of food safety handling in domestic kitchens, which consisted of 26 questions with a total of five subsections that tested knowledge of food storage with six questions, knowledge of food handling via four questions, knowledge of the usage and maintenance of kitchen facilities through six questions, knowledge of personal hygiene with five questions and knowledge of food poisoning via five questions. Once the design of the questionnaire was established, it was pilot-tested amongst food safety and business management professionals to ensure

accuracy, and adjustments were made to enhance the survey based on the feedback received.

2.2 Target Participants

The target participants of the study were the people that reside in the Republic of Ireland, with the restrictions that they were over the age of 18, speak English in order to understand the survey, and handle food in their domestic kitchen to test their knowledge of food safety practices.

2.3 Data Collection

McLeod (2014) highlights that surveys are a useful tool to obtain a high volume of information from a large number of people in an efficient way and in a short period of time. In order to assure coverage in multiple areas on the Republic of Ireland, a survey was conducted across the Republic of Ireland. The participants were selected at random and were approached both in person with a print version of the survey or an electronic link to the survey was sent out for participation and completion of the survey. The print version was to be returned after it was completed on the spot, while participants who used the electronic link filled either on the spot or later at their own convenience. The participants were explained the objective of the study before completion of the survey, and assurance of their complete confidentiality as per the institution ethical guidelines. Furthermore, to ensure a non-bias sampling in coverage, the sample had a frame that covered the demographic aspects of the survey including: gender, age, place of residents, per capita annual income (in Euro's), educational level, and marital status.

The survey was distributed and responses were collected from September to December of 2016. On average, the participants spend around 20-30 minutes to complete the survey. Participants were approached in high traffic areas, such as popular streets, buildings, events, gatherings etc. Some of the participants were approached in their own households to get the

142 older age range and countryside array involved. The participants were contacted in a non-
143 systematic way, a total of 1,069 participants contributed, of which, 248 surveys were
144 dismissed due to incomplete survey or participants selected more than one option per
145 question. Thus, 821 surveys were included in this research.

146 **2.4 Data Analysis**

147 For the data analysis, the software package of SPSS version 20.0 by IBM Corporation was
148 used to statistically analyze all the data collected. There were twenty-six questions; each
149 question answered correctly would award the participant one point and zero for incorrect
150 answers, percentages of correct and incorrect answers for each question was calculated.
151 Additionally, each subsection of the knowledge portion of the survey the participant could
152 receive between four to six points depending on the subsection. The entire knowledge section
153 of the survey as well as each subsection had their mean score and standard deviation
154 analyzed. After calculating correct and incorrect answers for each participant, the participants
155 that answered more than half of the questions on the survey correctly would have attained a
156 pass; furthermore, for each subsection and demographics group the passing rates were also
157 analyzed. If the participants achieved a passing rate of 70.0% or more, they were considered
158 to have a good level of knowledge, however, if the results showed a passing rate of less than
159 50.0% that would point towards a poor level of knowledge, with 51.0% to 69.0% considered
160 as an average level of knowledge.

161 As the data had a skewed distribution, this suggested that it did not follow normal distribution
162 and thus non-parametric analysis would be the most appropriate method for analyzing the
163 data (Sullivan, 2016). Non-parametric tests (Chi-square (x^2), Manne-Whitney U and
164 Kruskale-Wallis) were used to analyze the entire data. The Chi-square (x^2) test was adopted
165 to compare the different demographics with the passing rates of the respondents to determine

whether there was a difference. The Manne-Whitney U test was used to compare the demographics with two independent samples (Sullivan, 2016). Therefore, it was used to compare the difference between city residents and countryside residence with the mean score, and the Kruskale-Wallis test was used to compare the specific demographics of three or more independent samples (Sullivan, 2016). Thus, it was used for the rest of the demographics (gender, age, per capita annual income (in Euros), educational level and marital status), and compared them with the mean scores of the participants

3 Results and Discussion

3.1 Samples Profile

Table 1 presents 6 of the demographic characteristics of the sample. 51.3% of the respondents were females, 35.2% were between the ages of 26 and 35, 73.3% were from the city, 59.0% had an annual income of 30,000 euro's or below, which is equivalent to 31,354.5 US dollars by the end of 2016; 72.5% of the respondents had a university education or above, and 55.7% were unmarried.

3.2 Knowledge of Food Safety Practices in Domestic Homes in the Republic of Ireland

3.2.1 Knowledge on Food Storage

Table 2 presents the knowledge of food safety in food storage; there were 6 questions in this subsection to assess their knowledge, resulting in the mean score of 3.5 points (from a range of 0-6). If the respondents got three or more out of this section of questions correctly, they attained a pass. The passing rate for this section in Ireland was at 52.8%, indicating an average degree of knowledge in food storage, which links a higher risk of poor food safety practices with mistakes done with improper food storage practices (Langiano et al., 2012).

189 The highest pass rate in this subsection was that 78.1% of the respondents knew that meat
190 should be bought at the end of the shopping time. Moreover, the pass rate for the same
191 question in China was 36.7% (Gong et al., 2016), in Lebanon 59.7% (Hassan &Dimassi,
192 2014), in Greece 55.3% (Lazou et al., 2012), in Jordan 73.6% (Osailiet al., 2011), and in the
193 US it was observed 38.5% did not pick frozen foods or raw meat at the end of shopping time
194 (Yapet al., 2016), highlighting that Irish residents got the highest passing rate among the
195 countries discussed above.

196 However, the lowest knowledge in this subsection is whether or not freezing temperatures
197 would affect bacterial activity, in where Ireland's passing rate was only 28.6%; while in
198 Canada 77.0% (Courtney et al., 2016), and in China it was 12.4% (Gong et al., 2016), in
199 Lebanon 64.0% (Hassan & Damassi, 2014), in Greece 78.3% (Lazou et al., 2012), and in
200 Jordan 52.2% (Osaili et al., 2011), indicating that Ireland is one of the lower passing rate for
201 this question.

202 ***3.2.2 Knowledge on Food Handling***

203 Table 3 presents the knowledge of food safety in food handling; there were 4 questions in this
204 subsection to assess their knowledge, resulting in a mean score of 2.1 points (from a range of
205 0-4). The respondents needed to get two questions or more correctly in order to attain a pass
206 in this subsection, which was 10.8% in Ireland, indicating critically low degree of knowledge.

207 Most respondents in present study (66.1%) knew that the correct answer on washing
208 vegetables and fruits must be washed with running cold water, while in China 51% knew the
209 correct answer to this same question (Gong et al., 2016), in Canada 92.5% knew that fresh
210 produce should be washed with cold running water (Burke et al., 2016), in South Africa 82%
211 claimed to have washed their fruits and vegetables correctly (Sibanyoni et al., 2016), in
212 Lebanon 51.4% wash them under running water (Hassan &Dimassi, 2014), In Greece 72.8%

knew the correct answer (Lazou et al., 2012), in Saudi Arabia 91.7% knew the correct answer (Sharif & Al-Malki, 2010), and in Jordan 28.4% knew the correct answer (Osaili et al., 2011). Ireland's knowledge is on the lower average of the passing rate although this is the highest knowledge in this subsection.

The lowest knowledge in this subsection was regarding thawing of raw meat, 43.5% of the Irish residents knew that the least safe way to thaw raw meat is on the chopping board, while in China 38.2% knew the correct answer (Gong et al., 2016), 58.3% in Brazil knew the best way to defrost food (Uggioni & Salay, 2012), in the US among the elderly 50.0% did not thaw their meat in the refrigerator (Yap et al., 2016), while in the US 79.2% knew that the best way to thaw meat is in the refrigerator and only 1.4% thought that thawing on the countertop is the best way (Meysenburg et al., 2014), in Lebanon 28.0% knew to defrost raw meat in the refrigerator while 38.5% thought that on the countertop is the best way (Hassan & Dimassi, 2014), in Greece 24.1% knew the correct answer (Lazou et al., 2012), and in Jordan 27.1% knew the correct answer (Osaili et al., 2011). Irish residents in the present study are within the lower knowledge rate of this question.

Control measures that are currently in place by producers are not sufficient in eliminating the risk of food borne illness, so precautions taken by the consumer in handling food is critically important as it could avoid cross-contamination, eliminate or slow the growth of existent bacteria, which eventually would avoid foodborne illnesses, making it very important for the consumer to be well informed about proper food handling practices (Langiano et al., 2012; Mountjoy, 2014). Plus, Ireland is alarmingly low in knowledge in this subsection making it essential for the public to be better informed.

3.2.3 Knowledge on Usage and Maintenance of Kitchen Facilities

Table 4 presents the knowledge of food safety on usage and maintenance of kitchen facilities at domestic homes in Ireland; there are 6 questions in this subsection to assess their knowledge, resulting in a mean score of 3.7 points (from a range of 0-6). The respondents needed to get three questions or more correctly in order to attain a pass in this subsection, which was 59.0% in Ireland, confirming residents had average degree of knowledge.

The highest passing rate in this subsection was that 71.6% of the respondents knew the correct temperature to store food in the refrigerator, while in China it was 32.4% (Gong et al., 2016), in Portugal 69.5% of respondents chose the answer of below or at 2-8°C (Carbas et al., 2013), in Wales 84.0% of the elderly were unaware of the proper temperature of the refrigerator (Evans & Redmond, 2016), in Lebanon 53.1% knew the correct answer (Hassan & Damassi, 2014), in Greece 44.4% knew the correct answer (Lazou et al., 2012), and in Jordan 34.1% knew the correct answer (Osaili et al., 2011). Results showed that Ireland is at the higher end of knowledge with regard to this question, and that Irish participants scored highest in this subsection.

On the other hand, the lowest knowledge in this subsection is on the use of the chopping board for raw meat and fresh fruit. 51.2% of the Irish respondents got the correct answer, while in Canada it was 97.7% (Burke et al., 2016), in China 12.4% (Gong et al., 2016), in Brazil 54.0% (Uggioni & Salay 2012), 21.0% among elderly in the US did not use a separate cutting board (Yap et al., 2016), in Lebanon 38.6% knew the correct answer (Hassan & Dimassi, 2014), and in Jordan 61.6% knew the correct answer (Osaili et al., 2011). Survey reveals that Ireland ranks average in where it could be improved.

This subsection is of importance to have knowledge in usage and maintenance of kitchen facilities to avoid pathogenic growth or cross-contamination in order to gain food safety

practice (Evans & Redmond, 2016; Langiano et al., 2012), including the need to concentrate on hotspots that gather the highest bacterial count based on studies (NHS, 2014), since the Irish consumer has average knowledge, it is clear that the knowledge can and should be improved in order to see decreased incidence of foodborne illnesses.

3.2.4 Knowledge on Personal Hygiene

Table 5 presents the knowledge of personal hygiene in the Republic of Ireland; there were 5 questions in this subsection to assess their knowledge, resulting in a mean score of 3.5 points (from a range of 0-5). The respondents needed to get three questions or more correct in order to attain a pass in this subsection, which was 61.0% in Ireland, which is an average degree of knowledge.

85.0% participants in Ireland that knew to wash their hands with soap and warm water then wipe dry after handling raw meat. While in Canada 66.4% between the ages of 19-29 knew the correct answer (Burke, et al., 2016), while 71.5% of the Canadian undergraduate university students knew how to wash their hands correctly (Courtney et al., 2016), in china 27.2% (Gong et al., 2016), and in the US 30.8% in 1998 and 21.5% in 2010 reported that they did not wash their hands before preparing food showing a decreased curve which indicates improved knowledge over the years and that could be due to several federal media coverage on food safety (Fein et al, 2011), 50.0% in another study showed that young adults in the US washed their hands properly after handling raw chicken (Byrd-Bredbenner et al., 2009), in another study 91.4% among the elderly in the US washed their hands properly before preparing food (Yap et al., 2016), while another showed that 45.8% of the elderly did not know or did not wash their hands properly after handling raw meat (Cates et al., 2009), and in the US 95.8% of the parents with young children knew to wash their hands before preparing food (Meysenburg, et al., 2014), in South Africa 97.0% claimed to wash their hands after

handling raw food (Sibanyoni et al., 2016), in Ghana 75.6% agree that hands should be washed before prepping food (Akonor&Akonor, 2013), in Greece 57.5% knew the correct answer (Lazou et al., 2012), and in Saudi Arabia 96.1% of university students wash their hands before preparing foods (Sharif & Al-Malki, 2010), 92% of chefs in Ireland from a previous study knew the correct answer (Bolton et al., 2008). Present study showed that knowledge on when and how to wash hands properly is important and Ireland was on the higher end of the passing rate with knowing both aspects in washing hands after handling raw meats and how to wash it correctly, showing a decent degree of knowledge in personal hygiene.

The lowest knowledge in this subsection was related to whether it is safe to handle food as long as gloves are worn. Only 46.3%Irish participants answered this question correctly. In China, 25.5% knew the correct answer (Gong et al. 2016); in Brazil, 29.1% were correct (Uggioni & Salay 2012); in Greece, 19.6% chose the correct answer (Lazou et al. 2012); 64.0% of Hispanic families with younger children knew the correct answer (Stenger et al. 2014); and, in Jordan, 23.0% were aware of the correct answer (Osaili et al. 2011). It is evident that, although Irish participants had the poorest level of knowledge in this subsection, they scored at the higher end in terms of knowledge when compared to other countries. However, it is noteworthy that they scored below 50.0%, which is considered a poor degree of knowledge, and there is scope for improvement.

According to research, knowledge of the importance of personal hygiene immediately coincides with the adherence to personal hygiene practices (Ismail et al., 2016; Jianu & Goleţ, 2014), however, research has shown that knowledge on hand hygiene and adherence to the knowledge does not necessarily coincide, which correspondingly needs more attention and stress on its importance (Jianu & Goleţ, 2014).

3.2.5 Knowledge on Food Poisoning

Table 6 presents the knowledge of personal hygiene in the Republic of Ireland; there are 5 questions in this subsection to assess this knowledge, resulting in a mean score of 2.4 points (from a range of 0-5). The respondents needed to get three questions or more correctly in order to attain a pass in this subsection, which was 20.1% in Ireland, which is critically poor degree of knowledge.

The highest knowledge in this section was regarding raw or undercooked beef or eggs causing food poisoning and 74.5% of participants knew the correct answer, this can be easily explained with how recommendations of the Food Safety Authority in Ireland (FSAI) on labelling or serving safely based on the study that showed present pathogens in raw meat and the fact that the European Union (EU) made it mandatory to present safety instructions on cooking raw meat or eggs to avoid food borne illnesses (FSAI, 2013; EC NO 1169/2011); while in China 25.3% knew undercooked beef, 8.9% knew raw eggs or 12.2% knew that both could cause food poisoning (Gong et al., 2016), in Portugal 12.5% respondents knew that undercooked beef, 19.0% knew raw eggs, or 43.8% knew that both including unpasteurized milk could cause food poisoning (Carbas et al., 2013), in South Africa 64.3% knew that raw eggs could cause food poisoning (Sibanyoni et al., 2016), 44.1% in Ghana agree that it is safer to eat fully cooked eggs rather than raw (Akonor & Akonor, 2013), in Saudi Arabia 43.9% knew that eating raw eggs was not safe while 86.1% knew that eating under cooked meats is not safe (Sharif & Al-Malki, 2010), of Hispanic families with young children 35.0% knew that under cooked eggs can be unsafe and 82.0% knew that undercooked meat is unsafe (Stenger et al., 2014), and in Jordan 52.9% knew that undercooked eggs can be unsafe and 79% knew that undercooked meat is unsafe (Osaili et al., 2011). Ireland though shows decent knowledge in comparison to other countries, yet it is evident from our results that this needs improvements.

The lowest knowledge in this subsection was that 10.1% of the respondents knew that meat sauce from the deli is most likely to become contaminated with *Listeria* in comparison to raw or undercooked meat, eggs or vegetables; while in China 24.3% knew the correct answer (Gong et al., 2016), in Greece it was 15.1% (Lazou et al., 2012), and only 40% in the US ever heard of *Listeria* (Cates et al., 2009). Overall results showed that Ireland has critically poor knowledge in food poisoning.

This section is of extreme importance for the Irish residents to understand on how to handle the food to avoid cross contamination and how to cook it properly according to the safety guidelines that are provided by the FDA and USDA in order to avoid food poisoning, moreover, to understand the possible risks of foodborne illnesses if they are to occur (FDA, 2016-b& USDA, 2016-b). An example for this is, in 2015 in Ireland reports showed that one of the most common bacteria is *Campylobacter* in where 2,451 cases were reported this is the fifth consecutive year to where numbers of cases are elevated; Ireland also had the highest number of cases of verotoxigenic *Escherichia coli "E. coli"* (VTEC) comparison to Europe where 730 of reported cases and rising every year; 269 cases of *Salmonella* cases, and 19 cases of *Listeriosis* and rising (HPSC, 2016), if the consumer is eating at home, pathogenic foodborne could be avoided with proper handling using four simple steps, making sure personal and kitchen hygiene is present, separating to avoid cross contamination, cooking each food item to the proper temperature using a thermometer, and chilling promptly (USDA, 2016b), and if dining out to assure that the restaurant takes these precautions with hygiene and that the food is fully cooked (Cunningham, 2015).

3.3 The Relation between the Demographic Characteristics and Knowledge of Food Safety in Homes

There were 5 subsections in total that covered different aspects on food safety knowledge in Ireland, which consisted of 26 questions in total, if the respondent were to get thirteen or more of the overall questions correctly then they have attained a pass, the mean score for the entire survey was 15.3 points (from a rage of 0-26) and a standard deviation of 5.1, with an overall passing rate of 67.0%. Table 7 presents the relation between specific demographic characteristics and mean score and overall passing rate between respondents, using the non-parametric tests (Chi-square (x^2), Manne-Whitney U, and Kruskale-Wallis).

The results showed that, gender, age, place of residents, educational level, and marital status with the ($P < 0.05$) for all five categories showed significant factors that impact the knowledge of food safety practice in the Republic of Ireland, while on the other hand, per capita annual income did not have any significance with the ($P > 0.05$), which suggests that educators should direct their programs to those 5 factors in order to make an impact on their knowledge level.

Females were better with food safety knowledge with the passing rate of 59.0%, respondents at the age of 26-35 years old were more knowledgeable with a passing rate of 33.0%, people that lived in cities were significantly more knowledgeable with the passing rate of 69.1%, educated people with a university and above degree at 74.2% passing rate and unmarried were with a passing rate of 53.3%, while married with children and married without children showed significant results in passing rates as 31.1% and 7.8% respectively. It is however noteworthy that as the participants were randomly selected, the pass rates of some demographic groups can be very low due to the very small number of respondents in those groups. The findings correlate with a report by WHO in 2015, that “demographic, cultural,

economic and environmental developments, an ageing population, changing consumer trends and habits, new technologies" all factor increase foodborne health risks (Copenhagen, 2015). Additionally, based on the research findings, it is argued that the aspects that affect food safety practices and knowledge are broad, further education is universally needed in order to help decrease foodborne illnesses and better understand the problem of why food safety is a globally epidemic issue (Copenhagen, 2015).

4 Conclusion

With the overall passing score of participant being 67.0% and a mean score of 15.3 points (a range of 0-26), residents of Ireland can be regarded as having an average level of knowledge of food safety practices. Yet, when analysed for the different aspects of the 5 subsections in the survey, their knowledge was found to be critically low in food handling (10.8% passing rate) and alarmingly low with regard to the knowledge of food poisoning. Furthermore, the different demographics did show some significant differences, overall women appeared to be more knowledgeable and the eldest (51 years old and above) and youngest (18-25years) groups had the least level of knowledge; people who lived in the city were more knowledgeable than those who lived in the countryside; educated people who had at least a university or above degree knew the most about food safety; and unmarried or married with children had the highest level of knowledge versus those who did not have children and others. Overall, the study indicates that there is scope for improvements about food safety knowledge in people living in Ireland. It is recommended that researchers, educators, food safety communicators, and the media should work towards educating the population to advance their food safety knowledge to safer food practices.

Acknowledgement

The authors would like to acknowledge the support and facilities provided by Dublin Institute of Technology, Dublin, Ireland. The researcher Nora A. Moreb was financially supported by the Saudi Arabian Government, Saudi Arabia.

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550 **Table Legends**

551 Table 1. Sample characteristics

552 Table 2. Respondents knowledge on food storage, pass rate, mean score and standard
553 devastation

554 Table 3. Respondents knowledge on food handling, pass rate, mean score and standard
555 devastation

556 Table 4. Respondents knowledge on usage and maintenance of kitchen facilities, pass rate,
557 mean score and standard devastation

558 Table 5. Respondents knowledge on personal hygiene, pass rate, mean score and standard
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561 devastation

562 Table 7. The relation between the demographic characteristics and knowledge of food safety
563 in homes

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Table 1. Sample characteristics

Demographic Characteristics	N	Category	Respondents (n.)	Percentage (%)
Gender	802	Male	372	46.4
		Female	421	51.3
		Other	9	1.1
Age	805	18 - 25	254	31.6
		26 - 35	283	35.2
		36 - 50	175	21.7
		51 and above	93	11.6
Place of Residence	798	City	585	73.3
		Countryside	213	26.7
Per Capita Annual income (Euro's)	785	Below 30,000	463	59.0
		30,000 – 60,000	223	28.4
		60,001 – 100,000	74	9.4
		100,000 and above	25	3.2
Educational Level	801	University and Above	581	72.5
		Leaving Cert – Senior Secondary	147	18.4
		Junior Cert – Junior Secondary	47	5.9
		No qualification	26	3.2
Marital Status	803	Unmarried	447	55.7
		Married without children	84	10.5
		Married with children	218	27.1
		Other	54	6.7

Note: exchange rate was 1 euro equals 1.05 US dollars by the end of 2016.

Table 2. Respondents' knowledge on food storage, pass rate, mean score and standard devastation

Questions	N	Category	Respondents (n.)	Percentage (%)
1. How should chunks of raw meat be stored?	816	Store it directly in the refrigerator	315	38.6
		Slice it into smaller pieces, then store them in the refrigerator	56	6.9
		Slice into smaller pieces, seal and store them in the refrigerator	**392**	**48.0**
		Store it in a cool place	53	6.5
2. Can bacteria in food be killed by freezing at -18°C?	818	Yes, totally	115	14.1
		Yes, partly	306	37.4
		Not at all	**234**	**28.6**
		Do not know	163	19.9
3. When is the best time to purchase frozen food when shopping?	818	At the beginning of the shopping time	49	6.0
		At the end of the shopping time	**639**	**78.1**
		Whenever, does not matter	101	12.3
		Do not know	29	3.5
4. What is the optimal temperature for storing frozen food?	810	4 °C	63	7.8
		0 °C	117	14.4
		-18 °C or Below	**516**	**63.7**
		Do not know	114	14.1
5. What should be done with freshly prepared food that will be consumed 3 hours later?	808	**Put in the refrigerator, then reheat when ready to eat**	**526**	**65.1**
		Put it in the cupboard, then reheat when ready to eat	86	10.6
		Put it in the microwave oven	57	7.1
		Cover it and put it on the cabinet	139	17.2
6. Should thawed meat be frozen for later use?	805	Yes	96	11.9
		No	**544**	**67.6**
		Maybe	72	8.9
		Do not know	93	11.6
Total Score			430	52.8
Pass rate (%)				
Mean score ± standard deviation				3.5±1.4

The correct answer for each question is highlighted in bold

Table 3. Respondents' knowledge on food handling, pass rate, mean score and standard devastation

Questions	N	Category	Respondents (n.)	Percent (%)
7. How should vegetables and fruits be washed?	805	Soak in detergent	23	2.9
		Wash with hot water	100	12.4
		Wash with running cold water	**532**	**66.1**
		Soak in cold water, then wash	150	18.6
8. Of the following, which is the least safe way to thaw raw meat?	797	In refrigerator	113	14.2
		On chopping board	**347**	**43.5**
		In microwave oven	218	27.4
		In cold water in sealed package	119	14.9
9. Of the following, which is the correct way to heat leftovers?	805	Heat it to the temperature you prefer	235	29.2
		Reheat is not necessary if it is during the summer	42	5.2
		Heat until they are boiling	**428**	**53.2**
		Do not know	100	12.4
10. What should be done if the leftovers are still not eaten completely?	805	**Discard them immediately**	**399**	**49.6**
		Put in the refrigerator immediately and reheat before consuming	293	36.4
		Store in kitchen and reheat before consuming	54	6.7
		As long as they smell good, eat them	59	7.3
Total Score			89	10.8
Pass rate (%)				
Mean score ± standard deviation				2.1±1.1

The correct answer for each question is highlighted in bold

Table 4. Respondents knowledge on usage and maintenance of kitchen facilities, pass rate, mean score and standard devastation

Questions	N	Category	Respondents (n.)	Percentage (%)
11. A refrigerator has three shelves, on which shelf do you think raw meat should be placed?	805	Top shelf	157	19.5
		Middle shelf	56	7.0
		Bottom shelf	**508**	**63.1**
		Does not matter	84	10.4
12. What is the recommended temperature for fridges?	814	12 °C	51	6.3
		4 °C	**583**	**71.6**
		0 °C	86	10.6
		Do not know	94	11.5
13. How long should leftovers be kept in the fridge?	810	**No more than 2 days**	**564**	**69.6**
		No more than 5 days	113	14.0
		As long as the food has not gone bad	99	12.2
		Do not know	34	4.2
14. Of the following, which is the correct way to clean the kitchen countertop and stove?	811	Clean with dry rag	36	4.4
		Clean with wet rag	77	9.5
		Clean with detergent and warm water	**534**	**65.8**
		All of the above	164	20.2
15. Of the following, which do you think is the correct way to wash dishes?	806	Soak in water, after several hours, wash with the same water	20	2.5
		Wash immediately after meal	**453**	**56.2**
		Wash in water basin, dry with dishcloth	284	35.2
		Other	49	6.1
16. A person has cut meat on a chopping board and now he/she wants to cut fruit. Of the following, which are the correct ways?	808	Rinse the chopping board with hot water before cutting fruit	81	10.0
		Use the other side of the chopping board to cut fruit	63	7.8
		Clean the chopping board with detergent and hot water before cutting fruit	250	30.9
		Use another chopping board to cut fruit	**414**	**51.2**
Total Score			484	59.0
Pass rate (%)				
Mean score ± standard deviation				3.7±1.6

The correct answer for each question is highlighted in bold

Table 5. Respondents knowledge on personal hygiene, pass rate, mean score and standard devastation

Questions	N	Category	Respondents (n.)	Percentage (%)
17. Is it safe to handle food if a person has a wound on the back of his/her hand?	805	Yes, as long as the wound is not infected	70	8.7
		Yes, as long as the wound has a bandage on it	185	23.0
		Yes, as long as gloves are worn	**373**	**46.3**
		Not at all	177	22.0
18. Of the following, which is the correct way to wash hands?	810	Wash with running cold water, wipe dry	32	4.0
		Wash with running warm water, wipe dry	64	7.9
		Wet hands with cold water in a basin, use soap and then wash hands with cold water in the basin, wipe dry	98	12.1
		Wet hands with running warm water, use soap and then wash with running warm water, wipe dry	**616**	**76.0**
19. Of the following, which is the correct way to wash hands after handling raw meat?	806	Wipe with towel	21	2.6
		Wash with cold water, wipe dry	41	5.1
		Wash with warm water, wipe dry	59	7.3
		Wash with soap and warm water, wipe dry	**685**	**85.0**
20. After touching which of the following should a person wash his/her hands during the course of preparing food?	800	Face	30	3.8
		Pimple on the surface of skin	123	15.4
		Clothes	42	5.3
		All of the above	**605**	**75.6**
21. People with which of the following symptoms should not cook for others?	801	**Diarrhea, Fever, Sore throat or Flu**	**607**	**75.8**
		Skin allergies	96	12.0
		AIDS	78	9.7
		Headache	20	2.5
Total Score			501	61.0
Pass rate (%)				
Mean score ± standard deviation				3.5±1.4

The correct answer for each question is highlighted in bold

Table 6. Respondents knowledge on food poisoning, pass rate, mean score and standard devastation

Questions	N	Category	Respondents (n.)	Percentage (%)
22. Which is the most important for preventing food poisoning?	799	Spray the kitchen with insecticides weekly	41	5.1
		Avoid eating leftovers	138	17.3
		Keep food refrigerated until it is time to serve them	**346**	**43.3**
		Use detergent to disinfect kitchen countertop and stove weekly	274	34.3
23. How to prevent *salmonella* poisoning?	803	**Fully heat food**	**554**	**69.0**
		Wash food with very hot water	50	6.2
		Freeze food for more than 3 days	48	6.0
		Do not know	151	18.8
24. Which of the following is most likely to become contaminated with *Escherichia Coli (E. coli)*?	802	Tap water	139	17.3
		Raw pork or beef	**423**	**52.7**
		Raw vegetables	90	11.2
		Do not know	150	18.7
25. Which of the following is most likely to become contaminated with *Listeria*?	801	Raw or uncooked meat and eggs	361	45.1
		Meat sauce from the deli	**81**	**10.1**
		Raw vegetables	**85**	**10.6**
		Do not know	274	34.2
26. You can get food poisoning from eating which of the following?	801	Fruits taken out of the refrigerator immediately	17	2.1
		Unheated canned food	88	11.0
		Raw or undercooked beef and eggs	**597**	**74.5**
		Other	99	12.4
Total Score			165	20.1
Pass rate (%)				
Mean score ± standard deviation				2.4±1.2

The correct answer for each question is highlighted in bold

Table 7. The relation between the demographic characteristics and knowledge of food safety in homes

Variables	N	Pass rate (%)	P-value	Mean score	P-value
Gender	802		0.000		0.000
Male		39.7		14.4	
Female		59.8		16.4	
Other		0.6		11.3	
Age	805		0.000		0.000
18 – 25		29.2		14.8	
26 – 35		33.0		14.8	
36 – 50		23.6		16.4	
51 and above		14.2		17.0	
Place of Residence	798		0.000		0.000
City		69.1		15.0	
Countryside		30.9		16.7	
Per Capita Annual income (Euro's)	785		0.321		0.130
Below 30,000		58.9		15.2	
30,000 – 60,000		29.6		16.1	
60,001– 100,000		8.9		15.0	
100,000 and above		2.6		14.7	
Educational Level	801		0.000		0.000
University and Above		74.2		15.7	
Leaving Cert – Senior Secondary		20.8		16.2	
Junior Cert – Junior Secondary		3.3		11.9	
No qualification		1.7		11.0	
Marital Status	803		0.000		0.000
Unmarried		53.3		15.0	
Married without children		7.8		13.2	
Married with children		31.1		16.7	
Other		7.8		16.7	

Note: exchange rate was 1 euro equals 1.05 US dollars by the end of 2016.
Pass rates tested using Chi-square (X^2) Test
Mean scores tested using Manne-Whitney U and Kruskal-Wallis Tests