

Research Article

Knowledge of Safe Food Temperature among Restaurant Supervisors in Dammam, Saudi Arabia

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Received 12 May 2021; Revised 21 June 2021; Accepted 1 July 2021; Published 12 July 2021

Academic Editor: Efstathios Giaouris

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Foodborne diseases are usually caused by consuming foods that are stored at an inappropriate temperature. This study aims to evaluate the knowledge of safe food temperature control among restaurant supervisors of Dammam city, Saudi Arabia. A cross-sectional study was carried out during January 2019 to May 2019. A close-ended questionnaire was used to assess knowledge and source of information about food temperature control from restaurant supervisors. The response rate of the study was 97 (80.8%). Demographic profile and knowledge scores of restaurant supervisors are reported as percentage. Chi-square test was used to compare group differences in knowledge. p value <0.05 was considered significant. Restaurant supervisors had good knowledge about safe temperature for cold food (93.8%) and storing food in the freezer (83.5%) and in the refrigerator (79.4%), while they had poor knowledge of safe temperature for hot food (14.4%) and the range of temperature in which bacteria grow rapidly (danger zone temperature) in food (15.5%). All restaurant supervisors reported food and environmental inspector as their main source of information about food temperature control. Restaurant supervisors' education level and place of work showed a significant association with safe temperature for storing food in the refrigerator and the best method to check safe cooking temperature. The high percentage of lack in the knowledge of safe temperature control for hot foods and danger zone temperature among restaurant supervisors is of great concern for public health as it exposes the customers to foodborne illnesses. The study results emphasize on the necessity to conduct education and training programs for restaurant supervisors to improve the quality of food served to consumers and protect them from foodborne illnesses and food poisoning.

1. Introduction

Foodborne diseases (FBDs) are caused by the consumption of contaminated food, which, in turn, can be a result of storage at an inappropriate temperature. They are a major public health problem not only in developing countries but also in developed countries. A study conducted in 2010 reported 600 million FBDs and 420K mortality around the world [1], resulting in loss of about 33 million healthy life years [2]. A study done during 2006 reported 31 FBD (251 cases) outbreaks in Qassim, Saudi Arabia. The majority of FBD outbreaks (65.4%) were reported in summer, higher

proportion was of men (66.9%), and maximum cases (68.9%) got sick after consuming commercially prepared foods [3]. Another study reported that the FBD outbreaks from households and commercial sources in Saudi Arabia decreased from 264 in 2010 to 255 in 2011, but the cases of FBD increased from 1647 ill people and one death in 2010 to 2066 people in 2011. The study claimed that commercial sources were responsible for 62% of those who fell ill [4]. Occasional foodborne disease outbreaks were reported during Hajj when pilgrims were hospitalized in Madinah complaining of vomiting, nausea, abdominal pain, and diarrhea after eating food prepared by the caterer [5–7].

The World Health Organization (WHO) has pointed out five factors to be associated with the occurrence of FBDs, namely, unhygienic practices and inadequate sanitation followed by the food handlers, inadequate cooking procedures, improper storage without considering temperature requirements, cross-contamination, and lastly obtaining food from insecure places [8]. Hazard Analysis Critical Control Point (HACCP) is a systematic approach of constructing a food safety program to reduce the risk of FBDs by focusing on each step of the food preparation process from receiving to service [9]. The importance of HACCP principles is to control risk factors associated with FBD, and it is recognized by the food safety professionals since the 1960s. Though it is still not mandatory to implement HACCP in restaurants, it is considered as a best practice. There are seven HACCP principles which include hazard analysis, critical control point (CCP) identification, establishing critical limits, monitoring procedures, corrective actions, verification procedures, and record-keeping and documentation [9]. If such a system is followed appropriately under the active supervision over food service employees, outbreaks of foodborne illnesses can easily be prevented.

The restaurant supervisor and manager are responsible to monitor the food service employees to follow safe food-handling practices such as hand washing, cleaning and sanitizing, and taking food temperatures [10]. The role of managers and supervisors is of great importance as they encourage and motivate the employees to follow proper practices. The knowledge of restaurant managers about the food safety measures is crucial as they are involved in the establishment of food safety policies and standards, expected to take accountability, serve as an ideal, provide training, and needed resources to the food service employees to follow food safety practices in the restaurant [10]. According to the FDA recommendation, the managers and employees should be properly motivated and trained so that the HACCP program can successfully reduce the occurrence of FBD risk factors [9].

It has been documented that if food is left in the danger zone temperature (4.44°C to 66°C), within 20 minutes, the bacteria multiply and double their number which increases the risk of foodborne illness. The bacteria which grow rapidly in danger zone temperature are *Campylobacter*, *Salmonella* Enteritidis, *Staphylococcus aureus*, and *Escherichia coli* O157:H7 [11]. Furthermore, studies have reported that undercooked meat transmit pathogens such as *Salmonella* serotypes, *Escherichia coli*, and *Campylobacter jejuni* from animals to humans [12–14]. It is important to minimize the amount of time that food spends in the temperature danger zone. Temperature control is the most effective method of reducing the growth of harmful pathogens in food.

Temperature control refers to cooking and maintaining food at appropriate temperature to protect it from microbes. Food should always be cooked, cooled, chilled, reheated, and stored at appropriate temperature to minimize the risk of FBDs. Research studies had shown that temperature control is the best way to eliminate foodborne pathogens [15–18].

In recent decades, a major change in lifestyles and living conditions of Saudi Arabia has accounted to increased visits to restaurants for consumption of local and international cuisines. A good food safety and hygiene practice followed in the restaurants enables it to provide quality food and protect the consumers from the FBDs. According to Bas et al. [19], poor temperature control is one of the main barriers for the implementation of HACCP and food safety plan systems in food businesses. Various studies have demonstrated the association of inadequate food handlers' knowledge, attitude, and practice with the occurrence of food poisoning [20–22]. There are few studies which have assessed the knowledge of restaurant managers, and the studies have reported that the food safety knowledge score was higher among the certified managers than noncertified managers [23, 24].

As the Environmental Health Authorities are planning to implement HACCP in Saudi restaurants, it is important to assess the competency of restaurant supervisors to plan HACCP for their restaurants. The food temperature control is one of the principles that is required in HACCP planning, and there is a lack of literature about the restaurants' supervisor knowledge in temperature control from Saudi Arabia. Therefore, the present study was designed to evaluate the knowledge about food temperature control among the restaurant supervisors working in Dammam, the capital of the Eastern Province and the third largest city in Saudi Arabia.

2. Materials and Methods

2.1. Study Design and Participants. A cross-sectional descriptive study design was adopted to carry out the survey among restaurant supervisors from the local and international restaurants (categorized by the municipality) that fulfilled the inclusion criteria that are as follows: restaurants are authorized from the municipal council, located in residential areas, and serve local food or fast food or international food with at least one meat product (beef, chicken, and lamb) in any of the three municipality regions of Dammam city. A total of 120 restaurants were visited and invited to participate in the survey. Ninety seven (80.8%) restaurants participated, and one restaurant supervisor from each restaurant completed the questionnaire; therefore, a total of 97 responses were available for analysis.

2.2. Questionnaire Design. The guideline provided by the WHO for food handlers was used by researchers to develop a close-ended questionnaire for the restaurant supervisor to assess their knowledge about food temperature control [8]. The questionnaire was finalized after taking into consideration suggestions and recommendations of experts in the field (Supplementary file available (here)).

2.3. Data Collection. Stratified random sampling method was used for data collection from restaurant supervisors by visiting the restaurants personally. The researchers visited Dammam municipality and collected a list of all registered

local and international restaurants. The list of restaurants was categorized into three geographical regions of Dammam city, i.e., east, middle, and west regions, and the researchers randomly selected forty restaurants from each region to have equal coverage of the three regions (Figure 1). If the restaurant had more than one branch, the data were collected from any one branch. The data were collected during the period January 2019 to May 2019 (18 weeks). If the restaurant management agreed to participate, the restaurant supervisor was administered the online questionnaire using SurveyMonkey through the smart device in the presence of the researcher.

2.4. Data Analysis. Knowledge about food temperature was assessed using closed-ended multiple-choice questions. Polychotomous responses were dichotomized for analysis. Each right answer was assigned a score of “1” and “0” if the answer was wrong. The total score was calculated and converted into the percent score to evaluate the overall knowledge level among the restaurant supervisors. The total percent score was considered “poor” if the score was <50%, “fair” if 50–75%, and good if $\geq 75\%$ for the overall knowledge level [23]. Statistical Package for Social Sciences (IBM SPSS version 24 software) was utilized for statistical analysis. The demographic characteristics of restaurant supervisors and knowledge scores were reported as percentages. Chi-square test was used to compare the group differences in knowledge. p value less than 0.05 was considered to be significant.

2.5. Ethical Considerations. The study protocol was reviewed and approved by the Institutional Review Board of Saudi Electronic University. The restaurant supervisors were briefly explained about the purpose, objective of the research, and confidentiality of their responses. They were explained that their participation in the study is voluntary and they have the right to refuse to participate. After obtaining informed oral consent, the online questionnaire was administered.

3. Results

A close-ended questionnaire was used to assess the knowledge of restaurant supervisors regarding the temperature control. Cronbach's alpha test for internal consistency of knowledge questions was found to be 0.83. The response rate of the study was 80.8%.

3.1. Demographic Characteristics of the Study Participants. The maximum supervisors (60 (61.9%)) were in the age group of 31–40 years, and a higher proportion of supervisors (59 (60.8%)) had high school education. Sixty one (62.9%) supervisors had more than five years of working experience, while they were equally distributed between international (48 (49.5%)) and local (49 (50.5%)) restaurants. The majority of the supervisors (94 (96.9%)) responded to have food safety training (Table 1).

3.2. Knowledge about Food Temperature Control. The supervisors had good knowledge about the safe temperature for cold food (91 (93.8%)), storing food in the freezer (81 (83.5%)), and storing food in the refrigerator (77 (79.4%)). However, they showed a poor level of knowledge about safe temperature for hot food (14/97 responded correctly) and for the range of temperature in which bacteria grow rapidly in food (danger zone temperature) (15/97 responded correctly). The majority of the supervisors (71 (73.2%)) had a fair level of overall knowledge about food temperature control (Table 2).

3.3. Sources of Information. All the supervisors responded that they received the information of food temperature control from the food and environmental inspector. The other sources of information about food temperature control reported by supervisors were public internet website (57 (58.8%)), friends (37 (38.1%)), and food safety training course (30 (30.9%)). Table 3 shows various sources of information of restaurant supervisors about food temperature control.

3.4. Demographic Factors Associated with Good Knowledge about Food Temperature Control. The supervisors in the age group 21–30 years showed a significantly higher level of knowledge regarding the range of temperature in which bacteria grow rapidly in food (danger zone temperature) (8 (53.3%) vs. 7 (46.7%); $p = 0.012$), while the supervisors in age group 31–40 years showed a significantly higher level of knowledge regarding the best method to check the safe cooking temperature (44 (71.0%) vs. 18 (29.0%); $p = 0.014$) compared to other age groups. The supervisors with higher and secondary level of education showed a significantly higher level of knowledge regarding safe temperature for storing food in the refrigerator (52 (67.5%) vs. 25 (32.5%); $p = 0.002$) and regarding the best method to check the safe cooking temperature (43 (69.3%) vs. 19 (30.7%); $p = 0.011$) than other levels of education (Table 4). The supervisors working in international restaurants showed a significantly higher level of knowledge regarding safe temperature for storing food in the refrigerator (44 (57.1%) vs. 33 (42.9%); $p = 0.005$) and for storing food in the freezer (48 (59.3%) vs. 33 (40.7%); $p = 0.0001$), the best method to check the safe cooking temperature (45 (72.6%) vs. 17 (27.4%); $p = 0.0001$), and time for which cooked food can be kept safely at room temperature before refrigeration (36 (80%) vs. 9 (20%); $p = 0.0001$). No correlation was found between the food safety training and the level of knowledge in the participants (Table 4).

3.5. Demographic Factors Associated with Poor Knowledge about Food Temperature Control. The supervisors in the age group 21–30 showed significantly poor knowledge regarding time for which cooked food can be kept safely at room temperature before refrigeration (7 (15.5%) vs. 38 (84.5%); $p = 0.02$), and the supervisors in the age group 41–50 showed significantly poor knowledge regarding safe



FIGURE 1: Map showing Dammam city.

TABLE 1: Demographic profile of restaurant supervisors.

Demographics	Number ($n = 97$)	Percentage
<i>Age (years)</i>		
21–30	26	26.8
31–40	60	61.9
41–50	11	11.3
<i>Education level</i>		
Primary	7	7.2
Secondary	31	32.0
High and above	59	60.8
<i>Working experience (years)</i>		
≤5	36	37.1
>5	61	62.9
<i>Food safety training</i>		
Yes	94	96.9
No	3	3.1
<i>Type of restaurant</i>		
International	48	49.5
Local	49	50.5

TABLE 2: Correct responses of restaurant supervisors regarding food temperature control knowledge.

Knowledge questions	Number ($n = 97$)	Percentage
Safe temperature for cold food (good)	91	93.8
Safe temperature for hot food (poor)	14	14.4
Range of temperature in which bacteria grow rapidly in food (poor)	15	15.5
Safe internal temperature to cook meat (fair)	67	69.1
Safe temperature for storing food in the refrigerator (good)	77	79.4
Safe temperature for storing food in the freezer (good)	81	83.5
Best method to check the safe cooking temperature (fair)	62	63.9
Time for which cooked food can be kept safely at room temperature before refrigeration (poor)	45	46.4
<i>Overall knowledge level</i>		
Poor (<50%)	18	18.6
Fair (50%–75%)	71	73.2
Good (>75%)	8	8.2

TABLE 3: Restaurant supervisors' source of information for food temperature control.

Sources of information	Number (<i>n</i> = 97)	Percentage
Government website	4	4.1
TV	2	2.1
Public internet website	57	58.8
Friends	37	38.1
Family	3	3.1
Food and environmental health inspector	97	100
Food safety training course	30	30.9
Scientific internet website	5	5.1
Social media	8	8.2
International websites	3	3.1

TABLE 4: Association between the demographic profile and level of knowledge among restaurant supervisors.

Demographics	Safe temperature for cold food	Safe temperature for hot food	Range of temperature in which bacteria grow rapidly in food	Safe internal temperature to cook meat	Safe temperature for storing food in the refrigerator	Safe temperature for storing food in the freezer	Best method to check the safe cooking temperature	Time for which food can be kept safely at room temperature before refrigeration
<i>Age</i>								
21–30	0.40; 0.528	0.66; 0.416	6.36; 0.012*	0.94; 0.331	0.04; 0.838	0.19; 0.660	2.98; 0.084	5.41; 0.020*
31–40	1.25; 0.263	0.15; 0.695	1.73; 0.188	0.50; 0.481	1.50; 0.220	1.14; 0.285	6.05; 0.014*	0.11; 0.738
41–50	0.18; 0.671	0.29; 0.592	0.53; 0.465	0.08; 0.780	4.68; 0.030*	1.05; 0.306	1.83; 0.176	0.50; 0.479
<i>Education level</i>								
Primary	0.60; 0.439	0.0001; 0.991	0.99; 0.319	2.43; 0.119	2.28; 0.131	3.81; 0.051	10.17; 0.001*	3.13; 0.077
Secondary	1.86; 0.172	2.40; 0.121	0.31; 0.579	3.11; 0.078	9.32; 0.002*	2.05; 0.152	6.53; 0.011*	1.65; 0.199
High and above	3.28; 0.070	2.60; 0.108	0.0009; 0.975	0.97; 0.326	5.52; 0.019*	0.18; 0.674	0.427; 0.513	0.13; 0.714
<i>Working experience</i>								
≤5 years	3.77; 0.052	2.81; 0.094	0.83; 0.362	0.004; 0.951	3.16; 0.075	0.28; 0.595	3.05; 0.081	0.30; 0.584
<i>Food safety training</i>								
No	0.20; 0.651	0.89; 0.344	0.57; 0.452	0.008; 0.927	0.31; 0.580	0.64; 0.425	0.01; 0.920	0.21; 0.645
<i>Restaurant</i>								
Local	0.67; 0.678	1.43; 0.231	9.28; 0.002*	1.56; 0.273	8.76; 0.005*	18.77; 0.0001*	36.67; 0.0001*	31.27; 0.0001*

* *p* value <0.05 is considered to be significant.

temperature for storing food in the refrigerator (6 (7.8%) vs. 71 (92.2%); $p = 0.03$). The supervisors with the primary level of education showed poor knowledge regarding the best method to check the safe cooking temperature (0 (0%) vs. 62 (100%); $p = 0.001$), and supervisors with the high level of education showed significantly poor knowledge of safe temperature for storing food in the refrigerator (21 (27.3%) vs. 56 (72.7%); $p = 0.019$) than other levels of education. The supervisors working in international restaurants showed significantly poor knowledge regarding the range of temperature in which bacteria grow rapidly in food (danger zone temperature) compared to those working in local restaurants (2 (13.3%) vs. 13 (86.7%); $p = 0.002$) (Table 4).

4. Discussion

The present study offers insight into the level of knowledge about the food temperature control in restaurant supervisors from Dammam, Saudi Arabia. The majority of restaurant

supervisors revealed an overall fair level (50–75% of the total score) of knowledge about food temperature control. A study conducted on restaurant managers and chefs in Brazil reported an unsatisfactory level of knowledge even after 75% respondents had training certificates [25]. As there are no studies assessing food temperature knowledge among restaurant managers from Saudi Arabia and only few studies from other countries, the factor affecting knowledge on food temperature control in this study is compared with the knowledge level of food handlers. However, the level of knowledge among the restaurant supervisors is expected to be higher than the other food handlers. A study from Riyadh reported that most of the food handlers (65.2%) were not aware of the importance of basic temperature control requirements needed to control microbial growth in food [26]. A study conducted by Bas et al. on food handlers in Turkey reported that respondents lacked knowledge about critical temperatures for foods, acceptable refrigerator temperature ranges, and cross-contamination [27]. However, in the

present study, it was observed that the supervisors had good knowledge about acceptable refrigerator and freezer temperatures but lacked knowledge about critical temperatures and time related to bacterial growth and storing of hot foods. These results are in agreement with the study from Spain which reported that only 65.1% of hot dishes had a temperature higher than 65°C, and 12.9% hot dishes were held below 55°C, showing a low level of knowledge among the food handlers related to storing of hot food [28]. Similarly, Liu et al. also reported that a majority of respondents from the coastal resort area in Guangdong Province, China, did not know the maximum stored time at room temperature [29].

Furthermore, in the present study, supervisors showed a fair level of knowledge about the internal temperature of cooked meat and best method to check safe cooking temperature, i.e., use of the thermometer. A study conducted in Malaysia by Mustafa et al. reported poor practice of thermometer usage as only 7% of the participants used the thermometer to check the internal temperature of cooked meat [30]. Furthermore, it is also recommended for the food handlers to use the thermometer to ensure that safe cooking temperature has reached because meat is a potential vector for pathogenic bacteria which are responsible for foodborne illnesses [31].

However, it is expected that restaurant supervisors should possess a good level of knowledge about the critical temperatures as it is known that if temperature controls are not properly maintained, it can lead to the proliferation of microbial growth and result in FBD [8, 32]. Saudi Arabia is planning to introduce HACCP in restaurants; then, it will be the supervisor's responsibility to plan and implement it properly. According to the HACCP guide, the risk factors are the poor condition, procedures, or practice that result in out-of-control food safety hazard. The risk factors include food from unsafe sources, inadequate cooking, improper holding temperature, contaminated equipment, and poor personal hygiene [9]. This highlights the importance of knowledge about the safe temperature that restaurant managers should have in order to make the HACCP plan. The HACCP plan delineates the procedures that need to be followed according to the principles of HACCP. The monitoring of the CCP is accomplished through the use of physical and chemical tests and through visual observations which help in an early detection of deviation, and appropriate steps can be timely taken to assure that potentially hazardous products do not reach the consumer [9].

All the supervisors reported their source of information about food temperature control as the food and environmental health inspector. However, other sources selected by the supervisors were mainly nonreliable sources such as public internet website (57 (58.8%)) and friends (37 (38.1%)). Therefore, the level of knowledge regarding safe food temperature is poor among the supervisors, and regular training programs are required to improve their knowledge. Presently, people have access to the internet service on different portable digital devices, anywhere and at any time, which helps them to extract needed information swiftly and conveniently. However, the public internet websites' information may be beneficial for the general population to get knowledge about a subject but not for the professionals. The

professionals should have the correct information which is essential for maintaining the quality service of the restaurant and for the safety of their customers. Therefore, they should search for information in authenticated websites of government and nongovernment agencies as accurate information is necessary for good practices.

Knowledge about the food temperature control varied across the age groups; supervisors aged 21–30 were six times more likely to know about the correct range of temperature in which bacteria grow rapidly in food (danger zone temperature) which may be due to the theoretical knowledge obtained from their education; however, they were 5 times more likely to be not aware about time for which cooked food can be kept at room temperature before refrigeration, which shows their lack of practical experience. Therefore, it is recommended to provide preemployment training and also on-job training to the supervisors to improve their overall knowledge related to food temperature control.

The supervisors with primary education were ten times more likely to be not aware about the best method to check the safe cooking temperature. The supervisors working in international restaurants were 9 to 37 times more likely to know about the food temperature control than those working in local restaurants. These findings illustrate that the restaurant supervisors with the primary level of education and those working in local restaurants should be provided with regular training programs about the food temperature control to improve their knowledge and to reduce the occurrence of foodborne illnesses.

Moreover, it was observed that the supervisors working in international restaurants were nine times more likely to be not aware about the range of temperature in which bacteria grow rapidly in food (danger zone temperature). This information about food temperature is important for quality service and protection of food from bacterial growth and to prevent food poisoning; lack of this knowledge is a matter of concern.

The findings of this study emphasize on educational and training programs to be conducted for the restaurant supervisors of all age groups working in the local and international restaurants. Moreover, the restaurant supervisors should be assessed for their level of knowledge after the completion of the education program; if they passed the test, then only the certificate should be provided. Distributing the certificates to the participants just for attending the training program is not beneficial. As in the present study, 94 (96.9%) supervisors reported having food safety training but still lacked knowledge about food temperature control. Training programs are important tools to provide knowledge to restaurant supervisors, but completing training programs and owning a certificate are not synonyms of good handling practices. It is fundamental to provide continuous training and to assure that knowledge translates into adequate practices. A study conducted by Brown et al. reported that the certified managers and workers had greater food safety knowledge than noncertified managers and workers [23].

The strength of the study is the complete coverage of restaurants from Dammam city as the restaurant supervisors

were included from all the three municipality regions of Dammam. Moreover, the method employed for the survey, i.e., face to face meeting with the participant and providing them the online survey questionnaire to complete, led to uniform sampling from different regions with no repetition of restaurants with multiple branches in the city. However, the limitation of the study is, firstly, the small number of restaurants included in the survey. Secondly, the data collection was based on self-reporting which might have resulted in the overreported responses to the question on food safety training and source of information (food and environmental food inspector), suggesting social desirability bias.

Further studies should be conducted on the restaurant supervisors in the two holy cities of Saudi Arabia, where a large mass gathering occurs around the year for Umrah, and the visitors totally rely on the restaurants for their meals. The knowledge of restaurant supervisors should be assessed for equipment cleaning and sanitizing, HACCP reporting, and food safety in emergency situations.

5. Conclusions

The present study results indicate a poor level of knowledge among restaurant supervisors about food temperature control, especially among those who have a low level of education and are working in local restaurants. The study results emphasize on the necessity of education and training programs on food temperature control to improve the knowledge of restaurant supervisors. If proper training is provided to restaurant supervisors, knowledge attained will reflect in their practice which will lead to improvement in the quality of food served to the consumers and reduction in the incidence of FBDs. The restaurant supervisors should undergo training programs with certification examination as this will motivate them not only to learn to pass the examination to get or keep their jobs but also to retain food safety information.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Acknowledgments

The authors extend their thanks to the Deanship of Scientific Research, Saudi Electronic University, Saudi Arabia, for the financial support provided for this study (\$10,000).

Supplementary Materials

The file contains the questionnaire used in the study to collect the data about food temperature control knowledge from restaurant supervisors. (*Supplementary Materials*)

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