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Unnecessary illness and death as well as billions of dollars could be saved if a few scientifically based preventive measures were taken against foodborne illness. However, foodborne illness remains a worldwide health problem. The primary place of mishandling of food is either in the foodservice establishment or in the household. There are certain groups of people who are at a higher risk for foodborne illness. Pregnant women, infants, the elderly, as well as those who are immunocompromised can develop more severe symptoms than other people as well as having a higher death rate. Educational material about food safety is limited, especially for these critical high risk groups. However, the key to the solution is education.

The purpose of this study was to develop a module to be used with low income parents and to test the effectiveness of it with participants of the Special Supplemental Food Program for Women, Infants, and Children (WIC) in three counties in Oregon. Three scientifically researched food safety recommendations were the basis for the concepts taught. An interactive teaching style which incorporated the instructional strategies of visual aids, auditory aids, interactive questions, demonstrations, and hands-on activities was used. Four classes were held for a total of seventeen WIC participants (6,9,1,1) to provide an evaluation of the module in the form of knowledge tests and self-assessed behavioral changes. Sixteen WIC staff members provided professional assessment of the module.

The results of the knowledge test demonstrated that there was a statistically significant difference ($p < 0.001$) ($n = 15$) between the mean score on the pretest (75%) and posttest (same day) (91%) as well as between the mean score of the 10 people who took both the pretest and the two-week follow-up test (94%) ($p < 0.05$). Knowledge had increased and was retained. Two weeks after the class, in self-assessed behavioral changes, 30% of the participants reported that they had made positive changes as a result of the class in the area of cooking foods well, 60% in the area of preventing cross contamination, and 50% in the area of keeping hot food hot and cold food cold. Professional assessment indicated that the food safety module would be simple to use with WIC clients.

Groups such as the elderly who participate in community day care center, diabetic support clubs as well as support groups for AIDS patients could benefit from food safety knowledge. The interactive teaching style as well as the same three concepts of the module could be used; however, the introduction so that it is specific for each group as well as adaptations for different literacy levels should be addressed. Food safety concerns while shopping, eating out, microwave cooking and traveling abroad could be incorporated.

A Food Safety Education Module for Low Income Parents

by

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I. INTRODUCTION

Even though effective control and preventive measures are known, foodborne illness remains a worldwide public health problem. Unnecessary illness and death occur, as well as billions of dollars are spent, as the result of eating food which has been mishandled somewhere along the food chain, primarily at the location of preparation, either in a foodservice institution or in the household (1). The magnitude of foodborne illness is enormous. In developing countries, diarrhea appears to be a factor in child malnutrition, as well as being estimated to cause approximately 3.5 million deaths per year (2). The main causes of diarrhea are lack of clean drinking water and poor hygiene (2). The top three organisms in order of rank which cause acute diarrhea, a major cause of morbidity and mortality of young children in developing countries, are rotavirus, enterotoxigenic Escherichia coli, and Campylobacter (3,4).

Precise numbers are not known due to misdiagnosed or non-diagnosed cases, as well as nonexistent or inaccurate reporting systems. It has been estimated in developing countries that the ratio between actual and reported cases may be 100:1 (5). Others would put it at a much higher figure. In developing countries the number of cases is expected to increase as urbanization brings people to more crowded environments. Unclean water supplies and unsanitary disposal of excreta, as well as mishandling of food, are primary reasons for foodborne illness in developing countries.

Despite advances in modern technology, foodborne illness is a major problem in developed countries as well. In the U.S. an estimated 24 million cases of foodborne diarrheal disease occur each year, which means that an estimated 1 out of 10 people experience a food-associated illness (6). Between

1974 and 1984, the Centers for Disease Control (CDC) reported 151 deaths, and 4,529 outbreaks involving 136,025 people, due to foodborne disease (7). (Outbreaks are defined as an incident in which 2 or more persons experience a similar illness after ingestion of a common food.) It has been estimated that the true incidence of foodborne disease in the United States is 10-100 times greater than that reported to the CDC (7). Some food safety experts estimate that 99% of the cases of salmonellosis go unrecognized and unreported (8). Leading the list of microbial agents responsible for foodborne illness are the familiar names of Salmonella, Staphylococcus aureus, and Clostridium perfringens (9). Campylobacter jejuni, as well as Escherichia coli, should be added to this list, the latter especially in developing countries. The reason for 75% of these outbreaks was attributed to improper holding temperatures (9).

The foods with higher risk in the United States are raw shellfish, especially mollusks; underdone poultry; raw eggs; rare meats; raw milk, and cooked food which another person handled before it was packaged and chilled. In addition to those foods listed, developing countries could add raw vegetables, raw fruits that cannot be peeled, sidewalk vended foods as well as tap water or water from unknown sources (10).

Though everyone is at risk for foodborne illness, certain groups of people develop more severe symptoms and are at a greater risk for serious illness and death. Higher risk groups include pregnant women, very young children, senior citizens, and the immunocompromised such as AIDS (acquired immune deficiency syndrome) and cancer patients (11). Pregnant women need to be aware that their unborn child is especially vulnerable to disease due to an immature immune system (12). Medical conditions, poor nutrition, decrease in sense of taste and smell as well as poor blood circulation can add to the vulnerability of the elderly to foodborne illness (12). AIDS patients are at least 20 times more likely than other people to become infected with salmonellae and 200-300 times more susceptible to listeriosis than the general public as reported by Peter Hawley, M.D. of the Whitman-Walker Clinic (13). Since the

number of people in the high risk categories is increasing, preventing foodborne disease is critical (14).

In addition to the agents listed above, there are three others which are also important for those at high risk. One of these is Listeria monocytogenes, which was first documented as foodborne in 1981. It is rare but causes serious illness in the United States. It is associated with consumption of raw milk, nonreheated hot dogs, undercooked chicken, various soft cheeses (i.e. Mexican style, feta, Brie, Camembert and blue-veined cheese), and food purchased from delicatessen counters. Most people are at low risk of becoming seriously ill after ingesting listeriae; however, pregnant women are at high risk. An update study of listeriosis in the U.S. from 1988-1990 reported that of the 301 cases recorded, 99 (33%) occurred among pregnant women or their newborns (15). Listeriosis causes a short-term illness in pregnant women; however this bacteria can also cause stillbirths and spontaneous abortions (14). Toxoplasma gondii is also of particular risk for pregnant women. For this reason, raw or very rare meat should not be eaten. In addition, since cats may shed these cysts in their feces, it is recommended that someone else change the cat litter box. (14).

As the antibodies from the mother are lost, infants become more susceptible to foodborne illness. Botulism generally occurs by the ingestion of the toxin; however, in infant botulism it is the spores which germinate in the intestine and the production of the toxin in vivo which causes the illness. The most common form of human botulism in the United States is infant botulism (16). Almost half of these reported cases occur in infants less than two months of age (17). Since honey and corn syrup have been found to contain spores, it is recommended that they not be fed to infants under one year of age, especially under 6 months of age (17).

It has also been reported that the poor are at higher risk for foodborne illness. "High risk" households are defined as those who were judged more vulnerable to an incidence of foodborne illness. Those people from low incomes represent "high risk" households (18). Secretary Madigan of the

United States Department of Agriculture (USDA) on February 28, 1992 in a speech reported that one goal of the USDA was to help educate low income adults on how to handle food safely. Woodburn and VanDeRiet (19) reported that consumers under the age of 30 have less information on safe food practices than those who are older.

There is ample information regarding the prevention of foodborne illness and yet many outbreaks are still reported due to carelessness in the kitchen. The key to the solution is education. The problem is how to transform food safety messages into a format that can reach people, especially the high risk populations (20). Good food safety is basically good common sense, yet it can only make sense when the consumer has acquired some knowledge as to how foodborne pathogens spread and food safety steps to apply to prevent foodborne illness (21).

Current food safety education designed for low income parents is limited. Some programs that have education materials for low income people are the Special Supplemental Food Program for Women, Infants, and Children (WIC) and the Expanded Food and Nutrition Education Program (EFNEP). On file at the WIC office in Benton County, Oregon were two brochures which the director said were not used often. One was on infant botulism and one on boiling baby bottles. The Nutrition Education Resource Guide (22), which is a bibliography of educational material for the WIC program, listed no modules on general food safety education. One lesson touched on food safety education when dealing with tips for eating when one is immuno-suppressed. EFNEP in their program currently uses four flash card books on the topics: Where do Germs Grow?, Before Handling Food, Check For..., Use Only Clean Utensils and Dishes, and Handle Food With Care to Stay Well (23).

The director reported that informal polls conducted by staff at WIC demonstrated there was a need and interest among participants of the WIC program for food safety education. The purpose of this study was to fill the food safety education gap by developing and evaluating an interactive-type

educational module. The challenge was to develop an effective module to be used in teaching the high risk groups of low income, pregnant women.

The objectives of this study were to

1. Develop a 45-minute food safety education module, with an accompanying instructor's manual, to be used with low income parents.
2. Determine the effectiveness of the module with WIC parents in Benton, Linn, and Lane Counties in Oregon.

II. REVIEW OF LITERATURE

Even though throughout history people had tried many methods to preserve foods and keep them from spoiling, the relationship between illness and pathogens or toxins in food was not recognized and documented until the nineteenth century. It was then that the French chemist, Louis Pasteur, demonstrated that the microorganisms in raw milk caused spoilage (24). The discipline of food microbiology had begun. As the control of microorganisms and the reduction of their detrimental effects were characterized, recommendations for the general public on proper food cooking, handling, and storage were implemented. How to retard and prevent spoilage and how to stop the transmission of foodborne illness were and still are the foci of these recommendations.

Most of the documented cases of foodborne illness are caused by just a few types of pathogens. The major biological agents of foodborne disease that will be focused on for this study are divided into bacteria, parasites, and viruses. Today we still have the same "basic four" bacterial problems that had also been documented in the early 1900's of Salmonella, Staphylococcus aureus, Clostridium botulinum, and Clostridium perfringens (Clostridium welchii). Escherichia coli in 1942 by Jensen (25) had been defined as those bacteria "incapable of causing food poisoning" based on research by Hunter and Dack in 1938. Today, Escherichia coli can be added to the list of the most common bacteria that cause foodborne illness as well as Campylobacter jejuni, and Listeria monocytogenes. Parasites included in this presentation are Trichinella spiralis and Toxoplasma gondii. The viruses included are Norwalk, hepatitis A, and rotavirus.

From the farm to the table, food can be contaminated by disease-causing organisms at any step of the food handling chain. An important role of government and industry is to assure a safe food supply. Setting and

monitoring food safety standards are the responsibility of the U.S. Food and Drug Administration (FDA) under the auspices of the U.S. Department of Health and Human Services and the Food Safety and Inspection Service (FSIS) under the auspices of the U.S. Department of Agriculture (USDA). The FDA is responsible for the wholesomeness of all food sold in interstate commerce except meat and poultry while the USDA is responsible for the inspection of meat and poultry sold in interstate commerce and internationally. Some major food safety laws and policies which have guided the provision of safe food are the Federal Food and Drugs Act in 1906, the Federal Meat Inspection Act in 1906/1907, the Food, Drug and Cosmetic Act in 1938, and the Poultry Products Inspection Act in 1957. The food supply in the United States has been credited as being among the "safest in the world" (p. 1557, 26).

Several recent publications have summarized our current state of knowledge of the biology and epidemiology of the microorganisms that cause foodborne illness (1; 6; 27; 28). Therefore, the microbiology will not be included in this review. The emphasis will be on concepts recommended for the prevention of foodborne illness.

The World Health Organization recommends these 10 rules for food safety (29):

1. Choose foods processed for safety.
2. Cook foods thoroughly.
3. Eat cooked foods immediately.
4. Store cooked foods carefully.
5. Reheat cooked foods thoroughly.
6. Avoid contact between raw foods and cooked foods.
7. Wash hands repeatedly.
8. Keep all kitchen surfaces meticulously clean.
9. Protect foods from insects, rodents, and other animals.
10. Use pure water.

In the United States, participants in the Conference for Food Protection in 1984, (30) recommended that these seven food safety messages be implemented:

1. Wash hands thoroughly.
2. Heat foods quickly and cool foods quickly.
3. Keep hot foods hot and cold foods cold.
4. Obtain foods from safe sources.
5. Prepare foods properly.
6. Do not use swollen, leaking or severely damaged cans or unsealed containers.
7. When in doubt, throw it out.

Based upon the research literature and the suggestions which have been made by other groups, these recommendations can be grouped together for a general audience in the United States. They are:

1. Cook foods well.
2. Prevent cross contamination.
3. Keep hot food hot and cold food cold.

Research Base for Recommendations.

Recommendations are set in order to minimize hazards that exist. The scientific research upon which these are based is done using media and foods which try to simulate the conditions in which consumers act in order to test the behavior of foodborne pathogens. The research bases for these recommendations are described as well as the specific microorganisms that could be prevented from causing foodborne illness if these recommendations were followed.

Cook Foods Well.

Cooking foods well means cooking foods to a high enough temperature in the slowest to heat part and for a long enough time to destroy pathogens

which have already gained access to foods. Heat can be used to decrease the number of organisms as well as for sterilization.

Cooking foods well is only a concern when they have become previously contaminated from other sources or are naturally contaminated. There are a number of possible sources of contamination of food products.

Coastal water may contaminate seafood. Because filter-feeding marine animals such as clams, scallops, oysters, cockles and mussels, and some fish such as anchovies, sardines, and herring, live by pumping in sea water and sieving out organisms they need for food, they have the ability to concentrate suspended material by many orders of magnitude. An 18-month old oyster filters 5 quarts of water per day (31). Consequently, shellfish grown in contaminated coastal waters are the most frequent vehicle of hepatitis A virus (32). Norwalk virus can also accumulate (32).

Feed for animals is another possible source of contamination. Meat could become contaminated because the animals ate feed that had been contaminated, particularly with salmonellae. The industry-wide incidence of salmonella in feed in 1989 was about 49% (27). Estimates of salmonellae on carcasses before fabrication range from 74% for beef, 84% for pork and 34% for chicken (33).

Pigs, which are able to wander freely to eat rodents and other animal carcasses as well as are fed garbage such as untreated restaurant refuge, are the major sources of meat contaminated with Trichinella spiralis. This parasitic worm can become embedded in the muscles of animals and in turn can be ingested. In the 1940's approximately 300-400 cases of Trichinella spiralis occurred annually; however, in the 1980's approximately 100-150 cases occurred annually. Though there is no trichinae inspection of swine in the United States, one reason for the decrease in incidence was the passage of laws prohibiting untreated garbage being fed to swine. Of the cases from 1975-1981, pork accounted for 79%, wild meat 14% and ground beef (which is believed to have been adulterated with pork) 7% of the cases (34).

Contaminated eggs can be another vehicle of foodborne illness. Contamination of eggs can occur from external as well as internal sources. If moist conditions are present and there is a crack in the shell, the fecal material of hens carrying this organism can penetrate the shell and membrane of the egg and multiply. There has been a recent emergence of Salmonella enteritidis, particularly in the Northeastern part of the United States, in the intact egg. Contamination is hypothesized to occur in the oviduct of the hen before laying (35). Food vehicles in which Salmonella enteritidis has been reported include sandwiches dipped in eggs and cooked, hollandaise sauce, eggs benedict, commercial frozen pasta with raw egg-cheese stuffing, Caesar salad dressing and blended food in which cross contamination had occurred. Other foods such as cookie or cake dough or homemade ice cream made with raw eggs are other possible vehicles of foodborne illness (35).

Milk, especially raw milk, can be contaminated. Sources of milk contaminants could come from an unhealthy cow (i.e. mastitis, major infection of the mammary gland of the dairy cow) with Staphylococcus aureus, Escherichia coli (24) or Streptococcus; unclean methods of milking such as teats not cleaned well before attaching to milker and unclean utensils (milking tanks). If milk is not cooled fast enough, contaminants can multiply.

Modern mechanized milking parlors have reduced but not eliminated foodborne pathogens. Postpasteurization contamination may occur, especially if bulk tanks or equipment have not been properly cleaned and sanitized. In 1985 in Chicago one of the largest salmonellosis outbreaks occurred with the causal food being pasteurized milk. Over 16,000 people were infected and 10 died. A small connecting piece in the milk tank which allowed milk and microorganisms to collect was determined to be the source of the contamination (36). Consequently, bulk tanks should be properly maintained and piping should be inspected regularly for opportunities for raw milk to contaminate the pasteurized product.

Ready-to-eat foods are another major vehicle of contamination. Cross contamination may occur via raw meat, fish, poultry and hands to ready-to-eat foods. The ready-to-eat foods will often not be reheated so the pathogens will not be killed before the food is eaten as they would have been in the raw meat, fish, and poultry.

High temperatures preserve foods by denaturing the proteins and thus inactivating the enzymes needed for normal metabolism by both the plant or animal cells and the microorganisms. It is also hypothesized that high temperatures damage the plasma protein membrane so cell leakage of DNA, RNA and free amino acids is accompanied by cell death (27). It is often times undesirable to exceed the minimum amount of heat necessary to kill the microorganisms because of the alterations in appearance, flavor, and chemical composition of the food.

In terms of preventing foodborne illness and yet keeping the food appealing, a specific time and temperature cooking relationship is critical; however, there are many parameters affecting heat resistance of bacteria in foods. For example, for heating for 10 minutes, the thermal death point of E. coli in cream is 73°C; however, in bouillon (broth) the thermal death point is 61°C (cited by 37).

Water activity is a key concept in evaluating the correct time and temperature necessary to kill organisms. Water activity (Aw) is the customary unit in which the moisture required for microbial growth is expressed. Aw is the ratio of the water vapor pressure of a food substrate to the vapor pressure of pure water at the same temperature. The heat resistance increases with decreasing Aw. For example, Goepfert and Biggie (38) demonstrated that reduced Aw levels increased the heat resistance of salmonellae in milk chocolate. Also, in a liquid medium, the heat will penetrate more quickly via convection currents than in a solid medium where the heat will travel more slowly by conduction (39).

At their optimum pH of growth, which is about 7.0 for most microorganisms, the heat resistance is the greatest (27). If there is a change of pH, there is a consequent change in heat sensitivity. For example, high acid foods require considerably less heat than neutral foods in order to achieve sterilization (27).

The greater the number of organisms, the greater the degree of heat resistance. For example, the thermal death time at 100°C required to kill spores of C. botulinum differs depending on the number of organisms. The thermal death time of 72,000,000,000 spores is 240 minutes while the thermal death time of 328 spores is 40 minutes (cited by 27).

As the temperature increases, the greater the killing effect of heat. For example, to kill 10,000 Salmonella senftenberg 775W bacteria at 57°C (135°F) takes 83 minutes while at 66°C (150°F) it only takes 5.5 minutes (40).

The thermal death point (TDP) is the lowest temperature required to destroy a microbial suspension in 10 minutes. The thermal death time (TDT) is the shortest period of time needed to kill all the organisms in a microbial population at a specific temperature and under defined conditions (24). Often times, data are reported as D values or the time required to kill 90% of the organisms present in a given food.

Cell death occurs in a logarithmic fashion which means that at a constant temperature a certain percentage die during a constant period of time. For example, if 90% of the organisms died in the first minute, then in the second minute, 90% of the remaining 10% would die. Thus, 99.9% of the original organisms would be dead and 0.1% would be alive. In the next minute, 99.99% of the original organisms would be dead and only 0.01% would remain and so on.

Spores are more heat resistant than vegetative cells. For the following organisms we need to be concerned about spore destruction: C. botulinum, C. perfringens, and Bacillus cereus. Some hypotheses as to why spores may be

more heat resistant are the effect of protoplast dehydration, mineralization, and thermal coadaptation.

The thermal death point or thermal death time based on the original research for specific organisms is presented in Table 1.

Table 1. Thermal inactivation temperatures for selected foodborne microorganisms and parasites that cause foodborne illness. (h = hours, m = minutes, s = seconds, * = D value, ** = most heat resistant strain, ORNC = original reference not cited)

Organism	Temperature	Time	Substrate	Source
Salmonella manhattan	60°C 140°F 60°C 140°F	2.44 m * 0.40 m *	custard chicken a'la king	40
S. typhimurium	70°C 160°F	4 m	fried covered eggs	41
S. enteritidis	60°C 140°F	3.5 m	whole egg homogenate	42
S. enteritidis Strain B6660	60°C 140°F	31.3 s	liquid whole egg	43
S. senftenberg 775W **	60°C 140°F	95+ m	21/24 foods	44
S. senftenberg 775W **	60°C 140°F 60°C 140°F	11.32 m * 9.61 m *	custard chicken a'la king	40
Salmonella sp.	57°C 135°F	.6-31 m *		45 ORNC
Salmonella sp.	60°C 140°F	30 m		46 ORNC
Staphylococcus aureus 196E MS149 196E MS149	 60°C 140°F 60°C 140°F 60°C 140°F 60°C 140°F	 5.37 m * 5.17 m * 7.82 m * 7.68 m *	 chicken-a'la king custard custard	40
S. aureus	64°C 147°F	3 m/side	eggs	41
S. aureus 16 strains	66°C 151°F	2 m		46 ORNC
Staphylococcus sp.	65°C 149°F	18.8 m	broth, pH 7.05	25 ORNC

Table 1 continued

E. coli O157:H7	57°C 135°F 60°C 140°F 63°C 145°F 64°C 147°F	270 s * 45 s * 24 s * 9.6 s *	ground beef	47
Campylobacter jejuni	55°C 131°F	30 m roasted	turkey thighs	48
C. jejuni	70°C 158°F	10 m	ground beef	49
C. jejuni	60°C 140°F	1 m	peptone yeast extract broth	50
Listeria monocytogenes	60°C 140°F	30 m		51 ORNC
L. monocytogenes	100°C 212°F boiling water	4.3 m, boil again +3m	ravioli from deli stores	52
L. monocytogenes	65°C 149°F	1.3 m *	chicken gravy	53
L. monocytogenes	58°C 136°F	10 m	cabbage juice	54
Clostridium perfringens	59°C 138°F	10.6 m	ground beef	55
C. perfringens spore	104°C 219°F	6.6 - 8.0 m *	beef gravy	56
C. perfringens spore	100°C 212°F	0.35 - 15.30 m *	SEC broth	57
Trichinella spiralis	-18°C -0.4°F -12°C +10°F	6-10 d 11-15 d	pork	58
T. spiralis	55°C 131°F	5 m	rats with Trichinella larvae	59
T. spiralis	60°C 140°F		pork roasts	60
T. spiralis	55°C 131°F	6 m	rats with Trichinella larvae	61
Toxoplasma gondii	60°C 140°F		meats	62

Recommendations for cooking temperatures are not only based on the temperature required to kill foodborne pathogens but also for aesthetics and palatability. Generally a margin of safety is built into the cooking temperature because of the possibility of non-uniform heating. For example, even if the internal temperature at the geometric center was high enough to kill an organism, this might not represent the temperature of the whole food item. For example with red meat or poultry, there may be thicker sections as well as meat near a bone which would require a higher cooking temperature or a longer cooking time. Based upon generally accepted temperature requirements, cooking red meat until 71°C (160°F) will reach the thermal death point for Salmonella, Campylobacter, Clostridium perfringens (vegetative cells), Listeria, Trichinella, and Toxoplasma (Table 1). These organisms will be killed by the time the meat reaches 63°C (145°F); however, due to unequal heating especially near bones, there is a margin of safety in the generally recommended minimum temperature of 71°C (160°F) (63).

The Code of Federal Regulations (64) states that poultry and meat products should be cooked to an internal temperature of 71.6°C (160°F). The safe end point temperatures to which these foods should be cooked recommended by the U.S. Department of Agriculture are as follows (65):

Beef - minimum 72°C (160°F)
Veal - minimum 72°C (160°F)
Lamb - minimum 72°C (160°F)
Pork - minimum 72°C (160°F), fresh or raw, cured
Chicken or other poultry - 77°C (170°F) white meat
83°C (180°F) dark meat

These end-point temperatures are based on an acceptable quality of meat as well as safety; however, this can be confusing to the consumer.

Since the color of red meat changes with heat, color change is often used as an indicator of doneness. Uncooked red meat is a purplish red color due to the myoglobin. During the cooking process, it turns a grayish brown

color due to the formation of denatured globin hemichrome (31). However, other factors in addition to temperature influence the color of cooked meat.

Cooked meat is often defined as rare, medium, and well done. Rare meat has an interior that is bright pink with a thin brown surface layer due to the denatured globin hemichrome. It is plump and juicy. These color changes indicate that an internal temperature of 60°C (140°F) have been attained. Medium done meat has a lighter pink interior because more myoglobin has been denatured as well as the surface layer of brown is deeper. It is less plump and less juicy. These changes indicate that an internal temperature of 71°C (160°F) has been attained. Well done meat has an interior that is uniform brown throughout. It is no longer plump and still less juicy. These changes indicate that an internal temperature of 77°C (170°F) has been reached (31).

Poultry is cooked to the well-done stage for palatability. Tenderness is indicated when there is a flexible knee or hip joint. Another indicator is that juices do not look pink when the meat is pierced with a fork.

Fish should be cooked until it loses its translucent appearance and flakes when pierced with a fork. Fish flakes when it is done because the fish collagen in the myocommata is degraded to gelatin and thus the myomeres (layers of muscle fibers) separate as flakes (31).

Eggs should be thoroughly cooked until the yolk is thickened and the white is firm and not runny. The egg white coagulates at 60°C (140°F) and the yolk begins to coagulate at 65°C (149°F) and no longer flows at 70°C (158°F) (31). Baker et al. (41) experimented with eggs that had been inoculated with Salmonella into the yolk to determine what cooking time was necessary to kill the organisms. Cooking eggs longer than usual, such as boiling for seven minutes, poaching for five minutes, and frying for three minutes on each side was essential to kill the organisms. No duration of time was enough to kill the Salmonella organisms on a "sunny-side up" egg - one that had not been turned over and cooked with the yolk side down. The yolk should be at least partially thickened if heating has been adequate.

The FDA, Cornell University, the American Egg Board, and the Egg Nutrition Center recommend the following cooking times (66):

* Scrambled - 1 minute at medium stove-top setting (250°F for electric frying pans)
* Sunny side up - 7 minutes at 250°F, or cook covered 4 minutes at 250°F
* Fried, over easy - 3 minutes at medium setting (250°F) on one side, then turn and fry 2 minutes on the other side
* Poached - 5 minutes in boiling water
* Boiled - 7 minutes in boiling water

Pasteurization (heat treatment) of milk is used to destroy pathogenic microorganisms and to decrease the number of nonpathogenic spoilage organisms by 95-99% (24). Milk due to its composition of protein, water content, and a neutral pH, is an ideal culture medium for many pathogens. Historically the diseases of tuberculosis (Mycobacterium tuberculosis), scarlet fever (Streptococcus pyogenes), other streptococcus infections, typhoid fever (Salmonella typhi), and diphtheria (Corynebacterium diphtheriae) have been associated with raw or unpasteurized milk (67). Interestingly, the reporting of foodborne illness was initiated in the 1920's by the United States Public Health Service (USPHS) when annual summaries of milkborne disease outbreaks were recorded and reported (26). Later, reports of waterborne and foodborne diseases were added.

Current potential hazards of drinking raw milk, in addition to Streptococcus, are Campylobacter jejuni, Salmonella, Listeria monocytogenes, and E. coli. Homemade cheese made from unpasteurized milk has been linked as the vehicle for the transmission of Streptococcus C (68). Campylobacteriosis is another major problem associated with raw milk. In the United States from 1978 - 1986, of the 80% of the cases of campylobacteriosis in which a food vehicle was identified, 70% were caused by raw milk (69).

Consequently, universal pasteurization of milk could possibly prevent 70% of the cases of campylobacteriosis. Another 8% were sporadic cases linked to poultry that was raw or undercooked.

The sale of raw milk is permitted in a few states. In Oregon, in the combined counties of Benton, Linn, Lane, Marion, and Multonomah, between 1980-1981, there were 200+ outbreaks (1 or more cases) of campylobacteriosis associated with raw milk consumption. In all of these cases, C. jejuni was isolated from the raw milk and the milk-producing animal (70).

In raw milk samples obtained from bulk tank trucks, McManus and Lanier (71) isolated 32 (4.7%) Salmonella out of 678 milk samples and Campylobacter jejuni, 1 out of 237 samples (0.4%). Lovett et al. (72) in a survey of 195 separate farms, isolated a higher incidence (1.5%) of C. jejuni in milk from bulk tanks. The specific serovars of Salmonella associated with raw milk consumption are Salmonella dublin (27, 71) and Salmonella typhimurium (71). However, other strains may also be transmitted. Listeria monocytogenes is associated also with raw milk and can be isolated from 5% of raw milk samples (73). Raw milk as a vehicle of transmission of E. coli was first recognized in 1986 with the determination of two illnesses. In both cases, E. coli was identified from the stools of the patients and the feces of the heifers (74).

One way to help prevent these diseases is by drinking only pasteurized milk. Pasteurization, developed by the French chemist Louis Pasteur in the 1860's, is a mild heating method used to destroy pathogenic microorganisms and to decrease the number of nonpathogenic spoilage organisms by 95-99% (24). Even though pasteurization kills vegetative microorganisms, the process does not alter greatly the physical and chemical characteristics of the milk.

Time-temperature relationships for pasteurization or sterilization are based on the most heat resistant organism. Consequently, since Coxiella burnetti is the most heat resistant organism, pasteurization is based on the time-temperature relationship needed to kill this pathogen (1). The pasteurization of milk can be achieved by heating as follows (p. 335, 27):

145°F (63°C) for 30 min. - low temperature long time (LTLT)
161°F (72°C) for 15 sec. - high temperature short time (HTST)
191°F (89°C) for 1.0 sec.
194°F (90°C) for 0.5 sec.
201°F (94°C) for 0.1 sec.
212°F (100°C) for 0.01 sec.

* Cooked/chilled foods which are served hot (leftovers) should be reheated to an internal temperature of 74°C (165°F) (75). This is only important if there is a possibility of contamination after cooking or if the raw foods had been previously contaminated with spores, i.e. Clostridium perfringens. During storage at temperatures which permit microbial growth, the spores can germinate to vegetative cells and multiply rapidly. If care is taken to prevent cross contamination after cooking and leftovers are promptly refrigerated, reheating to 74°C (165°F) would not be necessary. Since an internal temperature of 74°C (165°F) will not destroy the enterotoxin of Staphylococcus aureus, keeping hot food hot and cold food cold is the only way that absolutely controls these organisms from causing foodborne illness.

Consequently, foodborne microorganisms that could be killed if these recommendations for adequate cooking are followed are Salmonella, Escherichia coli, Clostridium perfringens (vegetative cells), Campylobacter jejuni, Listeria monocytogenes, Trichinella spiralis, and Toxoplasma gondii (Table 1). Staphylococcus aureus is not included in this list because the enterotoxin is heat stable and only destroyed at temperatures which have not been determined in foods because they are impractical and would result in an unacceptable quality (27).

* Prevent Cross Contamination.

Cross contamination occurs when microorganisms are transmitted from humans, cutting boards and utensils to food. Contamination between foods, especially raw meat and poultry to fresh vegetables or other ready-to-eat foods, is a major problem.

Much evidence has documented that the food handler can be the culprit in the spread of foodborne illness. Staphylococcus is harbored in the nose, throat and skin. Consequently, one can imagine how sneezing, blowing one's nose, as well as coughing can cause these organisms to be distributed. Rutherford (cited in 76) traced the infecting strain of Staphylococcus in a contaminated ham back to the same strain from the nose and throat of a foodhandler who had prepared that ham.

Hands are the main conveyors of bacteria and viruses. Sources that could contribute to microorganisms on hands are the air, soil, water, dust, nasal cavity, mouth, and the gastrointestinal tract. Carl et al. (77) reported that proper hand washing is more important in controlling hepatitis A virus than testing asymptomatic people. Most of the time that mishandling occurs, the foodhandler does not show any apparent signs of illness and is in the incubating or convalescent stage of hepatitis A.

Buice et al. (78) demonstrated that Escherichia coli of intestinal origin was present on 8% of the 337 hands of foodhandlers tested. The waiters that were tested did not wash their hands after using the lavatory.

Washing hands with water and soap helps prevent the spread of pathogens. Water is a cleansing agent that helps remove microorganisms and soil particles. Washing one's hands with warm or hot water is often recommended although the author could not find a research base to support the recommendation of this water temperature. Perhaps the reason is that if people enjoy the warmth of the water, they will wash their hands for a longer period of time which is important to remove organisms. Hot water is not germicidal because workers cannot tolerate water temperatures that are high enough (i.e. pasteurization temperature) as well as long enough in order to actually destroy the pathogens. The hottest water temperature that 30 tested subjects could tolerate was between 49°C (120°F) and 57°C (135°F) (cited in 79).

Soap is an agent that increases the cleaning capacity of water. Acuff et al. (48) found that foodhandlers who had prepared a turkey thigh contaminated with C. jejuni and then rinsed their hands in tap water for 15 seconds without soap and dried on a paper towel had viable C. jejuni on their hands. However, under the same experimental conditions, hands that were washed with hand soap for 15 seconds and dried on a paper towel were negative for C. jejuni.

Thoroughly washed hands can still be a source of bacteria so one should use tongs and spoons to prevent contamination. DeWit et al., (80) found that washing hands is only partially effective in removing transient bacteria. In a study of the hands of 280 foodhandlers, it was found that some bacteria remained when the numbers of bacteria before and after washing were compared. Though salmonellae could not be isolated, Enterobacteriaceae and Staphylococcus aureus occurred on 8% of the hands after "normal" hand washing. Acuff et al. (48) found that fingernails remained positive for C. jejuni after two fifteen second hand washes with soap and drying with a paper towel.

It is especially important to wash one's hands after certain activities. Since pathogens live in nasal passages, one should wash her/his hands after blowing the nose or sneezing. Since pathogens can live on perianal skin, it is important to wash one's hands after using the lavatory. Purely the expression "oral-fecal route", demonstrates the importance of washing hands after diapering a baby. Any or all of the Enterobacteriaceae could be expected in fecal wastes along with the intestinal pathogens including Toxoplasma (27). To eliminate skin organisms from contaminating food, it is important to wash one's hands after combing the hair (81). After smoking, the possibility of saliva being transferred from hands to mouth, makes this also an especially important time to wash one's hands (81).

After petting or touching animals or pets, it is important that hands be washed. Cases have been reported of salmonellae being spread via a pet turtle (28) as well as by touching baby ducks with hands, especially during the Easter and spring season. In this case, Salmonella hadar was the main

serotype identified (82). Since young children are often given a duckling for a pet, they are at higher risk for salmonellosis. Deming et al. (83) reported a relationship between touching cats and then eating food with hands as another vehicle of Campylobacter.

In order to prevent cross contamination, kitchen surfaces need to be cleaned and sanitized. The main sources of contamination in household kitchens discovered in a project when 55 meals were prepared are working surfaces, both plastic and wood, and kitchen- and cutting-machines (84). Cutting boards can be an excellent breeding ground for organisms. If a cutting board is contaminated with an initial sample, an increase in organisms could quickly occur.

Thoroughly washing and sanitizing cutting surfaces between cutting raw foods and cooked or other ready-to-eat foods is critical in order to interrupt the infection chain. Cleaning, the first step, is the removal of dirt, impurities, and nutrients for growth from a cutting surface using a detergent. Sanitizing, the second step, is a method of actually killing the organisms left on the surface with chlorine, iodine, or quaternary ammonia compounds (QAC).

The first cleaning step is very important because organic material inactivates the antimicrobial action of the chlorine by possibly either a chemical reaction between the organic material and the chlorine, thus leaving less chlorine to attack the microorganisms, or perhaps by protecting organisms from attack by the chlorine (85).

In the absence of organic debris, chlorine even in very low concentrations such as 44.4 mL (3 tablespoons) chlorine solution to 3.79 L (1 gallon) of water rapidly inactivates pathogens. Although the actual mechanism is not known, the germicidal activity of HOCl (hypochlorous which is more effective than OCl) is believed to be its ability to induce free radicals or combine with protein and thus inhibit key enzyme reactions and alter cell membrane permeability. Borneff et al. (86) found that when normal cleanser was replaced by a hypochlorite solution that the bacterial cleanliness of the surface was

determined to be 90% greater. Chlorine is known to be a potent sporicidal agent (87), as well as to inactivate viruses (88).

It is widely recommended that wooden cutting boards not be used to cut food products on. Wood is an excellent breeding ground for pathogens due to its rough surface. Acuff et al. (48) found that C. jejuni on surfaces and utensils were removed by washing with commercial dishwashing soap from all surfaces, including knives and a plexiglass cutting board, except a wooden cutting board.

Foodborne microorganisms that could be prevented from causing foodborne illness if the recommendations for preventing cross contamination were followed are Salmonella, Escherichia coli, Campylobacter, Listeria, Norwalk virus, hepatitis A, and rotavirus.

Keep Hot Food Hot and Cold Food Cold.

Though the growth rate for microorganisms is dependent on the water activity, pH, aerobic/anaerobic conditions, competing organisms, and the nutrient level of the medium, each organism has a characteristic temperature growth range. Specific cardinal temperatures consisting of minimum, optimum, and maximum temperatures have been determined. The usual growth range spans 30 degrees Celsius but some are narrower and some wider.

The generation time or doubling time is the specific length of time required for the population to double. The generation time varies with the species and the environmental conditions and can range from 10 minutes to several days. The generation time in culture takes less time generally than in nature (24).

Within the optimal temperature range, an organism can proliferate quickly to disease-causing levels. The optimum growth temperature for Salmonella is 37°C (97°F). At this temperature under ideal conditions, Salmonella can double in 23 minutes. If there were 10 organisms in a food at breakfast at 8:00 a.m., then at 8:23 a.m. there would be 20 organisms. By lunch, a pathogenic level for susceptible individuals could be reached.

In order to cause disease, the number of organisms in any given food must usually increase significantly from its original levels. The greater the number of organisms, i.e. salmonellae, the shorter the incubation time for the onset of symptoms and often the more acute the symptoms. The pathogenic dose varies by strain of the organism and the individual. The production of enterotoxin by Staphylococcus aureus occurs only during the multiplication and early stationery phase so growth is essential.

Since epidemiological evidence demonstrates that foods that were contaminated and then maintained at temperatures in the growth range for an appropriate time were responsible for most cases of foodborne illness (9), it is critical to select a proper storage temperature. Jensen in 1945 (89) coined the term "incubation zone" and recommended that foods be stored at temperatures lower than 10°C (50°F) and higher than 49°C (120°F). He reported that organisms, particularly the toxin-producing staphylococci, could multiply to disease-causing levels in the temperature range of 15.6°C (60°F) to 46.1°C (115°F) in four to eight hours. For the general public, he also advised placing a margin of safety of 10 degrees at the lower end and 5 degrees at the higher end, thus putting the "incubation zone at 10°C (50°F) and 49°C (120°F). Jensen (89) was particularly concerned with the growth response of C. botulinum type A and B, staphylococci, and salmonellae.

Much research has been done to define the limits of the incubation zone for various pathogens. Since foodborne pathogens like other organisms need certain conditions in order to survive and grow, these interdependent factors are also taken into consideration when determining growth ranges.

Perishable foods as defined by the FDA are fresh foods that are unprocessed (not heat treated, frozen, or preserved) and would be adversely affected if held for longer than 7 days under normal shipping and storage conditions (90). To prevent foodborne illness these interdependent parameters for perishable foods must be controlled: available water (Aw), pH, presence or absence of oxygen, and time and temperature of handling and storage.

Water activity (Aw) is the moisture required for microbial growth. Aw is the ratio of the water vapor pressure of a food substrate to the vapor pressure of pure water at the same temperature. Simply drying a food or adding a high concentration of solutes such as salt and sugar to make the water of the food less available can prevent multiplication of the organism. When the Aw is 0.998 - 0.980 the growth and toxin production by most foodborne pathogens are the most rapid. However, Staphylococcus aureus can grow and produce its toxin at a water activity level as low as 0.86 (28).

The pH, the measure of acidity or alkalinity of an environment, also affects the ability of a pathogen to survive and grow. An acid environment, pH < 4.6 generally prevents multiplication and may kill microorganisms. Perishable foods have a pH above 4.6.

The presence or absence of oxygen affects the growth of specific pathogens. Clostridium perfringens and Clostridium botulinum are anaerobic organisms. Facultative anaerobes are Salmonella, Staphylococcus aureus, E. coli and Listeria monocytogenes. Campylobacter jejuni is aerobic and microaerophilic.

With these parameters taken into consideration, the temperature growth ranges for selected organism are presented in Table 2.

Table 2. Optimum and maximum growth temperatures for selected microorganisms that cause foodborne illness. (a = mean generation time in minutes as calculated by Rivituso and Snyder, (91), ORNC = original reference not cited).

Organism	Optimum Temp.	Max. Temp.	Gen. Time	Substrate	Source
Salmonella	37°C 99°F			urea medium	92
	35°C 95°F	46°C 115°F		custard, ham salad, chicken a'la king	40
Salmonella	35°C 95°F 10°C 50°F 35°C 95°F 35°C 95°F		253 a 800 a 155 a 873 a	custard chicken chicken ham salad	91 from data of 40
Staphylococcus aureus	30-37°C 86-99°F	45°C 113°F			51
S. aureus	35-37°C 95-99°F	46°C 115°F		custard, ham, chicken	40
S. aureus	10°C 50°F 35°C 95°F 10°C 50°F 35°C 95°F 35°C 95°F		722 a 201 a 1220 a 218 a 261 a	custard custard chicken chicken ham salad	91 from data of 40
S. aureus enterotoxin production	40-45°C 104-113°F				27 ORNC
S. aureus	41°C 106°F		6-8 h	rich medium	89 ORNC

Table 2 continued

E. coli O157:H7 ATCC11775 Biotype I (clam)	24°C 75°F 29°C 84°F 33°C 91°F	41°C 106°F 45°C 113°F 45°C 113°F	24 h	E. coli medium	93
Campylobacter jejuni	42-43°C 108-109°F	45°C 113°F			92
C. jejuni	42°C 108°F		24 h	GC medium	94
Clostridium perfringens type A,D,E type B,C	 45°C 113°F 37-45°C 99-113°F	 50°C 122°F 50°C 122°F			51
C. perfringens	30-40°C 86-104°F			Thiogly-collate medium	95
C. perfringens sporulation	37-40°C 99-104°F			Ellner's medium	95
Clostridium botulinum type A, proteolytic B,F type E, nonproteolytic B,F	 30-40°C 86-104°F 25-37°C 77-99°F	 45°C 113°F 45°C 113°F			51
C. botulinum type E	20°C 68°F		24 h	herring fillets	96
C. botulinum type E	35°C 95°F		1.77 division/ h	Neopep-tone, yeast extract - glucose (N.Y.G.)	97

Table 2 continued

C. botulinum type A,B	40°C 104°F			N.Y.G.	97
Listeria monocytogenes	30-37°C 86-99°F	45°C 113°F			51
L. monocytogenes	30-37°C 86-99°F	45°C 113°F			98
L. monocytogenes	21°C 70°F 35°C 95°F 21°C 70°F 35°C 95°F 21°C 70°F 35°C 95°F 21°C 70°F 35°C 95°F		1.9/h .69/h 1.8/h .69/h 1.6/h .65/h 1.7/h .67/h	skim milk skim milk wholemilk wholemilk choc.milk choc.milk cream cream	99

* The highest temperature that allows multiplication of foodborne pathogens is 52°C (126°F) (100). The U.S. FDA states that foods will be held below 7.2°C (45°F) or above 60°C (140°F) and that foods should be cooled to 7.2°C with 4 hours. The especially critical zone is from 16°C (60°F) through 49°C (120°F) because in this region most pathogens, especially mesophiles, multiply most rapidly. Room temperature falls within this critical zone. Consequently, foods should be chilled quickly if not kept hot.

The recommendation for the maximum refrigerator temperature has changed as more research regarding minimum temperatures at which organisms can grow in specific foods has been generated (Table 3). Originally, 10°C (50°F) was recommended for refrigerator temperatures in order to prevent the formation of botulinum toxin, types A and B in foods. Later research with other foodborne pathogens demonstrated that temperatures lower than 10°C (50°F) are necessary. Angelotti et al. (101) demonstrated that in custard, ham salad, and chicken a'la king the growth of salmonellae and staphylococci occurred below 10°C (50°F) but not below 6.7°C (44°F).

Today the debate is whether 7.2°C (45°F) or 4.4°C (40°F) or 1.7°C (35°F) should be recommended. Currently, the FDA recommends that for refrigerators for commercial foodservices the temperature be set at 7.2°C (45°F). Even though refrigeration can retard growth, with extended storage psychrotrophs Listeria, Yersinia enterocolitica, and C. botulinum nonproteolytic B, E, and F, can multiply slowly and thus cause foodborne illness (Table 3).

Table 3. Minimum reported growth temperatures for selected foodborne microbial species that grow at or below 7°C (45°F).

Organism	Temperature	Growth detected	Substrate	Source
Salmonella panama	4°C 39°F	27 d	Glucose tryptone soya peptone agar	102
S.typhimurium S.heidelberg S.derby	6.1°C 43°F 5.5°C 42°F 6.1°C 43°F	7 d	Trypticase Soy agar (TSA)	103
S. heidelberg	5.2°C 41°F	7 d	TSA	104
Staphylococcus aureus 3 strains	6.7°C 44°F		chicken a'la king	101
S. aureus	5°C 41°F		bacon	105
Listeria monocytogenes	5°C 41°F	25 d	unheated shredded cabbage	54
L. monocytogenes	1°C 34°F			51
L. monocytogenes 3 strains	-0.1 - +0.4°C 32-33°F	131 h 62 h	chicken broth/UHT milk	106
L. monocytogenes	3°C 37°F	5-8 d	broth or solid medium	98
L. monocytogenes	4.4°C 40°F	14 d	sliced chicken/ ham	107
L. monocytogenes	7°C 45°F	1.5 log/d	chicken gravy	53

Table 3 continued

L. monocytogenes	4°C 39°F	31-37 h 30-36 h 29-41 h 27-45 h	skim milk whole milk choc. milk cream	99
Clostridium botulinum type E strain 1537	3°C 37°F	120 d	meat broth fish juice	96
C. botulinum type E	3.3°C 38°F	31-45 d	beef stew	108
Yersinia enterocolitica	4°C 39°F	8 d	sterile milk	109, 92
Y. enterocolitica 4/20 strains	3-6°C 37-43°F	7 d	trypticase soy broth	110
E. coli *	4°C 39°F	8 d	sterile milk	109

*not replicable, other sources reputed

Consequently, the long-held premise that refrigeration between 4°C (39°F) and 7°C (45°F) is sufficient to prevent foodborne organisms from multiplying is not valid (107). We are mainly concerned with Yersinia; nonproteolytic B, E, F, C. botulinum; and Listeria. Of the data represented here, Yersinia can grow between 3°C (37°F) and 6°C (43°F); however, the strains that grew at these low temperatures were different from ones that been isolated from people with yersiniosis. Listeria can grow even at 0°C (32°F) in unfrozen portions of food. Decreasing the refrigerator temperature this low is not practical. C. botulinum type E, grows slowly at 3.3°C (38°F), but is mainly present in marine food. However, other nonproteolytic strains can also grow slowly. The Microbiological Criteria Committee of the National Food Processors Association recommended in 1988 to lower refrigerator temperatures to less than 4.4°C (40°F) (111). Concern is also that the internal temperature of food should reach 7.2°C (45°F) in four hours and should not linger in the

temperature range of 48.9°C (120°F) to 15.6°C (60°F) for more than 2 hours. Fast cooling cannot be achieved unless the temperature is lower than 7.2°C (45°C).

Listeria is of major concern, especially in ready-to-eat foods that are refrigerated for long periods of time, raw vegetables, and soft cheeses. For example, L. monocytogenes was cultured from food from 79 (64%) refrigerators out of 123 that were examined in households of patients with listeriosis. Twenty-six (33%) of these 79 refrigerators had the same strain of L. monocytogenes that caused the illness (15). This also illustrates the spread of bacteria by contact. Pregnant women, those who are immunosuppressed, and the elderly can decrease their risk by not eating soft cheeses, such as Brie, Camembert, feta, Mexican-style, and blue-veined cheese (112) as well as foods from delicatessen counters (15). Leftovers and ready-to-eat foods (e.g. hot dogs) should be reheated so that they are steaming hot (15).

By following these guidelines for temperature control, the following foodborne microorganisms can be prevented from multiplying: Salmonella, Escherichia coli, Staphylococcus aureus, Clostridium botulinum, and Campylobacter jejuni. Listeria monocytogenes will multiply less rapidly although numbers will continue to increase at refrigerator temperatures. Since the presence of viable S. aureus bacteria does not cause foodborne illness but only the ingestion of enterotoxin preformed in the food, temperature control so that S. aureus cannot multiply absolutely prevents that foodborne illness.

^0 High Risk Groups.

Pregnant women, very young children, the elderly, and those with compromised immune systems are more susceptible to foodborne illness (11). These people who are physiologically stressed can have foodborne illness with greater severity and frequency. The infecting dose is dependent on age and individual susceptibility.

During pregnancy, a mother's immune system is suppressed. Regulation of immunity is a requirement in order for the maternal cells to accept the new paternal cells (113). Though the blocking factors, such as human chorionic gonadotropin (HCG) and alpha fetoprotein, a glycoprotein, play an important role in promoting the maternal acceptance of the fetus, they also inhibit the immune response of the pregnant woman (114). Consequently, pregnant women are more susceptible to foodborne illness.

Foodborne pathogens of greatest concern for a pregnant woman and her fetus include Salmonella, Campylobacter jejuni, Yersinia enterocolitica, and especially Listeria monocytogenes. In California in 1985, 58 cases of listeriosis in mother-infant pairs including 29 deaths were reported due to the mother's consumption of soft cheese that had been contaminated with Listeria (115). Though Listeria in the food supply is believed to be decreasing due to increased government regulations in cheese, dairy products, and packaged ready-to-eat meats, there is no evidence that salmonellae and campylobacters are decreasing in raw food products.

Even though adults may have intestinal colonization without signs of disease, infants have little resistance to salmonella and if infected become seriously ill. Cliver (28) reported that the highest rates of reported salmonella infections are in infants from one to six months old and that 40% of cases occur in children less than five years of age.

From 1981-1990, 698 cases of infant botulism have been reported in the United States (116). One known cause is the ingestion of honey or corn syrup which contains spores of Clostridium botulinum. In a nationwide survey, the spores of C. botulinum were isolated from 5 out of 961 bottles of corn syrup (117). In a microbiological survey, 5% of honey samples from 154 individual honey producers contained spores of C. botulinum (118). Since the pH of the infant's stomach is higher than adults and the infant's intestine does not have a developed microflora, these spores can germinate and produce the toxin within the gastrointestinal tract. Consequently, not feeding honey or corn syrup to

infants less than one year old, especially less than six months old, is recommended (17).

Breastfeeding is another way to combat foodborne illness in infants. Breast milk offers immunological protection by providing antibacterial agents such as lactoferrin, antiviral agents such as immunoglobulins, enzymes, and hormones, such as thyroid hormone and prostaglandins, which also help fight infections (119).

Infants that are breast fed have greater resistance to gastroenteritis compared to infants that have been bottle fed. Bullen and Willis (120) found that the feces of breast-fed infants had a greater number of anaerobic lactobacilli specimens and less E. coli, and a lower pH than the feces of bottle-fed infants. Factors in the breast milk and colostrum promote the maintenance of a lactobacillary flora in the infant's intestine as well as a low pH which prevents the growth of other more harmful bacteria. These two factors offer natural resistance to enteric infections. Breast milk also provides a greater portion of lactose (69g/100ml) than whole milk (48g/100ml) (120). When undigested lactose is fermented by bacteria, the production of acid will cause the pH to fall.

Many of the elderly, defined as adults over 60, also are more susceptible to salmonellosis because of their individual reduced immune response (28). The elderly may be more vulnerable due to age-related multiple illness, changes in immunity, reduction of gastric juices (increase in pH), as well as frequent use of antibiotics and antacids (12). One major underemphasized public health problem of the elderly is that of gastroenteritis. This illness is a well-recognized disease in children; however, as Gangarosa et al. (121) reported, the case-fatality ratio is higher in the elderly than in children.

Those whose immune system are compromised are more vulnerable to foodborne illness. Of the 301 cases of listeriosis identified from November 1988 through December 1990, 98 persons with nonperinatal listeriosis had at least one immunosuppressive condition. Thirty-one percent reported using

corticosteriods, 29% malignancy, 24% renal disease, 24% diabetes, and 20% had acquired immunodeficiency syndrome (15).

Those who are under immunosuppressive therapy, such as transplant patients and chemotherapy patients, need to be especially concerned about preventing foodborne illness. In order to meet the needs of those who are immunocompromised, particularly AIDS patients, the Centers for Disease Control and the Food and Drug Administration have developed a special film for these patients (122).

As documented previously, there is a research base for these food safety recommendations. It has been widely acknowledged that the way to decrease foodborne illness is through education. WIC is a program in which low income, pregnant women, newborns, and children up to age five are participants. Targeting this audience for food safety education provides a vital link to help decrease foodborne illness in these critical high risk groups.

* Strategies to Teach WIC Participants.

Learning styles and teaching styles need to compliment each other. Three basic principles of learning are we learn best when there is need for learning, we learn best by doing, and we learn new things best in terms of the old (123). Consequently, based on principle one, helping students to understand the purpose of the concept being taught, promotes the learning process. A teaching style that creates curiosity can help to stimulate the need for the material being taught. The theory of learning by doing is long established. "To **hear** about something is good; to **see** the thing is better; **to do the thing is best of all.**" (p. 7, 123). When the hand and the mind work together, knowledge retention and application are more efficient. By referring to students' past experiences, an instructor can teach new concepts through analogies, associations, and comparisons.

In order to learn, the message must be acquired through the senses. The five senses of learning are sight 75%, hearing 12%, touch 6%, smell 4%,

and taste 3% (123). Even though psychologists differ in the percentile values, they generally agree in the order of importance in learning. By utilizing a combination of senses, reinforcement and retention are stimulated.

In Bloom's taxonomy of education, the degree of learning progresses positively from cognitive to application and synthesis (124). Those methods of teaching which promote change in the higher-order thinking skills will have a more lasting impact on the person.

The two major categories of teaching styles are teacher dominant and learner supportive (124). In a teacher-dominant style, an authoritarian structure is established and students are expected to only be the receiver of the message. In a learner-supportive teaching style, a nonauthoritarian structure is maintained and the students are encouraged to actively participate in an interactive manner with fellow students and the instructor.

Education programs which involve interaction either between the instructor and the participants or among the participants are "more likely to gain attention" as well as more likely to "achieve acceptance" (p. S-49, 125) and hence the desired outcome. This form of teaching style can have the added benefit that when people talk about a topic, i.e. food safety, they can share personal experiences which can have a greater impact in promoting positive behavior change of others within the group. Also, receiver-sender interaction can personalize the message to the audience so that the information conveyed is useful and relevant. People have a chance to ask questions that they feel are important. In order to transfer didactic learning to behavior change, it is important to be able to apply the knowledge in the classroom setting (126). In order to have long-term retention and application within education, the elements of interest and meaning need to be addressed (127).

A variety of instructional strategies can be used to enhance the learning process. As compiled by Womack (128), instructional procedures and strategies include formal lecture, informal lecture, discussion, laboratory, demonstration, parable, anecdote, field trips, visual aids, auditory aids, tutorial,

forum, panel, debate, examinations, student reports, dramatization, construction, exhibitions, written reports, guest instructors, use of local people (resources), concert, recital, direct conversational method, computer-assisted instruction, educational games, problem solving, contracting, performance-based evaluation, behavior modification techniques, and repetitive examinations. Though other strategies are possible, this helps to illustrate methods that can help students learn.

Teaching adults in a group setting, is a challenge because they come from divergent experiences such as a variety of backgrounds, learning styles, and cultures. Consequently, in facilitating adult learning, it is important that a variety of teaching methods be used (129).

When examining what motivates adults to learn, Zemke and Zemke (130) reported that 80-90% of the time adults have need for the knowledge or skill being sought. "Learning is a means to an end, not an end in itself" (p. 58, 130). Adults also tend to appreciate classes in which "single-theory courses" focus on practical relevant material and learning information that can be used to solve these problems.

Often times people are unable to learn from health professionals due to the inability to read. Many materials are written for the 10th grade reading level or above; however, 45 million Americans in the population of those most in need of nutrition education read at the eighth grade level or below (cited in 126). There is a need for material to be developed for the low literate population. Ease of comprehension is also important for information presented verbally. Ways to decrease the difficulty are to limit the amount of information to one or two concepts, add visual aspects and personalize the lesson by asking questions and saying "you" or knowing their names. Most of the educational programs available for the WIC program as advertised in the annotated bibliography are designed for the fourth through the eighth grade reading level (22), so the needs of this audience in terms of literacy are focused on when educational materials are developed.

Since time is precious within the WIC setting, the philosophy "Make it quick - Make it simple" is emphasized for education of the WIC participants (131). Features include focused education with a single concept taught, action plan oriented for a behavior change, and easy to document tools.

Attendance is difficult in the WIC setting. An excellent time for participants to learn is while they are sitting in the waiting room for their appointments. An EFNEP program in California decided to use this time efficiently and thus provided hands-on learning activities while people waited. Clients often pick up free brochures while waiting. Since it is difficult to motivate people to come to classes, this would be a way to convey important public health issue information while people wait (132).

Evaluation of results is important in order to determine the effectiveness of educational programs. A measurement instrument should be tested in order to assure validity; it measures what it is supposed to measure. Content validity which assesses the instrument in terms of its specific field of knowledge should be evaluated by independent content specialists (133). Quantitative data are collected in order to assess the effectiveness by degree of change evidenced between pre- and post-intervention testing. Qualitative data are obtained in order to discover how and why changes have occurred. In the standard open-ended question interview, the topic and sentence wording are predetermined (134).

The outcomes of the interactive form of teaching style can be cognitive acceptance, affective acceptance, behavioral intention, and behavioral acceptance (125). For this module, data on cognitive acceptance and behavioral acceptance were collected. Cognitive acceptance means that a knowledge change has occurred; this is the basic "belief-level" acceptance in which the audience thinks that the information is valid and factual. Behavioral acceptance means that a specific change has occurred in a person's lifestyle.

Professional assessment by those who will be using the educational method is important to discover whether the educational method is useable and

practical to implement. For each of the modules listed in the WIC annotated bibliography (22), an appraisal by professionals in that field are given.

There are many statistical techniques which are commonly used in nutrition education research. Writers of a summary article on commonly used techniques for analyzing nutrition education effectiveness evaluated 6600 research articles published from 1980-1986 in 14 nutrition and food science journals cited in the Journal of Nutrition Education (JNE). Of those, 101 JNE research articles were randomly chosen and the frequency of use of various statistical techniques in research articles was determined. Descriptive techniques were used in 70% of the research studies and the t-test was used in 27% (135).

III. METHODOLOGY

The food safety module was designed to be a very practical educational tool which both a novice and an expert could use to teach safe food practices to WIC parents. In 45 minutes, the module covers the three major food safety concepts of cooking foods well, preventing cross contamination, and keeping hot food hot and cold food cold with a focus on the high risk groups of pregnant women and infants. The content was determined not only by recommendations of other groups, but by a review of food safety research literature.

Module Development.

Based on the steps of lesson planning as described in the book Creative Home Economics Instruction (136), specific learning objectives were set for each of the three scientifically-based food safety recommendations. Then, learning experiences which involved a variety of instructional strategies were created to help the students learn, retain, and apply the three basic food safety concepts. Since a broad spectrum of reading levels as well as a range of knowledge bases were expected of the participants, an interactive teaching style was implemented in the module with appropriate instructional strategies incorporated in order to support this approach. As recommended by the literature reviewed, a variety of teaching techniques were used. These included visual aids, demonstrations, interactive questions, auditory aids, and hands-on activities. (See appendix D for module.)

Grammatik IV, a computer program, available from Reference Software International (137) was used to determine the reading level of the script of the food safety module. Based mainly on vocabulary level and words per sentence, the reading level was determined to be sixth grade. The knowledge test was determined to be a third grade reading level. Though no reading level

was documented for the FDA publication entitled Keep Your Food Safe (138), it was developed for "those with limited reading ability" (139).

After the module was created, a knowledge test was developed. A fifteen question test was constructed with four questions per concept plus three questions covering the introductory material. The test was then validated for content by four food safety experts. Since the answers of the experts to each question matched that expected by the test designer, the test was determined to be valid. Suggestions for changes in wording were considered, and some were incorporated. The same test was used for pre-, post-, and two-week follow up testing. (See appendix A for test.) Demographic data on age and education level were also collected. (See appendix B for sample.)

The literature review, pre- and posttest, as well as other required material were submitted to the Oregon State University Human Subjects Committee. Approval was granted by the Human Subjects Committee.

Pilot Study and Revisions.

A pilot study was conducted with eight volunteer parents whose children participated in the day care program at the Bates Family Study Center on the campus of Oregon State University, Corvallis, Oregon. The food safety class was taught following the script. A pre- and posttest were distributed. The parameters of time, content, and methodology were evaluated. Revisions were based on feedback from the participants, a food safety expert, and observations of the instructor. Some demonstrations were eliminated and others added that were considered to be more effective.

Since the pretest was distributed as participants entered the room over a 10 minute period, the time needed to complete the pretest was longer than expected which increased the length of the class to about 60 minutes. Consequently, the pretest was shortened to 12 questions. The questions that were eliminated were not good discriminators since all of the participants answered two of them correctly and all but one person answered the other one

correctly. The rest of the questions were kept the same, but the format of the test was changed for greater speed of test taking.

Some of the participants asked questions as to why they did not get foodborne illness even though they knew that they did not always follow the food safety rules they had just learned. Consequently, another section was added to the script addressing this issue. (See appendix D for script.) In teaching food safety, it is important that the instructor provide the knowledge base in such a way that the participants are able to make their own decisions. Consequently, the script points out that just because a person does not follow the rules does not necessarily mean that he/she will develop foodborne illness. However, if a person does follow these rules, the risk will be decreased. The script emphasized that it is especially important for people in the high risk categories to follow these rules.

Testing of the Module.

Audience. The test audience for this module were WIC participants living in three different counties in Oregon. The nation-wide governmental agency, WIC, is a health and nutrition program which helps low income pregnant women and young children to improve their health. Due to previous experience with other one hour classes offered monthly by WIC in which zero to 25 people would come to a class, various methods to encourage people to attend were tried.

The first two food safety classes were taught at the WIC center in Corvallis, Oregon which is the headquarters for Benton County. An advertisement with the date, place, time and title "Is it safe to eat my leftover Canadian bacon pizza?" was placed in the monthly WIC newsletter which was distributed to 1000 participants. A large colorful poster advertising the class was placed in the WIC waiting room where participants sit before their appointment. If time permitted during client certification the month before the class, the four Benton County WIC employees told people about the class. The

name and phone number of people who were interested were written down. The day before the class those participants who signed up were called and reminded of the class the next day as well as the free babysitting and refreshments that were available. A total of 15 people were present for the two classes taught. Six people were in the first class and 9 in the second class.

The module was also advertised and taught at the Linn County WIC center. A bright pink advertisement was randomly sent in 75 out of 3000 monthly voucher envelopes. A recruiter called approximately 35 people to tell them about the class. One person was present for the class.

In Lane County the food safety class was advertised in the monthly WIC newsletter that 6000 participants receive. One person was present for the class.

Evaluation.

A comparison of three tests per participant consisting of the same instrument given as a pretest, posttest (same day) and two-week follow-up phone interview was the main form of evaluation for the food safety module. During the two-week follow up phone interview, participants were given the matched 12-point test orally as well as given the opportunity to identify and explain their own behavior changes in regard to food safety after the class. After the knowledge test was given, the question, "What changes, if any, have you made regarding food safety in your own home after the food safety class?" was asked. Responses were recorded. These qualitative data regarding the participant's own appraisal of their behavior changes two weeks after the class were grouped by concept.

To test for possible selection bias due to the motivation of those people who volunteer for classes and those people who do not, the pretest scores for food safety class participants were compared to pretest scores of random WIC clients who had not taken the food safety class. Data were collected during

regular WIC hours at the Benton County office. Initially, the researcher wanted to collect data by distributing pretests to WIC clients who had an appointment on Tuesday morning or Thursday afternoon, which were the same times the WIC classes were taught. However, due to the quick pace necessary to certify WIC clients, there was not enough time for the clients to stop and fill out the form with the researcher. Consequently, the pretests were given to the WIC certifiers and if time allowed they gave the test to their client during their certification time period. The data were collected within a one-week period.

In order to test for the bias of test taking, the pretest and posttest were given to 15 WIC participants who had volunteered for one of three other WIC classes, in which the topic of food safety was not covered. This determined whether taking the pretest improved the score on the posttest.

For data analysis the Statistical Package for the Social Sciences for Personal Computer (SPSS PC) was used and a paired t-test was determined (140). Descriptive statistics, including mean, median, range, and percent gain or loss were calculated.

The food safety class was taught to 16 WIC staff members from Lane County in order to receive professional assessment of the module. The class was taught using the same module developed for the WIC clients. A pre- and post knowledge test was given as well as oral and written feedback was obtained.

IV. RESULTS AND DISCUSSION

The purpose of this study was to develop a food safety education module with an accompanying instructor's manual and to evaluate it with WIC participants. A knowledge test used as a pretest, posttest, and a two-week follow-up test was the main form of evaluation. In addition, subjective behavior changes were also documented. A professional assessment by WIC staff, people who may be using the module, was also done.

Demographics of WIC Participants.

Of the 17 WIC participants that attended the class, 16 completed the background information questions (Table 4). These data indicated that 57% (9/16) of the participants were under 30 years old and 44% (7/16) were 30 years or older. In terms of educational attainment, 63% (10/16) had education beyond high school, either technical or college; another 25% (4/16) were high school graduates; and 13% (2/16) had completed some high school. Previous foodborne illness was reported by 88% (14/16), while 13% (2/16) believed that they had never had foodborne illness.

Table 4. Demographic data of 16 WIC participants in a study testing the effectiveness of a food safety education module.

Demographics	No. of Participants	Percentage
Age		
Under 30 years	9	57
30 years +	7	44
Education		
some high school	2	13
high school graduate	4	25
additional education	10	63
Foodborne illness		
Yes	14	88
No	2	13

Results of Knowledge Test and Descriptive Information.

The food safety knowledge test for 17 WIC participants was analyzed by comparing tests given at three different periods (Figures 1 & 2). The analyses involved comparing pretest and posttest (same day) scores, pretest and two-week follow-up test scores, and posttest and two-week follow-up test scores.

The scores on the pretest ranged from 42% (5 correct of 12 questions) to 100% (12 correct of 12 questions) with the mean and median score of 75% (9 correct of 12 questions). These scores indicated that there were varied backgrounds in terms of food safety knowledge. The scores on the posttest ranged from 58% (7 correct of 12 questions) to 100% (12 correct of 12 questions) with the mean and median score of 91% (11 correct of 12 questions). These scores indicated an increase of knowledge of 17% (+2.0). This difference was determined to be significant ($p < 0.001$) as determined by the paired t-test ($n = 15$ with exclusion of participants in the 2 classes which each had only 1 person in attendance).

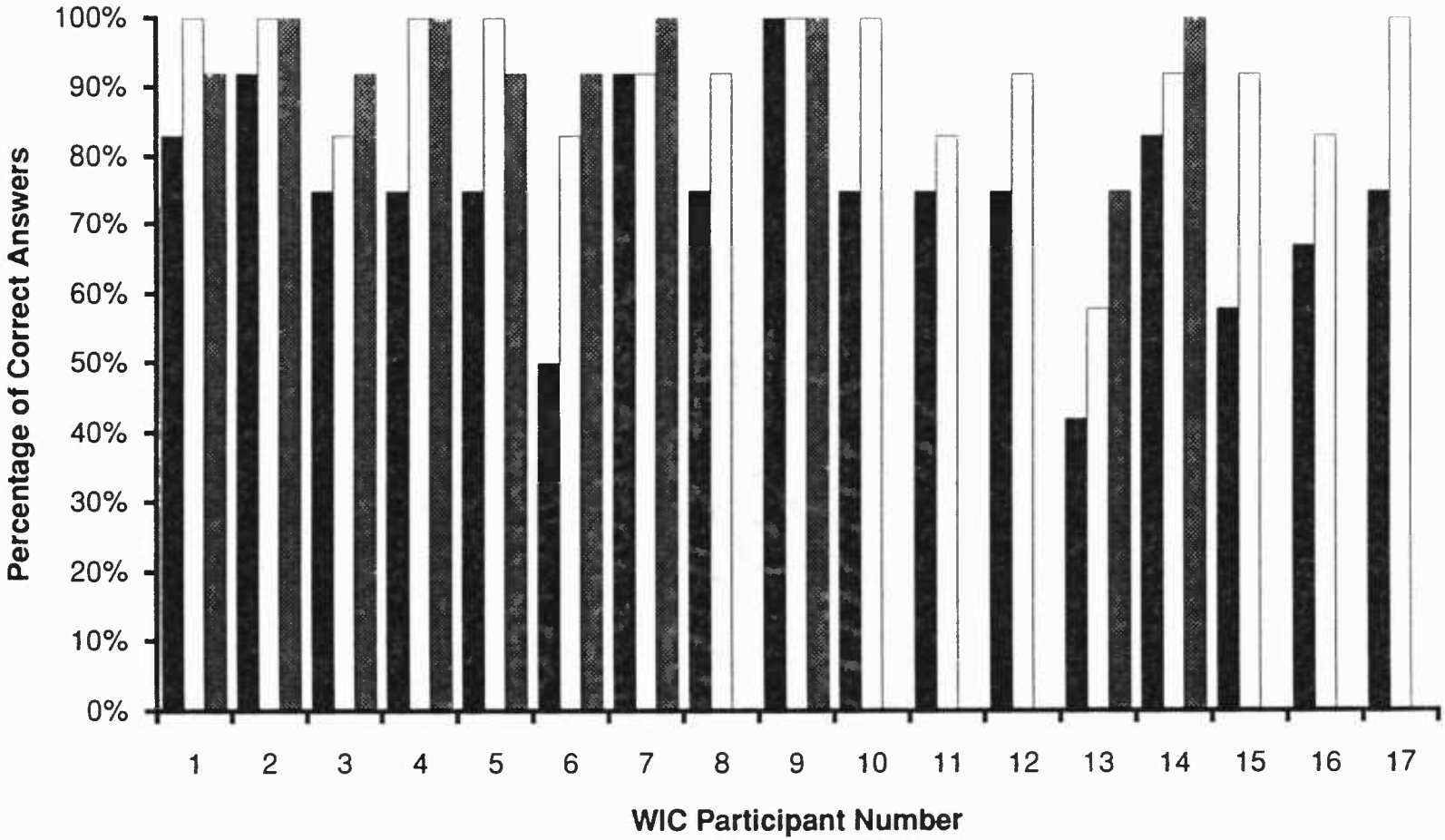

Fig. 1 Food safety knowledge test scores of 17 participants in the Special Supplemental Food Program for Women, Infants, and Children (WIC) in a class designed to test an educational module: Pretest ■, Posttest □, 2-Week Follow-Up Test ▨.

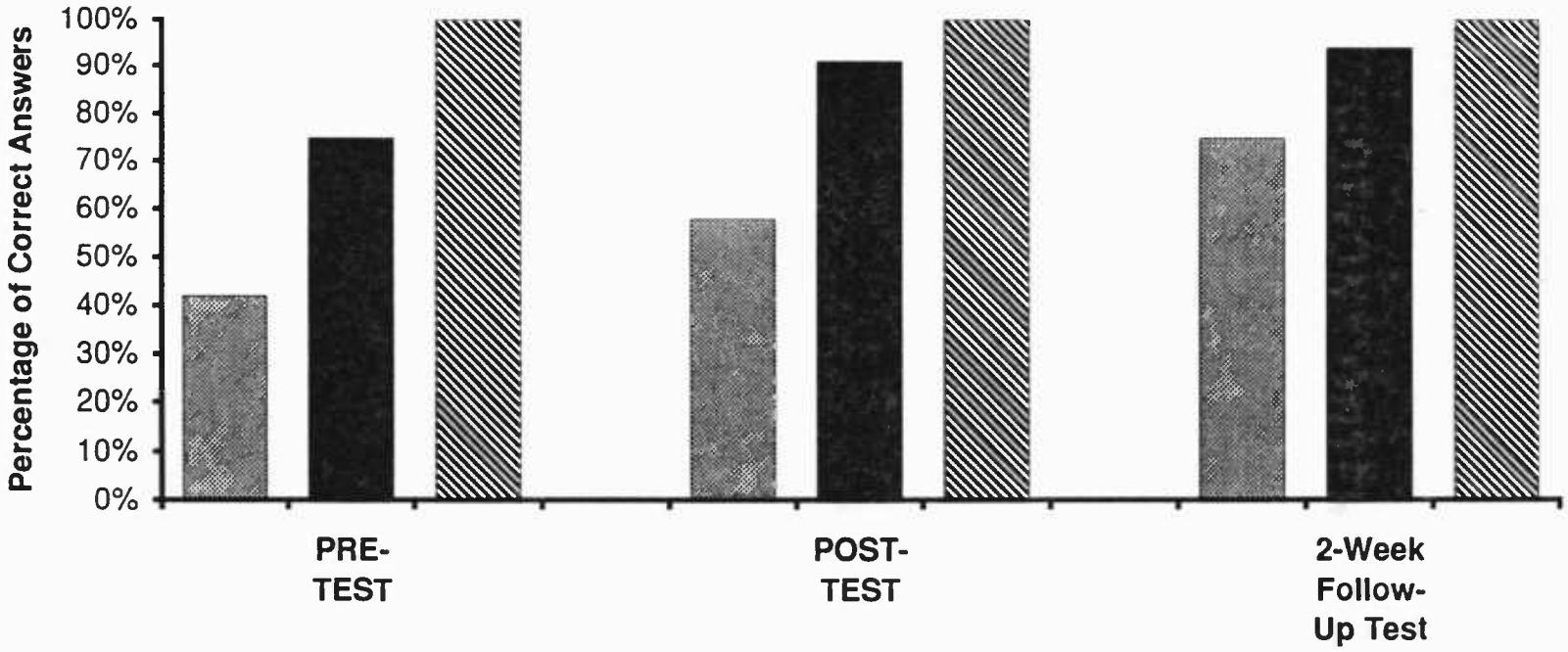

Fig. 2 Mean ■, minimum ▒, maximum ▨, food safety knowledge test scores of participants in the Special Supplemental Food Program for Women, Infants, and Children (WIC) in a class designed to test an educational module. (n = 17 for pre-and posttests, n = 10 for 2-week follow-up tests)

No common characteristics could be identified when demographic information regarding the four people who received a score less than 70% on their pretests were compared. Three of the four were 30 years or older; one had some high school, one was a high school graduate and two had additional education. All of them missed questions 4, 6, and 8 (Table 5). The three people who received over 90% on their pretest scores were all under 30 years old. One had completed some high school and two were high school graduates.

Ten of the 17 WIC participants were called exactly two weeks after the class for a follow-up phone interview which included a knowledge test and a subjective evaluation of their behavior changes in terms of food safety. Seven people were not called due to lack of a telephone (1), a disconnected telephone (1), out of town on vacation (1), or an indication on the posttest that they preferred not to be contacted (4).

The scores on the two-week follow-up test ranged from 75% (9 correct of 12 questions) to 100% (12 correct of 12 questions) with the mean score of 94% (11 correct of 12 questions) and the median score of 100% (12 correct of 12 questions). This indicated an increase from the posttest to the two-week follow-up test of 3% (+0.36). This difference was determined to be statistically insignificant ($p > 0.05$). There was also an increase from the pretest of these 10, (75%, 9 correct of 12 questions) to the two-week follow-up test of 22% (+2.6). This was a significant ($p < 0.05$) increase as determined by the paired t-test ($n = 10$). Both of these differences demonstrate that the knowledge had been retained.

An increase in test scores from the posttest to the two-week follow-up test could be due to time the participants needed to analyze what they had learned in their own homes. The two hand-outs on food safety which were distributed after the class may have been read and resulted in increased knowledge. Also, the test was given orally over the phone and previously the

test had been written. Literacy is usually a challenge in the WIC population. Thus, giving the test orally could give people more of a chance to respond based on their understanding of food safety, not on their reading level. However, all except 2 of these participants were high school graduates. Of the two that were not high school graduates, one was not able to be contacted two weeks after the class and the other received 100% on both her posttest and two-week follow-up test. Consequently, giving the test orally would not have been expected to apply to this particular group.

An analysis of individual questions demonstrated that there were two (5 and 10) which were not good discriminators because every one answered them correctly on the pretest (Table 5). When pilot tested, they had been determined to be good discriminators. Participants received less than 70% correct on questions 2,3,4, and 6 on the pretest. On question 2, participants increased their knowledge, yet in the posttest and two-week follow-up test, still only 70% of the participants answered it correctly. Perhaps these WIC participants had more preconceived beliefs about themselves when they were pregnant, thus it was difficult to change this personal perception. Some participants informally after the class told the researcher that they felt better during parts of their pregnancy than when they were not pregnant and that this was a sign to them that they were "more healthy". Many women remarked, "What about the healthy glow of pregnancy?" One woman emphatically stated that if she could remain two to three months pregnant for the rest of her life, she would because she felt so healthy. In informal discussions with WIC staff members, the researcher found that they had a common belief that when the WIC mothers were pregnant that there was an increased awareness and behavior changes in regards to a more healthy lifestyle and better nutrition.

Table 5. Summary of individual test questions and results on pretests (n=17), posttests (n=17) and two-week follow-up tests (n=10) for a food safety class for WIC participants. (Scoring key is Appendix A)

Question		Pretest % Correct	Posttest % Correct	2 Week Test % Correct
1.	Symptoms similar to the "24 hour flu" may be caused by something you ate.	77	100	100
2.	When I am pregnant, I am more resistant to illness than when I am not.	35	71	70
3.	Smoking a cigarette and then making a sandwich may cause bacteria to be spread.	47	94	90
4.	A plastic cutting board may be used to cut raw chicken on and then rinsed with water, and then used to cut fresh vegetables on for supper.	65	88	80
5.	It is safe to eat the leftover Canadian bacon pizza that I forgot in my car last night after dinner.	100	100	100
6.	Raw milk is safe to buy if I store it in the refrigerator.	35	88	100
7.	Cooked chicken may be placed on the same plate or pan the raw chicken was on.	88	94	90
8.	Hamburgers fried quickly until they are rare are safe to eat.	77	100	100
9.	It is risky to feed honey to my three month old infant.	94	82	100
10.	A peanut butter and jelly sandwich is a safer choice for my child's brown bag sack lunch than a sliced ham sandwich.	100	100	100
11.	Chicken that I fry may not always be completely done for some pieces, but it is still safe to eat.	82	94	100
12.	Old milk left at room temperature from the last feeding is safe for the baby if the bottle of milk is reheated.	94	88	100

During the telephone interview, participants were also given the opportunity to identify and explain their own behavior changes in regard to food safety after the class. After the knowledge test was given orally, the question asked was "What changes, if any, have you made regarding food safety in your home after the food safety class?" The replies were categorized into groups based on the three food safety concepts taught in the class: cook foods well, prevent cross contamination including human contamination, and keep hot food hot and cold food cold.

Thirty percent (3/10) reported that as a result of the class they were cooking foods well, especially meat, eggs and chicken. One participant remarked that now she knew how to tell when chicken was done.

Sixty percent (6/10) of the participants made changes to prevent cross contamination. Specific behavior changes included washing hands longer by making a game of it with her daughter, cutting vegetables then meat on a cutting board, buying a spray bottle and mixing a diluted bleach solution in it, and buying a plastic cutting board for raw meat.

Fifty percent (5/10) of the participants reported that they had made changes to keep hot food hot and cold food cold. Specific changes were putting leftovers in the refrigerator sooner (before she used to leave it on the counter to cool), using shallower containers to store food in, and following the two hour rule for perishable foods.

Some participants remarked that this was a good refresher class for them. Two of the participants remarked that they had taken a foodhandler's class less than nine months ago. The people who were vegetarians often remarked that they felt safer because they did not have the problem of cross contamination between cutting boards with raw meats as well as a concern of cooking foods, especially meat, fish, poultry, to a high enough temperature for a long enough time.

A subjective evaluation by the instructor as well as oral feedback from the participants demonstrated that the interactive approach was successful in teaching food safety concepts. This approach kept the attention of the participants, especially if there were children running in and out of the room, as well as provided an opportunity for participants to ask questions which were important to them. This method also allowed participants to voice their own experiences involving foodborne illness which emphasizes the importance of food safety especially for pregnant women and infants. The selection of instructional strategies used appealed to a wide variety of people.

Selection Bias Pretest.

In order to test for selection bias due to the motivation of those people who volunteer for classes as compared to those people who do not, pretest scores for food safety class participants were compared to pretest scores of WIC clients who had not taken the food safety class. The pretest scores of 17 WIC clients who had not taken the food safety class demonstrated a range of 42% (5 correct of 12 questions) to 92% (11 correct of 12 questions) with a mean and median score of 72% (9 correct of 12 questions). The pretest scores of the 17 people who had volunteered for the food safety class ranged from 42% (5 correct of 12 questions) to 100% (12 correct of 12 questions) with the mean score of 75% (9 correct of 12 questions). Those who volunteered for the class showed an average of 3% (+0.35) higher scores than those who did not volunteer for the class. This difference was determined to be statistically insignificant ($p > 0.05$).

Test Bias Results.

In order to test for the bias of test taking, the pretest and posttest were given to 15 WIC participants who had volunteered for three other WIC classes. These WIC classes entitled: "Getting Your Children to Eat Fruits and Vegetables", "Prenatal Nutrition Class", and "Making Your Own Baby Food" did

not teach any aspect of food safety. This analysis determined whether taking the pretest improved the score on the posttest. The scores on the pretest ranged from 25% (3 correct of 12 questions) to 92% (11 correct of 12 questions) with a mean and median score of 70% (8 correct of 12 questions). The scores on the posttest ranged from 33% (4 correct of 12 questions) to 92% (11 correct of 12 questions) with the mean and median score of 72% (9 correct of 12 questions). This demonstrated an increase of 2% (+0.2) from the pretest to the posttest. This difference was determined to be statistically insignificant ($p > 0.05$) using a t-test.

Comprehensive Model Evaluation.

Part of a comprehensive model for evaluating innovative nutrition education programs (141) was used as a guideline for evaluating this food safety education module. This module fit these evaluation questions:

1. Extent and distribution of program participation. This information was compiled by asking the administration of the WIC program for each county. Benton County has 1000 participants, Linn County has 3000 participants, and Lane County has 6000 participants.

Questions regarding age and educational attainment were asked on the posttest regarding characteristics of the clients in order to help define the audience. Low income level had been predetermined since this is a prerequisite for acceptance into the WIC program. Low income based on Federal Poverty Income Guidelines as documented in the service discount schedule of the Benton County Health Department, Community Health Division, April 1, 1991, is $1,020/month for a family of one, $1,368/month for a family of two and $1,716/month for a family of three.

2. Recruitment and qualification of instructors. WIC certifiers, people that would be using the food safety manual, come from diverse educational backgrounds. In Oregon, neither Registered Dietitian status is required nor a degree in nutrition. Some employees have a bachelor's degree while others

have master's in a variety of fields. The results of the pre- and posttest scores from the staff at the WIC in Lane County reflected this variety of knowledge base. Consequently, the format of the food safety module is set up for both the novice and the expert in food safety.

3. Appropriateness of program design and materials. Professional feedback provided by the WIC staff in Lane County was that the module was well organized and easy to understand. They thought it would be relevant to the WIC clients. The Grammatik program was used to evaluate the reading level of the module. The script was determined to be a sixth grade reading level.

4. Analysis of program outcomes. The results demonstrated that there was a statistically significant increase from the pretest to the posttest (same day) knowledge test as well as between the pretest and the two-week follow-up test. Retention of knowledge was shown. Self-reported behavioral changes also indicated that WIC participants were applying their food safety knowledge after taking the food safety class.

Professional Assessment.

The food safety class, using the same module created for WIC participants, was taught to the WIC staff of Lane County. Professional assessment involved staff members taking the pretest and posttest as well as providing oral and written feedback.

Background information to help define the Lane County WIC staff were that 25% (4/16) were under 30 years old and thus 75% (12/16) were 30 years or older. Most of the WIC staff, 81% (13/16) had education beyond high school, either technical or college, while another 19% (3/16) were high school graduates. All except one of the staff people, 94% (15/16) thought that they had had foodborne illness previously (Table 6).

Table 6. Demographic data of 16 Lane County WIC staff members who evaluated the effectiveness of a food safety education module to be used with clients.

Demographic	No. of Participants	Percentage
Age		
under 30 years	4	25
30 years +	12	75
Education		
some high school	0	0
high school graduate	3	19
additional education	13	81
Foodborne illness		
Yes	15	94
No	1	6

The knowledge test scores demonstrated a wide range of backgrounds about food safety among WIC staff people. For the 16 staff members who attended the class, the range of scores for the pretest was from 42% (5 correct of 12 questions) to 100% (12 correct of 12 questions) with the mean score of 77% (9 correct of 12 questions) and the median score of 83% (10 correct of 12 questions). The posttest scores ranged from 92% (11 correct of 12 questions) to 100% (12 correct of 12 questions) with the mean and median score of 100% (12 correct of 12 questions). There was an increase of 21% (+2.5) from the pretest to the posttest. This was determined to be statistically significant ($p < 0.001$).

The WIC staff evaluated the module as simple to follow with good demonstrations. For WIC clients they thought the concepts were basic enough for a broad range of people to understand. The test scores of the WIC staff demonstrated that there is a varied knowledge base of WIC staff members.

Consequently, a food safety instructor's manual for both a novice and an expert was important to construct in order to make it applicable.

Perceptions about Raw Milk.

Oregon is one of the few states that allows certified raw milk to be sold (142). One question on the knowledge test was stated as follows: Raw milk is safe to buy if I store it in the refrigerator. The answer is no. Examining this question for all of the pretests, from the food safety class (17), the test bias (15), and the nonvolunteers (17), a total of 49 pretests, it was found that 67% (33/49) responded yes or unsure. Of those participants, 33% responded yes and 35% responded unsure. Only 33% (16/49) responded no. Of the pretest answers for this question from the 16 WIC staff person, 56% (9/16) answered yes or unsure. Of those staff members, 25% responded yes and 31% responded unsure. Only 44% (7/16) responded no. These results indicated that people generally do not have a concern in terms of food safety about the hazards of drinking raw milk. Consequently, health professionals need to be aware of the facts about the risks of drinking raw milk and to be able to advise people when they have questions (143). In some areas, people may have milk from their own cow and should be provided with information on pasteurization.

Reaching the WIC Audience.

One of the limitations of this study is the small number of participants. From previous experience, attendance at WIC classes is unpredictable. Zero to 25 people could attend a class. In order to encourage attendance at future WIC classes the author has these suggestions.

1. Transportation - provide a van for a certain area.
2. Make classes mandatory as at least one county in Oregon does. However, federal guidelines do not include this as an eligibility requirement.
3. Reward with a coupon for food at a local grocery store for attending class.
4. Incorporate a food safety lesson into the monthly schedule of classes and offer often.
5. Recruit aggressively by mentioning and encouraging signing up for a class to each WIC client during their certification or recertification time.

Recommendations for Further Development.

Questions that were asked during and after the food safety class that were not in the module follow. Possible revisions of the module could include these points of interest.

Cook foods well.

Is it okay to refreeze leftovers?
How could eggs bought at the store potentially have Salmonella if they are inspected?
How long should I smoke my fish?
Can you get tuberculosis (TB) from unpasteurized milk?
How safe is milk from your local dairy farmer?
Is it safe to make cheese from unpasteurized milk?
Is it safe to eat raw shrimp if you put lemon juice on it?

Prevent cross contamination.

Is antimicrobial soap better to wash your hands with than regular soap?
Is it ok to use soap in a bottle rather than bar soap to wash your hands?
Are vegetarians less prone to foodborne illness because they do not prepare or eat meat, fish, or poultry?
Is it better to cover food with plastic wrap or aluminum foil?
Is it safe for my child to put my finger in her/his mouth?
Why should I cover food in the refrigerator?
Could the chlorine solution be toxic?

Keep hot food hot and cold food cold.

Should spaghetti be reheated to the boiling point also?
If my children are waiting at the table for lunch, it is tough if I reheat my leftovers to the boiling point, to let it cool down before they start eating.
What can I pack for my child's sack lunch?

Is it safe to eat the rest of a jar of baby food that was opened in the morning and not refrigerated?

High risk groups.

Am I really less resistant to illness when I am pregnant? What about the "healthy glow" of pregnancy? "I always feel so much healthier when I am pregnant? If I could stay three or four months pregnant for the rest of my life I would."

Is Karo (corn syrup) syrup a risk, like honey, for my infant to eat?

The ecological implications of some of the recommendations of the module were concerns of both WIC participants and WIC staff members. The use of paper towels to dry one's hands as well as using a chemical bleach to sanitize were disturbing to some of the participants and they wanted more ecologically sound alternatives.

There were also many questions about the perishability of peanut butter and the concern for aflatoxin. Some participants reported that they stored their peanut butter in the refrigerator in order to prevent the dangerous effects of moldy peanut butter. However, the safety of peanut butter depends on the use of peanuts which were not moldy when it was made.

Other ideas for revision of the module include adapting it to be used with culturally diverse groups. For example, in Southern states, the preparation of chitterlings, pork intestines, as documented by the WIC program in Fulton County, Georgia, has been implicated as a source of foodborne illness (144). Also, with many new immigrants arriving in the United States, for example from cultures where raw or rare pork is consumed, it is important for them to understand how foodborne illness can be prevented.

Three concepts were developed. Each could be used for a mini-lesson or for a short visual aid. For a mini-lesson, each concept could be expanded on and additional instructional strategies could be incorporated.

Groups other than WIC participants could also benefit from this food safety knowledge. The concepts could be adapted for nursing home workers and day care staff. Also changes could be made in the module to instruct the

elderly who participate in community day centers, diabetic support clubs as well as support groups for AIDS patients. Though modifications would need to be made to the module, the interactive teaching style as well as the same three food safety concepts could be used when instructing these groups. Literacy of these audiences would need to be identified and corresponding alterations in the module should be made. For each of these groups, the introduction would change with an emphasis on why they in particular are part of a high risk group in terms of food safety. Specific areas of focus for modifications could include concerns while shopping, eating out, microwave cooking, and traveling abroad. Hand-outs developed specifically for each group could be created.

When educating the elderly, the correct refrigerator temperature, between 4.4°C (40°F) and 7°C (45°F) as well as the two hour rule may need to be emphasized. Many of these participants are depression survivors and concerned about not wasting energy and thus may set their refrigerator temperatures higher than recommended. Also, they may have been taught to let foods cool outside of the refrigerator for long periods of time in order to prevent the ice from melting in the ice box. With modern day refrigerators, these practices are no longer necessary.

For those people working in foodservice establishments such as nursing homes, specific food safety instructions could be incorporated into the standardized recipe in order to remind foodhandlers of the critical steps in which food safety recommendations need to be implemented. Since temperature abuse, or not keeping hot food hot and cold food cold, is the most critical problem in a foodservice establishment, writing specific serving and storage directions on the standardized recipe could enhance foodhandler's awareness of these steps.

In order for educational materials to be useful, others must know about them. Plans are to submit this food safety module to the Nutrition Educational Resource Guide: An Annotated Bibliography of Educational Material for the

WIC and CSF Program (22), as well as to the Journal of Nutrition Education in the section entitled GEMS, which focuses on new educational materials.

Suggestions for Future Research.

There are many other techniques which could be used to target food safety messages to WIC and other pregnant women. First of all, focus groups could be conducted to gain an understanding of the concerns of a particular group of people as well as to learn what would motivate a person in that group to come to a class on food safety. A videotape could be created for WIC participants and played while they are in the waiting room at the WIC center. Food safety tips could be incorporated into other WIC classes such as "Making Your Own Baby Food". Training WIC staff members so that they are a knowledgeable resource when questions arise from WIC participants as well as hanging a poster in their office or waiting room could target this groups. Food safety messages in the media via television, radio, and newspaper with phone numbers of food safety experts that could be contacted is another way for the food safety message to be spread. Grocery stores could also be solicited to hang food safety and storage tips for their consumers next to high risk foods. With a little creativity, there are many educational techniques that can be used to target food safety messages to high risk groups.

V. SUMMARY

Foodborne illness is preventable, yet many cases per year occur in developed and developing countries. The key to the solution is education and filling the knowledge gap between the scientific community and the general public. There are certain groups of people who are at a higher risk for foodborne illness. Consequently food safety educational materials need to be developed for the general public and especially targeted to these high risk groups. The purpose of this study was to develop an interactive module to be used with low income parents and to evaluate its effectiveness with participants of the Special Supplemental Food Program for Women, Infants, and Children (WIC).

The three food safety concepts taught are based on scientific research. An interactive teaching style was chosen which would be applicable for a broad range of people with diverse backgrounds. Instructional strategies of demonstrations, interactive questions, auditory aids and hands-on activitities were incorporated into this teaching style. In 45 minutes, the module which consists of a pretest/posttest, learning objectives, materials needed, script and hand-outs covers the three scientifically-based food safety recommendations. Since low literacy was expected to be a challenge, the words for the script for the module were chosen with that in mind (sixth grade reading level).

Using the module, four classes were taught to a total of 17 WIC participants (6,9,1,1) within three counties in Oregon. The results of the 12-item knowledge test demonstrated an increase in food safety knowledge as well as retention of knowledge after two weeks which was determined to be statistically significant. The results of the self-assessed behavior changes also demonstrated that people were making positive changes in terms of food safety in their own kitchens. The module was also taught to 16 WIC staff members.

Professional assessment demonstrated that it would be easy to use to teach WIC clients.

As determined by the increase in scores on the knowledge test and the retention of knowledge as demonstrated by the two-week follow-up test, as well as the self-assessed behavioral changes, this food safety education module was effective. Recommendations for further module development are to test and teach the module to other groups of people who are at high risk such as the elderly, diabetics, and AIDS patients, as well as adapting it to culturally diverse groups.

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APPENDICES

APPENDIX A

Knowledge Test and Answer Key

Knowledge Test (Pretest/Posttest/Two-Week Follow-Up Test)

WHAT DO YOU THINK?

Example:	It is safe to pack cheese slices for my child's snack at day care.	(YES) NO UNSURE
1.	Symptoms similar to the "24 hour flu" may be caused by something you ate.	YES NO UNSURE
2.	When I am pregnant, I am more resistant to illness than when I am not.	YES NO UNSURE
3.	Smoking a cigarette and then making a sandwich may cause bacteria to be spread.	YES NO UNSURE
4.	A plastic cutting board may be used to cut raw chicken on and then rinsed with water, and then used to cut fresh vegetables on for supper.	YES NO UNSURE
5.	It is safe to eat the leftover Canadian bacon pizza that I forgot in my car last night after dinner.	YES NO UNSURE
6.	Raw milk is safe to buy if I store it in the refrigerator.	YES NO UNSURE
7.	Cooked chicken may be placed on the same plate or pan the raw chicken was on.	YES NO UNSURE
8.	Hamburgers fried quickly until they are rare are safe to eat.	YES NO UNSURE
9.	It is risky to feed honey to my three month old infant.	YES NO UNSURE
10.	A peanut butter and jelly sandwich is a safer choice for my child's brown bag sack lunch than a sliced ham sandwich.	YES NO UNSURE
11.	Chicken that I fry may not always be completely done for some pieces, but it is still safe to eat.	YES NO UNSURE
12.	Old milk left at room temperature from the last feeding is safe for the baby if the bottle of milk is reheated.	YES NO UNSURE

Answer Key for Knowledge Test

WHAT DO YOU THINK?

Example:	It is safe to pack cheese slices for my child's snack at day care.	(YES) NO UNSURE
1.	Symptoms similar to the "24 hour flu" may be caused by something you ate.	(YES) NO UNSURE
2.	When I am pregnant, I am more resistant to illness than when I am not.	YES (NO) UNSURE
3.	Smoking a cigarette and then making a sandwich may cause bacteria to be spread.	(YES) NO UNSURE
4.	A plastic cutting board may be used to cut raw chicken on and then rinsed with water, and then used to cut fresh vegetables on for supper.	YES (NO) UNSURE
5.	It is safe to eat the leftover Canadian bacon pizza that I forgot in my car last night after dinner.	YES (NO) UNSURE
6.	Raw milk is safe to buy if I store it in the refrigerator.	YES (NO) UNSURE
7.	Cooked chicken may be placed on the same plate or pan the raw chicken was on.	YES (NO) UNSURE
8.	Hamburgers fried quickly until they are rare are safe to eat.	YES (NO) UNSURE
9.	It is risky to feed honey to my three month old infant.	(YES) NO UNSURE
10.	A peanut butter and jelly sandwich is a safer choice for my child's brown bag sack lunch than a sliced ham sandwich.	(YES) NO UNSURE
11.	Chicken that I fry may not always be completely done for some pieces, but it is still safe to eat.	YES (NO) UNSURE
12.	Old milk left at room temperature from the last feeding is safe for the baby if the bottle of milk is reheated.	YES (NO) UNSURE

APPENDIX B

Demographic Information on Participants

(ONLY ON THE BACK OF THE POSTTEST)

Thank you for participating in this food safety class.

To help us learn more about our participants, would you please answer these questions.

Please circle the answers that apply to you.

AGE:

Under 30 years of age

30 years or older

EDUCATIONAL ATTAINMENT:

Some High School

High School Graduate

Additional Education - Technical or College

QUESTION:

Do you think that you have ever had foodborne illness?

YES NO

May I call you in 2 weeks to see if you have any questions?_____

Phone number:_____

APPENDIX C

Pre-, Post- and Two-Week Follow-Up Responses of Correct/Incorrect/Unsure to Individual Test Questions

Summary of Individual Pretest Results (n = 17)

	Question	# Correct	# Incorrect	# Unsure
1.	Symptoms similar to the "24 hour flu" may be caused by something you ate.	13	2	2
2.	When I am pregnant, I am more resistant to illness than when I am not.	6	8	3
3.	Smoking a cigarette and then making a sandwich may cause bacteria to be spread.	8	3	6
4.	A plastic cutting board may be used to cut raw chicken on and then rinsed with water, and then used to cut fresh vegetables on for supper.	11	4	2
5.	It is safe to eat the leftover Canadian bacon pizza that I forgot in my car last night after dinner.	17	0	0
6.	Raw milk is safe to buy if I store it in the refrigerator.	6	4	7
7.	Cooked chicken may be placed on the same plate or pan the raw chicken was on.	15	0	2
8.	Hamburgers fried quickly until they are rare are safe to eat.	13	0	4
9.	It is risky to feed honey to my three month old infant.	16	0	1
10.	A peanut butter and jelly sandwich is a safer choice for my child's brown bag sack lunch than a sliced ham sandwich.	17	0	0
11.	Chicken that fry may not always be completely done for some pieces, but is still safe to eat.	14	1	2
12.	Old milk left at room temperature from the last feeding is safe for the baby if the bottle of milk is reheated.	16	0	1

Summary of Individual Posttest Results (n = 17)

	Question	# Correct	# Incorrect	# Unsure
1.	Symptoms similar to the "24 hour flu" may be caused by something you ate.	17	0	0
2.	When I am pregnant, I am more resistant to illness than when I am not.	12	5	0
3.	Smoking a cigarette and then making a sandwich may cause bacteria to be spread.	16	1	0
4.	A plastic cutting board may be used to cut raw chicken on and then rinsed with water, and then used to cut fresh vegetables on for supper.	15	1	1
5.	It is safe to eat the leftover Canadian bacon pizza that I forgot in my car last night after dinner.	16	1	0
6.	Raw milk is safe to buy if I store it in the refrigerator.	15	1	1
7.	Cooked chicken may be placed on the same plate or pan the raw chicken was on.	16	0	1
8.	Hamburgers fried quickly until they are rare are safe to eat.	17	0	0
9.	It is risky to feed honey to my three month old infant.	14	3	0
10.	A peanut butter and jelly sandwich is a safer choice for my child's brown bag sack lunch than a sliced ham sandwich.	17	0	0
11.	Chicken that fry may not always be completely done for some pieces, but is still safe to eat.	16	0	1
12.	Old milk left at room temperature from the last feeding is safe for the baby if the bottle of milk is reheated.	15	2	0

Summary of Individual Two-Week Follow-Up Results (n = 10)

	Question	# Correct	# Incorrect	# Unsure
1.	Symptoms similar to the "24 hour flu" may be caused by something you ate.	10	0	0
2.	When I am pregnant, I am more resistant to illness than when I am not.	7	3	0
3.	Smoking a cigarette and then making a sandwich may cause bacteria to be spread.	9	1	0
4.	A plastic cutting board may be used to cut raw chicken on and then rinsed with water, and then used to cut fresh vegetables on for supper.	8	1	1
5.	It is safe to eat the leftover Canadian bacon pizza that I forgot in my car last night after dinner.	10	0	0
6.	Raw milk is safe to buy if I store it in the refrigerator.	10	0	0
7.	Cooked chicken may be placed on the same plate or pan the raw chicken was on.	9	1	0
8.	Hamburgers fried quickly until they are rare are safe to eat.	10	0	0
9.	It is risky to feed honey to my three month old infant.	10	0	0
10.	A peanut butter and jelly sandwich is a safer choice for my child's brown bag sack lunch than a sliced ham sandwich.	10	0	0
11.	Chicken that fry may not always be completely done for some pieces, but is still safe to eat.	10	0	0
12.	Old milk left at room temperature from the last feeding is safe for the baby if the bottle of milk is reheated.	10	0	0

APPENDIX D

Food Safety Education Module

FOOD SAFETY EDUCATION

MODULE

TABLE OF CONTENTS

Introduction for Instructor

Hello Food Safety Instructor! You have been given a very important job of teaching food safety to WIC participants.

For those of you who are a novice at food safety, this module is easy and fun to use. There is a script you can read as well as instructions on how to incorporate demonstrations and models to teach basic food safety concepts. The items you will need for demonstrations are common household items. This module is designed to be inexpensive to implement. For those of you who are experts in food safety, this module will provide you with demonstration ideas and new ways to teach food safety using an interactive or hands-on approach to learning and teaching. Modify to apply to your clients, i.e. Mexican food, etc.

You are working with a group of people who are at high risk for foodborne illness: pregnant women and infants. This population may develop more severe symptoms than the general population as well as may even die due to the ingestion of bacteria, viruses, and parasites.

The food safety class takes about 45 minutes with plenty of time for questions from your participants. The three teaching concepts are

1. Prevent Cross Contamination
2. Keep Hot Food Hot and Cold Food Cold
3. Cook Foods Well.

The format of the module is set up in a manner that is easy to follow.

Title: Identifies the teaching concept.

Overview: Identifies purpose of teaching the lesson.

Learning Objectives: Identifies what the participant will have learned after the activity.

Things You Will Need: Identifies common household items needed for that particular demonstration.

Key Points: Instructor's summary of that teaching concept.

Script: Guide that may be read/followed for each concept. Words in parentheses indicate expected audience participation. Remember at the beginning of the class to mention that if participants have questions, they should ask them during the lesson and after the lesson.

If the instructor desires, use the pre and posttest.

Good luck and have fun teaching about this very important topic!

IS MY LEFTOVER CANADIAN BACON PIZZA SAFE TO EAT?

Lesson Outline

I. Introduction
- A. What is food safety?
- B. Why is it important to you? - pregnant women and infants
- C. You are in control!

II. Teaching Concepts
- A. Prevent Cross Contamination
  1. Human
     - Safe Personal Habits
     - Hand-Washing - How and When?
     - (Tape recording of sounds)
  2. Kitchen Tools
     - Identify and demonstrate tools needed for cleaning and sanitation. (Tools/Utensils)
     - Wooden cutting board vs. Plastic cutting board
- B. Keep Hot Food Hot and Cold Food Cold
  1. Identify perishable and nonperishable foods (Participants separate food models on the table)
  2. Identify the danger zone (Big thermometer poster)
- C. Cook Foods Well
  1. Why is it important?
  2. When is it done? (Food models)
     - Red meat, chicken, fish, eggs,
     - Raw milk vs. pasteurized
     - Reheating leftovers

III. Summary

IV. Conclusion
- Receive food safety hand out.

I. INTRODUCTION

TITLE: Yes, food safety is important!

OVERVIEW: Motivate. Provide the participant with background information on food safety, the concept that pregnant women and infants are more susceptible to foodborne illness, and an overview of preventive measures that demonstrate we can control foodborne illness and its consequences.

LEARNING OBJECTIVES:

1. Participants will know why food safety is important.
2. Participants will know that pregnant women and infants are more susceptible to foodborne illness.
3. Participants will understand how safe breast feeding is.

THINGS YOU WILL NEED:

Jar of honey
Blackboard/Poster/Flip Chart - 3 food safety rules written
1. Prevent Cross Contamination
2. Keep Cold Food Cold and Hot Food Hot
3. Cook Foods Well

KEY POINTS:

1. Food safety is important.
2. Pregnant women and infants are more susceptible to foodborne illness.
3. Breast feeding has many advantages including that it is safe.

SCRIPT:

Several hours or the day after eating food, have you ever felt sick with symptoms of nausea, upset stomach or diarrhea? How many of you think that something that you ate made you ill at some time? (Hands) You may have diagnosed yourself and said, "Oh, I just have the "24-hour flu". However, these are all signs of illness which can be caused by bacteria or viruses in food. We call these foodborne illnesses. How can you tell by just looking at a piece of food whether you could get foodborne illness? (Answers) Sometimes you can see it, especially with mold for example on bread; however, most of the time you cannot see it, taste it or smell it.

Due to various food safety laws, the food supply in the United States is credited to be among the safest in the world. The major cause of illness from foods is due to carelessness in preparing and storing food in your kitchen. For example, leaving leftovers out too long or handling ready-to-eat foods after raw meats.

How many of you have pets? (Hands) Did you know that not washing your hands after petting your pets or cleaning their space and then preparing a meal is another way that foodborne illness can be spread? If certain precautions are not followed, bacteria, viruses, and parasites can cause illness.

There are so many things to worry about as a mother that you may wonder how important is food safety. Does it really matter?

Though everyone is at risk for foodborne illness, there are certain groups of people which are at a higher risk. They can develop more severe symptoms as well as can die. These high risk groups are pregnant women, infants, the frail elderly, and severely ill people, such as cancer and AIDS patients.

Why are pregnant women more at risk for foodborne illness? If a pregnant women develops foodborne illness, she may have an upset stomach and diarrhea as well as cramps. In addition her unborn baby will also feel the illness, but to a larger degree. Since the unborn baby does not have a developed immune system, he/she is more helpless in fighting illnesses. In some extreme cases, for example, Listeria in foods which have been eaten have caused stillbirths and spontaneous abortions. It is also recommended that a pregnant woman does not change the cat litter box to prevent the spread of the parasite Toxoplasma and thus causing toxoplasmosis.

Because young infants, especially those under one year of age, also do not have a fully developed immune system, they too are more vulnerable to foodborne illness. You may have heard that you should not feed your infant honey. The reason is that Clostridium botulinum spores may be able to germinate in the infant's intestine and cause botulism.

Consequently, I think you can see "Yes, it is important for a mother to follow food safety rules," especially for herself during pregnancy as well as for her children.

Now that you see how important food safety is in preventing illness, let us look at some of the ways that you can control the safety of what you and your family eats. You are in control.

Breast feeding has many advantages. In addition to being a good healthy source of nutrients, it also has food safety and sanitation advantages. For example, it is ready when your baby is ready so there is no need to worry whether the milk has been out of the refrigerator for too long. Also, there is no need to worry about boiling the bottle or nipple to sterilize them. In addition, it is cheap!

There are three simple rules that are easy to learn and use in your own kitchen that can prevent the spread of foodborne illness. I want to be realistic and tell you that if you do not follow these rules you will not necessarily get

foodborne illness, but by following these rules you will definitely decrease your risk.

Questions? (Allow time to answer. If they will be answered in the next section, say so.)

The rules are prevent cross contamination, keep cold food cold and hot food hot, and cook foods well. (Point to poster) Can you do these?

Let us now do some activities and explore each of these rules, so that you can see you <u>are</u> in control.

II. Teaching Concepts

TITLE: (A1) You are in control of preventing cross contamination.

OVERVIEW: Preventive measures of human contamination are the focus with information on how and when to wash one's hands.

LEARNING OBJECTIVES:

1. Participants will know why it is important to wash their hands.
2. Participants will be able to wash their hands with soapy water effectively.
3. Participants will know times when it is especially important to wash their hands.

THINGS YOU WILL NEED:

1. Agar plates which were contaminated by a sneeze or hands and incubated. (The sanitarian in the local health department can provide information on securing these.)
2. Water in a tub (large enough to wash hands), soap, paper towels
3. Tape recorder
4. Cassette tape with sounds recorded
   after diapering the baby (baby crying), after flushing the toilet (toilet flushing) after playing with the dog (dog barking), and before cooking (pans clanging)
5. Cigarette

KEY POINTS:

1. 20-second rule of hand washing for effectiveness.
2. Importance of washing hands after using the toilet, diapering the baby, smoking, petting the dog and before cooking.

SCRIPT:

You may wonder why is hand-washing stressed so much in preventing contamination. You may also say, I know how to wash my hands and I am not a surgeon going into surgery. However, the importance of hand washing can never be overemphasized when our focus is food safety and preventing disease.

Here is an agar plate that I made 1 week ago with bacteria from my hands after a normal day's activities. If I made supper, with hands that look like

this, imagine all of the bacteria that could potentially infect me and my family and cause disease. (Show agar plate - pass it around)

Let me demonstrate the proper way to wash our hands with soap and water. The important part is to scrub long enough to remove most of the bacteria and viruses. How long is long enough? I am going to start scrubbing. Please count with me. When you think enough time has gone by and my hands are clean enough, stop counting. 1,2,3,.....20. (Wash hands) Even after washing, hands are a source of bacteria, so handle food as little as possible. For example, if you are tempted to mix your potato salad with your hands, stop, use a mixing spoon.

There are certain activities that it is especially important to wash your hands after. Let us listen to a tape recording of these activities. What are some other activities you can think of? (Discussion - Add washing children's hands before eating) (Demonstrate with cigarette.)

When you are at home, preparing food, remember the importance of washing your hands and the 20-second rule.

Questions?

TITLE: (A2) You are in control of preventing cross contamination.

OVERVIEW: You can equip yourself with utensils and tools in order to clean and sanitize properly.

LEARNING OBJECTIVES:

1. Participants will know what cross contamination means.
2. Participants will know what surfaces can become contaminated.
3. Participants will know what tools are needed for cleaning and sanitation.
4. Participants will know how to prevent cross contamination.

THINGS YOU WILL NEED:

Dry towels (2)
Paper towels
Plastic cutting board, knife
Food models, chicken, apple (Plastic food models can be ordered through NASCO, P.O. 3837, Modesto, CA 95352 or call 1-800-558-9595. Pictures of foods could also be used. Call your state Dairy Council.)
Cleaning cloth, dishwashing soap
Wire scrubber, SOS pad
Tub of water, Chlorox plus lid (1 tablespoon)
Spray bottle
Wooden cutting board
Tapioca pudding colored with green food coloring, spoon, cloth, water, dry towel
2 plates, raw chicken model, cooked chicken model, tongs

KEY POINTS:

1. Cross contamination between foods, especially raw meat and poultry to fresh vegetables or other ready-to-eat foods, is a major problem.
2. Surfaces can become contaminated with the juices from raw meat and poultry.
3. Tools used for cleaning and sanitation include soap and water and a diluted bleach solution.

SCRIPT:

How many of you have heard of cross contamination? (Hands) Cross contamination is caused by bacteria or viruses from one place being transmitted to another place. What can be carriers of bacteria and viruses? From our previous demonstration, we saw that hands can be a major carrier of disease-causing microorganisms. If you diaper the baby and then make a sandwich for lunch, without washing your hands, you can easily cross contaminate the food.

Another potential source of microorganisms are kitchen towels. Do you use the same towel to dry your hands and dry your dishes? Use 2 different dish towels to help prevent bacteria from being spread. (Show two towels) Better yet, dry your hands with a paper towel and dispose of it. Let dishes and glasses air dry.

Utensils and cutting surfaces can also be another source of bacteria. How can that be? Well, imagine you are preparing chicken stir-fry for dinner tonight. First of all, you cut up the chicken into cubes with a knife on a cutting board. (Use chicken food model and knife and pretend to cut it on the cutting board.) Then you decide to make a fruit salad for dessert. (Apple) You use the same knife and cutting board. You are at a large risk for foodborne illness. Why? (Answers)

First of all the juices and bacteria from the chicken are on the knife and the cutting board. Cooking the chicken well will prevent you from getting foodborne illness from the chicken. However, the fruit salad will not be cooked. The bacteria from the chicken has been carried to the fruit salad via the knife and the cutting board. What could you do instead? (Answers) In this situation, you may decide to cut the fruit first and then the chicken and then thoroughly clean and sanitize both the knife and the cutting board. Or you may decide to cut the chicken and then thoroughly clean and sanitize before you cut the fruit. Or you may have two cutting boards, one for raw meats and one for fruits and vegetables and other prepared foods.

In the last couple of statements you may have heard me say clean and sanitize these cutting boards. What is the difference? Cleaning and sanitizing is actually a two step process. How do we thoroughly clean and sanitize? Cleaning is the first step. Here we use soapy water and a cloth to remove the major debris from the surface. We could also use a wire scrubber or an SOS pad. The second step sanitizing involves using a diluted chloride solution to kill the bacteria and viruses. I will be using Chlorox today but any brand could be used. To clean kitchen surfaces, a ratio of 3 tablespoons to one gallon of lukewarm water is recommended. I measured the amount of Chlorox in one capful and it was exactly 1 Tablespoon. So for 1 gallon of water, which is 4 quarts or 16 cups, you would add 3 capfuls of Chlorox for your diluted bleach solution (Demonstrate 3 capfuls per gallon) Since Chlorox can be toxic if not diluted properly, remember to safely store it on a high shelf so that little ones

cannot get to it. Now, I will sanitize the surface of the bread board with this solution. At my home, I have a spray bottle with this solution already made up that is simple to grab and sanitize surfaces after I use them. (Demonstrate)

Dishwashers have both the cleaning and sanitation steps.

In addition to other surfaces, cutting boards can cause cross contamination to occur. Wooden cutting boards are the worst. Have you ever heard, never use a wooden cutting board to cut chicken on? (Hands) Why are wooden cutting boards the culprits and not plastic ones? Let us take a look. Here is a visual example to help you remember. I have here an old wooden cutting board with a lot of deep cracks and a plastic board. (Demonstrate) I will rub this green tapioca on each of these boards. Imagine that this is the juice from the raw chicken. Now I will wipe it off. You can see that some of the granules are stuck in the wooden cutting board. Bacteria and viruses are much smaller than these granules. If these granules can get stuck, just imagine how those germs can adhere and grow and spread to other foods when you use the cutting board again. Regardless, if you thoroughly clean and sanitize, wooden cutting boards can still hold germs in its cracks. It is Ok to use a wooden cutting board for some food items, such as fruits and vegetables and prepared foods. However, it is often a good idea to have 2 different cutting boards, one for raw meat and poultry and one for ready-to-eat products.

Serving plates can also be a carrier of bacteria and viruses. Let us pretend that you are grilling chicken outside on your grill. You take your raw chicken out to the grill on a plate and carry your barbecued chicken in on the same plate. You again are putting yourself at great risk for foodborne illness. Why? (Answers) What could you do differently? You could use two different plates. (Demonstrate - use tongs to remove cooked chicken) Make sure that you use a clean plate to carry your grilled chicken on.

Questions?

Though cross contamination can occur, I think you can see there are many ways that we can combat those bacteria and viruses and prevent cross contamination.

TITLE: (B1) You can control the temperature of your foods.

OVERVIEW: Perishable foods have bacterial growth at room temperature.

LEARNING OBJECTIVES:

1. Participants will identify perishable foods.
2. Participants will be able to separate perishable from nonperishable foods and place them in their appropriate storage locations.

THINGS YOU WILL NEED:

Food models or pictures of foods:

Perishable foods at risk of causing foodborne illness.
meats/alt. - meat, fish, poultry, bean dip, hard-cooked eggs
milk and milk products - milk, tofu, leftovers in baby bottle
breads/cereals - cooked rice
vegetables - cooked vegetables, tomato vegetable soup
combination foods - macaroni and cheese, pizza, potato salad

Nonperishable foods
meats/alt. - peanut butter, dried legumes
milk and milk products - nonfat dry milk, aged cheese
breads/cereals - cereal, bread, flour, dry rice
fruits/vegetables - raisins, orange, banana

Cardboard Signs to set on tables
3 = Refrigerator
3 = Table top/Counter

Set-up
Put a variety of perishable and nonperishable foods on a tray. Set-up enough trays so that people can work in groups of three or four in separating the foods that should go in the refrigerator (perishable foods) and the foods that can be stored on the counter (nonperishable foods). When the time in the script comes, put a tray on each table so that it is easily accessible for three or four people to work together on it.

KEY POINTS:

1. Perishable foods have a shorter shelf life than nonperishable foods.
2. Keep perishable foods in the refrigerator or freezer or hot in order to decrease bacteria growth.

SCRIPT:

What does grocery shopping, going on a picnic, serving food for a party, and packing food for your child's sack lunch all have in common? These are all occasions in which you may accidentally leave perishable foods out of the refrigerator for too long. Perishable foods are foods which do not keep for a long time out of the refrigerator or freezer without bacteria multiplying. Perishable foods should not be kept out of the refrigerator for more than 2 hours. This is also known as the 2 hour rule.

As we examine some of the food items, picture yourself grocery shopping or going on a picnic or serving food for a party or packing food for your child's sack lunch. What items would be safe to leave out more than 2 hours and what foods wouldn't be? Let me show you some models of foods that are perishable and nonperishable and then you will have a chance to get up and test your knowledge of perishable and nonperishable foods. (Demonstrate)

(Distribute trays and follow instructions in the set-up procedure). After a few minutes, discuss with the group as a whole which foods were perishable and which foods were nonperishable.

Questions?

I think that you now are all good at separating perishable from nonperishable foods and can understand another way you have to control foodborne illness.

TITLE: (B2) You can keep hot food hot and cold food cold.

OVERVIEW: Perishable foods left in the danger zone too long can cause bacteria to multiply to disease causing levels.

LEARNING OBJECTIVES:

1. Participants will know what the danger zone is.
2. Participants will understand how bacteria can multiply in the danger zone.
3. Participants will know why hot foods should be kept hot and cold foods cold.

THINGS YOU WILL NEED:

Thermometer Poster
Bread, one slice
knife, plate
Ice chest, shallow containers

KEY POINTS:

1. The danger zone is a range of temperatures from 40°F to 140°F in which bacteria can multiply.
2. There are many ways to keep hot food hot and cold food cold.

SCRIPT:

What do you think is the biggest cause of foodborne illness in the United States? (Answers) It is temperature abuse. This means that hot foods have not been kept hot and cold foods have not been kept cold.

The danger zone is a range of temperature from 40°F to 140°F or from 4.4°C to 60°C. What temperature is room temperature? (Answers) That falls right in the center of the danger zone. If you leave perishable foods out on the counter for longer than two hours you are putting yourself at great risk for foodborne illness. There is a margin of safety but in this range bacteria can multiply quickly in perishable foods. Remember which foods were perishable from your last exercise. (Thermometer poster)

Why is the danger zone so critical? Let me demonstrate this point. In the danger zone even though you cannot see it, bacteria are increasing in number. They can double and even quadruple in 15 to 30 minutes. Imagine that this whole piece of bread is one bacterium. When this one bacterium

divides we get two, when these two divide we get 4 bacteria and so on. I could keep cutting until all we had were crumbs. Bacteria divide in this way. Well, I think you get the point that bacteria in food can grow and increase in number if they are in the danger zone for too long.

I brought some everyday examples of how we can keep foods out of this danger zone, above 140°F or below 40°F. Let us look at some ways to keep hot foods hot and cold foods cold.

First of all, when you go shopping, make the grocery store the last stop. This way foods that you buy will probably not be in the danger zone longer than 2 hours.

When you are done eating, put the leftovers in the refrigerator or freezer as soon as possible. Do not leave foods that are perishable out for an afternoon snack on the counter top. If there is a very large amount, put the leftovers in shallow containers so that the foods will cool faster. (Demonstrate)

If you are packing a picnic, pack your food items in an ice chest to keep them cold or bring them slightly frozen.

Questions?

I think you can see there are many ways to help prevent foods from being in the danger zone for more than 2 hours.

TITLE: (C1) You can cook foods well.

OVERVIEW: Cooking food well is important in order to kill bacteria, viruses, and parasites.

LEARNING OBJECTIVES:

1. Participants will learn why it is important to cook foods well.
2. Participants can identify cooking end points of various foods.

THINGS YOU WILL NEED:

Food models or pictures of food:
Meats/Meat alternatives: red meat, chicken, fish, eggs (egg carton)
Milk/Milk products: raw milk carton, unpasteurized, if your state permits its sale
regular milk carton, pasteurized

KEY POINTS:

1. Adequate cooking is important to kill bacteria and viruses.
2. People at higher risk of foodborne illness should only eat foods which have been cooked well.

SCRIPT:

What is wrong with eating rare hamburgers right off the grill? What is wrong with drinking raw (unpasteurized) milk? What is wrong with drinking homemade egg nog?

All of these items have been inadequately cooked and thus it would be hazardous for you to eat them. Inadequate cooking contributes to foodborne illness because foods are often contaminated with bacteria or viruses. All foods must then be heated to the temperature and for a long enough time to kill these bacteria or viruses. People at higher risk of foodborne illness, which as you probably recall include pregnant women and infants, should only eat foods which have been cooked well.

1. Milk should go through a pasteurization process which kills bacteria and viruses. (Show two cartons of milk one that says pasteurized and one that says raw.) Explain the difference. (Pass the cartons around.) (If your state does not allow the sale of raw milk and your participants do not use farm milk, skip this one.)

2. How do you know when each of these food items are done? (Show specific food model with each cooking recommendation.)

a. Hamburger should be well cooked so that it is medium-brown inside. Push on the top and the juices that run out should be clear. Also, it should be firm.

b. Chicken should be cooked so that when it is poked with a fork the juices that run out look clear and not pink.

c. Fish should be cooked until it flakes with a fork.

d. Eggs should be cooked until they are firm not runny. In order not to make the white too done, cook them at a lower temperature for a longer period of time. If the egg is cracked from the carton, do not use it for frying. It is still safe to use if you use it in a fully baked product.

e. Reheated leftovers should be heated to boiling. It is a common practice for people to warm rather than to reboil leftovers; however, this does not kill the pathogens. Consequently, leftovers should be reheated until they boil.

Questions?

Cooking foods well is also another way to prevent foodborne illness.

III. Summary

TITLE: An interactive summary of the food safety concepts

OVERVIEW: Introduction and three concepts will be reviewed.

LEARNING OBJECTIVES:

1. Participants will be able to review their knowledge.

THINGS YOU WILL NEED:

Poster of main points
Food models or pictures and props used earlier

KEY POINTS:

1. Prevent cross contamination.
2. Keep hot food hot and cold food cold.
3. Cook foods well.

SCRIPT:

Even though you are conscientious mothers with many things to do, I think you can see how important food safety is not only for yourself but also for your children. Much serious illness and death and many dollars spent on health care and sick leave can be prevented if a few rules are followed.

Even if these three rules are not followed, you will not necessarily get foodborne illness; however, if you do follow these three simple rules you will be reducing your risk. Also <u>you</u> may be part of the high risk groups or have small children who are more susceptible to foodborne illness.

Let us review our three rules. Prevent cross-contamination, keep hot foods hot and cold foods cold, and cook your foods well. (Poster.)

Prevent cross contamination:

1. How long should you wash your and your children's hands? (Answers.) 20 seconds.
2. After what activities is it especially important to wash your hands? (Answers.)
   Even after washing your hands, they can still be a source of bacteria and viruses. If possible, use mixing or serving utensils instead of your hands.
3. What in your kitchen could cause cross contamination? (Answers.) Cutting boards, plates....

Keep hot food hot and cold food cold:

1. What foods are perishable? (Answers.) Baked potatoes, tofu...
2. What temperature range is the danger zone?
   40°F - 140°F or 4.4°C - 60°C
3. What happens when perishable foods are in the danger zone for too long? (Answers.) The bacteria multiply.
4. How long is too long? (Answers.) Over 2 hours

Cook food well:

1. How do you know when your hamburger is done? (Answers.)
2. Will you buy unpasteurized or raw milk? (Answers.) No.

As you think about these points, are there some things you think you will do differently now? (Discussion time for questions.)

Yes, food safety is important and you now have the knowledge and tools to control and prevent foodborne illness for you and your family.

Conclusion

Distribute a hand-out on food safety for people to take home with them. This is an excellent way for participants to review what they know and a place for them to refer to when teaching other family members about food safety.

The Food and Drug Administration designed a publication for low literacy audiences with many excellent visuals. For your food safety class feel free to order multiple copies for free. Call (1-800-535-4555) and ask for the publication:

> Keep Your Food Safe. FDA Publication. FDA 91-2234. USDA and USDDHS, February, 1991.

The hand-out at the end of this script has been designed by the Oregon State University Extension Service. You may duplicate this "refrigerator chart" to distribute to your participants.

WHAT DO YOU THINK?

Example:	It is safe to pack cheese slices for my child's snack at day care.	(YES) NO UNSURE
1.	Symptoms similar to the "24 hour flu" may be caused by something you ate.	YES NO UNSURE
2.	When I am pregnant, I am more resistant to illness than when I am not.	YES NO UNSURE
3.	Smoking a cigarette and then making a sandwich may cause bacteria to be spread.	YES NO UNSURE
4.	A plastic cutting board may be used to cut raw chicken on and then rinsed with water, and then used to cut fresh vegetables on for supper.	YES NO UNSURE
5.	It is safe to eat the leftover Canadian bacon pizza that I forgot in my car last night after dinner.	YES NO UNSURE
6.	Raw milk is safe to drink if I store it in the refrigerator.	YES NO UNSURE
7.	Cooked chicken may be placed on the same plate or pan the raw chicken was on.	YES NO UNSURE
8.	Hamburgers fried quickly until they are rare are safe to eat.	YES NO UNSURE
9.	It is risky to feed honey to my three month old infant.	YES NO UNSURE
10.	A peanut butter and jelly sandwich is a safer choice for my child's brown bag sack lunch than a sliced ham sandwich.	YES NO UNSURE
11.	Chicken that I fry may not always be completely done for some pieces, but it is still safe to eat.	YES NO UNSURE
12.	Old milk left at room temperature from the last feeding is safe for the baby if the bottle of milk is reheated.	YES NO UNSURE

Pretest/Posttest Answer Key

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1.	Symptoms similar to the "24 hour flu" may be caused by something you ate.	(YES) NO UNSURE
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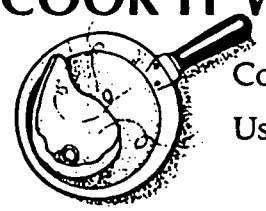
PREVENT FOOD POISONING!

KEEP IT CLEAN

Wash hands with soap and water before handling food — especially after using the toilet.

Wash utensils, cutting boards, and hands after handling raw meat, poultry, seafood, and eggs.

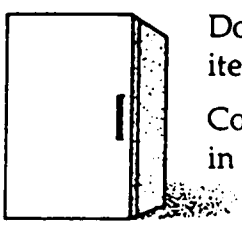
COOK IT WELL



Cook meat, poultry, seafood, and eggs thoroughly.

Use pasteurized milk.

DON'T WAIT...REFRIGERATE



Don't leave perishable foods (such as leftovers and deli items) at room temperature longer than 2 to 3 hours.

Cool soups and stews quickly by refrigerating them in shallow pans.

IF IN DOUBT...THROW IT OUT

Throw out any food that may be unsafe...especially if it will be eaten by people who are more likely to get food poisoning:

- pregnant women
- infants and young children
- frail elderly
- cancer and AIDS patients.

For more information, contact your county Extension Office.

OREGON STATE UNIVERSITY EXTENSION SERVICE

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