Accepted Manuscript

Title: Meat handlers training in Portugal: a survey on Knowledge and Practice

Authors: Eduarda Gomes Neves, Carla Sofia Cardoso, Ana Cristina Araújo, José Manuel Correia da Costa

PII: S0956-7135(10)00328-2

DOI: 10.1016/j.foodcont.2010.09.036

Reference: JFCO 2064

To appear in: *Food Control*

Received Date: 26 April 2010

Revised Date: 17 September 2010

Accepted Date: 24 September 2010

Please cite this article as: Neves, E.G., Cardoso, C.S., Araújo, A.C., Correia da Costa, M. Meat handlers training in Portugal: a survey on Knowledge and Practice, Food Control (2010), doi: 10.1016/j.foodcont.2010.09.036

Eduarda Gomes Neves[1], Carla Sofia Cardoso[2] Ana Cristina Araújo[3], and José Manuel Correia da Costa[4]

1. Molecular Pathology and Immunology, Instituto de Ciências Biomédicas Abel Salazar (ICBAS), University of Porto, Largo Prof. Abel Salazar 2, 4050-011 Porto, Portugal

2. University of Porto, Rua dos Bragas, 223, 4050-123, Porto, Portugal

3.Direcção Geral de Veterinária, Direcção de Serviços Veterinários da Região Norte, Rua Franca 534, S. Torcato, 4800-875 Guimarães, Portugal

4. INSA National Health Institute Dr. Ricardo Jorge, Rua Alexandre Herculano, 321, 4000-055 Porto, Portugal

***Corresponding author:**

Eduarda Gomes Neves

Molecular Pathology and Immunology

Instituto de Ciências Biomédicas Abel Salazar (ICBAS)

Universidade do Porto. Lg. Prof. Abel Salazar 2, 4050-011 Porto, Portugal

Phone: +351-22-2062200

Fax:+351-22-2062232

e-mail: egomesneves@mail.icav.up.pt

Meat handlers training in Portugal: a survey on Knowledge and Practice

Abstract

Professional training for meat handlers is an European Community food law requirement in order to apply HACCP principles and achieve food safety goals. A self-administered questionnaire designed to assess “Knowledge” and “Practice” of public hygiene measures was completed by meat handlers (MH) (n=159) in slaughterhouses in Portugal. A significant proportion of the group

(72.7%) has had professional training in two different areas: Good Practice in Food Industry (12.03%) and Work Safety and Hygiene (22.8%); 37.9% of the respondents have had training in both areas. However 24.5% of the subjects have never had training. Meat handlers with professional training in Good Practice in Food Industry (GPFI) and in both areas (BT) have had the highest proportions of correct answers in Knowledge (66.92±16.36 and 67.26±21.05, respectively) and Practice questions (70.53±17.47 and 68.67±22.58, respectively).

The results of this study point to the need to improve training, particularly in Good Practice in Food Industry, thus enabling meat handlers to achieve more correct answers in Knowledge and Practice. The development of evaluation criteria for the effectiveness of professional training is crucial to protect Public Health.

Key Words: Hygiene, Training, Meat handlers, Knowledge, Practice, Portugal.

Meat handlers training in Portugal: a survey on Knowledge and Practice

Abstract

Professional training for meat handlers is an European Community food law requirement in order to apply HACCP principles and achieve food safety goals. A self-administered questionnaire designed to assess “Knowledge” and “Practice” of public hygiene measures was completed by meat handlers (MH) (n=159) in slaughterhouses in Portugal. A significant proportion of the group (72.7%) has had professional training in two different areas: Good Practice in Food Industry (12.03%) and Work Safety and Hygiene (22.8%); 37.9% of the respondents have had training in both areas. However 24.5% of the subjects have never had training. Meat handlers with professional training in Good Practice in Food Industry (GPFI) and in both areas (BT) have had the highest proportions of correct answers in Knowledge (66.92±16.36 and 67.26±21.05, respectively) and Practice questions (70.53±17.47 and 68.67±22.58, respectively).

The results of this study point to the need to improve training, particularly in Good Practice in Food Industry, thus enabling meat handlers to achieve more correct answers in Knowledge and Practice. The development of evaluation criteria for the effectiveness of professional training is crucial to protect Public Health.

Key Words: Hygiene, Training, Meat handlers, Knowledge, Practice, Portugal.

1. Introduction

The increasing incidence of food borne diseases has been assigned to many different factors, including population growth, changes in food preparation habits, a rise in the number of food-service establishments, increased consumption of food outside the home and a lack of food safety training and education among consumers and food handlers (Motarjemi & Käferstein, 1999). Worker mishandling of food is one of the major causes of food borne disease outbreaks (WHO, 2000). Because outbreaks often lead to severe economic losses, food handler training is an important business strategy for managing food safety risks. Moreover, food handler training is seen as one strategy by which food safety can be increased, offering long-term benefits for the food industry (Smith, 1994). In addition, the European Parliament has adopted in April 2004 the Regulation (EU) No. 852/2004, underlining the need for all the food businesses to identify the steps of the production process in order to ensure food safety and this has been applied to all EU food businesses since the 1st January 2006. The main change relates to food safety management systems, i.e. risk-based methodologies to ensure food safety. The law's implementation recognizes education of food handlers as a crucial line of defence in the prevention of food borne illnesses (Sun & Ockerman, 2005; Legnani, Leoni, Berveglieri, Mirolo, & Alvaro, 2004; Worsfold, 2001; Martínez-Tomé, Vera & Murcia, 2000). Food business operators shall ensure that all stages of production, processing and distribution of food under their control satisfy the relevant hygiene requirements laid down in the Regulation (EU) No. 852/2004 (Jevšnik, Hlebec & Raspor, 2008). A successful implementation of the procedures based on the HACCP (Hazard Analysis and Critical Control Points) principles will require the full cooperation and commitment of food business employees and to this end they should undergo training. Under the personal program of HACCP, employees must be trained in such areas as food safety, manufacturing controls and personnel

hygiene. Once HACCP plans have been established, employees must be trained to manage any critical control points (CCPs). The necessity of application of the HACCP principles introduced by the *Codex Alimentarius* 30 years ago became law in Portugal in 1998 (Diário da República, 1998), and the Portuguese law has recently established the requisites for a “handler card” (Diário da República, 2006) for meat handlers (MH) working in meat retail businesses, to apply from 1st August 2008. To obtain this card, it is necessary to attend 15 hours of mandatory training on the following subjects: Meat Hygiene, Food Microbiology, Handlers' Personal Hygiene, Working spaces and Equipments' Hygiene, Packaging of meat and meat products, Hygiene of meat selling and delivery, Food Safety and HACCP, Work Safety and Hygiene. However, this training and this card are not required for working in abattoirs and deboning rooms, where it is considered that the EU regulations No. 852/2004 and No. 853/2004 regulate the need for professional training. The Portuguese general law that regulates work conditions has a legal requirement of 35 hours of yearly training for all workers (Diário da República, 2003, 2004). Recently, much has been written specifically on training in the food industry, but a great part of it is rather specific in nature and has been limited to discussions on single segments, primarily hotels and restaurants (Barrows, 2000; Seaman & Eves, 2006). There is a general lack of information about professional training for slaughterhouses and deboning rooms' workers.

The aim of this study was to evaluate and compare the level of general knowledge and practice of meat handlers from slaughterhouses and meat plants from northern Portugal, evaluating the professional training they have received. To our knowledge, this is the first survey on meat handling knowledge and practice in Portugal. Other similar studies have been reported in several countries focusing on food handlers (Walker, Pritchard & Forsythe, 2003; Nel, Lues, Buys & Venter, 2004; Seaman &

79 Eves, 2006; Gomes-Neves, Araújo, Ramos & Cardoso, 2007; Jevšnik, Hlebec &
80 Raspor, 2008).

2. Material and Methods

2.1. Questionnaire design

The self-administered questionnaire used in this study comprises 24 multiple choice questions with three or four possible answers, including “do not know” for the purpose of minimizing the possibility of selecting the correct answer by chance. In addition, the questionnaire has seven questions related to demographic and job characteristics of the respondents (age, gender, number of years of formal education, age at the beginning of professional activity, job description and years of experience in the present activity and present company, professional training and the opinion to additional training). The present questionnaire has been adapted from a questionnaire used in a previous study (Gomes-Neves et al, 2007).

The questions were designed and structured in two groups. A group of questions designated “Knowledge” (14 questions) was intended to assess the respondent’s knowledge about HACCP, microbiologic hazards development, food poisoning and food borne illness, safety and health requirements, high-risk food groups, dirty and clean areas in the workspace and water temperature in knife sterilizers. A second group of questions designated “Practice” (10 questions) was designed to assess respondents' habits focused on personal hygiene practice and cross contamination, working surfaces and instrument washing requirements and products, meat and chopped meat storage temperatures, freezing temperatures, temperature ranges and food poisoning agents development, water treatment and non potable water use, as water supply and quality and food security and safety are intertwined (Kirby, Bartram & Carr, 2003)(Table 1).

The participants answering the questionnaire have remained anonymous. Each participant has been informed of the purpose of the survey and that confidentiality would be assured.

2.2. Questionnaire delivery

The questionnaire has been delivered in person in seven red meat abattoirs with deboning rooms, during routine meat inspection of the Veterinary Official Services between May 2007 and May 2008, in two different regions of northern Portugal. In each meat plant, questionnaires have been delivered to all the employees performing tasks related with meat handling. The completed questionnaires have been collected in person one month later.

2.3. Statistical analysis

The analysis of the questionnaires has been performed using the computer software SPSS® (SPSS Inc., Chicago, IL; version17.0). The significance of the statistical differences of the proportion of correct answers between the groups of participants classified according to professional training has been identified using the Chi-Square test. The 95% confidence intervals (95% CI) of the proportion of correct answers in each group have been estimated according to the Wilson procedure with a correction for continuity (Wilson, 1927; Newcombe,1998). The differences in the mean scores of Knowledge and Practice questions between the same groups referred to above have been determined using one-way ANOVA with a post-hoc test. In all tests, the statistical significance was two-sided and considered significant at $p<0.05$.

3. Results

3.1. Quantitative results

3.1.1. Participants' response

Answers have been obtained from all the meat plants contacted, but 10% of the employees have not returned the questionnaire. The number of participants was 159 (115 male and 44 female). All but one were Portuguese. The participants' general characteristics are presented in Table 2.

134

135 3.1.2. Comparative analysis of training areas and periods of time among participants

136 Two different areas of professional training among meat handlers (MH) have been
137 identified: 1. Good practice in food industry (GPFI), and 2. Work Safety and Hygiene
138 (WSH). The vast majority of the respondents (72.7%) has had professional training.
139 Twelve percent (12.03%) of the respondents have had training in GPFI (12.03%),
140 22.8% in WSH and 37.9% in both areas (BT). During the previous year, 37.7% of
141 the MH have received between 20 and 35 hours of training, but 24.7% have never
142 attended professional training (NT). Eighteen percent have had more than 35 hours
143 of training. For comparison purposes, respondents were divided in four professional
144 training groups: GPFI, WSH, BT (both training) and NT (no training). Fifty percent
145 (50.3%) of MH with professional training think that training provides useful
146 information to their work and 64.9% are interested in future training and consider it
147 very important.

148 3.1.3. Comparative analysis of response to “Knowledge” and “Practice” questions

149 The group of respondents that has had training in the two areas (BT) reached the
150 highest mean score of proportion of correct answers in the group “Knowledge”
151 (67.26±21.05), followed by the GPFI with a mean score of 66.92±16.36 correct
152 answers; WSH had 49.21±22.77 and NT 47.89± 22.63.

153 In the group of questions “Practice”, GPFI has had the highest proportion of correct
154 answers with a mean score of 70.53±17.47, followed by BT (68.67±22.58). The
155 mean score of correct answers for WSH has been of 58.33±19.93, and for NT
156 63.44±21.70. The difference between the proportion of correct answers to the
157 questions “Knowledge” and “Practice” is statistically significant between the groups
158 (one–way ANOVA Table 3). For the group of questions “Knowledge”, a post-hoc test
159 (Tukey HSD test) has defined two different homogenous groups, one with the

respondents that have attended GPFI or both areas of professional training and the other with the respondents that have had WSH or no training. In the group of questions “Practice”, the same test has assumed two different groups, GPFI and NT. The other two groups (WSH and BT) could not be discriminated. This analysis underlines the fact that, for the questionnaire content and for the purpose of food safety improvement, WSH professional training has no positive impact.

3.2. Qualitative results

It has been considered important to detect finer differences among the answers to questions that tested the quality of the information sought (Tables 4A and 4B).

3.2.1. “Knowledge” Questions (Table 4A)

HACCP

Regarding HACCP, 29.3% of MH have never heard of the term and 7% are acquainted with the expression but do not know the meaning of it. Regarding training, from the WSH group, 55.6% answered “do not know” to the question “What is HACCP?” and that proportion increases to 66.7% in the NT group. The proportion of respondents who have given correct answers has been of 63.2% in the GPFI group and 51.7% in the BT group. This group has also had the highest proportion of incorrect answers: 31.7% (NT: 15.4%, WSH: 22.2% and GPFS:15,8%). These differences were statistically significant (p=0.000 using Pearson Chi-Square test).

Food Poisoning and Food Borne Illness

Almost the half (47.4%) of GPFI, 58.3% of WSH, 53.3% of BT and 43.6% of NT believe that they can identify whether meat is contaminated with food poisoning bacteria by visual, olfactory or taste checks (p=0.368, using Pearson Chi-Square test). Similar results have been obtained in other surveys among food handlers (Walker et al, 2003; Gomes-Neves et al, 2007; Jevšnik et al, 2008) The majority of

the MH (60.1%) are aware that insects, other food handlers and raw food are sources of bacteria, but 26.3 % of GPFI, 44.4% of WSH, 15% of BT and 33.3% think that MH can only contaminate meat if they are ill (p=0.001, using Pearson Chi-Square test). Twenty six percent (26.3%) of GPFI, 30.6% of WSH, 11.7% of BT and 41.0% of NT believe that MH can only get sick if they have contact with animal blood during work activity (p=0.000, using Pearson Chi-Square test). A significant majority of MH knows that diarrhoea is the symptom that is most associated with food borne illness (85.3%) but 33.3% of NT, 30.6% of WSH and 11.7% of BT have not been able to identify consequences of intestinal bacterial infection (*E. coli, Salmonella, Campylobacter* and *Yersinia*). These differences among groups of respondents were statistically significant (p=0.001, using Pearson Chi-Square test). Sixty two percent (61.5%) of NT have answered "do not know" to the question that relates *Listeria monocytogenes* with food borne Illness and 55.6% of WSH, 38.3% of BT and 26.3% of GPFI have given the same answer. Sixteen (16.0%) percent of all MH knew the name of the bacteria but did not identify the disease or transmission paths (p=0.108, using Pearson Chi-Square test).

Temperature and Food Poisoning Agent's Inactivation

Twenty percent of WSH (19.5) and NT (20.4) have answered "do not know" to the question "What happens to bacteria at 37ºC?". More than a half (52.6%) of GPFI, 41.7% of WSH, 51.7% of BT and 28.2% of NT think that pasteurised milk is a sterile product. Among the NT group, 43.6% have not answered the question "identify a sterile food product" (p=0.105, using Pearson Chi-Square test). High temperature has been recognised as a safe method to destroy bacteria by 52.6% of GPFI, 50.0% of WSH, 56.7% of BT and 48.7% of NT but 24.4% of MH think that refrigeration also kills bacteria. The majority (64.6%) of MH knows that 82 ºC is the correct temperature for the water in sterilisers for knives and steels in stations located along the slaughter floors (Eustace *et al*, 2007), but 21.1% of GPFI, 38.9% of WSH, 30.0%

of BT and 28.2% of NT have not answered correctly. The differences between the groups of respondents were not statistically significant.

Safety and Health Requirements

Many MH did not seem to be aware of basic safety and health requirements to work with food. A majority of GPFI, WSH and NT (52.6%, 52.8% and 51.3%, respectively) have not identified skin disease, gastrointestinal disturbances, eye/ear and throat disease as conditions that are not acceptable in meat handling. Only 28.3% of BT ignored these conditions. Thirty four percent of the MH answered that only a skin disease is a non acceptable condition for meat handling. Sixty eight percent (67.5%) of the MH were aware of the need for skin injury protection in meat handling (p=0.009, using Pearson Chi-Square test).

According to Jacob (1989), routine medical examinations of food handlers are of little value because they merely reveal the health status of the worker at a specific point in time. The author further states that these medical examinations are unreliable and that carriers of pathogens are unlikely to transmit these organisms. In this study, 72.4% of the respondents have indicated that they have been to routine medical examinations during the previous year, while 5.9% indicated that they have gone because they felt sick, whereas 12.5% needed to undergo medical examinations before employment. Food handlers must undergo medical examinations before employment to assess the general health. However, it has been suggested that routine medical examinations are regarded as not being cost-effective and, in fact, unreliable (Jacob, 1989; Nel *et al* 2004).

Dirty and Clean Workspaces at the Abattoir

Sixteen percent (15.8%) of GPFI, 44.4% of WSH, 20.0% of BT and 35.9% of NT have identified incorrectly all the dirty areas in the abattoir. Of all MH, 10% think that

only the lairage is a dirty space, and 18% have only identified the room where offal are washed and prepared (p=0.001, using Pearson Chi-Square test)..

3.2.2. “Practice” Questions (Table 4B)

Instruments and Working Surface Cleaning

Eighty nine percent (88.5%) of the respondents were aware of the working surfaces and instruments washing and disinfection routine and correct steps and only 5.7% answered that they did not have contact with that operation. As far as disinfection is concerned, 25.3% of MH thought that sodium hypochlorite is the best disinfectant in meat industry but 47.4% were aware of the need for regular rotation of products for this purpose (Meyer, 2006). However, 12% did not know that, after the use of disinfectant on instruments and surfaces, both of them must be cleaned with potable water. Forty two percent (42.1%) of GPFI, 25.0% of WSH, 31.7% of BT and 30.8% of NT thought that non-potable water could be used for the cleaning of working surfaces and instruments. These differences were not statistically significant.

Personal Hygiene

To the question “When do you wash your hands during a work day” only 3.2% of MH have not answered and 89.2% have answered that they washes them several times and whenever the activity is interrupted (p=0.181, using Pearson Chi-Square test). To the question “different steps to correct hand wash”, 5.8% of MH have not answered. The majority of MH referred all the steps for a correct hand wash, however 21.1% of GPFI, 38.9% of WSH, 30.0% of BT and 43.6% of NT have answered incorrectly, because they have not mentioned the use of nail brush (p=0.015, using Pearson Chi-Square test).

Temperature Control

From the three ranges of temperatures presented, 0-4 ºC/5-65 ºC/70-80 ºC, only 32.3% of the MH identified the range of 5-65ºC as the high-risk meat storing temperature. The GPFI group has also had the highest proportion of incorrect answers (63.2%), followed by BT (53.3%), WSH (52.8%) and NT (51.3%). Interestingly, the GPFI group seems to be confident regarding this topic since none of the respondents report "do not know" to this question, although the majority of the subjects has answered incorrectly. Seventy eight percent (77.8%) knew of the correct red meat storage temperature but only half of MH have reported the correct freezing temperature (50.6%) and the correct storage temperature for chopped meat (51.3%). If we consider professional training, WSH group has had a lower proportion of correct answers on red meat storage temperature (63.9%) than NT (74.4%). Twenty six percent (26.3%) of GPFI, 44.4% of WSH, 30.0% of BT and 23.1% of NT have answered incorrectly to the question about chopped meat storage temperature and 33.3% of NT answered "do not know" (p=0.036, using Pearson Chi-Square test).

Change of Clothes and Instruments and Cross-contamination Sources

Only twenty one percent (21.1%) of the GPFI, 27.8% of the WSH, 31.7% of BT and 33.3% of NT recognise the need to change clothes and knives by the end of the work at the abattoir (mainly in the first hours of the day), when they continue their tasks in the deboning room of the same building (p=0.087, using Pearson Chi-Square test). Fifty seven percent (56.8%) of all MH change their protective clothing but do not replace knives and 5.8% carry their clothes and knives from the slaughter room into the deboning room. Regarding the porosity of surfaces, it can be observed that porous surfaces (clothes, aprons, sponges, etc.) show lower transfer rates when compared to non-porous surfaces as stainless steel and knobs (Scott & Bloomfield, 1990; Kusumaningrum, Van Putten, Rombouts & Beumer, 2002). However, in this case, although apparently a lower risk might be associated to

transfer from fabrics, it should be noted that the residual water (and eventually blood) accumulated in clothes would enable bacteria to survive for longer periods and, consequently, bacterial transfer events could also be prolonged (Bloomfield, Arthur, Van Klingeren, Holah, Pullen & Elton,1994; Eustace, Midgley, Giarrusso, Laurent, Jenson & Sumner, 2007; Rusin , Maxwell & Gerba , 2002).

In addition to protective clothing fulfilling a safety function, 44.7% wear stainless steel mesh gloves. Stainless steel gloves also require cleaning and sterilisation, but these gloves are difficult to clean, due to their woven construction (Van Zyl, 1998). Upon asking the respondents about the frequency of cleaning, 59.5% have reported that they wash and sterilise their gloves several times a day, whenever they are visibly dirty (usually full of fatty or bloody deposits). Furthermore, a small percentage, 11.1% sterilises their gloves on a daily basis (end of work), while 22.2% have answered they never washed or sterilised their gloves because they were not connected with cleaning tasks. According to the Canadian Food Inspection Agency (CFIA), these gloves should be sterilised at regular intervals throughout the working shifts to prevent cross-contamination between gloves and meat (CFIA, 1990; Nel *et al*, 2004).

On the matter of Pre-Requisite Plans (PRP) participation, 56.6% did not participate in any activity. The highest participation is related with cleaning activity, since 17.8% complete cleaning checklist forms and only 9.2% participate in meat temperature control activities, whereas 8.6% have maintenance related tasks.

4. Discussion

The questionnaire designed for the present study has allowed to detect quantitative differences in “knowledge” and “practice” skills among the participants. The satisfactory participation has permitted to highlight the existence of differences between MH who have and have not received professional training, obtaining the

groups NT, WSH, GPFI and BT. This is remarkable and somewhat reassuring. Nevertheless, a further finer analysis of the content of the questions themselves (qualitative results) has not led to the same sense of reassurance. The proportion of correct answers in the MH groups who have had GPFI or BT training is significantly higher than the others from a statistical point of view, but results have also indicated that WSH training is not relevant to Food Hygiene and Food Safety knowledge and practice.

Regarding HACCP, which is a recent and relevant imposition of the EU Food Law, there was still a high proportion of MH (even with professional training, the WSH group) who were unacquainted with the concept. To the question “What is HACCP”, only half of BT have answered correctly and this group has also had the highest proportion of incorrect answers, somehow contrary to what should be expected. It seems to be very difficult to implement an HACCP based system in this industry, when a high proportion of employees is not familiar with this reality and does not participate in PRP. Mortimore and Smith (1998) have shown that many trainers had been willing to provide HACCP training without considering the scope (what has to be taught and what need not) and the depth of coverage. Although numerous companies have developed, documented and implemented training programs, few understand why employee training is important, what their training requirements are, or how to assess the effectiveness of in-house training programs.

In the matter of meat storiage temperatures, e.g. red meat, the WSH group has had the highest rate of incorrect answers and the lowest of correct answers. The BT group has not had better results, regarding the fact that they associate two different areas of professional training. A high proportion of GPFI, WSH and BT rely on visual, olfactory or taste checks to identify bacteria contaminated meat. This finding is difficult to explain, considering that they all have had professional training. The study demonstrates that there is also a general lack of knowledge on microbiological

food hazards, i.e. *E. coli, Salmonella, Campylobacter, Yersinia* and *Listeria monocytogenes*.

It is generally accepted that the hands of food handlers are an important vehicle of food cross-contamination and that improved personal hygiene and scrupulous hand washing lead to the basic control of spread of potentially pathogenic transient microorganisms (Allwood, Jenkins, Paulus, Johnson, & Hedberg, 2004; Daniels, MacKinnon, Rowe, Bean, Griffin, & Mead, 2002; Fry, Braden, Griffin, & Hughes, 2005; Lues & Van Tonder, 2007; Sneed, Strohbehn, Gilmore, & Mendonca, 2004). In this study, it has been possible to observe that in the four groups there are respondents who do not know all the steps for a correct hand wash. According to the results of Shojaei *et al* (2006), a dramatic reduction in hand contamination has been observed after a simple intervention that included a face-to-face health education on strict hand washing after visiting the toilet.

Concerning the topic of cross contamination, the majority of MH does not seem to be aware of the importance of changing clothes and working instruments, when they move from the tasks developed in “dirty spaces” (located at the abattoir) to “clean spaces” (deboning room). In addition, they also seem to have difficulties in identifying the differences between the spaces themselves. The UK surveillance system has reported that cross contamination was the main contributing factor (32%) for the outbreaks investigated in the period of 1999-2000 (WHO, 2003). Similarly, the US Centres for Disease Control and Prevention (CDC) have reported that 18 and 19% of food borne diseases caused by bacteria in the years 1993 and 1997 in the United States were associated with contaminated equipment and poor hygiene practices, respectively (CDC, 2000). Moreover, although most outbreaks result from extensive growth at abusive storage temperatures, insufficient cooking, etc., many are also associated with bacterial cross contamination/recontamination (Notermans, Zwietering &Mead, 1994; Roberts, 1990). Similarly, various authors

368 have stated that cross contamination of bacterial and viral pathogens in homes and
369 in food-service establishments could well be the major contributing factor to sporadic
370 and epidemic food borne illnesses (Beumer & Kusumaningrum, 2003; Bloomfield,
371 2003; Chen, Jackson, Chea, & Schaffner, 2001). In the present study, a high
372 proportion of respondents admits a potentially dangerous behaviour on a daily basis
373 without supervisory support, as 56.8% (n=88) change their knives but do not change
374 clothes when they end the work at the abattoir and start at the deboning room. In a
375 HACCP based system perspective this is an unacceptable occurrence.

376 As a result of EU law implementation, Portuguese slaughterhouse and deboning
377 room owners need to offer professional training to their employees but they do not
378 show special concerns about their own training program and its contents. According
379 to the evaluation of the present study, in a high proportion of MH who have had
380 professional training in WSH, this training has not produced a significant contribution
381 to meat safety. Furthermore, as several authors suggested, it seems that most
382 managers in food and meat industry have a limited understanding of the global food
383 safety strategy (Ehiri, Morris, & McEwen, 1997; Mortimore & Smith, 1998; Khandke
384 & Mayes, 1998; Williams, Smith, Gaze, Mortimore, Motarjemi, & Wallace, 2003).
385 MacAuslan (2003) has pointed out that the majority of food businesses do not have
386 satisfactory training policies for all their staff. The author emphasized that too much
387 reliance is being placed upon attaining a training certificate rather than attention paid
388 to achieving competency in food hygiene practice. More emphasis and resources
389 need to be diverted towards assisting managers to become highly motivated to food
390 hygiene managers who develop and maintain a food safety background within their
391 business. Few employers perceive a relationship between investment in their human
392 resource assets and successful business performance, and training is often
393 undertaken only to meet perceived statutory or inspection requirements (Pratten &
394 Curtis, 2002; Seaman & Eves, 2006). Food business owners may be tempted to

place the burden of training responsibility on an external employer, and not shoulder any responsibility themselves. This problem has two sides; firstly the employer lacks key management skills in leadership, motivation, training and evaluation, and secondly going for a certificate course as it is the ‘‘done thing” (MacAuslan, 2003). What we have observed in the present study is that the pressure to accomplish the law leads employers to get specialised training for their employees; however, there is no evidence that the worker practices improve when training programs provide only information (Nieto-Montenegro, Brown & LaBorde LF ,2008; Rennie, 1994). Several studies have demonstrated that increasing knowledge does not necessarily lead to changes in behaviours (Clayton, Griffith, Price, & Peters, 2002; Ehiri *et al,* 1997; Rennie, 1994, 1995). To be effective, training programs should be based on appropriate adult education theory (Rhodes, 1988). In the present study, we have verified a low educational level of MH, the average formal education years being 6.5 (in Portugal the mandatory formal education takes 12 years) in a group with a mean age of 35 (Table 2), which may be a possible explanation factor for our results. The findings in the study of Toh and Birchenough (2000) affirmed education as an important link to the two variables: knowledge and attitudes; customs and environment. Some other authors suggest that the training programs should incorporate activities that support skills development relevant to real life situations in which the workers can put information into practice (Edmunds, Lowe, Murray & Seymour,1999; Kowalski & Vaught, 2002). Food hygiene training is a legal requirement within food industry and should be only one part of an effective food safety management strategy. Training will only lead to an improvement in food safety if the knowledge imparted leads to desired changes in behaviour at the workplace (Nieto-Montenegro, Brown & LaBorde, 2008; Seaman & Eves, 2006). Professional training of MH in Portugal has been “classroom based” and this study aims to contribute to a reflexion on the need for evaluation towards practical improvements.

Evidence from the literature suggests that food hygiene training as a mean of improving food safety standards is limited by a lack of understanding of those factors contributing to successful outcomes. Training activities closely associated with work environment would be more appropriate than food hygiene courses that operate divorced from the workplace and use solely knowledge-based assessment techniques (Seaman & Eves, 2006). The training of managers is a necessary precursor to the implementation of realistic food safety practices within the workplace. The effectiveness of training is very dependent on both management attitude and their willingness to provide the resources and systems for food handlers to implement good practices. There is a need to develop training methods that proved to change behaviour as well as imparting knowledge (Egan *et al,* 2007). Further research in issues including course content, training location, duration of courses, motivational factors and refreshment training is needed. Such research needs to be clearly thought out, well designed with good baseline data to achieve worthwhile results (Egan *et al,* 2007; Seaman & Eves, 2006). Seaman (2010) proposes the *Food Hygiene Training Model* which includes evaluation stages, managerial components and overall performance measures to take into account both the effective planning of the training program, the managerial support required to facilitate the training process, and the overall performance measures needed to ensure that training transfers into the required safe food handling behaviours. The proposed model incorporates three evaluation stages of the food handlers: 1) documented training needs with individual record, establishing a starting point; 2) knowledge test and/or practical skill assessment shortly after training, assessing any deficiencies in skills or knowledge at this stage; 3) food handlers evaluation of the training program to measure the perceived value and relevance of the training program, allowing respondents to portray approval or disapproval towards certain aspects of the training (Seaman, 2010). The overall performance measures include two final evaluation categories: the effect of food hygiene training on the individual

451 food handler and the effect on the organization (Seaman, 2010). The success of
452 training relies on the choice of the program, considering the relevance of the course
453 to work activities, and providing food hygiene training in a language and at a level
454 that allows the food handler to understand the content (Seaman,2010; Rennie,
455 1994). Authors suggest that food hygiene courses should be shorter and focused on
456 the needs and motivation of the participant, and include refresher training to provide
457 both a physical and psychological environment conductive to food handler
458 development and the enactment of safe food handling practices (MacAuslan, 2001;
459 Rennie, 1994; Seaman, 2010; Worsfold, 2004).

460 The significance of the present results is limited in part by the sample size and by
461 the fact that it has based on self-reported behaviour and practice. It is possible to
462 conclude, however, that EU regulations have had a positive outcome in the matter of
463 professional training of MH in Portugal. Operators, however, cannot rely on the fact
464 that training has ever taken place. They must assume that all employees will need
465 thorough, repeated training in the area of food hygiene and safety, as we observed
466 that WSH training is not relevant to this aim (in spite of being relevant in terms of
467 occupational safety and health). We suggest what can be a major concern in the
468 moment of hiring new employees: to assess knowledge in food safety and promote
469 immediate professional training, in addition to asking about previous work
470 experience. In the present study, the MH show an average of 12.6 years of
471 experience in the activity. However, the respondents have had poor results on the
472 HACCP, microbiological hazards, temperature control, personal hygiene and cross-
473 contamination subjects .

474 In this activity, characterized by hard physical work and a traditionally low
475 educational level of the workers, professional training should be adapted, with a
476 strong connection knowledge-practice, considering motivational factors and beliefs.

Behaviour changes in MH should be evaluated according to those conditions, encouraging the learning process and rewarding practical improvements.

Acknowledgments

We gratefully acknowledge to Prof. Fátima Gärtner and Prof. Margarida Fonseca Cardoso for their comments and help in the preparation of the manuscript and Dr. Ana Isabel Oliveira for her cooperation on questionnaire delivery.

References

Allwood, P. B., Jenkins, T., Paulus, C., Johnson, L., & Hedberg, C. W. (2004). Hand washing compliance among retail food establishment workers in Minnesota. *Journal of Food Protection, 67*(12), 2825–2828.

Barrows, C.W. (2000) An exploratory study of food and beverage training in private clubs, *International Journal of Contemporary Hospitality* 12 (3), 190–197.

Beumer, R. R., & Kusumaningrum, H. (2003). Kitchen hygiene in daily life. *International Biodeterioration & Biodegradation*, 51, 299-302.

Bloomfield, S. F., Arthur, M., Van Klingeren, B., Holah, J. T., Pullen,W. & Elton, R. (1994). An evaluation of the repeatability and reproducibility of a surface test for the activity of disinfectants. *Journal of Applied Bacteriology*, 76, 86-94.

Bloomfield, S. F. (2003). Home hygiene: a risk approach. *International Journal of Hygiene and Environmental Health*, 206, 1-8.

CDC (Center for Disease Control and Prevention) (2000). Surveillance for Foodborne Disease Outbreaks e United States, 1993e1997. Available from http://www.cdc.gov/

Canadian Food Inspection Agency. (1990). Meat hygiene manual of procedures, Canada. Available: www.inspection.gc.ca Accessed2002-03-26

Clayton, D. A., Griffith, C. J., Price, P., & Peters, A. C. (2002). Foodhandlers' beliefs and self-reported practices. *International Journal of Environmental Health Research*, 12(1), 25–29.

Chen, Y., Jackson, K. M., Chea, F. P., & Schaffner, D. W. (2001). Quantification and variability analysis of bacterial cross-contamination rates in common food service tasks. *Journal of Food Protection*, 64, 72-80.

524 Daniels, N. A., MacKinnon, L., Rowe, S. M., Bean, N. H., Griffin, P. M., & Mead,
525 P. S. (2002). Food borne disease outbreaks in United States schools. *The*
526 *Pediatric Infectious Disease Journal, 21*(7), 623–628
527 Diário da República (1998). 1ª série A, Nº 65. Decreto-Lei no. 67/98 de 18 de
528 Março. Diário da República I, Série A, no. 65.
529 Diário da República (2003) 1ª série A, Nº197, Lei nº99/2003 de 27 de Agosto.
530 Aprova o Código do Trabalho. Diário da República, 1ª série A,197,5558-5675
531 Diário da República (2004) 1ª série A, Nº177,Lei Nº35/2004 de 29 de Julho.
532 Regulamenta a Lei Nº99/2003. 1ª série A,177,4810-4885
533 Diário da República (2006) 1ª série Nº146 Dec-lei 147/2006 31 Julho 2006..
534 Diário da República, 1ª série,146, 5442-5451
535 Edmunds, C., Lowe, K., Murray, M., & Seymour, A. (1999). The ultimate
536 educator: achieving maximum adult learning through training and instruction.
537 OfficeforVictimsofCrime.WebsiteAddress:http://www.ojp.usdoj.gov/ovc/assist/
538 educator/welcome.html.
539 Egan M. B, Raats M.M. , Grubb S.M. , Eves, A. , Lumbers, M.L., Dean, M.S. ,
540 Adams M.R. (2007) A review of food safety and food hygiene training studies
541 in the commercial sector. *Food Control*, 18, 1180-1190
542 Ehiri, J. E., Morris, G. P., & McEwen, J. (1997). Evaluation of a food hygiene
543 training course in Scotland. *Food Control*, 8(3), 137–147.
544 Eustace, Ian , Midgley, J., Giarrusso, C., Laurent, C. , Jenson, I, Sumner, J.
545 (2007) An alternative process for cleaning knives used on meat slaughter
546 floors International. *Journal of Food Microbiology*, 113, 23–27
547 Gomes-Neves, E., Araújo, A. C., Ramos, E., & Cardoso, C. S. (2007). Food
548 handling: comparative analysis of general knowledge and practice in three
549 relevant groups in Portugal. *Food Control*, 18(6), 707–712.
550 Jacob, M. (1989). Safe food handling: A training guide for managers of food
551 service establishments. Geneva: World Health Organization.

552 Jevšnik M. , Hlebec, V. , Raspor, P. (2008) Food safety knowledge and
553 practices among food handlers in Slovenia, *Food Control* 19, 1107–111
554 Khandke, S. S., & Mayes, T.(1998). HACCP implementation: A practical guide to
555 the HACCP plan. *Food Control*, 9(2-3), 103–109.
556 Kirby, R. M., Bartram, J. & Carr, R. (2003). Water in food production and
557 processing: quantity and quality concerns. *Food Control*, 14(5), 283-299
558 Kowalski, K. M., & Vaught, C. (2002). Principles of adult learning: application for
559 mine trainers. *NIOSH Information Circular*, 946, 3–8
560 Kusumaningrum, H. D., Van Putten, M. M., Rombouts, F. M., & Beumer, R. R.
561 (2002). Effects of antibacterial dishwashing liquid on foodborne pathogens
562 and competitive microorganisms in kitchen sponges. *Journal of Food*
563 *Protection, 65*, 61–65.
564 Legnani P, Leoni E, Berveglieri M, Mirolo G, Alvaro N (2004). Hygienic control of
565 mass catering establishments, microbiological monitoring of food and
566 equipment. *Food Control*, 15, 205-211
567 Lues, J.F.R., Van Tonder, I (2007)The occurrence of indicator bacteria on hands
568 and aprons of food handlers in delicatessen sections of a retail group. *Food*
569 *Control,* 18, 326-332
570 MacAuslan, E. (2003). The boss, the owner, the proprietor...the food hygiene
571 manager? *The Journal of the Royal Society for the Promotion of Health,*
572 123(4), 229–232.
573 Martínez-Tomé, M., Vera, A. M. & Murcia, A. (2000). Improving the control of
574 food production in catering establishments with particular reference to the
575 safety of salads. *Food Control*, 11, 437-445.
576 Meyer, Bernhard (2006) Does microbial resistance to biocides create a hazard to
577 food hygiene? *International Journal of Food Microbiology*, 112 (2006) 275–
578 279

579 Mortimore, S., & Smith, R. A. (1998). Standardized HACCP training: assurance
580 for food authorities. *Food Control*, 9(2), 141–145.
581 Motarjemi, Y., Käferstein, F.(1999) Food safety, hazard analysis and critical
582 control point and increase in foodborne diseases: a paradox? *Food Control,*
583 10 (4–5), 325–333
584 Nel, S., Lues, J. F. R., Buys, E. M. & Venter, P. (2004). The personal and
585 general hygiene practices in the deboning room of a high throughput red
586 meat abattoir. *Food Control*, 15 (7), 571-578.
587 Newcombe, Robert G.(1998) "Two-Sided Confidence Intervals for the Single
588 Proportion: Comparison of Seven Methods," *Statistics in Medicine,* 17, 857-
589 872
590 Nieto-Montenegro SN, Brown JL, LaBorde LF (2008) Development and
591 assessment of pilot food safety educational materials and training strategies
592 for Hispanic workers in the mushroom industry using the Health Action
593 Model. *Food Control*,19, 616-633.
594 Notermans, S., Zwietering, M.H., Mead, G.C.(1994)The HACCP concept:
595 identifications of potentially hazardous micro organisms. *Food Microbiology*
596 11, 203–214
597 Pratten, J.D., Curtis, S., (2002). Attitudes towards training in UK licensed retail:
598 an exploratory case study, *Hospitality Management* 21, 393–403
599 Regulation (EC) No 852/2004 the European Parliament and of the Council of 29
600 ofApril 2004 , on the hygiene of foodstuffs. *Off. J. Eur. Comm*. 01.02.2002
601 L31, pp. 1–24.
602 Rennie, M. D. (1994). Evaluation of food hygiene education. *British Food*
603 *Journal*, 96(11), 20–25.
604 Rennie, M. D. (1995). Health education models and food hygiene education.
605 *Journal of the Royal Society of Health*, 115(2), 75–79.

606 Rhodes, L.B.(1988).In M.E. Rhodes (Ed.), Competency-based adult learning in
607 food safety programs in food protection technology II. Chelsea, MI: Lewis
608 Publishers
609 Roberts, D. (1990). Foodborne illness, sources of infection: food. *Lancet*, 336,
610 859-861.
611 Rusin, P., Maxwell, S., & Gerba, C. (2002). Comparative surface to-hand and
612 fingertip-to-mouth transfer efficiency of gram-positive bacteria, gram-negative
613 bacteria, phage. *Journal of Applied Bacteriology*, 93, 585-592.
614 Scott, E., & Bloomfield, S. F. (1990). The survival and transfer of microbial-
615 contamination via cloths, hands and utensils. *Journal of Applied Bacteriology,*
616 68, 271–278.
617 Seaman, P. & Eves, A. (2006). The management of food safety—the role of food
618 hygiene training in the UK service sector. *International Journal of Hospitality*
619 *Management*, 25, 278-296.
620 Seaman, P. (2010) Food Hygiene Training: Introducing the Food Hygiene
621 Training Model. *Food Control,* 21,381-387.
622 Shojaei, H, Shooshtaripoor, J., Amiri, M. .(2006) Efficacy of simple hand-
623 washing in reduction of microbial hand contamination of Iranian food
624 handlers. *Food Research International* 39 , 525–529
625 Smith, R. (1994). Food hygiene training: the chance to create a coherent training
626 policy. *British Food Journal, 96*(7), 41–45.
627 Sneed, J., Strohbehn, C., Gilmore, S. A., & Mendonca, A. (2004). Microbiological
628 evaluation of foodservice contact surfaces in Iowa assisted-living facilities.
629 *Journal of the American Dietetic Association,* 104(11),1722–1724.
630 Sun, Y. M. & Ockerman, H. (2005). A review of the needs and current
631 applications of HACCP system in foodservice areas. *Food Control*, 16(4)
632 325-332.

633 Toh, P. S., & Birchenough, A. (2000). Food safety knowledge and attitudes:
634 culture and environment impact on hawkers in Malaysia. Knowledge and
635 attitudes are key attributes of concern in hawkerfoodhandling practices and
636 outbreaks of food poisoning and their prevention. *Food Control*, 11, 447–452.
637 Van Zyl, A. P. (1998). *Red meat manual for veterinary public health*. Pretoria:
638 Directorate Veterinary Public Health.
639 Walker, E., Pritchard, C., & Forsythe, S. (2003). Food handlers' hygiene
640 knowledge in small food businesses. *Food Control*, 14(5), 339–343.
641 Williams, A. P., Smith, R. A., Gaze, R., Mortimore, S. E., Motarjemi, Y.,&
642 Wallace, C. A. (2003). An international future for standards of HACCP
643 training. *Food Control*, 14, 111–121.
644 Wilson, E. B. (1927) Probable Inference, the Law of Succession, and Statistical
645 Inference, *Journal of the American Statistical Association,* 22, 209-212.
646 World Health Organization (2000). Foodborne disease: a focus for health
647 education. World Health Organization: Geneva.
648 World Health Organization (2003). Eighth report 1999-2000 of WHO Surveillance
649 Programme for control of foodborneinfections and intoxications in Europe.
650 Available from http://www.bfr.bund.de/internet/8threport/8threp_fr.htm.
651 Worsfold, D. (2001). Food safety behaviour in butchers' shops. *Nutrition & Food*
652 *Science*, 31(1), 13-18.
653

Table 1

Summary of the focus of the questionnaire contents

Questions "Knowledge"
HACCP- what is it?
Identify sterile food
What happens to bacteria at 37ºC?
Food borne illness most frequent symptoms
Food borne illness agents transmission
Visual, olfactory or taste checks identify bacteria contaminated meat?
Meat Handler hygiene and health and food borne illness agents
Health conditions that are not acceptable in food handling
Potential health consequences of animal intestinal bacteria (*E. coli, salmonella, Campylobacter* and *Yersinia*)
Listeria monocitogenes and food borne illness
Dirty and Clean workspaces in the abattoir
Food borne agents inactivation
Temperature of knifes sterilisers
Questions "Practice"
Working surfaces and instruments washing requirements and products
Potable water use/Water supply
Red Meat storage temperatures
Chopped meat storage temperatures
Freezing temperatures for meat
Temperature ranges and food poisoning agents development
Different situations that imply hand washing before food handling

Different steps to correct hand wash
Cross contamination and change of working instruments and clothes

Table 2

Demographic data and job information of the participants

Participants (N=159)	***Average ±SD***	***Minimum-Maximum***
Age (N=155)	35.19 ± 10.15	16-58
Years of formal education (N=151)	6.50 ± 2.59	0-13
Age at the beginning of the professional activity (N=153)	15.68±2.53	9-24
Years of experience in the same activity (N=133)	12.65 ± 9.35	0 - 35
Years in the present company (N=154)	8.89 ± 7.57	0 - 33

Table 3

Percentage of correct answers to the “Knowledge” and “Practice” questions within each group defined by professional training.

Participant Group	***Question Group***	
	Knowledge	**Practice**
	N=14 questions	**N=10 questions**
GPFI (N=36)	66.92±16.36 [1]	70.53±17.47
WSH (N=19)	49.21±22.77	58.33±19.93
BT (N=60)	67.26±21.05	68.67±22.58
NT (N=39)	47.89±22.63	63.44±21.70
one-way ANOVA	d.f. =3 F= 10.393 p=0.000	d.f.=3 F=3.986 p=0.009

[1]Mean±1SD

Table 4A

Percentage of correct answers and 95% Confidence Intervals*(CI) of the questions “Knowledge” (qualitative results)

	% of Correct	**Answers**	**(95% CI)**	
Questions “Knowledge”	GPF	WSH	BT	NT

	N=36I	N=19	N=60	N=39
What is HACCP?	63.2 (38.6-82.8)	22.2 (10.7-39.6)	51.7 (38.5-64.6)	17.9 (8.1-34.1)
Identify sterile food	21.1 (7,0-46.1)	25.0 (12.7-42.5)	31.7 (20.6-45.1)	28.2 (15.6-45.1)
What happens to bacteria at 37ºC?	89.5 (65.5-98.2)	61.1 (43.5-76.4)	83.3 (71.0-91.3)	59.0 (42.2-74.0)
Food borne illness most frequent symptoms	100.0 (79.1-100.0)	77.8 (60.4-89.3)	95.0 (85.2-98.7)	71.8 (54.9-84.4)
Food borne illness agents transmission	73.7 (48.6-89.9)	52.8 (35.7-69.2)	65.0 (51.5-76.5)	56.4 (39.8-71.8)
Visual, olfactory or taste checks identify bacteria contaminated food?	42.1 (21.1-66.0)	41.7 (26.0-59.1)	45.0 (32.3-58.3)	51.3 (35.0-67.3)
How can MH contaminate meat?	73.7 (48.6-89.9)	55.6 (38.3-71.7)	85.0 (72.9-92.5)	56.4 (39.8-71.8)
MH can get ill in consequence of meat handling?	47.4 (25.2-70.5)	63.9 (46.2-78.7)	88.3 (76.8-94.8)	51.3 (35.0-67.3)
Health conditions that are not acceptable in food handling	47.4 (25.2-70.5	36.1 (21.3-53.8)	65.0 (51.5-76.5)	30.8 (17.5-47.7)

Potential health consequences of animal intestinal bacteria	100.0 (79.1-100.0)	58.3 (40.9-74.0)	75.0 (61.9-84.9)	43.6 (28.2-60.2)
Listeria monocitogenes and food borne illness	68.4 (43.5-86.4)	36.1 (21.3-53.8)	53.3 (40.1-66.1)	33.3 (19.6-50.3)
Dirty and Clean workspaces in the abattoir	78.9 (53.9-93.0)	52.8 (35.7-69.2)	80.0 (67.3-88.8)	48.7 (32.7-65.0)
Food borne agents inactivation	52.6 (29.5-74.8)	50.0 (33.2-66.8)	56.7 (43.3-69.2)	48.7 (32.7-65.0)
Temperature of knives sterilisers	78.9 (53.9-93.0)	55.6 (38.3-71.7)	66.7 (53.2-78.0)	59.0 (42.2-74.0)

* Wilson procedure with a correction for continuity (Wilson, 1927; Newcombe,1998)

Table 4B

Percentage of correct answers and 95% Confidence Intervals* (CI) of the questions "Practice" (qualitative results)

	% Correct	**Answers**	**(95% CI)**	
Questions "Practice"	GPF	WSH	BT	NT
	N=36	N=19	N=60	N=39
Working surfaces and instruments washing	84.2 (59.5-95.8)	94.4 (80.0-99.0)	90.0 (78.8-95.9)	89.7 (74.8-96.7)
Working surfaces and instruments disinfection products	47.4 (25.2-70.5)	36.1 (21.3-53.8)	58.3 (44.9-70.7)	43.6 (28.2-60.2)
Potable water use for washing purposes	57.9 (34.0-78.9)	58.3 (40.9-74.0)	61.7 (48.2-73.6)	59.0 (42.2-74.0)
Temperature ranges and meat preservation	36.8 (17.2-61.4)	27.8 (14.8-45.4)	38.3 (26.3-51.8)	25.6 (13.6-42.4)
Red Meat storage temperatures	100.0 (79.1-100.0)	63.9 (46.2-78.7)	83.3 (71.0-91.3)	74.4 (57.6-86.4)
Chopped meat storage temperatures	68.4 (43.5-86.4)	38.9 (23.6-56.5)	56.7 (43.3-69.2)	43.6 (28.2-60.2)
Freezing temperatures for meat	57,9 (34.0-78.9)	47,2 (30.8-64.3)	56,7 (43.3-69.2)	41,0 (26.0-57.8)
Different situations that imply hand washing before meat handling	100.0 (79.1-100.0)	100.0 (88.0-100.0)	86.7 (74.9-93.7)	84.6 (68.8-93.6)
Different steps to correct hand wash	78.9 (53.9-93.0)	52.8 (35.7-69.2)	70.0 (56.6-80.8)	43.6 (28.2-60.2)
Cross contamination and change of working instruments and clothes	21.0 (7.0-46.1)	27.8 (14.8-45.4)	31.7 (20.6-45.1)	33.3 (19.6-50.3)

* Wilson procedure with a correction for continuity (Wilson, 1927; Newcombe,1998)