



Knowledge on food hygiene of food service staff working in nursing homes and kindergartens in Porto region – Portugal



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ABSTRACT

In this study the food-hygiene knowledge of food handlers working in nursing homes and kindergartens was evaluated. From a global population of 1392 food handlers, a sample was selected of 335 participants from 155 institutions (kindergartens and nursing homes), in the region of Porto, Portugal. Data was collected through a self-administrated, multiple-choice questionnaire that was filled-in individually, in the presence of the researchers. The average score of correctly answered questions was 13.9 ($\pm 3.65SD$), corresponding to 60.7% of the questions. The level of knowledge shown was heterogeneous, varying according to the topics covered and the socio-demographic characteristics of the participants, although some pattern could be discerned as to areas of strength and weakness. Knowledge relating to temperature control (44.2% of correct answers) and to risk associated to foods (50.2% of correct answers) was significantly lower ($p < 0.001$) than the overall knowledge (60.7% of correct answers). Education and training (over the previous 12 months) were positively correlated to higher knowledge on food hygiene ($p < 0.001$). The same could not be verified in relation to hazard analysis and critical control points (HACCP) implementation ($p = 0.454$). The results underline the importance of assessing training needs and consider such needs when designing training programs.

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1. Introduction

Epidemiological data show that children, especially under the age of 5 years, and older adults (>65 years) are two of the main risk groups associated with food borne diseases (Buzby, 2002; CDC, 2011b; EFSA, 2010). However, the reasons which enhance the risk in each group are different.

In children, an immune system not yet fully developed along with a reduced body mass, results in a generally lower infective dose for food-borne pathogens when compared with healthy adults (Buzby, 2001). Also, children are dependent on the selection and preparation of meals and generally they are ignorant of food safety risks (Buzby, 2001).

In respect of this latter factor, the opposite appears to be true for the elderly. The knowledge of this group, concerning food hygiene and food safety, makes them more careful and judicious in the selection of foods and the conditions for their consumption, reducing the risk of food borne diseases (Buzby, 2002). Nevertheless, this positive factor is diminished when autonomy and decision-making power over foods is lost when, for example, individuals come to reside in nursing homes. Some of the circumstances that can accentuate some health risk factors associated with old age, such as loss of appetite or refusal to eat, which can lead to malnutrition, are also relevant in nursing homes (Buzby, 2002; Rocha, 2007).

In addition to malnutrition, higher susceptibility to food borne infections and their greater severity arises from a more weakened immune system; a reduction in the acidity of the stomach, allowing the passage of more pathogenic micro-organisms into the intestine; the reduction in the peristaltic movements of the intestine, increasing the possibility of colonization and toxin production; the excessive use of antibiotics and the use of invasive devices (Buccheri et al., 2010; Buzby, 2002; Rocha, 2007).

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Elderly people, when compared with younger adults, show a higher incidence of infections caused by *Listeria*, *Salmonella*, *Vibrio*, *Yersinia* and *Escherichia coli* VTEC, *Clostridium perfringens* and *Campylobacter jejuni*, due to the factors listed above (Greig & Lee, 2009). Buccheri et al. (2010) reported that outbreaks of gastrointestinal diseases, including those caused by *Salmonella*, *E. coli* O157:H7 and norovirus are a common phenomenon in nursing homes. Data published by the European Food Safety Authority (EFSA) for 2010 in the EU, showed that 2.7% of food borne outbreaks, in which the place of food consumption was identified, occurred in social facilities for the support of the elderly. In the same year, 6.7% of food borne outbreaks occurred in kindergartens and schools, a similar percentage to that obtained in 2008 (5.3%) (EFSA, 2010, 2012).

In September 2012, an outbreak caused by norovirus affected more than 11,000 individuals, mostly children who attended more than 100 kindergartens and schools in 5 regions of Germany. The food associated with the disease was a jam produced from a batch of frozen strawberries (ECDC, 2012). This is one of many published reports of food borne diseases affecting children (CDC, 2011a; Daniels et al., 2002; EFSA, 2012; WHO, 2000).

The application of good hygiene practices in food businesses is essential to protect consumers from food borne illness. The application of such practices requires that food handlers have the necessary knowledge and skills to fulfill their obligations as relates to food hygiene according to the general hygiene regulations (EU, 2004). Non-application of such practices, as a result of lack of knowledge or negligence, is cited as an important factor in the prevalence of these diseases (WHO, 2000).

Training and education are essential for food hygiene awareness and knowledge, although these do not always result in a positive change in food handling behavior (Clayton, Griffith, Price, & Peters, 2002; Seaman & Eves, 2008). Food hygiene and food safety training has been considered by several authors and organizations, as one of the fundamental requirements for the reduction of inappropriate practices, both in the management of food safety systems as in good hygiene practices (CAC, 2003; Egan et al., 2007; Gomes-Neves, Cardoso, Araújo, & Costa, 2011; ISO, 2005; Seaman, 2010; Sun & Ockerman, 2005; WHO, 2000). Certainly the need for training of food handlers is an essential part of the HACCP concept and is thus recognized in EU legislation (EU Regulation 852/2004) and by international organizations such as the WHO (WHO, 2000).

Several studies point to the positive effects of training in food hygiene knowledge, but often this is insufficient to raise the knowledge to satisfactory levels and maintain these over time. Training has also been found not always to be sufficient in providing harmonized knowledge across the various critical issues for food safety nor between populations with different socio-demographic characteristics (Acikel et al., 2008; Ansari-Lari, Soodbakhsh, & Lakzadeh, 2010; Baş, Ersun, & Kivanç, 2006; Bolton, Meally, Blair, McDowell, & Cowan, 2008; Egan et al., 2007; Gomes-Neves, Araújo, Ramos, & Cardoso, 2007; Jevšnik, Hlebec, & Raspor, 2008; Jianu & Chis, 2012; Marais, Conradie, & Labadarios, 2007; Santos, Nogueira, Patarata, & Mayan, 2008; Walker, Pritchard, & Forsythe, 2003).

The aim of this present study was to evaluate food handlers' knowledge on food hygiene in nursing homes and kindergartens in the cities of Porto and Vila Nova de Gaia – Portugal, using a previously applied questionnaire (Gomes-Neves et al., 2007; Martins, Hogg, & Otero, 2012).

2. Material and method

2.1. Population under study and sampling method

From a global population of kindergartens ($N = 343$) and nursing homes ($N = 121$), in the region of Porto, 155 institutions

were selected to be studied. These institutions were selected by stratified random sampling, producing characteristics in the sample that are proportional to the overall population. We consider 3 different groups in the sampling process: the specific activity of the institution (kindergartens or nursing homes), ownership of the institutions (public, private or religious), and location of the institutions (Porto or Vila Nova de Gaia, the two most populous cities of the region of Porto). The questionnaires were applied to 335 food handlers (72% of the total number of food handlers working in the selected institutions).

2.2. The questionnaire and the collection of data

Data collection was conducted between January and July 2010 through a 335 identical questionnaires distributed by the 116 kindergartens and 39 nursing homes. Questionnaires were filled-in individually, in the presence of the researcher. In general, the time required for completion was less than 30 min. The purpose of the questionnaire and how it should be filled-in (in all questions only one option should be registered) was explained to participants. A code was assigned to each completed questionnaire, enabling the identification of the institution whilst maintaining the anonymity of the participant. The right of non-participation was guaranteed.

The questionnaire consists of 28 multiple choice questions that do not allow multiple answers. Five (5) of these questions were entirely factual, dealing with the respondents' gender, age, education, professional experience and training. The remaining 23 questions were intended to assess knowledge of participants in relation to food hygiene. These questions fall under 4 food hygiene topics: temperature control (5), surface and utensils hygiene (4), sources of contamination (8) and risk associated with foods (6).

This questionnaire was developed by Gomes-Neves et al. (2007) and previously applied by those authors and by Martins et al. (2012) in Portugal.

All answers are measured on a nominal scale, except those relating to age, education and professional experience (ordinal scale). The number of optional answers varies between 3 and 5, with the exception of gender (2) and education (6). All 23 questions on food hygiene have the option "Do Not Know" to reduce the probability of selecting the answer by chance. As an example, question 10 "Nitrate contaminated water is proper to consume if boiled for 10 min?" has the following alternative answers: a) True; b) False; c) Do not know. Another example is question 4 "Which is the most common symptom of food poisoning?" with the following alternative answers: a) Headache; b) Throat ache; c) Diarrhea; d) Do not know.

The score criterion for the answers was one (1) point for each correct answer and zero (0) points for each question not answered correctly, the score range thus potentially varying between 0 and 23 points. When more than one option was chosen by participants, not complying with the rules set, it was considered the answer "Do Not Know", and scored with zero (0) points.

A face-to-face structured interview applied to food safety manager (data not published) allowed data to be collected concerning the nature of the ownership of the institution and its HACCP implementation status.

2.3. Statistical analysis

Data analysis was based on descriptive statistics and the differences between groups were evaluated based on non-parametric tests, since normality assumption could not be granted for at least some of the dimensions. Kruskal–Wallis or Mann–Whitney tests were used to detect differences between variable subcategories,

and Friedman's two-way analysis of variance by ranks to detect differences between food hygiene topics in each variable subcategory. A linear model was used to identify the predictors of overall levels of knowledge on food hygiene. Significant values for $p < 0.05$ were considered. Data from questionnaires were analyzed using IBM® SPSS® Statistics, version 21.

3. Results

3.1. Sampling characteristics

The sample of food handlers is made up mostly (97.6%) by women. 61.5% of the participants were between 36 and 55 years old and 70.1% had been working in the sector for more than 5 years. 88.6% of them have had nine or less years of formal education, and 39.0% have had four or less years. About 72.0% of participants reported having participated in food hygiene training programs over the past 12 months and 42.8% work in units with a HACCP plan with critical control points (CCPs) identified (Table 1).

Porto provides 56.7% of food handlers in the sample. 65.1% of the participants work in kindergartens. 27.8% work in public institutions and the remaining are employed in religious (35.2%) or in others private institutions (37.0%) (Table 1). These percentages are the result of the stratified sampling method applied in this investigation.

3.2. Results concerning food hygiene knowledge

3.2.1. Overall questionnaire results

The average score of correct answers for the full questionnaire was 13.9 ($\pm 3.65SD$). This value corresponds to the 60.7% of questions answered correctly by the participants. The highest score achieved was 22 values (95.5%) and the lowest 1 (4.3%). Data shows that 34.4% of participants answered twelve (12) or less questions correctly and that 39.6% of them have a score between 12 and 16 points.

Eight (8) questions (34.8% of the questions) were answered correctly by less than 50% of the participants. The percentage of correct answers, for this subset of 8 questions drops to 33.5%.

3.2.2. Question by question results

Table 2 shows the percentage of correct and incorrect answers obtained for each question. Question 17 ("In the refrigerator, should cooked food be separated for raw food through containers or packages?") shows the highest percentage of participants that responded correctly (the only question with more than 90% of respondents answering correctly). Questions number 9 ("Which is the most common origin of *St. aureus* food contamination?") and 11 (about inappropriate holding temperatures), show the lowest percentage of correct answers, 17.0 and 22.2%, respectively. Question 11 also presents the greatest number of wrong answers (61.2%), while question 9 has the highest percentage of "Do not Know" answers (51.8%), followed in this respect by question 8 (about foods associated to botulism) (49.1%). In both cases, the "Do not know" is the most chosen by the participants. Questions with lowest percentage of wrong answers (less than 10%) are as follows: number 17 (6.3%), number 20 (7.8%) and number 22 (8.1%), the last two question relating to surface and utensils hygiene. All the questions on surface and utensils hygiene show more than 72% of correct answers.

3.2.3. Comparative analysis regarding sample characteristics

Table 3 shows the arithmetic mean and 95% confidence intervals within each of the variables categories, including gender, age,

Table 1
Demographic characteristics of respondents ($n = 335$).

Characteristics	Sample results (%)	n^a
<i>Gender</i>		
Female	97.6	321
Male	2.4	8
<i>Age (years)</i>		
<36	14.8	49
36–45	29.1	96
46–55	32.4	106
>55	23.6	78
<i>Education</i>		
Primary school	39.0	130
6th year	26.9	90
9th year	22.8	76
12th year	7.8	26
University	3.6	11
<i>Professional experience (years)</i>		
Up to 1	6.3	21
1–3	10.0	33
4–5	13.6	45
More than 5	70.1	231
<i>Training (last 12 months)</i>		
Yes	71.9	240
No	28.1	94
<i>HACCP implementation</i>		
Yes	42.8	143
No	57.2	191
<i>City</i>		
Porto	56.7	190
Gaia	43.3	145
<i>Institution activity</i>		
Kindergartens	65.1	218
Nursing homes	34.9	117
<i>Ownership</i>		
Private	37.0	124
Public	27.8	93
Religious	35.2	118

^a Number of respondents.

education, professional experience, training, HACCP implementation, city, institution activity and ownership.

Table 4 shows the p -value of Kruskal–Wallis and Mann–Whitney tests for the sample characteristics.

3.2.3.1. Gender. Due to the small number of male participants ($n = 8$), the application of an inferential statistical test has several intrinsic, associated errors, therefore such an analysis was not performed.

3.2.3.2. Age. No statistically significant differences have been detected in the scores obtained by the different categories of this variable, despite the older participants (>55 years) present the lowest score.

3.2.3.3. Education. Due to the small number of participants with university education ($n = 11$), for the statistical analysis we have transformed "12th year" and "university" categories in a single category.

There is a statistically significant difference ($p < 0.05$) between participants with different levels of education. The arithmetic mean of scores tends to increase with the increase in the number of years

Table 2

Percentage (%) of correct/incorrect answers for each question (difference to 100% indicates "Do Not Know" answers). Questions with less than 50% of correct answers are in bold.

Number	Question contents	Correct answers (%)	Incorrect answers (%)
1	Identify sterile food	37.7	45.8
2	Identify high-risk food	55.7	40.1
3	Food borne illness and food production animals	68.9	26.6
4	Food borne illness symptoms	85.0	10.8
5	Food borne illness transmission	69.8	24.3
6	Sensorial checks and identification of bacterial contamination	49.2	48.9
7	Insect control and foodstuffs hygiene	83.5	11.1
8	Food groups related with botulism	26.8	24.1
9	Origin of <i>S. aureus</i> present in foods	17.0	31.3
10	Removal of nitrates by boiling water	46.1	42.2
11	Dangerous temperatures range for food preservation	22.2	61.2
12	Freezing temperatures of foods	54.5	33.5
13	Storage temperatures for chopped meat	43.7	34.4
14	Frozen foods and validity date	86.2	10.5
15	Refrigeration temperatures and microorganisms death	75.4	17.4
16	Refrigerator food storage requirements	57.5	26.4
17	Refrigerator food packing requirements	90.4	6.3
18	Health conditions to prevent food handling	62.0	32.5
19	Cleaning of utensils and food handling	88.3	11.7
20	Surfaces and utensils washing products	89.5	7.8
21	Surfaces and utensils washing requirements	72.7	22.2
22	Cleaning of utensils and use of no potable water	87.7	8.1
23	Storage temperatures for beef	26.0	44.9

of formal education attended. Participants with 12 or more years of formal education (including university education) obtained a statistically different score (higher score) than all the others categories ($p < 0.001$ and $p = 0.002$ in the case of respondents with 9 years of formal, school education). On average, the percentage of correct answers of respondents with 12 or more years of formal education is, respectively, 9.3% and 12.9% higher than that of participants with 9 and 4 years (primary school) of formal education.

3.2.3.4. Professional experience. No statistically significant differences have been detected in the scores obtained by the different categories of professional experience. This variable does not seem to have any effect on the overall results obtained in the questionnaires.

3.2.3.5. Training (last 12 months). There is a statistically significant difference ($p < 0.05$) between participants with or without training in the last 12 months. Respondents who participated in training in the last 12 months have higher scores than those who did not.

3.2.3.6. HACCP implementation. No statistically significant differences were found between the arithmetic mean of scores from the respondents that were employed in units with HACCP implemented and those employed in units without, although the former have generally higher scores. This variable does not seem to have any effect on the overall results obtained from the questionnaires.

We consider the HACCP system implemented whenever a Food Safety Manual or equivalent document with a HACCP plan was present. The HACCP plan should describe the CCPs. The efficacy of the plans was not evaluated in the context of this present study.

3.2.3.7. Geographical area (city) where the institution is located. There is a statistically significant difference ($p < 0.05$) between participants working in units located in Porto or in Vila Nova de Gaia. Respondents from Porto have an average percentage of correct answers higher (64.0%) than those of Vila Nova de Gaia (56.7%).

3.2.3.8. Institution activity. There is a statistically significant difference ($p < 0.05$) between participants working in kindergartens and those working in nursing homes. Respondents from kindergartens have on average, higher percentage of correct answers (62.5%) than those from nursing homes (57.5%).

3.2.3.9. Ownership of the institution. No statistically significant differences were found between the arithmetic mean of scores from the respondents of institutions with different types of ownership (private, public or religious). This variable does not seem to have any effect on the overall results obtained in the questionnaires.

Attempting to identify the predictors of overall levels of knowledge on food hygiene and on its four dimensions described, a linear model was adopted that, despite having revealed little explanatory power, allowed the identification of the main predictors for each of these variables (Table 5).

In the case of overall levels of knowledge on food hygiene, the model accuracy is 14.6% and the identified predictors are education (relative importance of 0.397, $p < 0.001$); City (0.294; $p < 0.001$); Training (0.199; $p = 0.002$) and Institution (0.110; $p = 0.022$).

3.2.4. Results from questions regarding different food hygiene topics

Table 3 presents the arithmetic mean values and 95% confidence interval of scores for the full questionnaire and for each food hygiene topic, and p -values resulting from related samples Friedman's two-way analysis of variance by ranks.

Table 3 suggests that food handlers have a variable knowledge in relation to each of the 4 distinct topics on food hygiene analyzed. Knowledge related to temperature control (44.2% of correct answers) and to risk associated to foods (50.2% of correct answers) is significant lower than the overall knowledge (60.7% of correct answers). However, these two topics do not show statistically significant difference between them. On the other hand, knowledge related to hygiene of surfaces and utensils (84.5% of correct answers) and to sources of contamination (66.8% of correct answers), is significant higher than overall knowledge and significantly different between them and also between the other 2 topics analyzed.

Moreover, the level of knowledge in each of the food hygiene topics is significantly different in all categories for each of the variables.

Table 4 shows the p -values from Kruskal–Wallis and Mann–Whitney tests for each of the food hygiene topics covered in the questionnaire. Training is the sample characteristic which influences the average score of the highest number of food hygiene topics (all except risks associated with foods). Educational level is the only variable examined which affects knowledge on risk associated with foods. Statistically significant difference ($p < 0.001$) can be observed between participants with higher education (university or 12th years) (higher score) and all the others. Educational level also affects the average score of knowledge on sources of food contamination. Participants with higher education (university or 12th years) have statistically significant different scores (higher scores) than the other participants. The specific activity of the institution and the city where the institution is located is also relevant to knowledge on sources of contamination. Age and professional experience of the respondents, and HACCP

Table 3
Arithmetic mean^f and 95% confidence intervals within each of the variables (gender, age, education, professional experience, training, HACCP implementation, city, institution activity and ownership) categories for full questionnaire and for each topic, and *p*-values resulting from related samples Friedman's Two-Way Analysis of Variance by Ranks comparing the 4 food hygiene topics.

		Food hygiene topics					<i>p</i> -Value
		All topics (23) ^e	Temperature control (5) ^e	Surfaces and utensils hygiene (4) ^e	Sources of contamination (8) ^e	Risk associated to foods (6) ^e	
Gender	Female	0.604 (0.586–0.621)	0.436* (0.404–0.468)	0.848 (0.826–0.870)	0.661 (0.638–0.684)	0.500* (0.474–0.527)	<0.001
	Male	0.745 (0.627–0.862)	0.700 (0.447–0.953)	0.844 (0.688–0.999)	0.844 (0.736–0.952)	0.583 (0.336–0.830)	0.145
Age	<36 years	0.626 (0.577–0.676)	0.445 [#] (0.360–0.530)	0.806* (0.740–0.872)	0.707* (0.642–0.771)	0.551 [#] (0.481–0.621)	<0.001
	36–45 years	0.634 (0.605–0.663)	0.481* (0.421–0.541)	0.865 (0.829–0.900)	0.687 (0.647–0.723)	0.481* (0.421–0.541)	<0.001
	46–55 years	0.603 (0.575–0.632)	0.425* (0.373–0.477)	0.863 (0.829–0.897)	0.656 (0.615–0.697)	0.425* (0.373–0.477)	<0.001
	>55 years	0.580 (0.540–0.620)	0.434* (0.362–0.505)	0.821 (0.765–0.876)	0.641 (0.595–0.687)	0.434* (0.362–0.505)	<0.001
Education	Primary school ^b	0.585 (0.558–0.613)	0.416* (0.364–0.468)	0.845 (0.810–0.880)	0.648 (0.613–0.682)	0.464* (0.424–0.503)	<0.001
	6th year ^b	0.580 (0.548–0.613)	0.423* (0.365–0.480)	0.823 (0.775–0.872)	0.631 (0.587–0.674)	0.483* (0.432–0.534)	<0.001
	9th year ^c	0.621 (0.584–0.657)	0.474* (0.406–0.541)	0.855 (0.812–0.898)	0.676 (0.624–0.728)	0.513* (0.460–0.567)	<0.001
	12th year and university	0.714 (0.671–0.758)	0.514 [#] (0.410–0.616)	0.878* (0.825–0.933)	0.794 ^{##} (0.744–0.844)	0.667 ^{##} (0.583–0.750)	<0.001
Professional experience	<1 year	0.619 (0.564–0.674)	0.324* (0.263–0.421)	0.833 ^{z#} (0.750–0.916)	0.756 ^{+z} (0.695–0.817)	0.540 ^{##} (0.422–0.657)	<0.001
	1–3 years	0.572 (0.496–0.647)	0.449 [#] (0.334–0.563)	0.796 ⁺ (0.706–0.885)	0.625 ^{##} (0.538–0.712)	0.455* (0.351–0.558)	<0.001
	4–5 years	0.592 (0.547–0.638)	0.413* (0.321–0.506)	0.867 (0.815–0.919)	0.628 ⁺ (0.553–0.702)	0.511 ^{##} (0.436–0.586)	<0.001
	>5 years	0.614 (0.594–0.634)	0.457* (0.419–0.495)	0.849 (0.823–0.876)	0.671 (0.645–0.697)	0.504* (0.474–0.535)	<0.001
Training (last 12 months)	Yes	0.629 (0.610–0.648)	0.474* (0.436–0.512)	0.871 (0.849–0.893)	0.690 (0.667–0.714)	0.510* (0.478–0.541)	<0.001
	No	0.553 (0.519–0.588)	0.362* (0.306–0.418)	0.782 (0.730–0.834)	0.608 (0.557–0.658)	0.488* (0.441–0.534)	<0.001
HACCP implementation	Yes ^d	0.615 (0.588–0.642)	0.431* (0.383–0.479)	0.853 (0.820–0.886)	0.695 (0.663–0.726)	0.500* (0.460–0.540)	<0.001
	No	0.601 (0.579–0.624)	0.450* (0.407–0.493)	0.840 (0.811–0.869)	0.646 (0.615–0.677)	0.506* (0.472–0.541)	<0.001
City	Porto	0.640 (0.616–0.663)	0.469* (0.426–0.513)	0.846 (0.810–0.875)	0.726 (0.698–0.754)	0.519* (0.484–0.553)	<0.001
	Gaia	0.567 (0.543–0.591)	0.407* (0.361–0.453)	0.845 (0.811–0.879)	0.591 (0.558–0.625)	0.484* (0.444–0.524)	<0.001
Institution activity	Kindergartens	0.625 (0.605–0.646)	0.461* (0.423–0.499)	0.859 (0.835–0.883)	0.700 (0.675–0.725)	0.498* (0.466–0.530)	<0.001
	Nursing homes	0.575 (0.544–0.606)	0.407* (0.350–0.464)	0.821 (0.777–0.864)	0.606 ⁺ (0.563–0.648)	0.514 ^{##} (0.469–0.559)	<0.001
Ownership	Private	0.592 (0.564–0.621)	0.390 (0.346–0.435)	0.831 (0.790–0.871)	0.641 (0.602–0.681)	0.532 (0.489–0.575)	<0.001
	Public	0.613 (0.584–0.642)	0.479* (0.421–0.537)	0.878 (0.840–0.916)	0.669 (0.629–0.709)	0.471* (0.419–0.523)	<0.001
	Religious	0.619 (0.588–0.652)	0.467* (0.405–0.528)	0.836 (0.803–0.870)	0.693 (0.656–0.730)	0.499* (0.456–0.541)	<0.001
Total sample		0.607 (0.590–0.625)	0.442* (0.410–0.474)	0.845 (0.823–0.867)	0.668 (0.646–0.691)	0.502* (0.479–0.531)	<0.001

*+## No statistically significant differences between topics.

^a Essentially older workers who left school after primary education when this was permitted.

^b Essentially older workers who left school after primary education when this was permitted or those who left at 16 without completing the obligatory studies.

^c Workers who left after completing compulsory education of 9 years of schooling.

^d Assumes the presence of an HACCP plan with CCPs defined.

^e Number of questions in each topic.

^f Arithmetic mean is calculated dividing the average score of correct answers by the number of questions.

implementation have no apparent effect on the average score of knowledge of any of the 4 food hygiene topics.

4. Discussion

The sample studied is largely female (97.6%) which is consistent with the situation in the rest of the country for this area of work. According to a report from a Portuguese professional training agency (IQF, 2005), 85% of workers in this area are women. The low level of education of the participants, with about 40% with 4 or less years of formal education and 88.6% with 9 or less years of formal education, is in accordance with data published by Demunter (2008). This trend was also referred by Martins et al. (2012), however the population of the present study is older and has a lower overall level of education.

40.0% of the institutions selected have a HACCP-based system implemented (data not published). The criteria used to evaluate the whether or not HACCP had been implemented were the presence of

a HACCP plan with CCPs identified and the presence of operational records, relating to pre-requisite programs (PRPs) and HACCP. The percentage of institutions in this study which has HACCP implemented decreases to about 24% of the total when the criteria are altered to include the existence of verification plan (data not published).

The full questionnaire results show that, on average, food handlers who participated in the study answered 60.7% of the questions correctly (14/23 questions). This result is higher to that obtained by Martins et al. (2012), in a study carried out in Portugal, using the same questionnaire and the same methodology to collect data. The average percentage of correct answers obtained was 56.5%, and the population under study was food handlers ($n = 101$) of a catering company which manufactures and distributes meals to the canteens of schools, kindergartens and nursing homes.

Gomes-Neves et al. (2007) applied the same questionnaire to food handlers ($n = 79$) from small businesses in the regions of Porto

Table 4Results (*p*-values) of nonparametric tests: Mann–Whitney *U* test (for two categories) or Kruskal–Wallis test (for more than two categories).

	All topics	Temperature control	Surfaces and utensils hygiene	Sources of contamination	Risk associated with foods
Age	0.166	0.576	0.514	0.122	0.095
Education	<0.001	0.280	0.783	<0.001	<0.001
Professional experience	0.528	0.146	0.607	0.170	0.739
Training	<0.001	0.001	0.005	0.011	0.446
HACCP implementation	0.454	0.694	0.478	0.052	0.986
City	<0.001	0.106	0.818	<0.001	0.167
Institution activity	0.012	0.049	0.321	<0.001	0.566
Ownership	0.498	0.049	0.132	0.205	0.190

p-values below 0.05 are in bold.

and Viana do Castelo (North of Portugal). The percentage of correct answers was 62.9% (14.5 questions). However, the methodology used for data collection was different. The questionnaires were collected a week after their delivery to food handlers.

In another study in Portugal, knowledge on food hygiene of food handlers ($n = 124$) of 32 school canteens in Vila Real was assessed, by conducting face to face interviews based on a pre-established questionnaire (Santos et al., 2008). The average percentage of correct answers was 66.1% although this is not directly comparable as the questionnaires were not the same.

With the same general purpose, questionnaires were applied in South Africa (Marais et al., 2007), Turkey (Baş et al., 2006; Çakiroğlu & Uçar, 2008), and in Romania (Jianu & Chis, 2012). In the South African study, the average percentage of correct answers was 46.0%. In this study, participants ($n = 159$) completed a self-administrated questionnaire under the supervision of fieldworkers. In Turkey, one of the studies was conducted in Ankara, on a population of 764 food handlers and the average of correct answers was 43.4% (Baş et al., 2006). In the other study, performed in Ankara, Çakiroğlu and Uçar (2008) obtained a 70.3% of correct answers ($n = 400$ food handlers). To evaluate the hygiene knowledge of food handlers ($n = 198$) of small and medium-sized companies, in Romania, Jianu and Chis (2012) applied a self-administrated questionnaire. The questions were answered in the presence of the researchers and the percentage of correct answers was 63.2%.

Whilst accepting that comparisons of numerical or percentual scores are not valid between questionnaires which are themselves not identical or even harmonized it is interesting to note that levels of scores amongst different studies reported in the literature are relatively concordant and indicate that food handlers have a lack of knowledge on food hygiene, and certainly this is the case in Portugal.

Food handlers' knowledge of food hygiene is one factor that can contribute to awareness of the food safety risks inherent to the food business, reinforcing a positive attitude toward food safety. On the other hand, gaining new knowledge and skills, reinforces the belief in their ability to perform a given behavior (Ajzen, 1991; Taylor, 2008). Thus, the reinforcement of knowledge is one of the factors that can help to positively change behavior that will result in safer food and consumer protection. It is, however, mentioned in the bibliography that increased knowledge does not always have the effect of changing behavior related to food safety (Clayton et al., 2002; Egan et al., 2007; Seaman & Eves, 2008).

Analyzing the overall results of the questionnaire and considering the characteristics of the participants we found that age and professional experience of the participants do not seem to have a significant effect on the level of knowledge on food hygiene (Table 4). However, the educational level and training undertaken (previous 12 months) have a statistically significant effect ($p < 0.001$) on the average scores of correct answers. These two

Table 5

Predictors of overall knowledge on food hygiene and of its 4 dimensional topics based on Linear Models.

Predictors	All topics	Temperature control	Surfaces and utensils hygiene	Sources of contamination	Risk associated with foods
Age					0.192
<i>p</i> -Value					0.044
Education	0.397	0.192		0.199	0.808
<i>p</i> -Value	<0.001	0.014		<0.001	<0.001
Professional experience		0.242			
<i>p</i> -Value		0.006			
Training	0.199	0.256	0.832		
<i>p</i> -Value	0.002	0.004	<0.001		
City	0.294	0.101		0.497	
<i>p</i> -Value	<0.001	0.049		<0.001	
Institution activity	0.110			0.174	
<i>p</i> -Value	0.022			0.001	
Ownership		0.224	0.168		
<i>p</i> -Value		0.008	0.107		
Model accuracy ^a	14.6%	7.2%	4.1%	19.4%	6.3%

^a Linear model with forward stepwise model selection method.

variables were identified as predictors of food handlers' knowledge levels, educational level being the most relevant predictor (0.397; $p < 0.001$), despite the low accuracy (14.6%) of the linear model adopted (Table 5). The low accuracy of this model reveals its inadequacy for practical purposes and suggests that future works should include: 1) a broader sample with representative variable subcategories; and 2) a wide range of variables as potential predictors (e.g., the number of training sessions; training methodologies; motivation to learn).

The educational level of the respondents apparently correlates with the average scores. In a previous study, Martins et al. (2012) also found a statistically significant effect of educational level on food hygiene knowledge. However, the scores obtained by all levels of education were lower. In a study carried out by Çakiroğlu and Uçar (2008) to determine employees' perception of hygiene in the catering industry in Ankara (Turkey), the authors also found a statistically significant difference between different levels of education. Other authors produce similar data (Jianu & Chis, 2012). Santos et al. (2008) found no significant influence of formal education on the level of knowledge of food handlers. However, Tokuç, Ekuklu, Berberoğlu, Bilge, and Dedeler (2009), in a study conducted in three hospitals, in Turkey, with a sample of food handlers ($n = 81$), found that unsafe hygiene practices were more common among participants with higher educational level. According to these authors these findings may be a result of lack of theoretical and practical training on food hygiene and the adoption of practices based on empirical household routines.

The importance of food safety education, including teaching children safe behavior in the handling of food, is given as a priority by the WHO (WHO, 2000, 2012) and reported by several authors (Sanlier, 2009; Sharif & Al-Malki, 2010) as a way to prevent food borne diseases. Sanlier (2009) argues that food safety education should start in childhood, using formal or non-formal education and also the media. The inclusion in school curricula of an approach to food hygiene and food safety will allow an early adherence to safe behavior, making future adults, whether they will be professional food handlers or not, more capable to deal with food hazards.

In the present study, respondents who attended in training sessions in the last 12 months have statistic significant higher average scores ($p < 0.001$) than those who did not. Therefore there appears to be a positive effect of training on the level of food handlers' knowledge.

In a study conducted in nursing homes and long-term care facilities in Italy, Buccheri et al. (2010) concluded that the participation in training courses on food hygiene and food safety by food handlers ($n = 502$) improved their level of knowledge in some of the key topics to food safety, particularly in temperature control and in identification of risks associated to foods. Training was the only studied variable (age, education, experience and training) that was consistently shown to correlate with the average of correct answers of respondents. Angelillo, Viggiani, Greco, and Rito (2001), in a study conducted in 27 hospitals of Italy, carried out with 290 food handlers, demonstrated, using logistic regression (OR = 2.68; CI 95% = 1.49–4.82; $p = 0.001$), the positive relationship between the frequency of training and strengthening of knowledge on temperature control. In a study in school canteens Santos et al. (2008) showed that the presence in training sessions (food hygiene and food safety) increased the classification of respondents significantly ($p < 0.001$ – an increase of 7.6% in the scores), demonstrating that it has a positive effect on knowledge on food hygiene. In the same study the number of training sessions, number of training hours and the time since the previous training session were also considered. Of these variables, only the latter proved to have a significant effect ($p = 0.01$ – a rise of 10.2%) on the increasing knowledge of food handlers, when comparing respondents with

training sessions in the last twelve months with those receiving the last training session more than 6 years previously (Santos et al., 2008).

Since one of the prerequisites for the implementation of a food safety system based on HACCP is professional training on food hygiene and given the positive effect of training on food handlers' knowledge, it would be expected that the implementation of HACCP in an institution might also show a similar effect. Nevertheless, whether or not the institution in question has implemented HACCP does not seem to have any statistically significant effect on food handlers' knowledge on food hygiene. Results showed that participants with recent prior training, employed or not in institutions with HACCP implemented, always had higher percentage of correct answers (respectively 63.0% and 62.7%) than those without this training (54.9% and 55.5%, respectively, with and without HACCP implemented).

The results do not corroborate the findings of Angelillo et al. (2001) according to whom HACCP implementation promotes an increase in knowledge on good hygienic practices.

We found that the city where the institution is located ($p < 0.001$) and the activity of the institution ($p = 0.012$) have a statistically significant effect on the average scores of correct answers. Probably, some variables that may explain these results were not considered in this study, since it was not part of its objectives to explain differences between food handlers' knowledge of the two cities and of the two types of institutions activities (social responses). However, we verified that the education level of food handlers working in institutions located in Porto was significantly higher ($\chi^2 = 10.425$, $p = 0.034$) than those working in Vila Nova de Gaia, and that respondents working in kindergartens have a statistically significant difference (higher value) than those who work in nursing homes, as regards to the participation on training sessions in the last 12 months ($\chi^2 = 13.065$, $p = 0.001$).

Also evident from the analysis of our results is the difference between food handlers' knowledge among different food hygiene topics. Moreover, Table 3 shows the existence of a pattern of knowledge in all categories of all studied variables. Questions about temperature control of foods have the lowest average percentage of correct answers (44.2%). For each of the categories of the different variables, temperature control always has the lowest average percentage of correct answers compared with the other food hygiene topics. However, in most of the cases, there is no statistical difference between the average percentage of correct answers concerning temperature control of foods and those concerning risk associated with foods (Table 3). The lowest percentage of correct answers concerning temperature control of foods was obtained by participants with less than 1 year of professional experience (32.4% of correct answers) and participants without food hygiene training in the previous year (36.2% of correct answers) (Table 3). Three of the five questions on this topic (namely question nos. 11, 13, and 23) have a percentage of correct answers below 50% (Table 2). Question no. 11, about dangerous temperatures for food preservation presents the greatest number of wrong answers (61.2%). In this question, only 22.2% of the participants give the correct answer (5–65 °C). The other options were 0–4 °C (16.5%), 70–80 °C (44.7%) and “Do not know” (16.5%). Others studies point to the same conclusion: temperature control is a shortcoming on food handlers' knowledge (Baş et al., 2006; Egan et al., 2007; Jevšnik et al., 2008; Jianu & Chis, 2012; Marais et al., 2007; Martins et al., 2012; Santos et al., 2008; Walker et al., 2003). On the opposite side, considering all categories for each of the variables, knowledge related to surface and utensil hygiene always has the higher average percentage of correct answers compared with the other food hygiene topics (Table 3). All the questions on this topic have a percentage of correct answers above 70% (Table 2). The other food hygiene topic which

shows significantly higher results than for overall knowledge on food hygiene concerns sources of contamination.

Corroborating results from others studies, it is possible to conclude from our study that, despite the statistically significant effect of training on the level of food handlers' knowledge on food hygiene, it is not sufficient to create a homogeneous level among different food hygiene topics and to eliminate their lack of knowledge.

According to a number of authors, one of the main reasons for the lack of effectiveness of training in food hygiene is related to the Knowledge–Attitudes–Practices (KAP) model adopted in most of the training programmes (Coleman & Roberts, 2005; Egan et al., 2007; Ehiri, Morris, & McEwen, 1997). This model is based on the assumption that if information is provided to food handlers they will use it to change behavior. This model does not consider or reflect the effect of others relevant factors for the success of training like pedagogical, social, cultural, motivational and environmental factors (Coleman & Roberts, 2005; Ehiri et al., 1997; Rennie, 1995; Seaman & Eves, 2006).

The results of the present study corroborate studies that reinforce the need to properly design training, incorporated into a training plan that should meet the needs of individuals in the context of the organization in which they operate. However, the systematic identification of training needs does not seem to be a widespread practice, particularly in small organizations (Worsfold, 2005). A food hygiene training model proposed by Seaman (2010), which combines social cognitive models with education theories, suggests the identification and analysis of training needs to assess food handlers' current knowledge, skills and attitudes toward safe food handling behavior, as a starting point for a training process.

The choice of externally derived, modular training courses, often taught by trainers without knowledge of the trainees' needs and with an undifferentiated content regardless of prior training and skills acquired by them, does not seem to provide effective results. Training courses with information which is not relevant for their needs or which is already known by them can be perceived as a waste of time and resulting in lack of motivation (Seaman, 2010).

If the starting point should be the identification of training needs, the choice of training program and all the socio-cognitive factors that influence learning and its transfer will condition effectiveness of training (Nieto-Montenegro, Brown, & LaBorde, 2006; Seaman, 2010).

Several authors argue that active learning methods are more effective, resulting in greater knowledge retention and transfer. On-job training, role-playing activities or training based on new technologies, using computer programs that provide instructions via computer or by using the Internet (e-learning), are examples of active methods that have demonstrated effective results (Clayton et al., 2002; Eckerman et al., 2004; Kowalski & Vaught, 2002; Niode, Bruhn & Simonne, 2011; Rhoades & Ellis, 2010; Seaman & Eves, 2006; Soon & Baines, 2012). Nevertheless, the expository methods, mainly classroom training, based on KAP model, remain the most widely used in Portugal (Gomes-Neves et al., 2011). This form of training is selected often for economic reasons, having as main the motivation compliance with legal requirements. Most food managers put too much reliance on obtaining training certificates than on achieving knowledge and competency in food hygiene practice (Gomes-Neves et al., 2011; MacAuslan, 2003; Seaman, 2010).

Several authors argue that training in food hygiene and safety should be developed based on the concept of risk (Clayton et al., 2002; Coleman & Roberts, 2005; Niode, Bruhn, & Simonne, 2011). It should be emphasized the risk associated with malpractices, for example, presenting real cases with dramatic consequences for real

people. Quantitative approaches, merely statistical, should be replaced by qualitative approaches where real cases and their consequences are presented (Griffith, Livesey, & Clayton, 2010).

The organizational environment in which the training takes place has an influence on motivation to learn and for application of gained knowledge in the workplace. Certainly this is the case for aspects such as the individual's perception of managerial and peer support for behavioral changes in food handling (Ajzen, 1991; Ball, Wilcock, & Aung, 2009; Rennie, 1995; Seaman, 2010). Seaman (2010) refers to the effect of incentives (e.g., financial, working conditions improvement, availability of time) on food handlers' motivation to change relevant behavior.

Assessment of food hygiene training is necessary to attribute value to the intervention. Seaman (2010) suggested three evaluation stages for the effectiveness of the training interventions; the first one, a documented training needs analysis; the second one, measures the knowledge retained or the practical capabilities developed by the food handler; the third one, provides information about food handlers' evaluation of the training programs. A well-designed training program should have a positive effect on individual and organizational performance.

The present study shows a lack of knowledge on food hygiene of food service staff working in nursing homes and kindergartens, in the Porto region. Also presents a pattern of knowledge on food hygiene for all the categories of participants (except participants with university education) considering the four different topics studied. Based on our assessment of training needs we suggest the design of training programs that reinforce the topics where major knowledge gaps were found. Models combining social cognitive models with education theories, like food hygiene training model proposed by Seaman (2010), should be consider to increase the success of the intervention.

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