

Review Article

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Food Safety Issues and Risk Associated with Refrigerated Foods

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ABSTRACT

Food safety is an increasingly important public health issue. It refers to the conditions and practices that preserve the quality of food to prevent contaminated microbes or toxic chemicals resulting in food borne illness. Most food borne illness is preventable if food protection principles are followed from production to consumption, to ensure safety. The proper implementation of good hygienic practices (GHPs) in the production of food and its proper storage at the right temperature are two cornerstones for preventing microbial potentials and to keep food safe for human consumption. However, the critical link in this chain is home food preparation, where most of the food borne illness can be prevented by avoiding contamination during handling, preparation, and storage of food. Refrigerators are one of the most important kitchen appliances found in homes used in storing and keeping food products so as to prolong the shelf-life of the foods. Cooling is a popular food storage technique and works by controlling the rate of certain chemical and enzymatic reactions as well as rate of growth of food microorganisms. The food borne illness initiated in domestic refrigerator may be attributed to inappropriate food storage including ineffective chill storage and refrigerator management. Failure to follow correct practices in the maintenance, use or cleaning of domestic refrigerator poses a number of risks to consumers. Microbial contamination caused by unwashed raw foods, hands, leaking packages, utensil surface, etc are introduced to domestic refrigerator and can directly contaminate other stored foods. Consumers should learn to ensure that only safe food reaches their tables. Public education and community participation are recognized as important strategies to improve food safety and prevent food borne diseases.

Keywords

Food safety, Safe storage, Refrigerated foods, Food borne illness, Microbial contamination.

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Introduction

Food safety has emerged as an important public health issue (WHO, 2004). It refers to the conditions and practices that preserve the quality of food to prevent contaminated microbes or toxic chemicals that cause food borne illness (Medeiros *et al.*, 2004). Food borne illness can be prevented if food protection principles are followed from production to consumption. But it is practically impossible to apply in developing countries. Therefore, the critical link in the

chain should be home food preparation to prevent contamination during its handling, preparation, and storage (Medeiros *et al.*, 2001). The proper implementation of good hygienic practices (GHPs) in the production of food and its proper storage at the right temperature are two cornerstones for preventing microbial potentials and to keep food safe for human consumption (Carrasco *et al.*, 2012). Some of the food safety standards like Codex Alimentarius

Comission (CAC) and International Food Standards, (ISO 22000) and management procedures such as documentation or monitoring procedures in Hazard Analysis Critical Control Point (HACCP) all deals with the specifications and criteria for the characteristics of the various products leading to general good manufacturing practices aspects for food safety from farm to fork.

Food safety considerations, in regards to industry to market practices, include the origins of food including the practices relating to food labeling, food hygiene, food additives and pesticide residues, as well as policies governing food and on biotechnology. These considerations also include guidelines for the management of governmental import and export inspection and certification systems for foods. When we consider market to consumer practices, the most important aspect is to keep food safe in the market and the concern is safe delivery and preparation of the food for the consumer. Therefore, food safety standards are essentially process standards with the aim to improve safety of the end products. The quality of raw materials and the hygiene implemented during manipulation certainly affect the microbiological quality of the products. However, the safety of a food may also be conditioned by the individual consumer after the purchase of the product if it is not kept at the right temperature. Even in the home, in the kitchen, there may be dangerous microbial cross-contamination that allows food pathogens to move from one food to another (Anderson *et al.*, 2004; Carrasco *et al.*, 2012).

Several researchers have observed and claimed that the food borne illness is initiated in domestic refrigerator three times more frequently than in commercial refrigerator. And this may be due to the inappropriate food storage including ineffective chill storage and refrigerator management (Ryan *et al.*, 1996).

Refrigeration has never been thought of that critically important and so consumers often fail to follow correct practices in the adjustment maintenance, use or cleaning of domestic refrigerator posing a number of risks to their health. When unwashed raw foods, hands, leaking packages, utensil surface, etc. are stored in refrigerator, bacterial contamination get introduced and can directly contaminate other stored foods (Michaels *et al.*, 2001). Bacteria can colonize a wide range of substrates like food preparation surface, utensils, domestic dish clothes, sponges and others cleaning materials from which they can be transfers into food and further could cause harmful effects on human (Rusin *et al.*, 2002). Therefore refrigeration is employed to control the rate of certain chemical and enzymatic reactions as well as rate of growth of food microorganisms. And even safe pre-preparation and preparation practices of foods, personal hygiene-cleaning of hands nails, clothes etc. and utensils surface with soap, bar and detergents are suggested to retards the growth of bacteria that causes food to spoil.

Refrigerators are one of the most important kitchen appliances found in homes used in storing and keeping food products so as to prolong the shelf-life of the foods. Lower temperature in a confined volume lowers the reproduction rate of bacteria, so the refrigerator reduces the rate of spoilage. (Shrivastava and Kumar, 2006).

Importance of refrigeration

The most popular food storage technique in almost every country is cooling and works by decreasing the reproduction rate of bacteria. Based on this technique, refrigerator is the device, used to reduce the rate of spoilage of foodstuffs (Godwin *et al.*, 2006). It is one of the most important kitchen appliances found in homes used in storing and keeping food

products so as to prolong the shelf-life of the foods. Lower temperature in a confined volume lowers the reproduction rate of bacteria, so the refrigerator reduces the rate of spoilage (Shrivastava and Kumar, 2006).

Refrigeration slows bacterial growth. Bacteria exist everywhere in nature and can grow rapidly when they have nutrients (food), moisture, and favorable temperatures, increasing in numbers and resulting in illness. Bacterial growth is most between 40 and 140 °F, generally considered as the "Danger Zone".

For safety purpose, it is important to verify the temperature of the refrigerator. It should be set to maintain a temperature of 40 °F or below. Some refrigerators have built-in thermometers to measure their internal temperature. For those refrigerators without this feature, an appliance thermometer can be kept in the refrigerator to monitor the temperature.

Types of bacteria in refrigerated foods

There are two different families of bacteria: pathogenic bacteria, the kind that cause foodborne illness, and spoilage bacteria, the kind of bacteria that cause foods to deteriorate and develop unpleasant odors, tastes, and textures. Pathogenic bacteria are those that can grow rapidly in the "Danger Zone," the temperature range between 40 and 140 °F, but they do not generally affect the taste, smell, or appearance of a food. In other words, one cannot tell that a pathogen is present. Bacteria that can grow at low temperatures, such as in the refrigerator are Spoilage bacteria. They cause food to develop off or bad tastes and smells. However, they do not cause any severe sickness. It comes down to an issue of quality versus safety: Food that has been left for too long on the counter may be dangerous to eat.

Food that has been stored for too long in the refrigerator or freezer may be of lessened quality, but most likely would not make anyone sick. (However, there are also some bacteria such as *Listeria monocytogenes* that can thrive at cold temperatures, and if present, will multiply in the refrigerator over time and could cause illness.)

Ineffective Refrigeration and Food borne illness at home

Even though there have been substantial developments in food production and safety management, developed countries continue to deal with numerous and critical food safety problems (Toyofuku, 2006). In fact, despite the recent introduction of careful legislation on improvement in food production and storage techniques, food borne diseases represent significant concerns for the economic consequences of public health (Hoffman *et al.*, 2005; Kim, 2009). Consumers associate food borne illness with the consumption of foods outside of home; however, it is well known that foods prepared and consumed at home also represent a risk for Food Borne Illness (FBI) outbreaks (Jackson *et al.*, 2007). Indeed, FBI originates in private homes three times more frequently than in food service operations (Kennedy *et al.*, 2005). Research indicates that perhaps as many as 50% of household FBI can be attributed to an inappropriate food storage including ineffective chill storage and refrigerator management (Godwin *et al.*, 2006). Some of the reviews are as follows:

Food safety practices in refrigeration

Clean -The goal of "clean" is to prevent cross contamination—or the transfer of disease causing microorganisms from one food, object, or surface to another food—by washing hands, food contact surfaces, and kitchen equipment (WHO, 2012).

Ineffective refrigeration and food borne illness at home

Author Name	Name of the Journal and Topic	Findings and Interpretations	Year of Publication
Kennedy <i>et al.</i> ,	Journal of Food Protection Food Safety Knowledge of Consumers and the Microbiological and Temperature Status of Their Refrigerators.	The author concluded that consumers who scored better in terms of basic food safety knowledge had reduced levels of bacterial contamination in their refrigerators and reported a reduced incidence of food-associated illnesses	2005
Terpstra <i>et al.</i> ,	Journal of Food Protection Food storage and disposal: consumer practices and knowledge	The author interpreted that the consumers dealing with meat and dairy products relatively hygienically but their knowledge regarding food safety and handling regarding other food stuffs is not adequate and they need to be educated regarding the same	2005
Marklinder <i>et al.</i> ,	Journal of Food Protection Home Storage Temperatures and Consumer Handling of Refrigerated Foods in Sweden.	The results from this study concluded that most of the respondents knew the recommended maximum temperature, but less than one fourth claimed to know the temperature in their own refrigerator resulting in improper knowledge regarding storage temperature and handling of refrigerated foods.	2004
Janjicet <i>al.</i> ,	International Journal of Consumer Studies Temperatures, Cleanliness and Food Storage Practices in Domestic Refrigerators in Serbia, Belgrade	The results from this study indicate that knowledge of recommended behavior about good food safety practice do not always translate into practice in the home.	2016
Lagendijk <i>et al.</i> ,	Journal of Food Protection Domestic Refrigeration Practices with Emphasis on Hygiene: Analysis of a Survey and Consumer Recommendations	The results revealed that the consumers' knowledge regarding refrigeration practices specifically emphasizing on hygiene, storage of foods, optimum temp concerning to perishable foods is not adequate.	2008
Katherine <i>et al.</i> ,	Journal of Food Protection Consumer Home Refrigeration Practices: Results of a Web-Based Survey	To reduce bacterial growth and to ensure the quality and safety of food products especially from the bacteria listeriosis at home, the author advise consumers to clean their refrigerators regularly and use a refrigerator thermometer for keeping temperatures at 40°F (4.4°C) or below.	2007
Jackson <i>et al.</i> ,	Food Control The Incidence of Significant Food borne Pathogens in Domestic Refrigerators	The study findings highlight the importance of adequate temperature control and thorough, regular cleaning of domestic refrigerators to ensure food safety, and of effective cooking as the last link in the domestic food service chain.	2007
Catellani <i>et al.</i> ,	Food Control Levels of microbial contamination of domestic refrigerators in Italy	The aim of this investigation is to ascertain the role played by internal surfaces of home refrigerators as possible sources of microbial contamination of foods.	2014

Hands are a major “vehicle” for spreading pathogens around the kitchen (Kennedy *et al.*, 2011)—thus hand washing is critical to preventing cross contamination (Van Asselt *et al.*, 2009)

Separate- “Separate”, like “clean”, is vital to preventing cross contamination. The goal of “separate” is to keep raw meat, poultry, and seafood separate from ready-to-eat foods like salads and cooked meat. About three-quarters of consumers report keeping raw meat, poultry, and seafood separate from ready-to-eat food products and nine in ten use different plates for raw and cooked meat (ADA, 2013). However, there is room for improvement especially considering that meat, poultry, and seafood are the leading causes of foodborne illness (Painter *et al.*, 2013).

Chill -“Chill” focuses on the refrigerator’s critical role in temperature control. But, it is important to also think about “clean” and “separate” in this appliance (Kennedy *et al.*, 2005). Many refrigerators are also not cool enough, with average temperatures exceeding the recommended 5 °C (40 °F). This problem has been noted in the U.S., U.K., Ireland, New Zealand, and Australia (Redmond *et al.*, 2009). Compounding the cooling problem is that refrigerators often are packed so tightly with food that air circulation is restricted. Tight packing also increases food-to-food cross-contamination risk (Byrd-Bredbenner *et al.*, 2007). Another aspect of “chill” is keeping perishable foods out of danger zone temperatures. Most consumers (79%) reported leaving prepared perishable food at room temperature no longer than the recommended two hour timeframe and nearly two-thirds report thawing food in the refrigerator (ADA, 2013).

Cook -The greatest area needing improvement is “cook”—according to Healthy People 2020, only about 37% of consumers achieve

the goal of heating foods, such as meat and poultry, to a temperature sufficiently high enough to kill harmful pathogens (USDHHS, 2010) Almost 9 in 10 consumers know that ground beef should be cooked to at least 160 °F (71 °C) and nearly two-thirds report they usually cook meats and poultry to this temperature (ADA, 2013). However, most do not know that color is not a good indicator of doneness (RTI, 2013) and less than a quarter actually validate the accuracy of the cooking temperature with a thermometer. Consumers continue to not use thermometers despite knowing that the greatest food poisoning risk is from undercooked foods and that “germs” in food are serious dangers (Fein *et al.*, 2011).

Safe handling or precautions regarding keeping of foods in refrigerator

Arrange food in refrigerators to allow maximum air circulation

All food should be labeled with the following (name of the food item, date, time, temperature)

Store food in a clean, non-absorbent, covered container. Be sure all container are properly sealed

To avoid cross contamination, store raw foods, uncooked foods away or below from prepared or ready to eat food.

Never allow fluids from raw poultry, fish or meat to come into contact with other foods. A large cut of meat or whole poultry should be divided into smaller pieces or placed in shallow containers before refrigerating. A large pot of food like soup or stew should be divided into small portions and put in shallow containers before being refrigerated. Hot food can be placed directly in the refrigerator or it can be rapidly chilled in an ice or cold water bath before refrigerating.

Cover foods to retain moisture and prevent them from picking up odors from other foods.

Store dairy products separately with foods having strong odor (onion, Cabbage and sea foods)

Store fruits in a separate section in a refrigerator from vegetables. The ethylene gas released by some fruits during ripening causes some vegetables to deteriorate rapidly.

Don't overload the refrigerator.

Food safety is a global problem and establishing a high standard of safety is the shared responsibility of governments, the food industry and consumers. There is a need of tremendous legislative, agricultural, industrial, and public health efforts for improving the safety of the food supply. However, the high rate and cost of foodborne illness highlights the need for health professionals to develop and implement more effective (*i.e.*, behaviorally focused, theory-driven, tailored, and personalized) food safety educational programs that result in safer food handling practices of consumers at all ages (Nyachuba, 2010). Therefore all governments should undertake intensive efforts to educate food handlers. Even there are many opportunities for health professionals to extend their practice by incorporating safe food handling in consumer communications. So consumers too should learn how to ensure that only safe food reaches their tables.

Public education and community participation are recognized as important strategies to improve food safety and prevent food borne diseases. Despite all the efforts from scientists, governments and industry it appears that it will continue as a major public health problem worldwide, with enormous implications for both the social welfare of populations and for national economies.

References

- Anderson, J. B., Shuster, T. A., Hansen, K. E., Levy, A. S., and Volk, A. 2004. A camera's view of consumer food-handling behaviors. *Journal of American Dietetic Association*. 104, 186-191.
- Byrd-Bredbenner, C., Maurer, J., Wheatley, V., Cottone, E., and Clancy, M. 2007. Food safety hazards lurk in the kitchens of young adults. *Journal of Food Prot.*70, 991-996.
- Carrasco, E., Morales-Rueda, A., and García-Gimeno, R.M. 2012. Cross-contamination and recontamination by *Salmonella* in foods. *Food Res. Int.* 45,545-56.
- Catellani, P., Scapin, R. M., Alberghini, L., Radu, I. L., and Giaccone, V. 2014. Levels of microbial contamination of domestic refrigerators in Italy. *Food Control*. 42: 257-62.
- Fein, S., Lando, A., Levy, A., Feisl, M., and Noblet, C. 2011. Trends in U.S. Consumers' safe handling and consumption of food and their risk perceptions, 1988 through 2010. *Journal of Food Prot.*74: 1513-1523.
- Godwin, S., Chen, F. C., and Chambers, E. 2006. Correlation of visual perception of cleanliness and reported cleaning practices with measures of microbial contamination in home refrigerators. *Food Prot. Trends*.264, 74-80.
- Hoffman, R. E., Greenblatt, N., Matyas, B. T., Sharp, D. J., Esteban, E., Hodge, K., and Liang, A. 2005. Capacity of state and territorial health agencies to prevent food borne illness. *Emerg Infect Dis*. 11, 11-16.
- <http://homefoodsafety.org/vault/2499/web/files/111121812-Desktop-Dining-Survey-2011.pdf>
- <http://homefoodsafety.org/vault/2499/web/files/111121812-Desktop-Dining-Survey->

- 2011.pdf
http://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/safe-food-handling/refrigeration-and-food-safety/ct_index
http://www.who.int/foodsafety/publications/consumer/manual_keys.pdf
http://www.who.int/foodsafety/publications/consumer/manual_keys.pdf
https://en.wikipedia.org/wiki/Food_safety
- Jackson, V., Blair, I. S., Dowell, M. D., Kennedy, J., and Boltan, J. 2007. The incidence of significant food borne pathogens in domestic refrigerator. *Food Cont.*18, 351-61.
- Janjić, J., Katić, V., Ivanović, J., Bošković, M., Starčević, M., Glamočlija, N., and Baltić, M. Ž. 2016. Temperatures, cleanliness and food storage practises in domestic refrigerators in Serbia, Belgrade. *International Journal of Consumer Studies.*40, 276–282.
- Kennedy, J., Gibney, S., Nolan, A., McMahon, M., McDowell, D., Fanning, S., and Wall, P. 2011. Identification of critical points during domestic preparation: An observational study. *Br. Food J.*113, 766– 783.
- Kennedy, J., Jackson, V., Blair, I. S., McDowell, D. A., and Cowan, C. 2005 a. Food safety knowledge of consumers and the microbiological and temperature status of their refrigerators. *Journal of Food Prot.*68, 1421-30.
- Kennedy, J., Jackson, V., Blair, I.S., McDowell, D.A., Cowan, C., and Bolton, D. 2005 b. Food safety knowledge of consumers and the microbiological and temperature status of their refrigerators. *J Food Prot.* 68, 1421–1430.
- Kosa, K. M., Cates, S.C., Karns, S., Godwin, S. L. and Chambers, D. 2007 Consumer home refrigeration practices: results of a web-based survey. *journal of food protection.* 70(7): 1640-1649.
- Lagendijk, E., Asséré, A., Derens, E., and Carpentier, B. 2008 Domestic refrigeration practices with emphasis on hygiene: analysis of a survey and consumer recommendations. *Journal of Food Protection.* 71(9): 1898-1904.
- Marklinder, I. M., Lindblad M., Eriksson L. M., Finnson A. M., and Lindqvist, R. 2004. Home storage temperatures and consumer handling of refrigerated foods in Sweden. *Journal of Food Protection.* 67(11): 2570-2577.
- Medeiros, L.C., Hillers, V. N., Chen, G., Bergmann, V., Kendall, P., and Schroeder, M. 2004. Design and development of food safety knowledge and attitude scales for consumer food safety education. *Journal of Am Diet Assoc.* 104, 1671-1677.
- Medeiros, L., Hillers, V., Kendall, P., and Mason, A. 2001. Evaluation of food safety education for consumers. *Journal of Nut. Educ. Behav.* 33, 27- 34.
- Michaels., Ayers, B. T., Celis, M., and Gangar, V. 2001. Inactivation of refrigerator biofilm bacteria for application in the food service environment. *Food Sci Tech.*169-179.
- Nyachuba, D. 2010 Foodborne illness: It is on the rise? *Nutr. Rev.*68: 257–269.
- Painter, J., Hoekstra, R., Ayers, T., Tauxe, R., Braden, C., Angulo, F., and Griffin, P. 2013. Attribution of foodborne illnesses, hospitalizations, and deaths to food commodities by using outbreak data, United States, 1998–2008. *Emerg. Infect. Dis.*
- Redmond, E., and Griffith, P. 2009. The importance of hygiene in the domestic kitchen: Implications for preparation and storage of food and infant formula. *Perspect. Public Health.*129, 69–76.
- Rusin, P., Maxwell, S., and Gerba, C. 2002. Comparative surface-to-hand and Wngertip-to mouth transfer efficiency

- of gram-positive bacteria, gram-negative bacteria, and phage. *Journal of Appl. Microb.* 93, 585-92.
- Ryan, M. J., Wall, P. G., Gilbert, R. J., Griffin, M., and Rowe, B. 1996. Risk factors for outbreaks of infectious intestinal disease linked to domestic catering. *Common Dis Rep Review.* 13, 179-82.
- Srivastav, R.P., and Kumar, S. 2006. *Fruits and Vegetable Preparation: Principles and Practices.* International Book Distributing Co. India, Lucknow. pp. 91-101.
- Terpstra, M.J., Steenbekkers, L. P. A., Maertelaere, N. C. M., and Nijhuis, S. 2005. Food storage and disposal: Consumer practices and knowledge. *Br Food Journal.*107, 526-533.
- Toyofuku, H. 2006. Harmonization of international risk assessment protocol. *Mar Pollut Bull.* 53, 579–590.
- United States Department of Health and Human Services. *Healthy People 2020: Food Safety*; United States Department of Health and Human Service, Office of Disease Prevention and Health Promotion: Washington, DC, USA, 2010.
- Van Asselt, E., Fischer, A., de Jong, A., Nauta, M., and de Jong, R., 2009. Cooking practices in the kitchen—observed versus predicted behavior. *Risk Anal.* 29, 533–540.
- WHO 2004 Surveillance programme for control of food borne infections and toxications in Europe 8th report. *Journal Infec.*43, 80-84.
- www.fsis.usda.gov/Oa/research/yparents.html
- www.fsis.usda.gov/Oa/research/yparents.html

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