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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.
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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, & Álvaro, 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 Equipment's 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 &
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; version 17.0). 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.
3.1.2. Comparative analysis of training areas and periods of time among participants

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

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

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

In the group of questions “Practice”, GPFI has had the highest proportion of correct answers with a mean score of 70.53±17.47, followed by BT (68.67±22.58). The mean score of correct answers for WSH has been of 58.33±19.93, and for NT 63.44±21.70. The difference between the proportion of correct answers to the questions “Knowledge” and “Practice” is statistically significant between the groups (one–way ANOVA Table 3). For the group of questions “Knowledge”, a post-hoc test (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 °C/5-65 °C/70-80 °C, only 32.3% of the MH identified the range of 5-65°C 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 Klinger, 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 storage 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
have stated that cross contamination of bacterial and viral pathogens in homes and
in food-service establishments could well be the major contributing factor to sporadic
and epidemic food borne illnesses (Beumer & Kusumaningrum, 2003; Bloomfield,
2003; Chen, Jackson, Chea, & Schaffner, 2001). In the present study, a high
proportion of respondents admits a potentially dangerous behaviour on a daily basis
without supervisory support, as 56.8% (n=88) change their knives but do not change
clothes when they end the work at the abattoir and start at the deboning room. In a
HACCP based system perspective this is an unacceptable occurrence.

As a result of EU law implementation, Portuguese slaughterhouse and deboning
room owners need to offer professional training to their employees but they do not
show special concerns about their own training program and its contents. According
to the evaluation of the present study, in a high proportion of MH who have had
professional training in WSH, this training has not produced a significant contribution
to meat safety. Furthermore, as several authors suggested, it seems that most
managers in food and meat industry have a limited understanding of the global food
safety strategy (Ehiri, Morris, & McEwen, 1997; Mortimore & Smith, 1998; Khandke
& Mayes, 1998; Williams, Smith, Gaze, Mortimore, Motarjemi, & Wallace, 2003).
MacAuslan (2003) has pointed out that the majority of food businesses do not have
satisfactory training policies for all their staff. The author emphasized that too much
reliance is being placed upon attaining a training certificate rather than attention paid
to achieving competency in food hygiene practice. More emphasis and resources
need to be diverted towards assisting managers to become highly motivated to food
hygiene managers who develop and maintain a food safety background within their
business. Few employers perceive a relationship between investment in their human
resource assets and successful business performance, and training is often
undertaken only to meet perceived statutory or inspection requirements (Pratten &
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 reflection 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
food handler and the effect on the organization (Seaman, 2010). The success of training relies on the choice of the program, considering the relevance of the course to work activities, and providing food hygiene training in a language and at a level that allows the food handler to understand the content (Seaman, 2010; Rennie, 1994). Authors suggest that food hygiene courses should be shorter and focused on the needs and motivation of the participant, and include refresher training to provide both a physical and psychological environment conducive to food handler development and the enactment of safe food handling practices (MacAuslan, 2001; Rennie, 1994; Seaman, 2010; Worsfold, 2004).

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

In this activity, characterized by hard physical work and a traditionally low educational level of the workers, professional training should be adapted, with a 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


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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

<table>
<thead>
<tr>
<th>Participants (N=159)</th>
<th>Average ±SD</th>
<th>Minimum-Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
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<tr>
<td>Years of formal education</td>
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<tr>
<td>Age at the beginning of the professional activity</td>
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<tr>
<td>Years of experience in the same activity</td>
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<tr>
<td>(N=133)</td>
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<tr>
<td>Years in the present company</td>
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Table 3

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

<table>
<thead>
<tr>
<th>Participant Group</th>
<th>Question Group</th>
<th>Knowledge</th>
<th>Practice</th>
</tr>
</thead>
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<tr>
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<td>N=14 questions</td>
<td>N=10 questions</td>
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<td>GPFI (N=36)</td>
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<td>66.92±16.36 1</td>
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<td>WSH (N=19)</td>
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<td>49.21±22.77</td>
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<td>BT (N=60)</td>
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<td>NT (N=39)</td>
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<td>47.89±22.63</td>
<td>63.44±21.70</td>
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</table>

one-way ANOVA  

<table>
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<th></th>
<th>d.f. =3 F= 10.393</th>
<th>d.f. =3 F=3.986</th>
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</table>

1Mean±1SD

Table 4A

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

<table>
<thead>
<tr>
<th>Questions “Knowledge”</th>
<th>% of Correct</th>
<th>Answers</th>
<th>(95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPF</td>
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<td></td>
</tr>
<tr>
<td>WSH</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>BT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NT</td>
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<tr>
<td>Question</td>
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<td>N=19</td>
<td>N=60</td>
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<tr>
<td>---------------------------------------------------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>What is HACCP?</td>
<td>63.2</td>
<td>22.2</td>
<td>51.7</td>
</tr>
<tr>
<td></td>
<td>(38.6-82.8)</td>
<td>(10.7-39.6)</td>
<td>(38.5-64.6)</td>
</tr>
<tr>
<td>Identify sterile food</td>
<td>21.1</td>
<td>25.0</td>
<td>31.7</td>
</tr>
<tr>
<td></td>
<td>(7.0-46.1)</td>
<td>(12.7-42.5)</td>
<td>(20.6-45.1)</td>
</tr>
<tr>
<td>What happens to bacteria at 37ºC?</td>
<td>89.5</td>
<td>61.1</td>
<td>83.3</td>
</tr>
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<td></td>
<td>(65.5-98.2)</td>
<td>(43.5-76.4)</td>
<td>(71.0-91.3)</td>
</tr>
<tr>
<td>Food borne illness most frequent symptoms</td>
<td>100.0</td>
<td>77.8</td>
<td>95.0</td>
</tr>
<tr>
<td></td>
<td>(79.1-100.0)</td>
<td>(60.4-89.3)</td>
<td>(85.2-98.7)</td>
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<td>Food borne illness agents transmission</td>
<td>73.7</td>
<td>52.8</td>
<td>65.0</td>
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<td></td>
<td>(48.6-89.9)</td>
<td>(35.7-69.2)</td>
<td>(51.5-76.5)</td>
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<tr>
<td>Visual, olfactory or taste checks identify bacteria contaminated food?</td>
<td>42.1</td>
<td>41.7</td>
<td>45.0</td>
</tr>
<tr>
<td></td>
<td>(21.1-66.0)</td>
<td>(26.0-59.1)</td>
<td>(32.3-58.3)</td>
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<tr>
<td>How can MH contaminate meat?</td>
<td>73.7</td>
<td>55.6</td>
<td>85.0</td>
</tr>
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<td></td>
<td>(48.6-89.9)</td>
<td>(38.3-71.7)</td>
<td>(72.9-92.5)</td>
</tr>
<tr>
<td>MH can get ill in consequence of meat handling?</td>
<td>47.4</td>
<td>63.9</td>
<td>88.3</td>
</tr>
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<td>(25.2-70.5)</td>
<td>(46.2-78.7)</td>
<td>(76.8-94.8)</td>
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<td>Health conditions that are not acceptable in food handling</td>
<td>47.4</td>
<td>36.1</td>
<td>65.0</td>
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<td>(25.2-70.5)</td>
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<tr>
<td>Potential health consequences</td>
<td>100.0</td>
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<td>75.0</td>
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<td>of animal intestinal bacteria</td>
<td>(79.1-100.0)</td>
<td>(40.9-74.0)</td>
<td>(61.9-84.9)</td>
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<td><em>Listeria monocytogenes</em></td>
<td>68.4</td>
<td>36.1</td>
<td>53.3</td>
</tr>
<tr>
<td>and food borne illness</td>
<td>(43.5-86.4)</td>
<td>(21.3-53.8)</td>
<td>(40.1-66.1)</td>
</tr>
<tr>
<td>Dirty and Clean workspaces in</td>
<td>78.9</td>
<td>52.8</td>
<td>80.0</td>
</tr>
<tr>
<td>the abattoir</td>
<td>(53.9-93.0)</td>
<td>(35.7-69.2)</td>
<td>(67.3-88.8)</td>
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<td>Food borne agents inactivation</td>
<td>52.6</td>
<td>50.0</td>
<td>56.7</td>
</tr>
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<td></td>
<td>(29.5-74.8)</td>
<td>(33.2-66.8)</td>
<td>(43.3-69.2)</td>
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<td>Temperature of knives sterilisers</td>
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<td>55.6</td>
<td>66.7</td>
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<td>(53.9-93.0)</td>
<td>(38.3-71.7)</td>
<td>(53.2-78.0)</td>
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</tbody>
</table>

* 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)

<table>
<thead>
<tr>
<th>Questions “Practice”</th>
<th>% Correct</th>
<th>Answers</th>
<th>(95% CI)</th>
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<td>Working surfaces and instruments washing</td>
<td>84.2</td>
<td>94.4</td>
<td>(59.5-95.8)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(80.0-99.0)</td>
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<td></td>
<td></td>
<td></td>
<td>(78.8-95.9)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(74.8-96.7)</td>
</tr>
<tr>
<td>Working surfaces and instruments disinfection</td>
<td>47.4</td>
<td>36.1</td>
<td>(25.2-70.5)</td>
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<td>products</td>
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<td>(44.9-70.7)</td>
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<td>Potable water use for washing purposes</td>
<td>57.9</td>
<td>58.3</td>
<td>(34.0-78.9)</td>
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<td>(40.9-74.0)</td>
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<td>(42.2-74.0)</td>
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<td>Temperature ranges and meat preservation</td>
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<td>(17.2-61.4)</td>
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<td>(79.1-100.0)</td>
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<td>(57.6-86.4)</td>
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<td>38.9</td>
<td>(43.5-86.4)</td>
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<td>(28.2-60.2)</td>
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<td>Freezing temperatures for meat</td>
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<td>Different steps to correct hand wash</td>
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* Wilson procedure with a correction for continuity (Wilson, 1927; Newcombe, 1998)