Evaluation of the effect of person-in-charge (PIC) program on knowledge and practice change of food handlers in Dubai

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Highlights

- Three of the four groups showed an increase in knowledge after the training
- There was no significant difference in practice between pre and post PIC intervention
- Work experience has significant effect on food safety knowledge of PIC individuals but only before the training intervention
- Education and professional training on food safety have significant effect on knowledge and practice
Running Title: Effect of PIC program on knowledge and practice of food handlers

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Evaluation of the effect of person in charge (PIC) program on knowledge and practice change of food handlers in Dubai

Abstract

The effect of Person in Charge (PIC) intervention on knowledge and practice of food handlers in Dubai was evaluated. Data were collected from 48 food establishments located in 4 zones in the city. Each establishment was visited twice in the assessment. In each visit, the same set of 12-knowledge questionnaire was asked and 20 observable practices evaluated. Hand and cutting board swabbing were also conducted to evaluate the personal hygiene of food handlers. Results showed that all the groups gained additional knowledge on food safety during training except group 4. Irrespective of knowledge gained, some of the trained PICs were unable to change food safety and handling practices at place of work. In group 1, the performance got worsen by 12%. Group 2 and 3 showed 4.3% and 10.3% improvement in food safety practices respectively. While, group 4 remained almost same as before the PIC intervention. With regards to cutting board swabbing, results showed that group 1 dropped by 16.6% while the remaining groups improved by 41.6%. In the case of hand swabbing all establishments in group 1 showed satisfactory results after training. Group 2, group 3 and group 4 showed 41.7% improvement. Statistics revealed that there was a significant improvement in the performance of food handlers in hand swabbing after the intervention with mean values of 60.4 % and 85.5% before and after respectively. In the case of cutting board swabbing, there was a considerable improvement but not statistically significant at (P<0.05) with mean values of 41.6% and 62.5% before and after respectively.
Key words: Training; Knowledge; Food handling practice, Food safety.

1. Introduction

Food and Agricultural Organization of the United Nations (FAO) and the World Health Organization (WHO) (2002) have jointly reported that millions of people get sick or die because of consuming unsafe food. Therefore, having a reliable and safe food supply chain remains one of the major preoccupations of many countries (McIntyre, Vallaster, Wicott, Henderson & Kosatsky 2013; Da Cunha, Stedefeldt & De Rosso, 2014). Literature reviewed has shown that, in the past, many foodborne outbreaks were associated with foods from animal sources. For example, Pires Vieira, Perez, Wong, and Hald (2012) conducted study on human foodborne illnesses and attributed sources in Latin America and Caribbean from (1993-2010) and reported that the most important sources of outbreaks varied substantially in the two decades. In 1990s, the researchers found that meat and dairy products were the most important sources of disease each contributing around 15% and 14.3% respectively. The researchers further mentioned that in this decade, the most frequently reported pathogens were *S. aureus*, *Salmonella*, *E. coli* and *C. perfringens*. In the 2000s, seafood and eggs appeared to be among the most important vehicle of reported illnesses and *Salmonella*, *V. Parahemolyticus*, and *Shigella spp*, were the most reported agents. The majority of the *Salmonella* outbreaks were reported in Cuba by Pires et al. (2012). Wallace, Guzewich, cambridge, Alterkruse and Morse (1999) also gave a detailed review of seafood-associated outbreaks in New York from (1980-1994).

In recent years, it has been observed that the shift in the consumption patterns towards eating minimally processed food have changed the picture Abadias, Usall, Anguera, Solsona, & Viñas, (2008). The driving force behind the increased consumption of fresh produce is the desire of
consumers to lead a healthy lifestyle. This desire perhaps was made stronger by the joint recommendation of FAO and WHO for people to have at least five servings of fruits and vegetable daily FAO and WHO (2006). Studies conducted recently showed that a number of disease outbreaks in countries like United States and within the European Union are associated with fresh produce and sprout seeds (Soon & Baines, 2012). The reported outbreak of haemolytic uremic syndrome (HUS) and bloody diarrhea in which the Shiga toxin-producing *Escherichia coli* 0104:H4 was implicated in Germany in May and June 2011 was a good example (Jansen & Kielstein, 2011). Another outbreak in south-west of France in June of the same year in which the causative strain was genetically related to the one identified in Germany supports the implication of fresh produce in many food borne outbreaks (Gault, Weill, Mariani-Kurkdjian, Jourdan-da Silva, King & Aldabe, 2011). In both outbreaks, the subsequent investigations concluded that both were associated to one lot of imported fenugreek seed and the consumers were accordingly advised not to use sprout or sprouted seeds without proper cooking (EFSA, 2011).

In addition to the accusation leveled against fresh produce, there are also several reports published in recent years that have shown poor handling to be an important cause of food borne illness (GonÇalves, 1998; Greig Todd, Bartleson, & Michaels, 2007; Silva, German, & Germano, 2003). The European Food Safety Authority (EFSA, 2010) reported that in year 2010 alone, about 48.7% of foodborne diseases were associated with catering establishments. Greig et al., (2007) have documented more than 233 outbreaks involving 16028 cases of food poisoning between 2000 and early 2006 and the majority of these cases happened in restaurants and catering establishments. Griffith (2000) also found that many food illnesses in USA, UK, Netherlands and, Korea were associated with food catering services. The principal causes of the reported outbreaks were associated with poor food handling practices, such as cross
contamination of raw and processed foods, slow cooling and inadequate refrigeration of foods (Da Cunha et al., 2014). Because of the strong association between foodborne illness and catering industry, numerous food safety trainings have been designed to address the problem in these establishments (Capunzo, Cavallo, Boccia, Brunetti, Buonoma & Mazza, 2005; Coleman & Roberts, 2005; Costello, Gaddis, Tamplin, & Morris, 1997; Medeiros, Cavalli, Salay, & Proença, 2011). Since food handlers have been blamed for many cases in outbreaks, it has been suggested by many producers and government agencies that this category of people in the food chain need to be educated on food safety and good food handling practices. For example, in British Columbia (BC) Canada, food safety training has become a legislated standard since July 2000 (McIntyre et al., 2013). According to the BC regulations, the operator and at least one worker in every food service establishment must have a certificate demonstrating successful completion of FOODSAFE level 1 training or equivalent food safety training course (McIntyre et al., 2013). In Brazil, Health Ministry resolution no 216 (Brazil – Health Ministry, 2004) established technical legislation that requires all food handlers to be trained periodically in food handling (Da Cunha et al., 2014). In Romania too, training food handlers in food hygiene is binding and a certificate valid for two years after which training must be conducted again is required as an evidence to support acquisition of basic hygiene knowledge (Jianu & Golet, 2014).

In Dubai, food safety is considered as a critical part of operating any food business (Food Control Department, 2012). Consequently, people in the food service business need to be trained on the risk and suffering that unsafe food can bring to the society. However, although training of food handlers was made mandatory since 2005, obtaining the desired outcomes in food safety remained to be a big challenge (Food Control Department, 2012). One of the explanations given is that most of the trained food handler’s work under managers who do not necessarily have the
skills and knowledge to appreciate the importance of food safety and facilitate activities geared
towards its attainment. The lack of understanding between food handlers and management
creates a weak point in the food supply change that is difficult to correct when there is no
designated person or point of contact. In order to solve this problem and harmonize the working
relationship between food control authorities and those in the catering service the concept of
having a person in charge (PIC) in every food establishment was created (Food Control
department, 2012).

Literature reviewed has shown that considerable studies on food safety knowledge and
practices have been conducted elsewhere (Sani & Siow, 2014). However, studies related to the
evaluation of food safety knowledge and personal hygiene of food handlers in Dubai is scarce at
the time of conducting this evaluation. Therefore, the objectives of this study were to evaluate
the effectiveness of the PIC intervention in providing food safety knowledge and to assess the
extent of utilization of knowledge gained in the PIC program to improve food safety practices
among handlers in selected food service establishments in Dubai.

2. Materials and methods

2.1. The PIC concept

In order to consolidate the gains registered in many sectors, it was deemed necessary for
the Dubai Government, to have a vibrant food catering business that will continue to provide
excellent service to inhabitants and visitors alike (Food Control Department, 2012). The concept
consisted of sets of sections. The first section defined mandatory requirements that all operating
food establishments have to meet.
One of the first obligations that any food establishment operating in Dubai must comply with is the employment of at least one full time, on-site PIC certified in Food safety. The PIC must receive adequate training in food safety depending on the role, responsibility and the risk category his food establishment is presenting.

Upon completion of the designed training modules, the PIC will be awarded a certificate that must be retained in the establishment and should be reachable when required for inspection. In the event that the PIC is terminated, the PIC requirements asked the food establishment to employ a new PIC within (30) days and the new PIC must enroll in a training program within 14 days. Table 1 represents a portion of the list of requirements for a person in charge based on business type and level of training required.

2.2. Key competency requirements of a certified PIC

In order to qualify for the job of a person in charge in food safety, certain criteria, which the individual must fulfill, have been set. The first among these criteria is to meet the requirements of ISO IEC 17024 standards in addition to the requirements set by the Food Control Department. The requirement of the Food Control Department includes (i) completing the approved Food Safety Certification Course for the identified food business activity and (ii) successfully passing the approved Food Safety Certification written examination administered jointly by the Department of Food Control and the Awarding Body.

2.3. Rules and requirements pertaining to the Awarding Bodies, Training companies and trainers

The second section of the PIC concept as outlined in Guidance Document of the Food Control Department of Dubai Municipality, Revised Edition, January (2012) focuses on the
roles and responsibilities of the awarding bodies, training companies and the trainers who offer
the accredited qualifications for person in charge of food establishments in Dubai. The section
identifies sets of roles and responsibilities for each stakeholder in the PIC concept. The first
stakeholder in the PIC framework is the Food Control Department of Dubai Municipality,
followed by the Awarding Bodies, the training companies and the trainers. The primary role of
the Food Control Department among other things include (i) developing appropriate training
programs and qualifications jointly with the Awarding bodies; (ii) monitoring implementation of
the agreed activities; and taking necessary action against partners short in fulfilling their
obligations etc. With regard to the awarding bodies, the key requirements include acquiring
approval of the Food Control Department and obtaining accreditation of Dubai Accreditation
Department, which is based on ISO 17024 standards. Their responsibilities include (i)
Developing relevant and up to date training programs and materials written in appropriate
languages including Arabic and English; (ii) The materials and programs must be approved by
the Food Control Department before they are offered to the industry.

2.4. Selection of PIC graduate and food handlers

Forty eight food establishments visited were selected randomly from four zones in Dubai.
Briefly, Dubai city was divided into four zones. In each zone, four types of food establishments
were identified and three food establishments were selected from each type. The types of
establishments that are similar in function were put together to form a group consisting of 12
food establishments. Group 1 represents 4 and 5 star hotels, group 2 consists of (chain
restaurants with big number of meals and limited variety), group 3 represents (normal
restaurants with limited meals and big variety) while group 4 represents small cafeterias.
2.5. Duties of the PIC

PIC is a person entrusted with supervisory responsibilities during all operating hours of the business and must be trained in the prevention of foodborne illness and injury. His primary duties include: (i) developing and implementing policies and procedures to prevent foodborne illness; (ii) ensuring that all employees are fully trained before they start to work; (iii) monitoring employee hygiene such as proper hand washing, cleaning and sanitizing of equipment and utensils.

2.6. Survey design

The survey approach consists of three parts. The first part deals with assessment of food safety knowledge among PIC graduates and the second part handles the application of food safety practices at selected food services establishments while the third part evaluates personal hygiene and sanitary condition adopted by food handlers under the supervision of the PICs. The knowledge assessment consisted of 12 knowledge questions and the food safety practice part consisted of 20 observable practices. Both of the knowledge and practice issues were generated from the training modules (available upon request) covered during the food safety training sessions conducted by the awarding bodies. The rationale of selecting these questions and observable action was to have a general idea about the effectiveness of the PIC concept and the food safety trainings that are being offered to impart knowledge and induce attitudinal change towards better food handling practices among food handlers.

In the knowledge-based questions, which were completed by the PIC individuals, the respondent is given score of two if the answer is correct and score of one if the answer is
unsatisfactory. This made the maximum possible score of 24 points and 12 points to be unsatisfactory. The second part consisted of twenty observable food safety practices that were evaluated by an evaluating team before and three months after the training. The evaluation scale ranged from excellent (4 points), acceptable (3 points), good (2 points) and bad (1 point).

The third part represents hand and cutting board hygiene. In this part, cutting board and hand swabbing were conducted to enumerate total plate count and coliform bacteria and to detect the presence of *E. coli* within the coliform group found in hands and cutting boards that were utilized by food handlers. The maximum acceptable limit for total plate count was set at 1000 CFU/cm², while the limit of *coliform* and *E. Coli* was set at 0/100cm². If the swabbing results were satisfactory, a score of 2 was given. If not a score of 1 is recorded. The swabbing was done following the method outlined in Yousef and Carlstrom (2003). Serial dilutions from each peptone sample were made by serial transfer of 1 ml from the previous test tube into a new 9 ml of sterile peptone saline. 1 ml from each dilution was inoculated into appropriate plate using pour plate technique. Plates were aerobically incubated at 37 °C for 18-24h for evidence of microbial growth. Total number of colony forming units (CFU) was determined from countable plates containing 20 to 200 CFU. The total number of colonies CFU / cm² was calculated using the equation given in Yousef and Carlstrom (2003). For the material applied (HiMedia Laboratories limited, Mumbai India) supplied all the Plate Count Agar (PCA), Violet Red Bile Agar (VRB agar), Brilliant Green Lactose Bile Broth (BGLB) and Eosin Methylene Blue Agar (EMB agar).

### 2.7. Statistical analysis
The statistical analysis of the data obtained from processing the results of the study was done using IBM SPSS (version 20) SPSS Inc. 233 S Wacker Drive, Chicago IL, USA. Analysis of Variance (ANOVA) was used to compare between means of the four groups before and after intervention. A regression model was used to determine if work experience, education level and type of food safety training received previously have any effect on reported food safety knowledge and practice of food handlers. T-test was used to determine if there was any significant difference between food safety knowledge and practice before and after intervention.

3. Results and discussion

3.1. Description and characteristic of the PIC respondents.

The education level, work experience and food safety training level of the PICs are shown in Table 2. The PICs vary in terms of level of education, years of experience and level of professional training. In terms of education, 11 (22.9%) of them received basic education, 11 (22.9%) hold diploma in management and 13 (27%) obtained bachelor’s degree in arts and the remaining 13 (27%) missed the train of education. In the case of working experience, 15 (31.2%) of them have experience ranging between 1 to 5 years, 9 (18.7%) between 5 to 10 years of experience, 14 (29.1%) fall in the 10 to 15 year range while 8 (16.7%) were in the job for more than 15 years. Two (4%) were fresh and 1 (2%) has only 5 months of experience at the time of the first visit.

3.2. Overall effect of PIC intervention on Food safety knowledge

Forty eight food establishments were visited twice in this assessment. The first visit was before the training intervention and the second visit was three months after. In each visit, the
same set of 12-knowledge questionnaire was asked and 20 food safety practice observations were assessed. The questionnaire aimed at testing the level of food safety knowledge of the PIC graduates before and after the training while, the food safety practices were geared towards assessing change in food safety practices.

Figure 1 represents the overall picture of the effect of training on the food safety knowledge of the PIC graduates before and after training. The figure shows that all groups gained additional knowledge about food safety issues raised during the training exercise except group 4. Group 4 did not achieve much from the training in terms of food safety knowledge. The low performance could be related to the fact that this group has the least trained PIC members prior to the intervention. Only 3 out of 12 PIC in the group (25%) received basic training in food safety and handling. The remaining 9 (75%) did not receive any kind of food safety training before. In addition to this, the education matrix Table 2 (a) has shown that 7 PIC individuals in this group representing (58 %) did not complete high school level. For the three PIC who have obtained bachelor’s degree, they got it in hotel management and tourism. The low level of education in addition to the fact that 75% of PICs in this group did not receive any form of food safety training prior to the PIC intervention may explain why this group has low scores in the food safety knowledge test.

In terms of variation of food safety knowledge between groups before the intervention, the ANOVA results (p<0.05) showed that group 1 was significantly different from other groups. The average score for group 1 was 88.2 % while group 2, group 3 and group 4 have the mean value of 67.3 %, 69.4% and 60.4% respectively. This trend of dominance in food safety knowledge continued to surface even after the PIC intervention where group 1 registered the highest score (93%) followed by group 2 and 3 with the mean value of 72% and 77%.
respectively. Group 4 maintained the lowest score of 61%. Based on the statistical values, one can reasonably conclude that group 1 has more ability to receive information from trainers when compared with other groups. However, there was no significant difference between group 2 and group 3 (p<0.05). The finding of the study showed that observed scores in knowledge on food safety among PIC interviewed were higher than what has been reported by (Jianu & Goleț 2014).

In a quantitative evaluation of knowledge and practice of meat handlers in Romania these researchers found that the average score of respondents was 10.34 (in a scale ranged from 0 to 16) representing (64.6%) when their knowledge on food poisoning, cross contamination, temperature and time control and personal hygiene was tested. Although these meat handlers were working in the industry for a considerable period, 71.43% of them could not recognize animal waste, minced meat and meat carcasses as a potential source of contamination with *E. coli*, while only 56.54% of them were able to realize that microbiological contamination of meat carcasses cannot be evaluated visually (Jianu & Goleț 2014).

3.2.1. Effect of work experience on food safety knowledge and observed practice

For the evaluation of the effect of work experience on the food safety knowledge of the PIC individuals and hygienic practice of food handlers, a regression analysis was conducted. Results showed that work experience has significant effect on food safety knowledge of PIC individuals but only before the training intervention (p<0.05). This can be understood because after the training, all of them have equal exposure to the educational modules covered. With respect to practice, number of years of experience of PICs did not show any significant effect on the hygienic practice of food handlers working in the food establishments neither before nor after PIC intervention (p<0.05). This seems logical because the actual persons doing the work at the establishment level are the food handlers and not the trained PIC individuals. However, this
finding suggests that a communication gap may exist between PIC individuals with supervisory role and food handlers at the field level.

To compare the overall performance of the PIC intervention before and after, a T-test was conducted on the data collected. Statistics showed that there was a significant improvement in terms of food safety knowledge of PIC individuals after the intervention. The mean values obtained before and after intervention were 71.3% and 76.1% respectively at (p<0.05).

In terms of food safety handling practice among the food handlers, results showed that there was no significant difference in performance between pre and post intervention with mean values of 70.4% and 69.8% respectively.

3.2.2. Effect of education and previous trainings on food safety knowledge

For the effect of educational level and professional training on food safety knowledge and practice, statistics showed that educational level has positive effect on the ability of the PIC to demonstrate knowledge. Analysis of results showed that PIC with tertiary education registered higher score in knowledge before and after the intervention with average score of 75% and 80.7% respectively. For those who have completed secondary school the average scores were 63.3% and 70% before and after the intervention. The candidates who did not complete secondary school recorded lowest scores 58% and 58.3% before and after intervention. With respect to the effect of previous training in food safety knowledge, results showed that the least trained PIC recorded the lowest scores in food safety knowledge with the average mean value of 60% and 63.9% before and after training respectively. The PIC who completed basic training achieved 70.2% and 76% before and after intervention while PIC with intermediate level showed higher scores with average values of 89 and 94.5 before and after. Beyond intermediate (advance) level
the average scores decrease to 87.5% and 89%. The decrease happened because there was an outlier in the data. The observations made in this study are similar to what Jianu and Goleț (2014) have reported. The researchers found that educational level and professional training have significant effect on food safety knowledge and practice.

3.3. Effect of PIC intervention on Food safety knowledge within groups

For better understanding of the performance of individual food service establishments in knowledge retention in each group Figure 2 was presented. Fig. 2 (a), showed that seven out of the twelve PIC contacted in group 1, have benefited from the food safety knowledge provided during the training. Three of them remained the same as before while 2 of them dropped. In group 2 and group 3, Fig. 2 (b & c), similar observations have been made. Group 4, Fig. 2 (d) represented special scenario in the sense that most of the members did not received any form of food safety training before and have lower level of education. As a result, only two of them registered gain in food safety knowledge after the training. Nine of them remained the same and one of them dropped.

Although the general picture looks unsatisfactory, the value are comparable to what have been reported in other studies conducted at other places. Bas, Ersun, and Kivanç (2006) performed study in Turkey and reported limited knowledge of food handlers, with only 43% providing correct answers. Da Cunha et al. (2014) carried out study in Brazil and documented 36% of foods handlers being unable to give correct answers on the knowledge questionnaire. The most problematic question that many of them failed to answer correctly was related to hand hygiene. A high proportion of food handlers believe that hand washing with mild detergent was adequate to prevent microbial contamination, which contradicts the recommended practice of
applying antiseptic soap or 70% alcohol. Another disturbing question that exposed low level of food safety knowledge among food handlers related to their inability to recognize that unsafe food does not have to always present altered sensory characteristics (Da Cunha et al., 2014).

In order to have better understanding of the ability of PIC to answer satisfactorily the basic food safety questions, eight questions were selected from the twelve and results presented in Table 3. The eight questions were selected because the remaining four were not related directly to food safety. For example one of them was asking whether a list of supplier is being maintained or not while another one was talking about whether the PIC can remember the last grade scored in the food inspection visit.

According to table 3, it was obvious that about 98% of the PIC were aware of the fact that, raw meat and cooked food should not be kept in the same chiller without separation even before the training. This suggests that many of the PIC candidates do have reasonable knowledge about cross-contamination as a potential vehicle to food poisoning unlike to what have been reported by Jianu and Goleţ (2014). With respect to how fast, a food should be cooled after cooking to avoid microbial proliferation in the danger zone; results have shown that 60% of the PIC’s interviewed were not able to give correct answers to the question presented. Unfortunately, the picture got worse after the training. This value is lower than what has been reported by Jianu and Goleţ (2014) who found that 62.5% of respondents are aware of the fact that bacterial proliferation is faster at 37 °C. The inability of PIC to maintain their position in relation to the basic food safety knowledge suggests that some of the answers given were based on guess rather than convincing knowledge.

For the availability of thermometers in kitchen as a measuring device, 65% of the PIC reported that they were keeping it before the training and the number increased to 70% after the
training. In addition to that, (63% of the PIC visited know that food should be kept below 5 °C in refrigerator and this knowledge was consolidated after the training by 14 % increase on the originally reported value. When asked about the right temperature to keep hot food hot, 33% of the PIC interviewed did not know that food meant to be served hot should be kept above 60 °C on the counter. Fortunately, this piece of information was well received during the training and by the end of the intervention only (18%) of them was not certain about the message Table 3. When it comes to application of sanitizers, Table 3 shows that, (44%) of the PIC visited were not able to differentiate between sanitizing and cleaning and their opinion did not change much even after training. For hand washing and drying, 97.7% of PIC reported that hands should be washed thoroughly after visiting toilet or when exposed to contaminated surface and they know the appropriate way of drying them. This revelation is similar to what Giritlioglu, Batman and Tetik, N. (2011) and Tan, Bakar, Karim, Lee and Mahyudin (2013) have reported (98.8% and 95.3%) respectively for a similar question.

3.3.1 Effect of education and work experience on observed practice within groups.

The group performance in hygiene practice is shown in Figure 3. For group 1 Fig. 3 (a), it can be noticed that although this group had more educated and highly experience managers, the majority of the trained PIC were unable to improve food safety handling practice in the place of work. Infact the performance of the group has worsen by 12% indicating that although the ability to learn is there, there could be some problems that is preventing them to translate what they have learned into real action. For group 2 and 3, Fig. 3 (b and c) there was a slight improvement in performance. Group 2 improved by 4.3% while group 3 registered about 10.3 % enhancement in food safety practices. Group 4 Fig. 3 (d) remained almost the same before and after the PIC
The decrease in the score for group 1 and the inability of group 4 to benefit from the PIC intervention is not easy to explain and it may involve more than one factor. One of the possible reasons is that the PIC individuals who received the training are different from the food handlers who are at the kitchen doing the work. The other possible reason could be that some of the PICs trained were not clear with the food safety messages and as a result, it may be very difficult for them to transfer the required knowledge to the food handlers. The third possibility may relate to the designing gap in the PIC concept. For example in all the PIC documents reviewed, there was no mention made of any form of motivation for the food handlers who are doing good job or what are the consequences if they did not perform well. Whatever the case might be, the picture is not that much different from what have been reported by other researchers (Tan et al., 2013; Nieto-Montenegro, Brown & LaBorde, 2008; Choudhury, Mahanta, Goswami, & Mazumder, 2011; Ehiri, Morris & McEwen, 1997; Rennie, 1994). In a study of hand hygiene knowledge, attitudes and practices among food handlers in Malaysia. Tan et al., (2013) found that in the self-reported hand hygiene practices 89.4% of the food handlers reported that they always use proper hand-washing procedures. However, in reality none of them was doing it correctly. To avoid this kind of disappointment, Nieto-Montenegro et al, (2008) suggested that a training session to increase awareness of the possibility of accumulation of *E. coli* bacteria for example under fingernails must be accompanied with correct demonstration of proper hand washing procedures followed by adequate practice until the learner masters the procedure. In another study conducted by Choudhury et al. (2011), in India, it was found that although 24%-66% increase was observed in knowledge score of food handlers, only 13% of increase was realized in the overall performance. This kind of observation perhaps lead Clayton, Griffith, Price, & Peter, (2002); Ehiri et al, (1997) to reported that improvement in food
safety knowledge does not necessarily lead to adoption of good practice. Rennie (1994) reported
that there is no evidence that food-handling practices improve when only information based
training programs are offered.

3.4. An overview of overall performance of food handlers at work

The performance of food handlers at work place is presented in Table 4. Review of the
tabled showed that, the availability of holding facility to keep food in safe condition increased
from 81.3 % to 83.4 % after the training. The percentage of those who were keeping cooked food
in chiller remained at 73%. The proportion of those with the ability to recognize the importance
of cooling food rapidly before storage improved from 41.3% to 54.1%, those who keep food
below 5 °C in refrigerator increased from 54.2% to 64.4% while those denouncing holding food
with bare hands slide back from 75% to 73%. With respect to cleaning food contact surface, a
potential source of cross contamination, results showed that the scores obtained by the food
handlers were not good enough (62.5%) and (52.1%) before and after respectively. In the case of
separating ready to eat food from raw meat, the results have improved from 66.7% to 70.8%.
This finding showed that scores reported in this study are much lower than what have been given
by Walker, Pritchard, and Forsythe (2003). These researchers found that, 97% of food handlers
in small businesses within the East Midlands region in United Kingdom know that raw food and
cooked food should be separated to prevent microbial transfer. Raw food contains harmful
bacteria that can spread easily to any surface that it touches. Therefore, inadequate cleaning can
lead to cross contamination which is a main factor contributing to the generation of food borne
illness. In order to reduce it Sneed, Strohbehn, Gilmore and Mendonca, (2004) suggested
application of correct hand washing steps, training and ongoing supervision of food handlers
including periodically checked standard cleaning procedures.
For proper application of these recommendations to inculcate the culture of good practice, one must address what Rennie (1995) described as five systems that are influential to behavior change. The first system is the knowledge system. Food handlers must be adequately trained in the job so that they know what to do. The second system is the normative system, which consists of worksite norms and rules. The third system is motivational system, which defines the remuneration of a person if a good job is done. The other two systems are the belief system that consists of values and beliefs of target audience and worksite environmental system, which addresses worksite physical conditions (Nieto-Motenegro, Brown & LaBorde, 2006). To a different extent, these systems have influence on each other. For example, the motivational system tends to be very influential on behavioral intent as shown in some nutritional education interventions (Gribble, Falciglia, Davis, & Couch, 2003; Miller, Edwards, Kissling, & Sanville, 2002). Motivation is an important process that can trigger and guide behavioral change. The food handler is more likely to wash his hand if the supervisor asked him to do that especially when a reward is attached to full compliance.

The score for keeping a supplier list was enhanced from 79.1% to 85% and the habit of sending sick person home increased from 56.3% to 64%. It can also be observed that a good number of food handlers are making effort to keep sickness report, which improved from 48% to 54.2%. Hand washing done by food handler when needed remained relatively high 79.2%. Other areas where reasonable improvements have been observed at acceptable level include pest control in the surrounding of food service establishments, which improved from 77.1% to 81.2%.

3.5. An overview of performance of food handlers within groups
For better understanding of the performance of individual establishments in each group, Figure 4 was presented. Fig.4 (a) displays the performance of 4 and 5 five star hotels in group 1. According to the figure, 7 hotels out of the 12 surveyed representing 58% have dropped in performance. Four of them remained the same and only one hotel has managed to change practice after the training. This suggests that there is an existing gap in translating knowledge into action in this category and the reasons for this decrease in performance need to be investigated.

The performance of establishments in group 2 is shown in Fig. 4 (b). Careful observation can show that 33.3% of the group dropped in performance. 16.6 % of them remained unchanged while 6 out of the 12 representing 50% remarkably improved their practice. Similar to group 2, the performance of group 3 is shown in Fig.4 (c). Here also four establishments did not do well. However, the remaining eight benefited from the training and their practices were changed accordingly. In group 4 business more or less remained in the same way Fig.4 (d). This revelation is expected since this group consisted of small cafeteria with one or two people who may not take the training very seriously.

In order to increase the chance of success and smooth running of food safety interventions, Arvanitoyannis and Kassaveti, (2009) reported that many trainers of food safety programs focus heavily on the provision of knowledge hoping that increasing knowledge will be eventually translated into concrete steps that will enhance performance of the food service industry. In reality, studies have shown that increasing knowledge does not necessarily lead to behavior change (Clayton et al., 2002; Ehiri et al., 1997; Rennie, 1994). In a study conducted by Byrd-Bredbenner et al., (2007), they have realized that although 97% of the participants considered their food safety knowledge high, only 40% of them did practice proper hand
washing with soap and water after touching raw poultry. The argument put forward by Griffith (2000) is that behavioral change and adoption of required hygiene practices are not easy to obtain and that consideration must be given to other factors such as motivation, constraints, barriers, facilities and cultural aspects.

The important lesson that can be learned from Fig. 4 and the Table 3 is that successful training program requires careful planning and that the needs of the trainees must be highly considered in the design of the training. Rennie, (1994); Nieto-Montenegro et al. (2008) reported that training programs which are more closely associated with the work site are potentially more effective especially if supported by practical reinforcement of the message. Consequently, to make the training program more effective, one must understand the food handler’s behavior and how it interacts with beliefs and levels of knowledge.

3.6. Personal hygiene and sanitary conditions

For the evaluation of the level of hygiene maintained in each establishment, swab analyses were conducted on hands and cutting board of each food handler who were working under the supervision of PIC personnel. Detailed results of the cutting board swab for each group are given in Figure 5. For a general view of the overall picture, results indicated that 27.1% were able to maintain their position of good performance while 29.2% registered improvement. The percentage of those who were not able to change their unsatisfactory position was 29.1%, while the remaining 14.5% slide back to unsatisfactory level. The T-test conducted on the mean values showed that although there was a considerable enhancement in performance, the difference was not statistically significant between the food handlers performance before and after the PIC intervention (p<0.05) with the mean values of 41.6% and 62.5% respectively.
It is well known that foods can be contaminated during preparation, processing or storage. In many foodservice establishments, factors such as unsafe sources, inadequate cooking, cross-contamination and poor personal hygiene are the leading cause of most of foodborne illnesses (Egan et al., 2007). Consequently, good personal hygiene such as proper hand washing before and after handling food together with correct food handling practices can greatly reduce chances of transferring disease causing organisms from food handlers to consumers (Evans, Madden, Doudlas, Adak, Obrien & Djuretic, 1998). In this regards, food handlers play very crucial role in the final stages of preventing food borne illnesses and must be prepared to take significant steps to minimize the number of pathogenic microorganisms in to the minimum level in food (Medeiros, Hillers, Chen, Bergmann, Kendall & Schoreder, 2004).

In considering the pivotal role that food handlers play in any foodservice establishment, the PIC concept from the very beginning put significant emphasis in imparting knowledge and skills needed to handle food in safe manner (Food Control Department, 2012). However, in spite of all the trainings conducted to provide skills and knowledge to handle food safely, human handling mistakes can still exist to cause food poisoning as reported by (Ehiri & Morris, 1996; Greig et al., 2007).

For the evaluation of hand washing, the results of the hand swabbing are shown in Figure 6. According to Fig., 6 (a), 4 and 5 star hotels in this group were practicing proper hand washing even before the training, with the exception of only one hotel. After the training, all food handlers in the group showed satisfactory results in hand swabbing. The high standard of personal hygiene that is being practiced in these hotels could be associated to the wealth of experience accumulated in many years and higher educational attainment of the PICs when compared with other counterparts. In the group, (11 PIC out of the 12) representing (91.6%) got
more than 5 years of experience. With respect to academic qualification, (9 out of 12) representing (75%) hold a diploma in management or bachelors in arts. Similarly, in terms of professional training, (8 out of 12), (66.6%) received intermediate level or HACCP and basic hygiene training.

For chain restaurants with big number of meals and limited variety Fig. 6 (b), and the normal restaurants with limited number of meals with big variety Fig. 6 (c), there performance in hand swabbing are quite similar. In both groups, remarkable improvement in hand washing practices have been realized after the PIC intervention. The scenario for group 4 representing small cafeterias is shown in Figure 6 (d). This group although consisted the least educated and most untrained members, the performance in the swabbing exercise was impressive (6 out of 12) (50%) maintained their satisfactory position while (5 out of 12) 41.6% were able to improve hand washing practice after the training. Only one cafeteria did not perform satisfactorily. In general, the global view of the results showed that 52.1% of the food handlers managed to keep their rightful position, while 33.3% were able to change incorrect hand washing practices. The percentage of those who failed to change incorrect hand washing practices was 6.2% and the remaining 8.3% slide back to wrong hand washing habits. The T-test conducted (P < 0.05) on the mean values showed significant difference between the food handlers performance before and after the PIC intervention (p < 0.05) with the mean value of 60.4% and 85.5% respectively.

4. Conclusion

This study was carried out to evaluate the overall effect of PIC intervention adopted by Dubai Municipality as a new strategy to enhance knowledge and practices of food handlers in order to maintain high standard of food safety measures in the City. Data were collected and
analyzed from 48 food establishments located in different parts of Dubai. The food establishments were categorized in four groups. Group 1 represents 12 four and five star hotels. Group 2 consisted of 12-chain restaurant with big number of meals and limited variety. Group 3 represents normal restaurants while group 4 was composed of 12 small cafeterias with two to three employees. Results obtained showed all the groups gained additional knowledge about the food safety issues raised during the training exercise except group 4. Group 4 did not achieve much from the training in terms of knowledge.

From a practical point of view, many of food handlers were able to effect changes in food handling habits however, a considerable number of them were unable to do so. In group 1 the ability to maintain proper food safety measures dropped by 12% indicating that although the ability to learn is there, there could be still some other problems that are preventing from translating knowledge and skill into real action. For group 2 and 3, there was slight improvement in the performance. Group 2 improved 4.3% while group 4 registered about 10.3% enhancement in food safety practice. Group 4 remained almost the same before and after the PIC intervention. For the swabbing exercise, there was a significant improvement in hand cleanliness but the cutting board cleaning requires additional efforts. Looking into the overall picture of the evaluation it can be suggested that, the PIC intervention needs to accommodate a motivating system in order to encourage food handlers to make extra effort in implementing the recommended practices.

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**Figure legends**

Fig. 1 Comparison of knowledge between PIC groups before and after training.

Fig. 2 Comparison of knowledge within PIC groups before and after training.

Fig. 3 Comparison of change in observed practice between PIC groups before and after training.

Fig. 4 Comparison of change in observed practice within PIC groups before and after training.

Fig. 5 Comparison of cutting board-swabbing satisfaction within PIC groups before and after training.

Fig. 6 Comparison of hand swabbing satisfaction within PIC groups before and after training.
Table 1: Selected examples of the PIC requirements for each business type.

<table>
<thead>
<tr>
<th>Business Type</th>
<th>Risk level</th>
<th>PIC requirement</th>
<th>Recommended qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakery/Confectionary Category 1, Meat, egg/cream/ milk based products.</td>
<td>High Risk</td>
<td>One per shift present in the production area.</td>
<td>At least with one PIC level 3 training and others with level 2 training.</td>
</tr>
<tr>
<td>Bakery/Confectionary Category 1, Bread chocolate, sweets, sugar, confectionary</td>
<td>Low risk</td>
<td>One per establishment.</td>
<td>At least one PIC with level 2 training</td>
</tr>
<tr>
<td>Central Kitchens of restaurant or catering services</td>
<td>High risk</td>
<td>One per shift per kitchen (depends on the size)</td>
<td>One PIC per kitchen with level 3 training</td>
</tr>
<tr>
<td>Hospital Kitchen High Risk</td>
<td>High Risk</td>
<td>One per shift present in the production area.</td>
<td>One PIC per kitchen with level 3 training</td>
</tr>
</tbody>
</table>
Table 2. Education level, work experience and food safety training of PIC respondents (n = 12 in each group).

**Experience matrix of PIC (a)**

<table>
<thead>
<tr>
<th></th>
<th>1-5 years</th>
<th>5-10 years</th>
<th>10-15 years</th>
<th>above 15 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Group 2</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Group 3</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Group 4</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**Education level of PIC (b)**

<table>
<thead>
<tr>
<th></th>
<th>Basic education</th>
<th>Diploma in management</th>
<th>Bachelors in arts</th>
<th>in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>7</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>4</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 3</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 4</td>
<td>7</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Training matrix of PIC ©**

<table>
<thead>
<tr>
<th></th>
<th>Basic</th>
<th>Intermediate</th>
<th>HACCP Basic</th>
<th>&amp; HACCP Intermediate &amp; HACCP &amp;</th>
<th>HACCP basic &amp; ISO</th>
<th>Untrained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Group 2</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Group 3</td>
<td>8</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Group 4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Comparison of correct and incorrect answers by PIC in basic food safety knowledge before and after training.

<table>
<thead>
<tr>
<th>Sr</th>
<th>Question</th>
<th>Answers % Before</th>
<th>Answers % After</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>correct</td>
<td>incorrect</td>
</tr>
<tr>
<td></td>
<td></td>
<td>correct</td>
<td>incorrect</td>
</tr>
<tr>
<td>1</td>
<td>Raw meat and cooked food can be stored together in the chiller without any separation</td>
<td>(47)97.9</td>
<td>(1) 0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>97.9</td>
</tr>
<tr>
<td>2</td>
<td>Once rice or meat is cooked, it should be kept at room temperature for two hours to cool and then placed in the refrigerator</td>
<td>(19)39.6</td>
<td>(31) 64.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>35.4</td>
</tr>
<tr>
<td>3</td>
<td>Do you have thermometer in your kitchen?</td>
<td>(31) 64.5</td>
<td>(14) 29.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>35.5</td>
</tr>
<tr>
<td>4</td>
<td>Cold food should be store at which temperature</td>
<td>(30) 62.5</td>
<td>(37)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>77.1</td>
</tr>
<tr>
<td>5</td>
<td>The temperature of the food held in the hot counter in a buffet should be at?</td>
<td>(32) 66.6</td>
<td>(9) 18.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16</td>
<td>81.2</td>
</tr>
<tr>
<td>6</td>
<td>Can you differentiate between disinfectant and cleaning</td>
<td>(27) 56.2</td>
<td>(29)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>60.4</td>
</tr>
<tr>
<td>7</td>
<td>What is the best way to dry our hands</td>
<td>(46) 95.8</td>
<td>(45)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>93.7</td>
</tr>
<tr>
<td>8</td>
<td>When do food handlers wash their hands</td>
<td>(48)</td>
<td>(47)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
<td>97.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>0.1</td>
</tr>
</tbody>
</table>
Table 4. Comparison of observable practices among food handlers before and after the PIC intervention.

<table>
<thead>
<tr>
<th>Item</th>
<th>% of excellent before</th>
<th>% of excellent after</th>
<th>% of acceptable before</th>
<th>% of acceptable after</th>
<th>% of good before</th>
<th>% of good after</th>
<th>% of bad before</th>
<th>% of bad after</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Is there a holding facility to keep food hot at 60 oC</td>
<td>56.3</td>
<td>41.7</td>
<td>25.0</td>
<td>41.7</td>
<td>8.3</td>
<td>12.5</td>
<td>10.4</td>
<td>4.2</td>
</tr>
<tr>
<td>2 Are there cooked foods in chiller?</td>
<td>31.3</td>
<td>27.1</td>
<td>41.7</td>
<td>45.8</td>
<td>16.7</td>
<td>22.9</td>
<td>10.4</td>
<td>4.2</td>
</tr>
<tr>
<td>3 Does the manager know that cooked food should be cooled rapidly from 60 oC to 5 oC or less within 6 hours before storing in the chiller?</td>
<td>33.3</td>
<td>20.8</td>
<td>8.3</td>
<td>33.3</td>
<td>14.6</td>
<td>18.8</td>
<td>43.8</td>
<td>27.1</td>
</tr>
<tr>
<td>4 Are foods in the refrigerator at the right temperature less than 5 oC</td>
<td>29.2</td>
<td>25.0</td>
<td>43.8</td>
<td>45.8</td>
<td>25.0</td>
<td>25.0</td>
<td>8.3</td>
<td>4.2</td>
</tr>
<tr>
<td>5 Is ready to eat food being handle with bare hands</td>
<td>16.7</td>
<td>12.5</td>
<td>58.3</td>
<td>60.4</td>
<td>18.8</td>
<td>18.8</td>
<td>6.3</td>
<td>8.3</td>
</tr>
<tr>
<td>6 Are ready to eat food clearly separated from raw food?</td>
<td>22.9</td>
<td>25.0</td>
<td>43.8</td>
<td>45.8</td>
<td>25.0</td>
<td>25.0</td>
<td>8.3</td>
<td>4.2</td>
</tr>
<tr>
<td>7 Is there a list of supplier</td>
<td>20.8</td>
<td>35.4</td>
<td>58.3</td>
<td>50.0</td>
<td>14.6</td>
<td>14.6</td>
<td>6.3</td>
<td>0.0</td>
</tr>
<tr>
<td>8 Are raw vegetable properly washed and sanitized prior to serving</td>
<td>22.9</td>
<td>12.5</td>
<td>25.0</td>
<td>37.5</td>
<td>27.1</td>
<td>25.0</td>
<td>25.0</td>
<td>25.0</td>
</tr>
<tr>
<td>9 Is food protected from potential source of contamination during storage, preparation, transportation, display or serving</td>
<td>18.8</td>
<td>14.6</td>
<td>37.5</td>
<td>50.0</td>
<td>35.4</td>
<td>27.1</td>
<td>8.3</td>
<td>8.3</td>
</tr>
<tr>
<td>10 Is there a sickness reporting system?</td>
<td>18.8</td>
<td>14.6</td>
<td>29.2</td>
<td>39.6</td>
<td>16.7</td>
<td>27.1</td>
<td>35.4</td>
<td>18.8</td>
</tr>
<tr>
<td>11 Do food handlers wash hands thoroughly when needed</td>
<td>22.9</td>
<td>14.6</td>
<td>56.3</td>
<td>64.6</td>
<td>16.7</td>
<td>16.7</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>12 Are there food items that are spoiled, adulterated or contaminated</td>
<td>27.1</td>
<td>16.7</td>
<td>56.3</td>
<td>52.1</td>
<td>16.7</td>
<td>25.0</td>
<td>0.0</td>
<td>6.3</td>
</tr>
<tr>
<td>13 Are there evidence of pest activity inside or outside of the kitchen</td>
<td>29.2</td>
<td>20.8</td>
<td>47.9</td>
<td>60.4</td>
<td>16.7</td>
<td>16.7</td>
<td>6.3</td>
<td>2.1</td>
</tr>
<tr>
<td>14 Is there a cleaning schedule</td>
<td>22.9</td>
<td>14.6</td>
<td>39.6</td>
<td>47.9</td>
<td>16.7</td>
<td>18.8</td>
<td>20.8</td>
<td>18.8</td>
</tr>
<tr>
<td>15 Are there facilities available to wash, rinse and sanitize utensils and equipment?</td>
<td>29.2</td>
<td>10.4</td>
<td>41.7</td>
<td>52.1</td>
<td>25.0</td>
<td>31.3</td>
<td>4.2</td>
<td>6.3</td>
</tr>
<tr>
<td>16 Are food contact surface properly washed and disinfected after each use?</td>
<td>25.0</td>
<td>16.7</td>
<td>37.5</td>
<td>35.4</td>
<td>33.3</td>
<td>41.7</td>
<td>4.2</td>
<td>6.3</td>
</tr>
<tr>
<td>17 Is hand washing facilities provided in or near food preparation area and toilet room?</td>
<td>22.9</td>
<td>14.6</td>
<td>50.0</td>
<td>56.3</td>
<td>16.7</td>
<td>20.8</td>
<td>10.4</td>
<td>8.3</td>
</tr>
<tr>
<td>18 Is there A/C inside the kitchen</td>
<td>25.0</td>
<td>25.0</td>
<td>52.1</td>
<td>56.3</td>
<td>16.7</td>
<td>14.6</td>
<td>6.3</td>
<td>4.2</td>
</tr>
<tr>
<td>19 Condition of the sewage system</td>
<td>22.9</td>
<td>16.7</td>
<td>43.8</td>
<td>58.3</td>
<td>27.1</td>
<td>18.8</td>
<td>6.3</td>
<td>6.3</td>
</tr>
<tr>
<td>20 How is the personal hygiene of staff</td>
<td>29.2</td>
<td>16.7</td>
<td>47.9</td>
<td>56.3</td>
<td>22.9</td>
<td>25.0</td>
<td>0.0</td>
<td>2.1</td>
</tr>
</tbody>
</table>
Figure 1.
Figure 2.
Figure 3.
Figure 4.
Figure 5.
Figure 6