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Effect of Food Safety Training on Food Safety Behaviors and Microbial Findings in Texas Childcare Centers

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Effect of Food Safety Training on Food Safety Behaviors and Microbial Findings in Texas Childcare Centers

by

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Dedication

To My Father:

Edward J. Staskel

Without you this would not have been possible.

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”It is not through effort alone that I am who and what I am. That would be impossible. It is by the grace of God.” –Maya Angelou

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Effect of Food Safety Training on Food Safety Behaviors and Microbial Findings in Texas Childcare Centers

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Research has demonstrated a relationship between inadequate childcare center sanitation and illnesses in children. Limited research is available regarding food safety training in childcare centers. The objectives of this research project conducted in a sample of Texas childcare centers was to: 1) assess the sanitation level of food contact surfaces and areas of potential cross-contamination by recovery and identification of selected enteric, gram-negative bacteria; 2) to evaluate food safety attitudes, knowledge, and behaviors of cooks in childcare centers; and 3) to evaluate the effect of a food safety training class on the microbial findings and the food safety behaviors of cooks. Validated instruments were used to collect data on attitudes, behaviors, and knowledge of foodservice personnel in 35 childcare centers. Baseline attitudinal data demonstrated 100% of foodservice personnel agreed or strongly agreed that food safety was part of their responsibilities and food safety education is important. Baseline knowledge test scores ranged 40% to 90% (mean = 70.97%) with 50% achieving a passing score.

Baseline (visit 1) and 12 month follow-up (visit2) site visits were made to collect microbial data on six foodservice surfaces and to observe food safety behaviors. Baseline microbial results showed 41% percent (68 of 167) of total swab samples collected tested positive for bacteria. Twenty-seven different types of bacteria were identified from positive swab samples. Most of the bacteria found are considered opportunistic pathogens which can pose serious health risks to those with compromised immune systems, such as young children. Intervention included a food safety class which was attended by 47% of the centers. Attendance did not significantly affect the food safety assessment scores from visit 1 to visit 2. Use of thermometers, properly labeling foods, hand washing, and recording of refrigerator temperatures all decreased by visit 2. Bacterial species numbers were greater by visit 2 on garbage can lids, food carts, and refrigerator handles. This study confirmed an overall lack of compliance with food safety standards and the need for continual food safety training and stronger standards for childcare centers.

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Chapter 1: Introduction

THE CHALLENGE OF FOOD SAFETY IN CHILDCARE

Over six million children live in Texas and almost one-third are age five or under (1, 2). Three out of five children under age six are cared for by someone other than their parents on a regular basis (3). In 2004, 56.5% of children less than six years of age had all parents working outside the home (1). Many parents rely on some form of non-relative childcare while they work (4). Children are one of the most vulnerable segments of our population and experience a disproportionately high rate of enteric disease, and they are more likely than adults to acquire foodborne illnesses and suffer long-long term consequences (5). Children do not have a role in purchasing or preparing food so it is the responsibility of parents and caregivers to ensure food is as safe and nutritious as possible (5, 7). Unlike restaurants, foodservice is only a part of the services offered in childcare centers and fewer resources are available for use on issues of food safety (8). Childcare center directors have many types of rules and regulations to follow apart from those imposed by the local health department. Grubb (9) found that only 5% of 15,000 childcare centers surveyed in Texas were in full compliance with state health and safety regulations. The lack of adequate training in food safety and compliance with regulations can greatly increase the risk for illnesses for children in childcare centers.

CHILDCARE STANDARDS

No universal food safety standards exist for childcare. Each state is responsible for the establishment and enforcement of its own food safety standards. The standards for food safety in childcare centers differ greatly, not only from state to state, but also from county to county. The standards for one childcare center in Texas may differ from another center in close proximity, if they happen to fall under different county jurisdictions. The health department of each county in Texas is responsible for setting and monitoring the health codes for the centers in that county. There are 254 counties in Texas, many without a local health department. If the county does not have its own local health department, the burden falls on the state health department to inspect all of the childcare centers.

The Williamson County Health Department requires each person handling food in a childcare center to have a Food Handler's Card (10). In Travis County the local health department requires that one person in each center has a Certified Food Manager's (CFM) Card (11), but that person does not have to be involved in food service. The center director often holds the CFM certification because of the high turn-over rate of staff in most centers. This means that the person who is most responsible for the safety of the foods the children receive may not have any food safety training. In a recent study by Enke, *et al*. childcare center directors reported that when the foodservice employee could not come to work, the director (65%), a teacher (34%), hired substitute (12%), aide (10%), or other individual (35%) would fill in (12). This person may or may not have any food safety training.

RESEARCH OBJECTIVES

The lack of food safety studies in childcare centers along with the continued plague of foodborne outbreaks emphasize the need for research documenting the extent of the problem and an intervention aimed at reducing the risks.

The objectives of this research project conducted in a sample of Texas childcare centers were to 1) assess the sanitation level of food contact surfaces and areas of potential cross-contamination by recovery and identification of selected enteric, gram-negative bacteria; 2) to evaluate food safety attitudes, knowledge, and behaviors of cooks in childcare centers; and 3) to evaluate the effect of a food safety training class on the microbial findings and the food safety behaviors of cooks.

Chapter 2: Review of Literature

FOOD SAFETY AND FOODBORNE ILLNESSES

According to the United States Government Accountability Office, safety regulation of the U. S. food supply is shared among approximately 15 separate federal agencies (13). The United States Department of Agriculture (USDA) and the Food and Drug Administration (FDA) assumes the majority of oversight responsibilities (13). The USDA monitors meat, poultry, and some egg products and the FDA regulates the safety of all other foods, including seafood, and fruits, vegetables shelled eggs, and dairy products (13, 14). The FDA food code is the model states follow when creating and updating their own food codes (15). States also include their own statutes, regulations, and agencies for regulating and inspecting the safety and quality of food products (15).

The United States has a food supply that is regarded as possibly the safest in the world (13, 16). The food supply in the United States and in many other developed countries has experienced dramatic changes over the last few decades (17). Food is no longer commonly procured from small, local farms and dairies. Food is often grown and raised in conglomerate farms and transported across the county and the globe. Today the average consumer relies on "fast foods" and convenience foods more than any other time in history. This translates to less control over how the foods they consume and share with others are handled and prepared. Instead of a small batch of locally-prepared, contaminated food sickening a small number of people, the current system of mass food production means many more people are likely to become ill and the source may be more difficult to trace (18). Many highly-publicized foodborne disease outbreaks highlight the increased risks of foodborne illnesses and the need for a change in which food is

produced, processed, and prepared to keep it safe (19-27). A poignant example is the recent nation-wide outbreak of Escherichia coli O157:H7 in fresh spinach which, to date, has resulted in 199 reported, confirmed cases of illness, including 31 cases of Hemolytic Uremic Syndrome (HUS), 102 hospitalizations and three deaths (28).

Reporting of foodborne illnesses in the United States began more than 50 years ago (29). State health officers were concerned about the high morbidity and mortality caused by typhoid fever and infantile diarrhea and suggested that cases of "enteric fever" be examined and reported (29). Information was acquired regarding the role of food, milk, and water in outbreaks of gastrointestinal illnesses which led to the enactment of important public health measures that greatly decreased the occurrence of foodborne illnesses (29).

Today, more than 250 known diseases are transmitted through food (30). Foodborne diseases can be caused by many different pathogens, including viruses, bacteria, parasites, and prions. In 2004, the CDC reported 1,319 disease outbreaks, up from 1,073 reported outbreaks in 2003, with the majority of them being caused by bacterial pathogens (31). The CDC reported that in 2004, bacteria were responsible for 40% of the reported foodborne illness outbreaks and 34% of the reported foodborne illness cases of known etiology (31). Part of the increase in the incidence of foodborne illnesses has resulted from the improved ability to identify microorganisms and recognize the signs and symptoms of the illnesses they cause along with improvements in foodborne illness reporting and tracking. Microorganisms are highly adaptive and more virulent strains are regularly emerging. The mass production and distribution of food, the overuse and misuse of antibiotics, along with many other factors in modern society has lead to the increase in dangerous pathogens in our food and our environment (32).

Foodborne illnesses present a significant public health burden in the United States (33). CDC estimates that approximately one in every four persons in the United States experience foodborne illnesses each year (33). The symptoms of foodborne illness range from mild gastroenteritis to life-threatening neurological, hepatic, and renal syndromes (34). The Food and Drug administration estimates that about two to three percent of all food poisoning cases lead to secondary long-term illness such as arthritis, kidney failure, meningitis, and Guillain-Barré syndrome (35). Hospitalizations due to foodborne illnesses are estimated to cost over $3 billion each year with an additional yearly cost of $20-$40 billion in lost worker productivity. Due to the serious ramification of foodborne diseases the United States government has developed National Health Objectives for Healthy People 2010 which cite specific goals for reducing foodborne illnesses (36).

Risk perception is a significant motivator of human behavior (37). Usually a higher perception of risk motivates behavioral changes, unless one feels there is little they can do to decrease the risk (37-39). The foodborne illness risk perception of many Americans is low in spite of evidence to the contrary (37, 40).

Research shows that among American adults, food safety compliance is limited (41-46). A study by Cody, et al. assessed the food safety knowledge and practices of a sample of persons responsible for the majority of home meal preparation in the United States (N=1,006) (47). Respondents did not think it was common for people in the US to get sick from home-prepared food (70%), and most did not associate symptoms (nausea, fever, chills) with food prepared at home (60%) (47). In this study, 35% of respondents claimed to know the safe internal temperature for cooking ground beef but only 9% were able to state the correct temperature (47).

FOODBORNE ILLNESSES IN CHILDREN

While no one is immune to acquiring a foodborne illness, certain groups are considered to be at a higher risk and can suffer more severe consequences (32, 48). These groups represent approximately 20% of the general population and include children, the elderly, pregnant women, and persons with compromised immune systems (49).

Children are an especially vulnerable segment of our population (50). Statistics show that children less than 10 years of age experience one-third of all the foodborne illnesses in the United States and a disproportionate number of enteric bacterial infections occur in children under the age of 5 (51, 52). Children consume more food in relation to their body weight then adults and a smaller amount of the pathogen will make them ill. Also, the gut flora of young children is not able to protect them as effectively and they lack a fully-developed immune system to fight the illness once infected. A study by Olowokure et al. found that very young children (0-4 years of age) experienced the highest hospital admission rates for infectious intestinal disease (53, 54). It is estimated that children under the age of five experience an average of 1.4 to 2.5 episodes of foodborne illness per year (55-57). Persons in institutional settings are also more likely to experience foodborne illnesses, which places children attending childcare centers at an even greater risk (30, 51, 58).

FOOD SAFETY IN CHILDCARE

In 2002, 11.6 million preschool children were regularly cared for by someone other than their parents (4). Almost one-fourth of these children were cared for by an organized facility, most often a childcare center (4). Research shows that infants and toddlers attending childcare centers have a 2.2-3.5 time higher rates of gastrointestinal

infections then same-aged children cared for at home (59). Most childcare centers have a home kitchen environment to prepare meals and snacks for children (60). Foodservice workers will generally follow the same practices at work that they do at home (61, 62). Many childcare center employees are not adequately trained to keep food safe and prevent foodborne illnesses (63). In addition, most of the centers have only one foodservice person who often helps teachers and cares for children as part of her/his workday. Limited space, personnel, equipment, and funding for foodservice can contribute to food safety problems, placing children at undue health risks.

Recent research reveals foodservice surfaces in childcare settings are prone to bacterial contamination (64, 65). Bacterial biofilms, which are defined as communities of bacteria in hydrated polymeric matrices that attach to surfaces, are found in most foodservice environments and are resistant to antimicrobial agents, increasing sanitation challenges (66, 67). Several studies have demonstrated the relationship among inadequate sanitation and illnesses in the children, staff, and families of those involved in childcare (59, 65, 68-73). Contaminated hands and moist sites (such as faucets and sinks) have been shown to be common areas of infection (74) and significantly predict diarrheal illnesses among children younger than 3 years of age (69). A sick child can affect the health of the family and the other children in the childcare center (70). Givon-Lai found that microorganisms spread from infected children to parents, siblings, relatives and into the community (75). Children needing to stay home from childcare can become an economic challenge for families. The United States Department of Agriculture Economic Research Service estimates that the total cost of foodborne illness is seven billion dollars a year due to medical costs and lost productivity (33).

Food safety can be defined as "controlling or eliminating hazards that might contaminate food and cause foodborne illnesses" (76). Improper food handling is one of

the most common causes of foodborne diseases (35, 41, 48). Common foodborne illness risk factors at the food preparation stage have been identified as poor holding temperatures, poor personal hygiene, and inadequate cooking (74). A study by Bermudes-Millan, et al. on the food safety knowledge, attitude, and behaviors of caretakers of young children (N=100) observed that only 10% of subjects washed their hands before preparing food, even though 97% of them reported doing so (77). Also, 96% of subjects did not use a thermometer to check if meats were cooked properly and 71% used the same cutting board for meats and vegetables (77).

The National Institutes of Health estimate that nearly half of all cases of foodborne illness could be eliminated if people would wash their hands more often when preparing and handling food (78). Frequent, proper handwashing is one of the most effective means of preventing the spread of bacteria (79-85). Alcohol-based hand gel sanitizers can be used after proper hand washing in foodservice to effectively reduce infectious foodborne pathogens on hands (83, 86). Disposable gloves aid in improving food safety when worn and changed often during food preparation and service (87). A study by Montville, et al. investigated bacterial transfer rates through foodservice quality gloves and found that bacterial transfer rate was 0.01% from food to hands and from hands to food when gloves were worn and 10% without gloves (87). A study by Chen, et al. examining the bacterial transfer rates between hands and other common household surfaces involved in food preparation in the kitchen found that rates are highly variable, as low as 0.00005% to 100% (74). The average transfer rates, in descending order, were chicken to hand, cutting board to lettuce, spigot to hand, hand to lettuce, hand washing efficiency, and hand to spigot (74). Disinfection of kitchen surfaces during food preparation also is recommended to reduce the risk of foodborne illnesses and cross-contamination (88, 89).

MICROBIAL TESTING OF FOODSERVICE SURFACES

Bacterial foodborne infection is a common cause of gastroenteritis (90). Members of the family Enterobacteriaceae are the cause of many enteric illnesses as well as septicemia and urinary tract infections (91). Enterobacteriaceae account for 38% of the total number of illnesses, 33% of the hospitalizations, and 36% of the deaths due to bacterial foodborne illnesses yearly in the United States (34). Enterobacteriaceae are most commonly found in the intestinal tract of humans and animals. Food contact surfaces could become contaminated through contact with raw materials, equipment, workers, pests, waste, transfer from other unsanitary surfaces, and production practices (92).

A study by Sneed, et al. assessed microbiological counts of food contact surfaces (work tables/counters; cooking equipment such as mixing bowls and cutting boards; refrigerator or freezer handles) in assisted-living foodservice operations (n=40) to determine effectiveness of cleaning and sanitation procedures (93). All samples were analyzed for aerobic plate count, Enterobacteriaceae, and Staphylococcus aureus (93). Testing confirmed only three of the 40 centers met the all three test standards for the each of the five samples (93). Aerobic plate counts were particularly high on cutting boards (93). The research results show several surfaces are a common food safety and cross-contamination risk in institutional foodservice operations (93). Also, more training and supervision on proper hand washing and effective cleaning and sanitation procedures is recommended (93).

A study was conducted by Cosby, et al. on the microbiological quality of foodservice surfaces (two kitchen and one serving area) and a non-food contact surface (a diaper changing area) in a sample of six childcare facilities (94). Samples were taken three times a day (pre-opening, lunch, and following clean up), twice per month, for eight

months (n = 252) (94). The aerobic plate count (APC), coliform, and Escherichia coli counts were done for each surface (94). This study found all six center surfaces mean log aerobic place count exceeded standards for microbial contamination and demonstrated the cross-contamination risks present in these centers (94).

FOOD SAFETY TRAINING OF FOODSERVICE PERSONNEL

Research conducted in other foodservice operations that serve children, such as schools, give insight into the barriers, attitudes, and training need of foodservice employees. Several studies have failed to find a relationship between the level of food safety knowledge and food handling behaviors (95-100). A study conducted by Henroid, et al. in a convenience sample of 40 Iowa schools found that correct food handling practices were not being followed (101). Foodservice employees had positive attitudes toward food safety and scored high (15.9+2.4 out of 20 possible points) on a food safety knowledge test (101). Though knowledge scores were high, this did always not translate into correct food safety behaviors (101). Higher food safety practice scores were obtained by those employees with a food handler certificate (101). Food temperatures were not tested nor recorded and proper handwashing practices were not followed in a majority of the schools in this study (101) and in other studies conducted in schools (102-105).

A study by Youn, et al. in school food service examined perceived barriers to applying food safety practices (106). School foodservice directors (n=414) reported employee training as the most significant barrier (106). Time and money were reported as resource barriers, but were not considered as much of a barrier as employee training (106).

FOOD SAFETY TRAINING IN CHILDCARE

Little research is available on food safety education or training in childcare. Several have demonstrated a need for increased training among childcare workers (8, 107-109). A pilot study designed to enhance knowledge and skills related to improved hygiene practices in a childcare setting was published by Petri, et al. in 1998 (110). The targeted audience for the training was caregivers and parents of children attending seven childcare centers located in a poor, predominantly African American, rural county in a Southeastern state. The training included 22 staff and 8 parents (n=30). This study provided training lasting about 1 hour and consisted of a 15 min videotape, handouts, posters, and a demonstration and practice teaching of hand washing (including ways to teach kids to wash their hands). An evaluation form and a small incentive to encourage return of form were given to participants. Approximately one month later a follow-up survey via telephone was conducted with one representative from each site. Forty-three percent of the evaluation forms were returned. Most participants reported positive impacts as a result of having participated in the hygiene program. This study had several limitations, including a small sample size; post-test only format; and behavior change that was self-reported.

A study by Murphy (1995) evaluated the food safety training needs of childcare providers (N=921) via a mailed questionnaire (111). This study found that the primary sources of food safety information for childcare home providers are the Child and Adult Care Food Program (CACFP) (81%) and newspapers/magazines (44%). This study also found that the 'relationship between children's health and food handling in the childcare environment' was a topic of high interest for all childcare providers and that print materials are preferred by most providers in both centers and homes (111).

A study by Nelson, et al. assessed the health education needs and barriers of licensed childcare programs in Alabama (112). A mailed questionnaire was sent to a random sample of 194 (of 854) licensed childcare programs. This study showed that both urban and rural childcare centers cited lack of educational resources and lack of money as barriers to health education. Rural centers also cited limited community resources as barriers and reported more diet/nutritional problems in their centers.

The lack of food safety studies in childcare centers along with the continued plague of foodborne outbreaks emphasizes the need for continued research documenting the extent of the problem and an increase in interventions to reduce the risk of children experiencing foodborne disease-related morbidity and mortality.

Chapter 3: Microbial Evaluation of Foodservice Surfaces in Texas Childcare Centers

ABSTRACT

Children under the age of five experience a disproportionately high rate of bacterial enteric infections. Research has demonstrated a relationship between inadequate childcare center sanitation and illnesses in children. This cross-sectional study assessed the sanitation levels of foodservice surfaces in a sample of 36 Texas childcare centers via recovery and identification of selected enteric, gram-negative bacteria. The centers in this study had the capacity to care for 50-332 children and represented diverse socioeconomic and racial profiles. Forty-one percent (68 of 167) of total swab samples collected tested positive for bacteria. Twenty-seven different types of bacteria were identified from positive swab samples. Most of the bacteria found are considered opportunistic pathogens which can pose serious health risks to those with compromised immune systems, such as young children. Two types of bacteria recovered, Salmonella paratyphi A and Klebsiella pneumonia, are considered non-opportunistic and can infect healthy individuals. The most common areas of bacterial contamination were the sink drain area of the dishwashing sink, the hand-washing sink facet handles, the handle of the garbage can lid, and cutting boards. It is vital for childcare staff to wash their hands often and disinfect all surfaces, since even surfaces that appear clean can harbor microorganisms.

INTRODUCTION

In 2002, 11.6 million preschool children were regularly cared for by someone other than their parents (4). Almost one-fourth of these children were cared for by an organized facility, most often a childcare center (4). Limited space, personnel, equipment, and funding for foodservice in childcare centers can contribute to food safety problems, placing children at undue health risks. Several studies have demonstrated the relationship among inadequate sanitation and illnesses in the children, staff, and families of those involved in childcare (59, 65, 68-71). Recent research reveals foodservice surfaces in childcare settings are prone to bacterial contamination (64, 65). Contaminated hands and moist sites (such as faucets and sinks) have been shown to be common areas of infection (74) and significantly predict diarrheal illnesses among children younger than 3 years of age (69). Children needing to stay home from childcare can become an economic challenge for families. The United States Department of Agriculture Economic Research Service estimates that the cost of foodborne illnesses in children under the age of ten is 2.3 billion dollars a year due to medical costs and missed work on the part of their parents (33).

Children are an especially vulnerable segment of our population (50). Research shows children under the age of five experience a disproportionately high rate of bacterial enteric infections (52). Members of the family Enterobacteriaceae are the cause of many enteric illnesses as well as septicemia and urinary tract infections (91). Enterobacteriaceae account for 38% of the total number of illnesses, 33% of the hospitalizations, and 36% of the deaths due to bacterial foodborne illnesses yearly in the United States (34).

The purpose of this study was to assess the sanitation level of food contact surfaces and areas of potential cross-contamination in a sample of Central Texas

childcare centers by recovery and identification of selected enteric, gram-negative bacteria.

METHODS

Subjects

Prior to the start of this research project, a pilot study was conducted among a sample of Texas childcare centers (12). Electronic spreadsheets listing the names of childcare centers, directors, and contact information were obtained from the Texas Department of State Health Services (TDSHS). From these lists, researchers identified childcare centers located in Travis and Williamson Counties that prepared and served meals at the center. Center directors were contacted to request participation in the pilot study. A 42-item questionnaire, adapted from a food handling survey developed by Iowa State University (102), was mailed to the 112 childcare center directors that agreed to participate in the pilot study. Seventy-one centers returned the pilot questionnaire (63%). The details and results of the pilot study are reported elsewhere (12).

The 71 childcare centers that completed and returned the pilot study questionnaire were invited to participate in the research study. A cross-sectional design was used for the study. Only one representative center was included from franchised childcare centers operated by the same organization. This eliminated 10 of the 71 centers from participating. Of the remaining 61 childcare centers, 36 (59%) agreed to participate in the study. The childcare centers in this study had the capacity to care for 50 to 332 children, with an average capacity of 144 children per center. The centers that participated in this study were a mixture of corporate, non-profit, religious, and sole proprietorships located in many different zip codes within Travis and Williamson

Counties. The children and staff at the centers represented diverse socioeconomic and racial profiles based on the demographic information collected from the centers during the pilot study (12) and as observed during study visits.

Each childcare center director was telephoned to request permission to visit their center and a possible time was agreed on for an on-site visit within a 2 - 4 week period of time. This allowed researchers to avoid dates directors would be unavailable but did not reveal the exact time of the on-site visit. Each center was visited by a Registered Dietitian during the preparation, serving, and cleaning activities in the childcare center kitchen. This researcher was responsible for collecting all microbial samples during the visit.

SAMPLING METHODS

The Institutional Review Board at The University of Texas at Austin (UT Austin) approved the study protocol. Researchers were trained by a microbiologist from UT Austin on correct microbial sample collection procedures.

For this study, 3M Quick Swabs (3M, St. Paul, MN) were used to collect samples. Recommendations from food safety experts and microbiologists at UT Austin and TDSHS , along with a review of the literature (59, 64, 65, 71, 74, 87, 99, 113-116), were used to determine which surfaces would be swabbed in the childcare centers. Swab samples were collected from food contact areas, including counter top surfaces used to prepare food, cutting boards, carts used to serve food, surfaces of the tables where children ate, hands of the foodservice workers, and mixing bowls or pans. Foodservice surfaces that did not come in direct contact with food but had the potential to harbor microorganisms and cause cross-contamination also were swabbed, including the hand washing sink handle, the refrigerator/freezer handle, the sink drain area, and the handle of

the kitchen garbage can lid. The locations of sample collections were not the same for all childcare centers because each childcare center kitchen was set-up and used in a different manner. For example, not all centers used carts to serve food, had a separate hand-washing sink, a lid on the garbage can, or used a cutting board. Thus, researchers tested areas based on the specific way food was handled and prepared in each facility.

The swab contact method (92) was employed to obtain samples from test surfaces. Swab samples were coded and labeled prior to use. Aluminum templates were employed to ensure that flat surfaces would be swabbed in a standard manner. Each template had an open hole in the center measuring 3.5 cm in diameter, providing a consistent area for swabbing, and a thumb area on one side to make a handle to hold without contaminating the surface. Templates were sterilized by the TDSHS and a fresh, sterile template was used for each sample. A template could not be used on non-flat surfaces, such as the hand-washing sink handle, the refrigerator/freezer handle, the sink drain area, and the handle of the kitchen garbage can lid. On these surfaces, a moistened swab was rubbed thoroughly in a back and forth motion over a six- by one-inch sample area for approximately twenty seconds as the swab was twisted so the entire swab made contact with the target surface. The samples were transported in a cooler containing an ice pack to the clinical microbiology laboratory at TDSHS for analysis within 30 minutes of collection. Although the temperature inside the cooler was not monitored during transportation, the use of refrigerated swabs, frozen ice packs, and insulated coolers ensured that swab samples remained within recommended transport temperatures (117).

MICROBIAL TESTING METHODS

Upon arrival at the TDSHS, swab samples were inoculated into Gram Negative broth and incubated for 24 hours at 37°C. After the initial incubation period, a loop of broth was inoculated onto four primary plating media, MacConkey agar, Hektoen Enteric agar, Sorbitol MacConkey agar, and 3M Petrifilm Enterobacteriaceae plates (3M, St. Paul, MN) and incubated for 24 hours (118, 119). Biochemical screening tests were performed on the resulting growth (120). Samples were tested in order to isolate and identify three pathogens: Salmonella, Shigella or Escherichia coli O157:H7.

When the presence of Salmonella, Shigella or Escherichia coli O157:H7 could not be identified in any of the samples obtained from the first nine childcare centers, the biochemical screening test protocol was expanded to include testing for aerobic and facultatively anaerobic rods, including members of the family Enterobacteriaceae. This protocol was used to identify microorganisms present in the samples from the remaining 27 childcare centers. For these samples, growth on the MacConkey agar plates was inoculated into Triple Sugar Iron Agar, Lysine Iron Agar, Combination Test Media with Indole strip, and Brain Heart Infusion broth. After incubation for 24 hours at 35°C, the reactions were recorded.

The 20E Analytical profile index (API 20E) system was used to identify the Genus and species of each isolate. All microorganisms identified to the genus and species level using the API 20E system, were tested further using Multiplex Polymerase Chain Reaction to detect virulence factor genes (121).

RESULTS AND DISCUSSION

One hundred sixty-seven swab samples were collected from the 27 centers undergoing the expanded biochemical screening test protocol. Of these, 68 (41%) tested

positive for bacteria. Bacteria from the Enterobacteriaceae family comprised 88% of the identified organisms found on childcare center foodservice areas while non-Enterobacteriaceae bacteria made up the remaining 12% of the identified bacteria.

Figure 1 shows the percentage of swab samples testing positive for bacteria by foodservice surface location. The most common areas of bacterial contamination were found on the sink drain area of the dishwashing sink (82% of the samples tested positive), the hand-washing sink faucet handles (74% tested positive), the handle of the garbage can lid (50% tested positive); cutting boards (50% tested positive), the hands of the foodservice employee who was preparing food (44% tested positive), the cart used to serve food to the children (43% tested positive), and the counter used to prepare food (41% tested positive).

Figure 2 shows the variety of bacterial species identified from the positive swab samples collected from the childcare foodservice surfaces. Enterobacter cloacae was the most common bacterium found, comprising 31% of the total bacteria recovered. Nine isolates (%) of the Enterobacter cloacae were detected on surfaces in six centers; on the counter top surface used to prepare food, on the hands of the foodservice worker, on the hand-washing sink faucet handle the garbage can lid handle, on the cutting board, and on a cart used to transport food. Enterobacter cloacae is a fecal coliform (92) that can cause opportunistic infections in immune compromised children and adults and is sometimes associated with urinary and respiratory tract infections (91).

Four isolates (6%) of Pseudomonas aeruginosa were detected on three areas in three different centers; on the cutting board, the garbage can lid handle, and on the hand-washing sink faucet handle. Pseudomonas aeruginosa is an opportunistic pathogen which is commonly antibiotic resistant. This pathogen rarely affects healthy hosts but in an

immune-compromised child or adult it can cause respiratory, gastrointestinal, and urinary tract infections (122).

Three isolates (4%) of Klebsiella oxytoca were identified three times in each of three separate centers; on the hands of the foodservice worker, the sink drain area, and the garbage can lid handle. Klebsiella oxytoca is an opportunistic pathogen and is most often associated with nosocomial infections (92).

Two isolates (3%) of Enterobacter sakazakii was discovered on the refrigerator handle and the sink drain area in two individual centers. Enterobacter sakazakii infections has been shown to cause sepsis, necrotizing enterocolitis, and meningitis in newborn infants, especially those born premature or with weakened immune systems (123). In recent years, Enterobacter sakazakii has been recovered from powdered, milk-based infant formulas resulting in FDA-issued warnings (124).

Most of the bacteria isolated in this study are considered opportunistic pathogens which can pose serious health risks to those with compromised immune systems, especially young children who lack fully-developed immune systems and may be attending childcare centers while ill. Two types of bacteria found in the childcare centers are considered non-opportunistic and can infect healthy individuals.

Four isolates (6%) of Klebsiella pneumoniae was found on a total of four sites in four different centers; twice on the carts used to transport food to the children and twice on the sink drain area of the dishwashing sink. Klebsiella pneumoniae is one of the most commonly observed gram-negative bacteria seen by physicians worldwide and frequently infects infants and immune-compromised adults (125). Klebsiella pneumoniae is often responsible for community-acquired respiratory infections in otherwise healthy people (125).

The sink drain area of one of the childcare centers tested positive for Salmonella paratyphi A. This frank pathogen can cause enteric (typhoid) fever in otherwise healthy individuals; however this disease is rarely encountered in the United States. Salmonella paratyphi A can be spread from human reservoirs or from contaminated food or water (91).

Although Escherichia coli O157:H7 was not identified from any of the samples obtained in this study, one species, Chryseomonas luteola, was found to be carrying the same Shiga toxin-producing gene (stx1). This bacterium was recovered from a food preparation table in a childcare kitchen. Shiga toxins belong to a family of toxins that are produced by a variety of organisms, including Shigella dysenteriae type I and Shiga toxin-producing strains of E. coli. These toxins are thought to cause bloody diarrhea in the infected host due to their cytotoxic effect on intestinal epithelial cells (91). Systemic spread of Shiga toxin causes renal endothelial cell toxicity and is believed to be responsible for hemolytic uremic syndrome that can occur in children following E. coli O157:H7 infections (91). It is unclear whether or not a strain of Chryseomonas luteola with the stx1 gene would be capable of causing hemolytic uremic syndrome.

There are limitations inherent to this study. Sampling at different times of the day, such as before or after food preparation, may yield different results. Researchers chose to sample during food preparation because the bacteria present and the possibility of cross-contamination to food could pose the greatest threat during this time period. Further, the results of this study cannot be generalized to all childcare centers in the United States since it was conducted in a small sample of childcare centers in Central Texas and a limited number of samples were collected in each center.

There may be many reasons why centers choose not to participate in the study. Some reasons centers chose not to participate may have been because of time constraints,

worry regarding strangers spending time in the center, or because they had unfavorable sanitary conditions. Thus, it is possible that contamination of surfaces within childcare may be even higher or lower than is indicated by these results.

CONCLUSIONS

Bacteria are a normal part of the human ecosystem. Although no childcare environment can be completely free of bacteria, these centers care for one of the most vulnerable segments of our population and must be vigilant regarding sanitation practices. The presence of enteric microorganisms on many of the food-contact surfaces in the childcare centers visited in this study indicates a lack of proper sanitation and hygiene practices, since these bacteria are easily killed by sanitizing solutions (126-128). Childcare directors and staff must maintain proper sanitation techniques for all surfaces in childcare centers to prevent cross-contamination and spread of pathogens.

Bacterial illnesses can be spread from infected children to parents, siblings, relatives, and into the community. It is vital for childcare center staff to disinfect all surfaces that are potentially contaminated with pathogens, since even surfaces that appear clean can harbor microorganisms. Childcare centers also need to coordinate with state and local health teams to provide childcare specific food safety training and more frequent inspections. Such on-going training by food safety experts could help reduce the enteric bacterial contamination of foodservice surfaces and reduce the risk of foodborne illness to children in childcare.

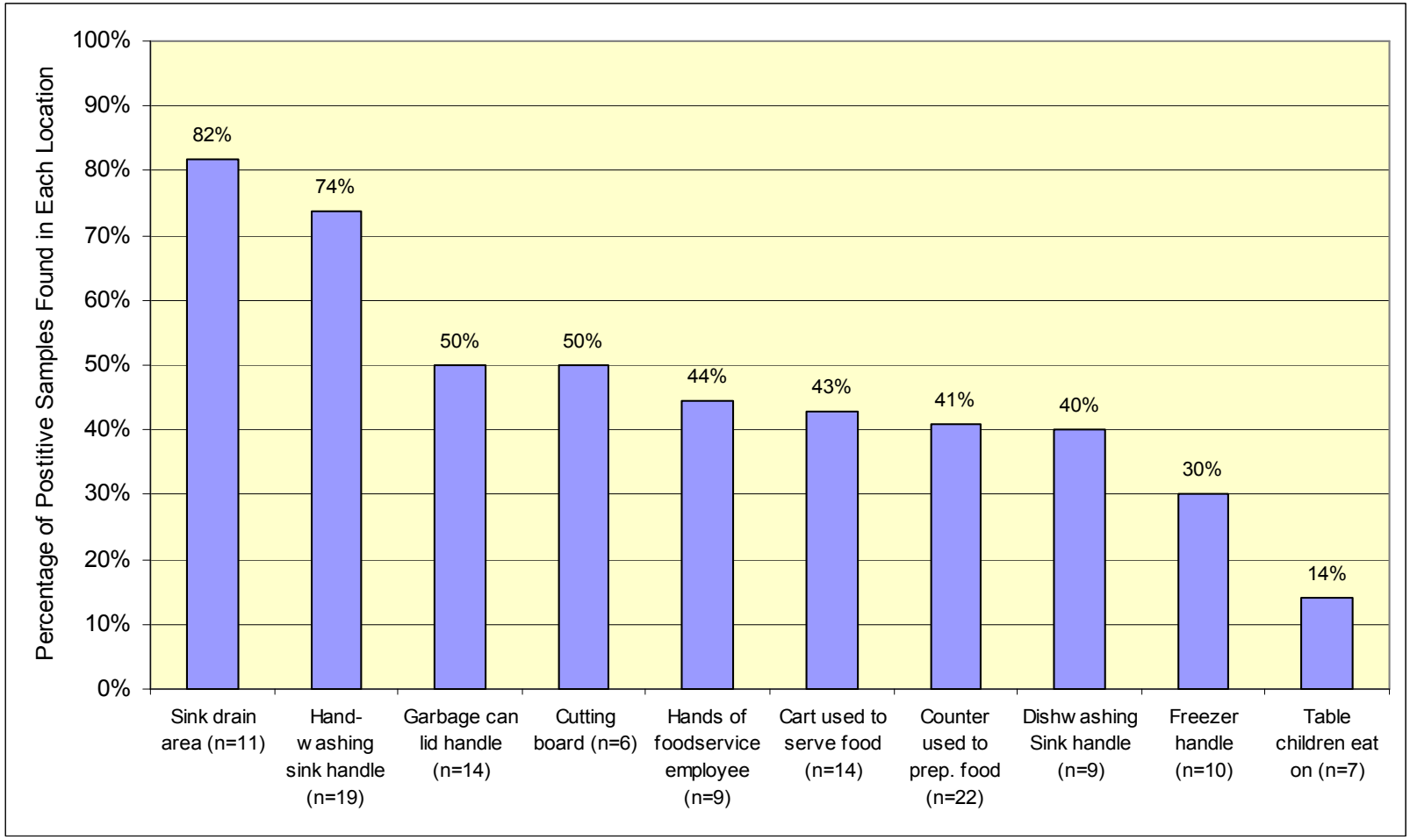

FIGURE 3.1 A sample of foodservice surface locations in Texas childcare centers testing positive for bacteria.

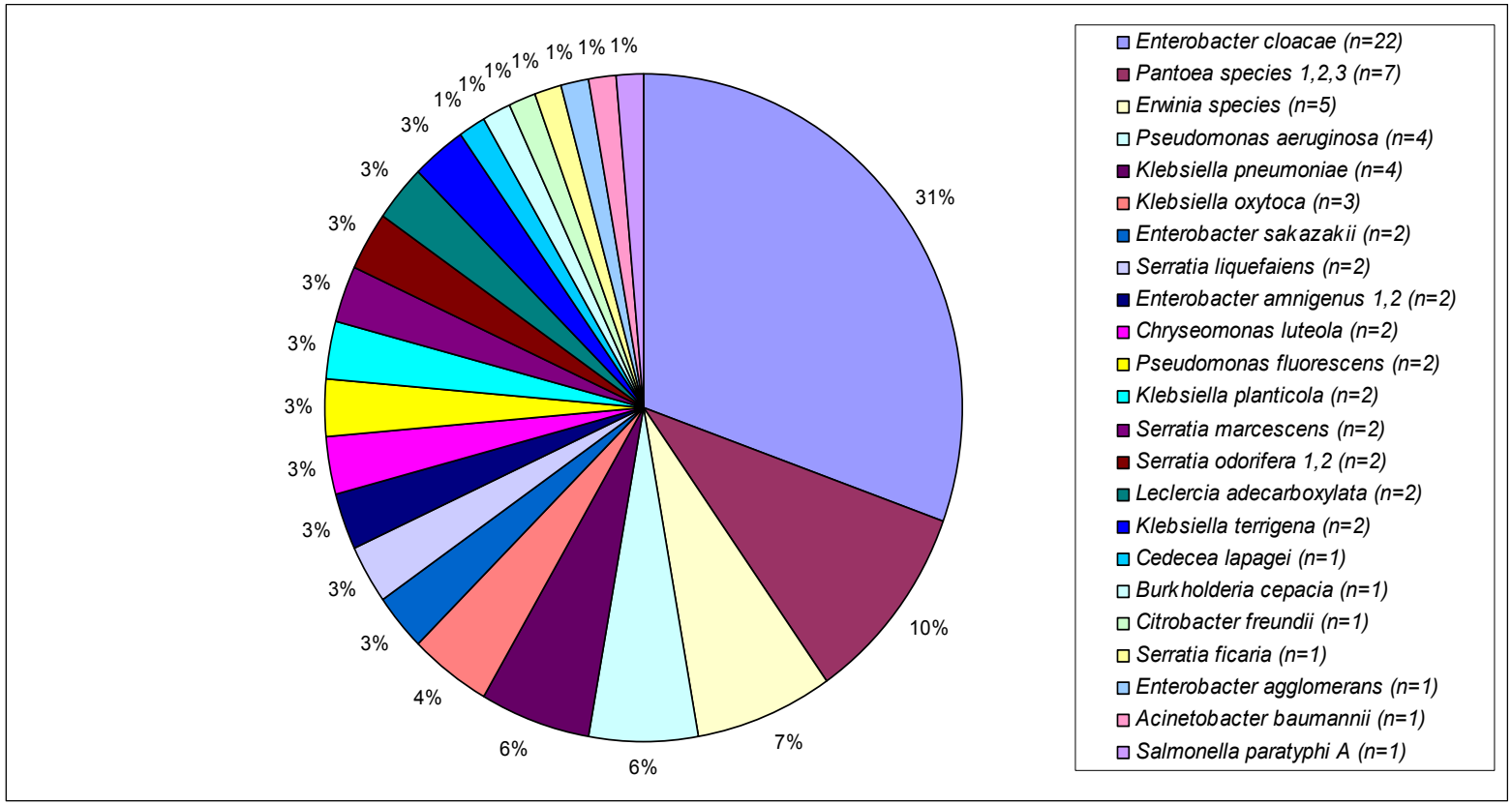

FIGURE 3.2 Bacterial species identified from the 68 positive swab samples collected from foodservice surfaces in 27 Texas childcare centers (n=167). Multiple species of bacteria were isolated from four of the samples.

Chapter 4: Food Safety Knowledge and Behaviors of Cooks in Texas Childcare Centers

ABSTRACT

The purpose of this study was to evaluate food safety attitudes, knowledge, and behaviors of food service workers in a sample of Texas childcare centers. The Food Safety Demographic, Knowledge and Attitude Questionnaire (FSQ) was completed by the head cook (n=36). 22 (61%) head foodservice personnel reported having food safety certification, while 14 (39%) did not. Half of the cooks (n=18) achieved passing scores on the knowledge portion of the FSQ. The Childcare Food Safety Assessment Form (FSA) was completed by the researcher while observing the head cook during preparation of the lunch meal (n=35). The scores ranged from 23% to 92% (mean = 57%). Texas Department of Health food safety inspection scores were obtained from 18 Travis County centers and were compared to the results of the FSA. Health inspection score averaged 93.4% (82% to 100%), while the FSA scores averaged 58.3% (26.9% to 92.3%). This study showed that food handlers are not adequately following food safety procedures and current inspections are not effectively uncovering deficiencies. It is imperative that all food service workers in childcare are required to have food safety certification training and be monitored regularly to assure strict cleaning and sanitation procedures are followed.

INTRODUCTION

Today, more than 250 known diseases are transmitted through food (30). The symptoms of foodborne illness range from mild gastroenteritis to life-threatening neurological, hepatic, and renal syndromes (34). Foodborne diseases can be caused by many different pathogens, including viruses, bacteria, parasites, and prions. In 2004, the CDC reported 1,319 disease outbreaks, up from 1,073 reported outbreaks in 2003, with the majority of them being caused by bacterial pathogens (31). Concern over food safety has prompted the Federal government to develop food safety objectives for improving public health in Healthy People 2010 (129).

While no one is immune to foodborne illnesses, several groups are considered high risk. This includes children, the elderly, pregnant women, and those with compromised immune systems (51). Statistics show that children less than 10 years of age experience one-third of all the foodborne illnesses in the United States and a disproportionate number of enteric bacterial infections occur in children under the age of 5 (51, 52). Children are particularly susceptible to the serious health consequences of foodborne diseases because a smaller quantity of pathogens will cause them to become ill due to lower body weights and lack of fully developed immune systems (5, 130). Persons in institutional settings are also more likely to experience foodborne illnesses, which places children attending childcare centers at an even greater risk (30, 51).

Food safety can be defined as "controlling or eliminating hazards that might contaminate food and cause foodborne illnesses" (76). Poor holding temperatures, poor personal hygiene, and inadequate cooking are the most common foodborne illness risk factors at the food preparation stage. (74). A study by Bermudes-Millan, et al. on the food safety knowledge, attitude, and behaviors of caretakers of young children (N=100) observed that only 10% of subjects washed their hands before preparing food, even

though 97% of them reported doing so (77). Also, 96% of subjects did not use a thermometer to check if meats were cooked properly and 71% used the same cutting board for meats and vegetables (77).

Most childcare centers prepare food in the same manner as domestic kitchens. A study by Cody, et al. assessed the food safety knowledge and practices of a sample of persons responsible for the majority of home meal preparation in the United States (N=1,006) (47). Respondents did not think it was common for people in the US to get sick from foods prepared at home (70%), and most did not associate symptoms (nausea, fever, chills) with food prepared at home (60%) (47). In this study, 35% of respondents claimed to know the safe internal temperature for cooking ground beef but only 9% were able to state the correct temperature (47).

Limited research is available concerning the food safety knowledge and behaviors of foodservice staff in childcare centers. The purpose of this study was to evaluate food safety attitudes, knowledge, and behaviors of cooks in a sample of central Texas childcare centers.

MATERIALS AND METHODS

Subject Sample

Before the start of this research project, researchers conducted a pilot study with a sample of Texas childcare centers that prepare and serve meals (12). Electronic spreadsheets listing the names of childcare centers, directors, and contact information were obtained from the Texas Department of State Health Services. From this list, researchers contacted childcare centers located in Travis and Williamson Counties that prepare and serve meals at the center to request permission to send a questionnaire to the

director of the center. This 42-item questionnaire was adapted from a food handling survey developed by Iowa State University (102) and was mailed to 112 childcare center directors that agreed to participate in the pilot study. Seventy-one centers returned the pilot questionnaire (63.4%). The details and results of the pilot study are reported elsewhere (12).

Childcare centers that completed and returned the pilot study questionnaire were invited to participate in this research study. In franchised childcare centers operated by the same organization, only one representative center was included. This eliminated 10 of the 71 centers from participating. Of the remaining 61 childcare centers, 36 (59%) agreed to participate in our study. The childcare centers in this study had the capacity to care for 50 to 332 children, with an average capacity of 144 children per center. Researchers telephoned each childcare center director to request permission to visit their center and agreed on a possible time for an on-site visit within a 2-4 week period of time. This allowed researchers to avoid dates directors would be unavailable but did not reveal the exact time of the on-site visit. The Institutional Review Board at The University of Texas at Austin approved the study protocol. One of the two researchers (both of whom are Registered Dietitians) visited each center during the preparation, serving, and cleaning activities in the childcare center kitchen. The cook observed in this study refers to the person at the childcare center most responsible for the preparation and handling of meals in that center.

SAMPLING METHODS

Researchers adapted the Demographic, Knowledge and Attitude Questionnaire and The Food Safety Assessment forms developed by Giampaoli, et al. (102) for use in childcare centers. Adaptation included changing wording and eliminating questions that

were not relevant to childcare settings. These modified questionnaires are referred to as The Food Safety Demographic, Knowledge and Attitude Questionnaire (FSQ) and The Childcare Food Safety Assessment Form (FSA), respectively, in this paper. Researchers conducted the assessments from 9:30 am - 1:30 pm to ensure the entire range of food handling practices was observed.

RESULTS AND DISCUSSION

Food Safety Demographic, Knowledge and Attitude Questionnaire

The Food Safety Demographic, Knowledge and Attitude Questionnaire (FSQ) was completed by the cook during the visit to the childcare center. This questionnaire included three demographic, seven attitudinal, and 20 multiple-choice food safety questions.

The demographic portion of the FSQ showed that of the 36 cooks, nine (25%) had worked in foodservice for less than 3 years, eight (22.2%) for 3-5 years, nine (25%) had worked in foodservice for 6-15 years, and seven (19%) for more than 25 years. Results showed that 22 (61%) of the 36 cooks reported having some form of food safety certification, while 14 (39%) did not. In centers where the cook did not have food safety certification, the childcare center director had the required safe food handling certification.

The FSQ test scores ranged from 40% to 90% with a mean score of 70.97%. A passing score on the FSQ was set at 75% (15 out of 20 questions correct) because that is the passing score established by the Texas Department of State Health Services for the certified food managers' exam. Results from the food safety knowledge portion of the

FSQ showed 50% (18 of 36) of the cooks passed the exam (18 of 36) while 50% (18 of 36) failed to achieve a passing score on the exam.

Results of the attitudinal questions on the FSQ (Figure 1) revealed that 100% of the cooks (n=36) strongly agreed or agreed with the statements "safe food handling is an important part of my job responsibilities", "learning more about food safety is important to me", "I believe how I handle food relates to food safety", and "I am responsible for making sure that the foods served to children are safe to eat". When asked if "my supervisor should have more responsibility for food safety than I do", 36% (n=13) of the cooks strongly agreed or agreed with the statement, 48% (n=17) disagreed or strongly disagreed, and 15% (n=6) remained neutral. The fact that 39% of the cooks do not have food safety certification, while their supervisors did, may contribute to the attitude in some of the cooks that the supervisor is then more responsible for food safety than they are.

Childcare Food Safety Assessment Form

The results of the Childcare Food Safety Assessment Form (FSA) are shown in Figure 2. The FSA was completed by the researcher while observing the cook during lunch preparation, serving, and cleaning. One of the 36 centers was used for researcher training to improve inter-rater reliability. The scores on the FSA from the two different researchers were compared and no significant difference in scores was observed (73% vs. 77%). The FSA results from this center are not included, reducing subject sample to 35. Behaviors that were not observed in all of the centers were also not reported. This includes such behaviors as "leftovers are reheated rapidly to 140°F in 2 hours" because many of the centers did not keep, and therefore did not reheat, leftovers. Other behaviors not observed in all of the centers included "smoking only in designated areas away from

food" and "employees take appropriate action when coughing or sneezing". The remaining 26 questions were used to determine a score. The lowest score received was a 23% and the highest score was a 92% with a mean score of 57% $\pm$ 2.6%. The FSA revealed that 60% of the cooks (21 of 35) held hot foods at or above 140 degrees Fahrenheit while 40% did not. Even though all childcare centers are required by TDSHS to have a thermometer on site, a majority of cooks (71%, or 25 of 35) did not use thermometers to check the food temperatures to ensure they were cooked to the recommended temperatures. Also, none of the cooks recorded the temperature of the foods they served. Cold foods were not held at or below 41 degrees Fahrenheit by 54% (19 of 35) of cooks, and in four instances this included the milk being served to the children. Only seven of the 35 employees (20%) were observed wearing hair restraints, as this is recommended but not mandated by the Travis and Williamson county health departments. Refrigerator and freezer temperatures were recorded in only 14% and 17% of centers, respectively. Despite the considerable research supporting handwashing as one of the easiest and most effective behavior to control the spread of pathogens and disease, only 57% (20 of 35) of cooks were observed washing their hands while preparing and serving food (79, 81, 82, 84, 85, 131-133).

No significant correlation was seen between the scores on the knowledge portion of the Food Safety Demographic, Knowledge and Attitude Questionnaire (FSQ) and the scores on the Childcare Food Safety Assessment Form (FSA) suggesting food safety knowledge alone may not predict food safety behaviors. These results are similar to results reported in other food safety knowledge and behaviors research (97-100). Risk perception is a significant motivator of behavior (37). The foodborne illness risk perception of many Americans is low in spite of evidence to the contrary (37, 40). It is likely that childcare foodservice employees do not recognize the risk of children in their

centers becoming ill due to foodborne illnesses and therefore do not strictly follow food safety procedures. It is vital that food safety training includes information on the serious risk of morbidity and mortality to children due to foodborne illnesses. Even one child needlessly becoming ill is too great of a risk.

Texas Department of Health food safety assessment inspection scores were obtained from the 18 centers in this study that reside in Travis County and were compared to the results of the food safety assessment form (FSA) used in this study. A sample evaluation form used by the Travis county health inspectors was obtained to ensure both forms evaluated based on similar criteria. No significant correlation was seen between the two scores. The average health inspection score for the 18 centers was a 93.4%, ranging from 82% to 100%. This was in stark contrast to the FSA scores for these 18 centers, which ranged from 26.9% to 92.3% with a mean score of 58.3%.

Differences in the Travis county health inspection scores and the scores on the food safety behavior form (FSA) may be due to many factors. It is likely that childcare staff is careful to follow all food safety procedures when an official inspection is anticipated or occurring. When researchers visited the centers to evaluate the food safety behaviors for this study, staff were assured that it would not be reported to any regulatory agencies and that only code numbers, not names, would be used. Researches feel this gave a more realistic picture of the day to day behaviors of childcare staff. Although the scores are not from an identical form and may not have been scored exactly in the same manner, the comparison does provide an idea that the health inspection process needs revising. Inspections that are unexpected, random, and strictly enforce behaviors with stronger penalties may encourage childcare centers to follow food safety procedures more closely.

The results of this study cannot be generalized to all childcare centers in the United States since it was conducted in a small sample of childcare centers in Central Texas. Also, the centers in this study were a convenience sample obtained from the centers that completed the pilot study and allowed visits to their center and may not represent a true cross section of childcare centers in Texas or the United States. There may be many reasons why centers chose not to participate in the study. Some reasons centers chose not to participate may have been because of time constraints, worry about strangers spending time in the center, or because they had unfavorable sanitary conditions. Thus, it is possible that sanitary conditions and food safety behaviors in childcare may be more or less favorable than is indicated by these results.

CONCLUSIONS

Patrons expect foodservice operations to be clean and for food to be served in a hygienic manner. Children at childcare centers and other high risk groups deserve the same assurances and warrant foodservice personnel to handle and serve food in especially stringent sanitary conditions.

Through observation of actual food safety behaviors in childcare centers, this study showed that food handlers are not adequately following food safety procedures. The lack of strict adherence to food safety measures may increase the risk for children at these centers to acquire foodborne illnesses. It is imperative that all foodservice workers in childcare are required to have food safety certification training and be monitored regularly to assure strict cleaning and sanitation procedures are followed.

Knowledge gaps are barriers to establishing appropriate food safety behaviors. This makes it especially important for childcare directors and local health authorities, such as state or county health inspectors, to educate workers and enforce food safety

behaviors, such as frequent, proper handwashing; adequate cooking; and proper holding temperatures, which research has demonstrated to be the most influential in preventing food borne illnesses (63, 74, 81, 85, 87, 134-136). If workers feel there are too many tasks to be completed and standards are not enforced, workers will be more likely to skip these tasks which may jeopardize the safety of the food environment.

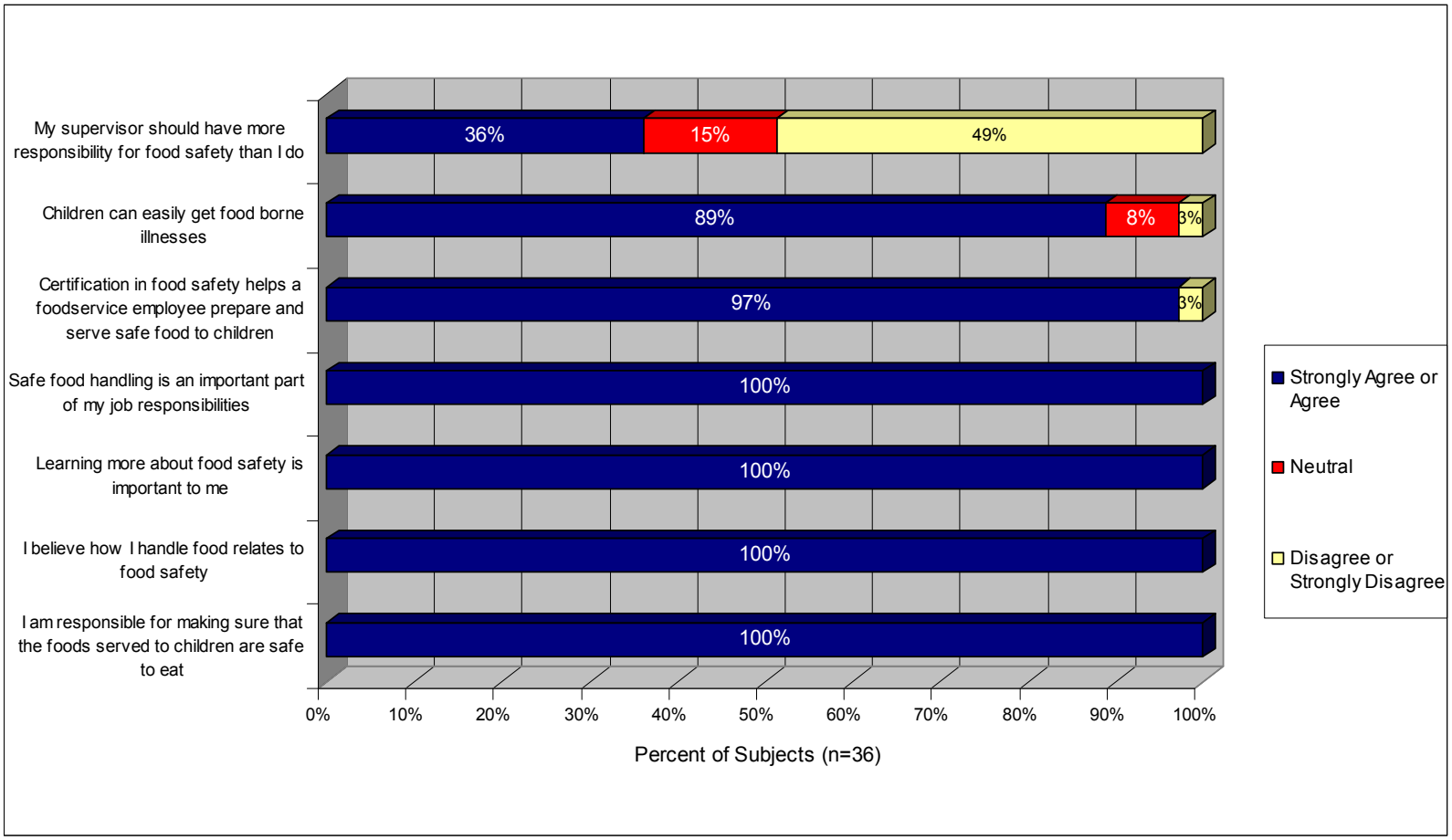

FIGURE 4.1 Distribution of results from the attitudinal questions on the Food Safety Questionnaire in a sample of Texas childcare cooks (N=36).

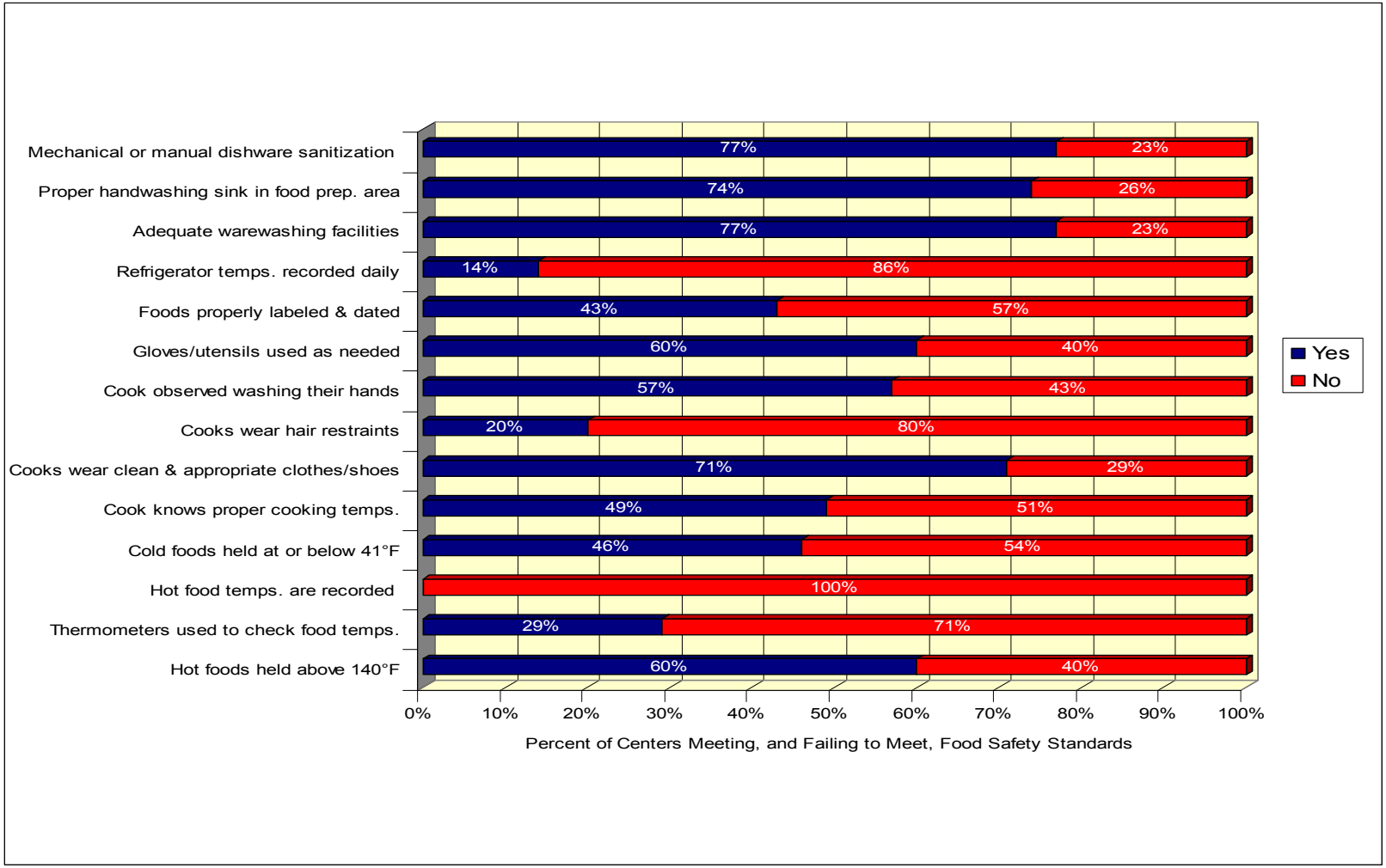

FIGURE 4.2 The sanitary conditions and observed food safety behaviors of cooks in a sample Texas childcare centers (N=35).

Chapter 5: The Effect of Food Safety Training on Food Safety Behaviors and Microbial Findings in Texas Childcare Centers

ABSTRACT

It is estimated that children under the age of five experience an average of 1.4 to 2.5 episodes of foodborne illness per year. Limited research is available regarding food safety training in childcare centers. The purpose of this study was to evaluate the effect of a food safety training class on the microbial findings and the food safety behaviors of the head food service worker in a sample of Texas childcare centers (n=32). Baseline and 12 month follow-up site visits were made to collect microbial data on six foodservice surfaces and to observe food safety behaviors. The Childcare Food Safety Assessment Form (FSA) was completed by the researcher during visit 1 (V1) and visit 2 (V2) while observing the cook during lunch preparation, serving, and cleaning. V2 was conducted approximately 12 months from the date of V1. Six months before the start of V2 a food safety training class was offered using Serving It Safe published by National Food Service Management Institute. The training class was attended by 47% (n=15) of the centers. Attendance at the food safety training session did not significantly affect the change in FSA scores from V1 to V2. If the subject attended the food safety training class, the FSA scores decreased in 47% (n=7), improved in 33% (n=5), and did not change in 3 of the subjects. The microbial data from 22 childcare centers were compared. The microbial data from 10 of the childcare centers from V1 could not be compared to the V2 results due to a change in biochemical testing methods. The number of bacterial species increased in ten of the 22 centers, decreased in six, and did not change in six of the centers. No significant differences were seen between the number, types, or locations

of the bacterial samples based on training. The results of this study show an overall lack of compliance with food safety standards in a sample of Texas childcare centers and a worsening of sanitary conditions over a 12-month time period. This demonstrates a need for more effective food safety training and enforcement strategies in childcare centers.

INTRODUCTION

Foodborne illnesses create a significant public health burden in the United States (33). The United States Centers for Disease Control and Prevention (CDC) estimates that approximately one in every four persons in the United States experiences foodborne illnesses each year (33). Bacterial foodborne infection is a common cause of gastroenteritis (90). A study by Olowokure, et al. found that very young children (0-4 years of age) experienced the highest hospital admission rates for infectious intestinal disease (53). Research shows that infants and toddlers attending childcare centers have higher rates of gastrointestinal infections then same-aged children cared for at home (59). Improper food handling is one of the most common causes of foodborne diseases (35, 41, 48). Many childcare center employees are not adequately trained to keep food safe and prevent foodborne illnesses (63). Effective food safety training and implementation of strict food safety standards are vital to preventing foodborne illness in childcare centers.

The establishment and enforcement of food safety standards in childcare centers differs greatly, not only from state to state, but even from county to county. The standards for one childcare center in Texas may differ from another center in close proximity, if they happen to fall under different county jurisdictions. The health department of each county in Texas is responsible for setting and monitoring the health codes for the centers in that county. If the county does not have its own local health department, the burden falls on the state health department to monitor all of those centers.

The Williamson County health department requires each person handling food in a childcare center to have a Food Handler's Card (10). In Travis County the local health department requires that one person in each center has a Certified Food Manager's (CFM) Card, but that person does not have to be involved in food service (11). The center director often holds the CFM certification because of the high turn-over rate of staff in most centers. This means that the person who is most responsible for the safety of the foods the children receive may not have any food safety training.

Limited research is available regarding food safety training in childcare centers. The purpose of this study was to evaluate the effect of a food safety training class on the microbial findings and the food safety behaviors of the head food service worker, in charge of actual food preparation, in a sample of childcare centers in Texas.

MATERIALS AND METHODS

Subjects

A pilot study was conducted among a sample of Texas childcare centers prior to the start of this research project (12). From the centers participating in the pilot study, 36 (59%) agreed to participate in this study. The recruitment methods and subject profiles are reported elsewhere (137). Between visits 1 (V1) and 2 (V2), four centers closed or changed ownership, reducing the final sample to 32 centers. Data collected from the 32 childcare centers that completed both study visits is reported in this paper. The Institutional Review Board at The University of Texas at Austin approved the study protocol.

V2 (visit 2) was conducted approximately 12 months from the date of V1 (visit 1). Registered Dietitians visited the centers for both visits, collected microbial samples,

and completed the food safety assessment forms. Approximately two months after the completion of V1, and about 6 months before the start of V2, a food safety training class was offered free to one childcare center director and one head cook/food service manager from each childcare center. A quasi-experimental design was used for this study due to the fact that the study participants decided if they where going to attend the food safety training and were not assigned to a treatment group.

Food Safety Training Class

The foodservice managers/head cooks and directors were offered three opportunities to attend the food safety training class (139, 140). Participants in need of local food safety certification were offered the opportunity to take the Certified Food Managers exam (for those working in Travis County) and the Food Handlers exam (for those working in Williamson County) free of charge. Incentives, such as grocery store gift cards and course completion certificates, were provided to encourage training attendance. The training class was conducted on The University of Texas at Austin campus by Registered Dietitians with certification in food safety.

Serving It Safe, published by National Food Service Management Institute, was used for the food safety education class (138). This course is based on a 6^{th} grade reading level and appropriate for this population. The six chapters that were covered during the Serving It Safe food safety training were: 1) Food Safety Is Top Priority describes why food safety is important and gives general guidance on how foodservice personnel can assure the preparation and service of safe foods; 2) Prevent Foodborne Illness - Understanding Microorganisms introduces the causes and prevention of foodborne illness; 3) Basic Facts about Microorganisms describes how the growth of these microorganisms can be prevented or controlled; 4) A Clean and Sanitary Foodservice

provides guidance on promoting food safety through good personal hygiene and maintaining a clean and sanitary environment for the preparation and service of food; 5) A Process for Preventing Foodborne Illness explains the eight steps in the food production process and how to prevent foodborne illness at each step; 6) Introduction to Hazard Analysis and Critical Control Point (HACCP) explains the seven principles of HACCP.

The Childcare Food Safety Assessment Form

The Childcare Food Safety Assessment Form (FSA) used for both visits was adapted from the form developed by Giampaoli, et al. (102), (141). The assessments were conducted from 9:30 am - 1:30 pm at both V1 and V2 to ensure the entire range of food handling practices was observed. The assessment results were recorded as "yes", "no", or "not observed". FSA scores were calculated as a percent of "yes" answers.

Microbial Sampling and Testing Methods

Swab samples were collected from food contact areas, including counter top surfaces used to prepare food, cutting boards, carts used to serve food, surfaces of the tables where children ate, hands of the foodservice workers, and mixing bowls or pans. Foodservice surfaces that did not come in direct contact with food but had the potential to harbor microorganisms and cause cross-contamination also were swabbed, including the hand washing sink handle, the refrigerator/freezer handle, the sink drain area, and the handle of the kitchen garbage can lid. The details of the microbial sampling and testing methods used in this study are reported elsewhere (137). Upon arrival at The Texas Department of State Health Services Laboratory, swab samples were inoculated into

Gram-Negative (GN) broth and incubated for 24 hours at 37°C. After incubation, a loop of inoculated GN broth was streaked on three primary plating media: MacConkey's Agar (MAC), Hektoen Enteric (HE) agar, and Tellurite Sorbitol MacConkey's (TCSMAC) agar (118). MAC plates were used to screen for Shigella species, HE agar was used to test for Salmonella species, and TCSMAC agar was used to select for E. coli O157:H7.

If growth was observed on the primary plating media, biochemical tests were performed. Biochemical screening used in this study tested for aerobic and facultatively anaerobic rods, including members of the family Enterobacteriaceae. Colonies selected from the MAC plate were inoculated into five media: a Triple Sugar Iron Agar (TSI) slant, a Lysine Iron Agar (LIA) slant, a Lysine Decarboxylase Broth (LDB), an Acetate Medium slant, and a Complex Test Medium (CTM). These biochemical tests were incubated in the 35°C incubator for 24 hours. Colonies selected from the HE plate underwent three biochemical tests: a TSI slant, a LIA slant, and a Urea slant. These biochemical tests were incubated in the 35°C incubator for 24 hours. Colonies selected from the TCSMAC plate underwent two biochemical tests: a Levine eosin methylene blue (Levine EMB) plate, and an E. coli broth, supplemented with the enzyme substrate 4-methylumbelliferyl-beta-D-glucuronide (EC with MUG broth). The Levine EMB plates were incubated in the 35°C incubator, while the EC with MUG broths were incubated with a positive control in a 44.5°C water bath; both tests were incubated for 24 hours.

All colonies that underwent biochemical tests also were inoculated onto TSA plates. These plates were incubated in the 35°C incubator for 24 hours. Growth from TSA plates was transferred using a sterile swab to a NaCl 0.85% Saline tube, until the turbidity of the solution was approximately equivalent to a 0.5 McFarland Standard. This solution served as the inoculums for the final set of 20 biochemical tests contained on the

20E Analytical profile index (API 20E) test system. The API 20E system was used to identify the Genus and species of each isolate.

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) (version 11.0.1, 2001, SPSS Inc, Chicago, IL). Frequencies and means were computed for descriptive purposes. Paired-samples t tests were used to examine overall changes in FSA scores pre- and post-intervention. Pearson correlations examined relationships between FSA test scores and continuous data (i.e., microbial species counts, total bacterial counts). Chi square statistics were used to determine if the change in FSA scores were associated with factors such as attendance to the food safety training class, change in microbial data, and if the same cook was observed during the two visits.

RESULTS AND DISCUSSION

Childcare Food Safety Assessment Form

A sample of the questions from the Childcare Food Safety Assessment Form (FSA) along with the results from V1 to V2 are shown in Figure 1 (n=32). The full V1 FSA details and results are reported elsewhere (141). The change in scores from V1 to V2 is shown in Figure 2. Both sets of test scores were normally distributed. The questions on the FSA fell into one of four categories: 1) food temperature and time control, 2) personal hygiene, 3) storage, and 4) warewashing. The scores on the V2 FSA were significantly different (P=<.05) from the initial FSA scores. Scores on the V1 FSA ranged from 18% to 95% with a mean score of 60.7% $\pm$ 15.8. Scores on the V2 FSA

ranged from 31% to 86% with a mean score of 59.3% ± 13.2. Scores increased from V1 to V2 in 11 cases, decreased in 15 cases, and stayed the same (+1) in 6 cases.

In 72% (n=23) of the centers, the same cook was observed during both the first visit second visit. The change in the FSA score from the first visit to the second was not significantly different based on whether the same cook was observed (-2.40) or not (2.24). The small sample size may have contributed to this result. When a new cook was observed the scores on the FSA from V1 to V2 decreased 44% (n=4) of the time, improved 44% (n=4) of the time, and did not change in one case.

The food safety training class was attended by 47% (n=15) of the centers. Whether or not subjects attended the food safety training session did not significantly affect the change in scores from V1 to V2. If the subject had attended the food safety training class, the scores on the FSA from V1 to V2 decreased 47% (n=7) of the time, improved 33% (n=5) of the time, and did not change in the remaining 3 cases. If the subject did not attend the food safety training class, the scores on the FSA from V1 to V2 decreased 47% (n=8) of the time, increased 35% (n=6) of the time, and did not change in the remaining 3 cases.

The scores on the storage portion of the FSA were the most strongly correlated (r=0.81) with the final scores on the full form. Scores from V1 to V2 increased significantly (P=<.05) on the storage and the personal hygiene sections. Poor personal hygiene is a leading cause of foodborne illnesses. A study by Medeiros estimated inadequate personal hygiene is associated with 9.3 million cases of foodborne illness per year (135). Food safety and personal hygiene education needs to be included in childcare training programs to help reduce the risk of foodborne illnesses in childcare centers.

Change in Microbial Findings

The microbial data from ten of the childcare centers from V1 could not be compared to the V2 results due to a change in biochemical testing methods for nine of the centers and because the one of the centers was no longer in the study. The remaining 22 childcare centers were compared. The number of bacterial species increased in ten of the centers, decreased in six, and did not change in six of the centers. Figure 3 shows the locations of the positive swab samples from the childcare centers (n=22) in V1 and V2. Figures 4 and 5 compare the variety of bacterial species identified from the positive swab samples collected from the childcare foodservice surfaces in the 22 childcare centers during V1 and V2. No significant differences were seen among the number, types, or locations of the bacterial samples based on training.

Most of the bacteria isolated during V1 and V2 are considered opportunistic pathogens. Opportunistic pathogens present a threat to those with compromised immune systems, such as young children, the elderly, pregnant women, and those with chronic diseases.

Salmonella arizonae was found on the handwashing sink handle in one of the centers. Although less hardy than most Salmonella species, S. arizonae can survive for months in soil, feed, and water resulting in salmonellosis (91). Most salmonellosis infections result from the consumption of contaminated food or from direct fecal-oral spread (118). According to the CDC's Active Surveillance Network (FoodNet), Salmonella is responsible for a higher percentage of food-related deaths in the United States than any other bacterial pathogen (142). The incidence of Salmonellosis is greatest in children under 5 and in adults over 60 years of age (118). Twenty-five percent of these hospitalizations and deaths due to Salmonella infection occurred in infants less than 1 year of age and another 15% occurred in children 1-9 years of age (142). A study by

Givon-Lai (143) found that 75% of the children attending childcare were infected with Salmonella with a greater than 60% chance of it spreading to another person in the child's household (116).

Yersinia pseudotuberculosis was recovered from a food preparation surface in one of the childcare centers. Y. pseudotuberculosis is a primarily enteric bacterium capable of causing gastroenteritis when contaminated foods are consumed (19, 91, 144, 145).

Escherichia coli was found on the sink drain areas of one of the childcare centers. Escherichia coli infections result from the consumption of contaminated foods or beverages and are a common cause of urinary tract infections, gastroenteritis, and sepsis (146).

Compliance

The compliance with food safety standards and the sanitary conditions declined in ten (45%) centers from V1 to V2 while seven centers (32%) experienced no overall change. However, five (23%) of the centers had an increase in food safety standards and sanitary conditions from V1 to V2.

The results of this study show an overall lack of compliance with food safety standards in this sample of Texas childcare centers and a decline in sanitary conditions over a 12-month time period. Use of thermometers, temperatures of dry storage areas, improperly labeled foods, lack of hand washing, and recording of refrigerator temperatures all decreased by V2 (Figure 1). Bacterial species numbers were greater by V2 on garbage can lids, food carts, and refrigerator handles. These items are handled frequently and pose a health risk to childcare center staff and students.

The results of this study cannot be generalized to all childcare centers due to the small sample size. However, the study does show a pending problem that is not currently adequately addressed. It further highlights an area of potential threat to young children who attend childcare centers, and the possibility of outbreaks that can quickly spread to families and others in the community. There is a need for additional food safety research in childcare centers to understand the current conditions and to identify measures to ensure that the food served to children in childcare centers is safe.

CONCLUSIONS

Food safety education alone does not always result in positive behavioral changes (95, 99, 147). In order for food safety training and certification to be successful at improving the sanitary conditions of any foodservice establishment, it must focus on the most effective strategies food handlers can use to reduce the risk of serving unsafe food (74, 83, 87, 135, 136). These strategies must also be applicable to all types of food service establishments that may be involved in the training programs, since the needs of different establishment vary greatly. The regulations that are established by the state and local health authorities must be strictly regulated and enforced, and yet be flexible enough to protect the population served by different types of establishments.

Unlike restaurants, foodservice in childcare centers is only a part of the services offered. This means that less time and resources are available for use on issues of food safety. Many times only one food service person is employed per center and the turn-over rates are high. Childcare center directors have many types of rules and regulations to follow apart from those imposed by the local health department. Due to time and resource constraints, childcare staff may focus on completing tasks most often enforced by regulatory agencies. That is why the food safety regulations established must include

established ways to reduce the incidence of foodborne illnesses while requiring the least possible investment of resources. The combination of these attributes will help make the food service environments of childcare centers clean and assure that the food served is safe and contributes to the reduction of foodborne illnesses.

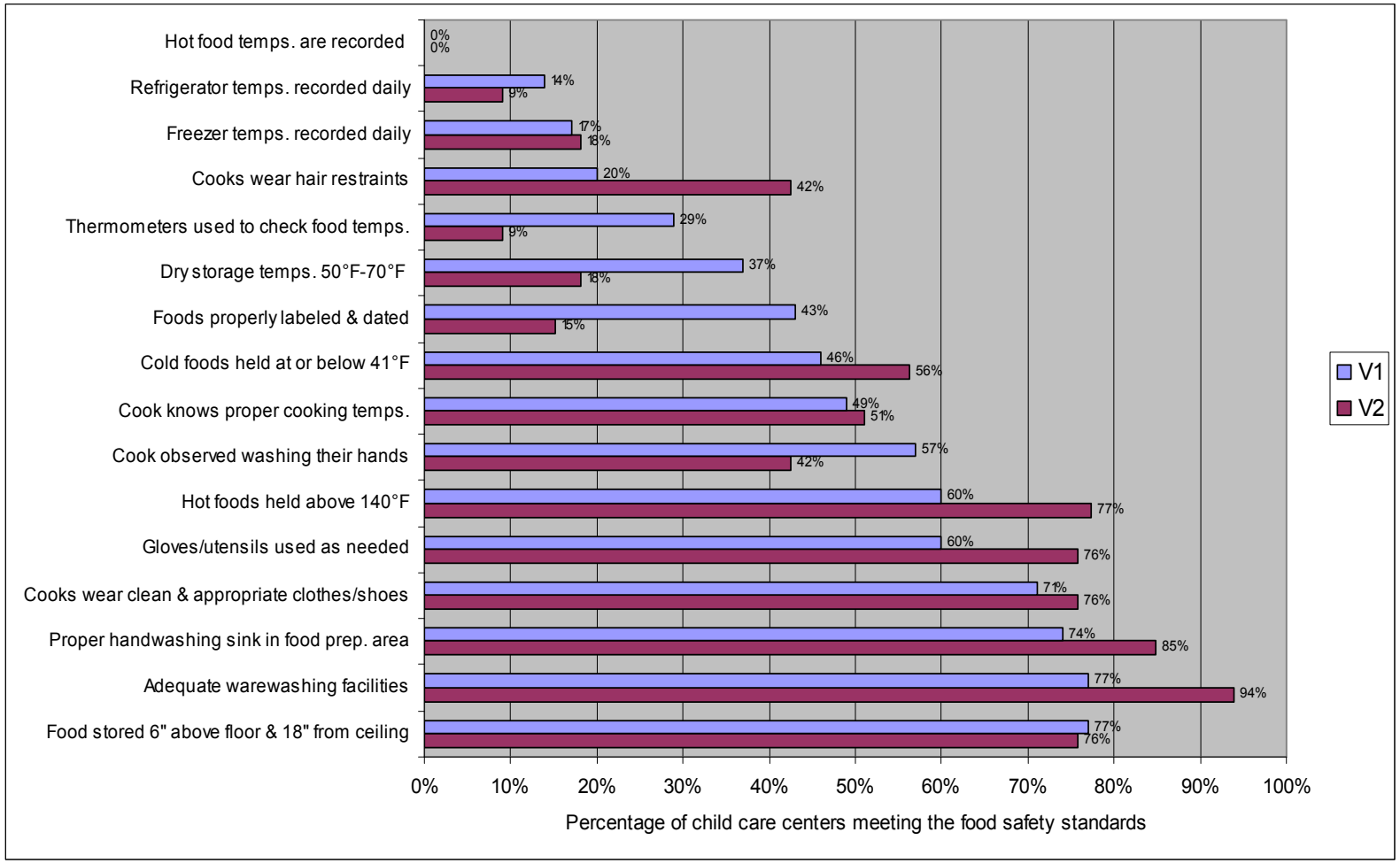

FIGURE 5.1 The sanitary conditions and observed food safety behaviors of cooks in Texas childcare centers at V1 and V2 (N=32).

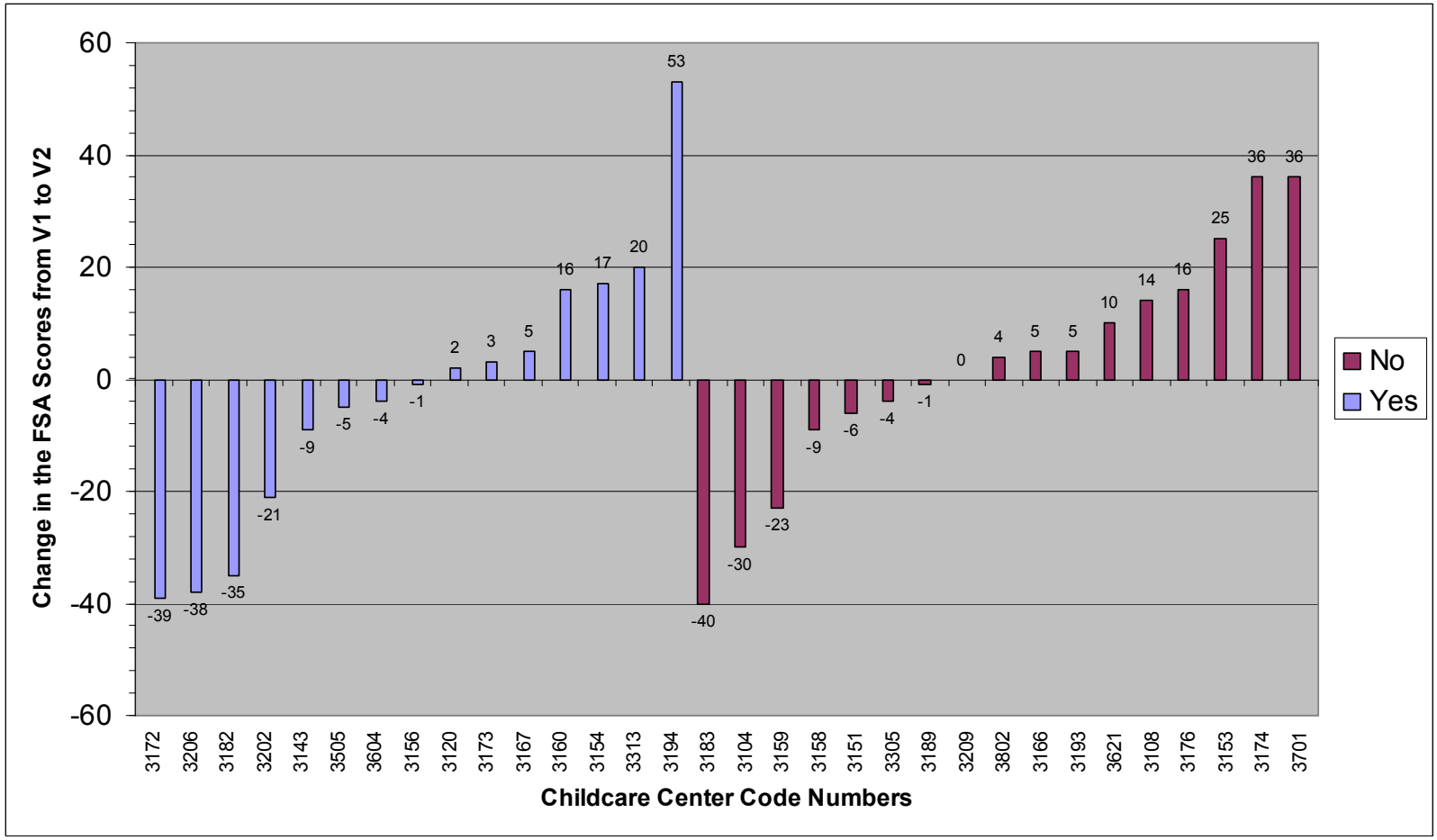

FIGURE 5.2 Change in the Food Safety Assessment (FSA) Scores from V1 to V2 grouped by the childcare centers that attended the Food Safety Training class (Yes) and the centers that did not attend (No).

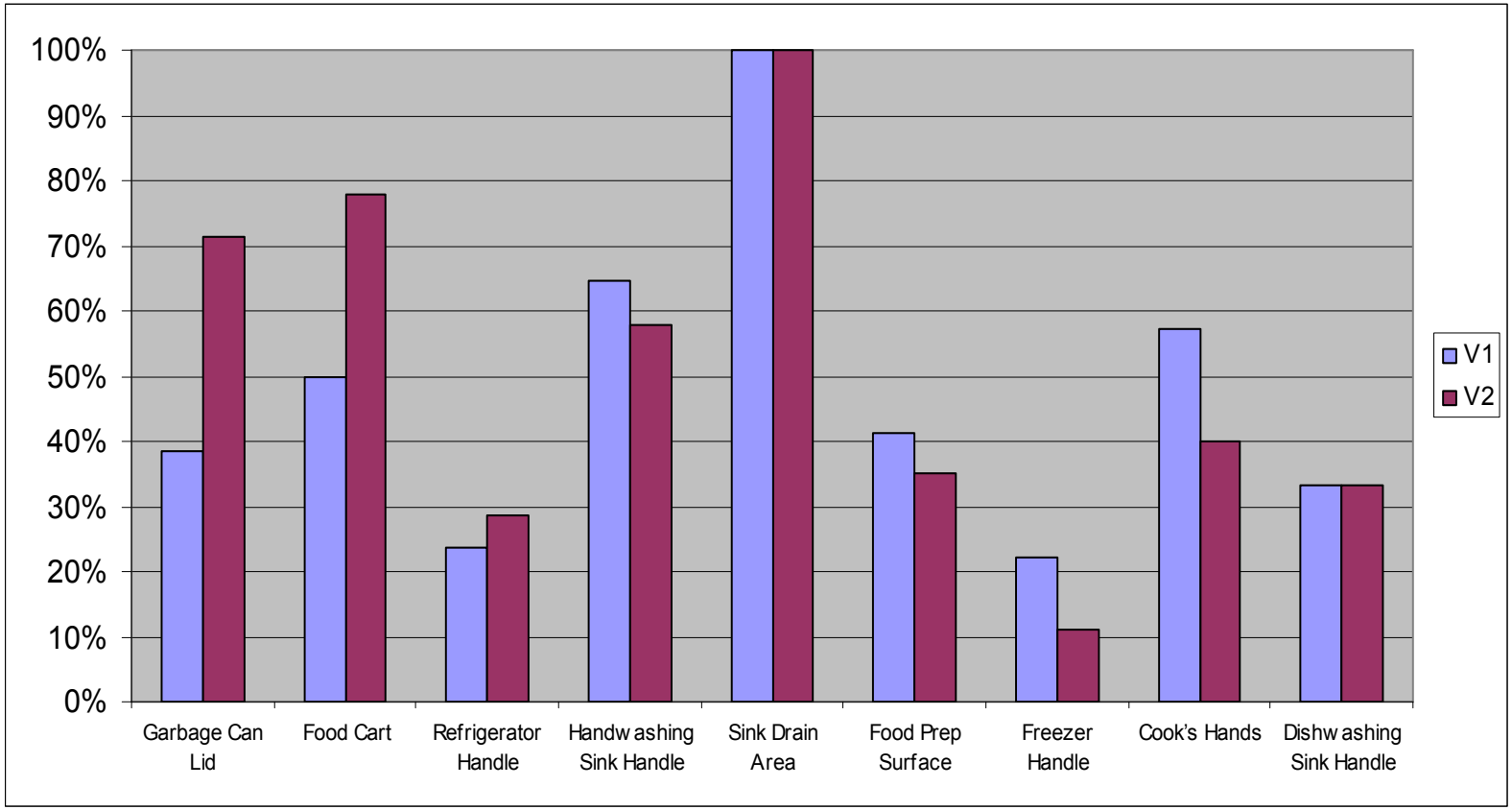

FIGURE 5.3 Percentage of swab samples testing positive for bacteria by foodservice surface location in 22 Texas childcare centers at V1 and V2.

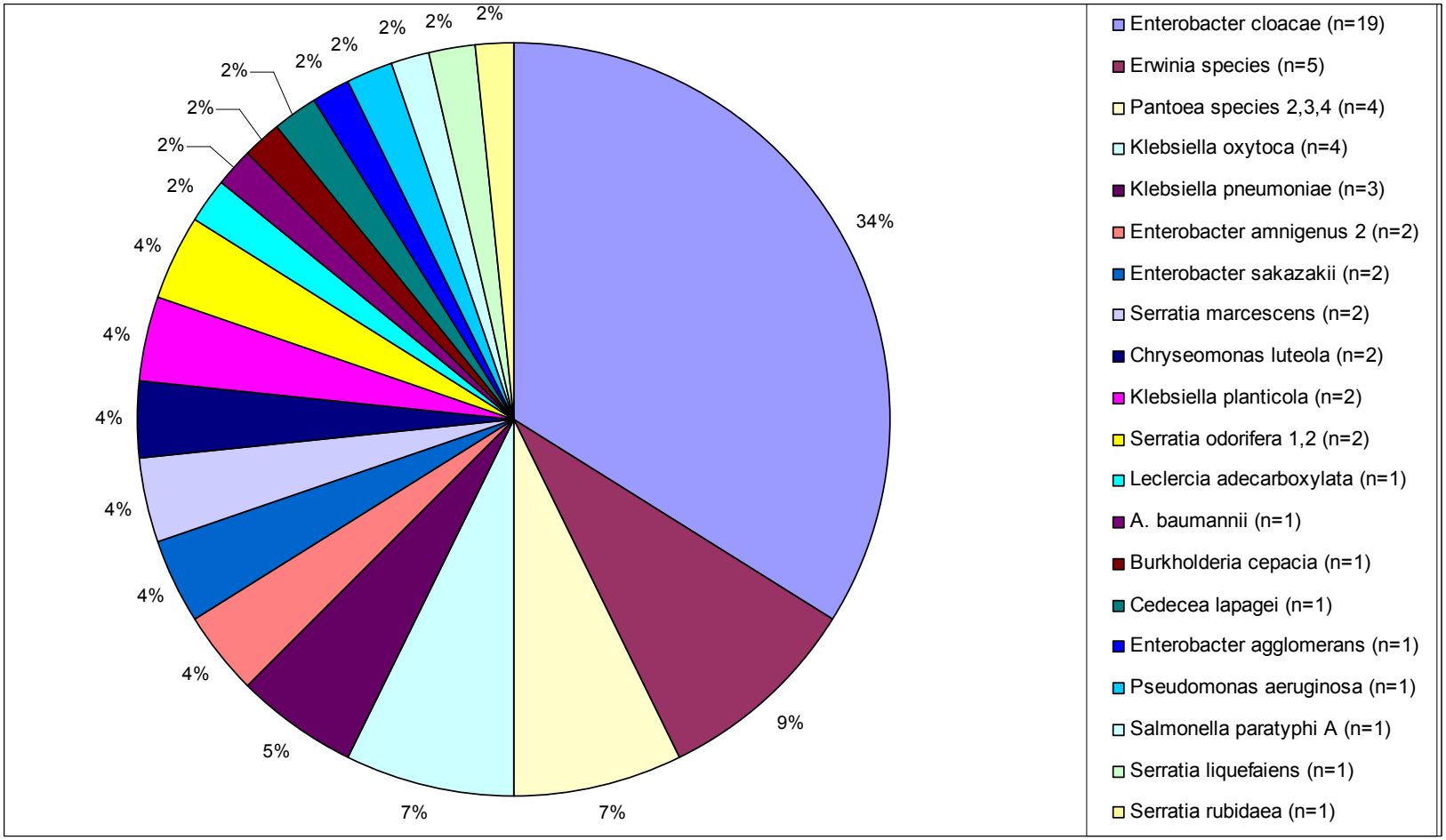

FIGURE 5.4 Visit 1 (V1) Bacterial species identified from the positive swab samples collected from foodservice surfaces in 22 Texas childcare centers. Multiple species of bacteria were isolated from two of the samples.

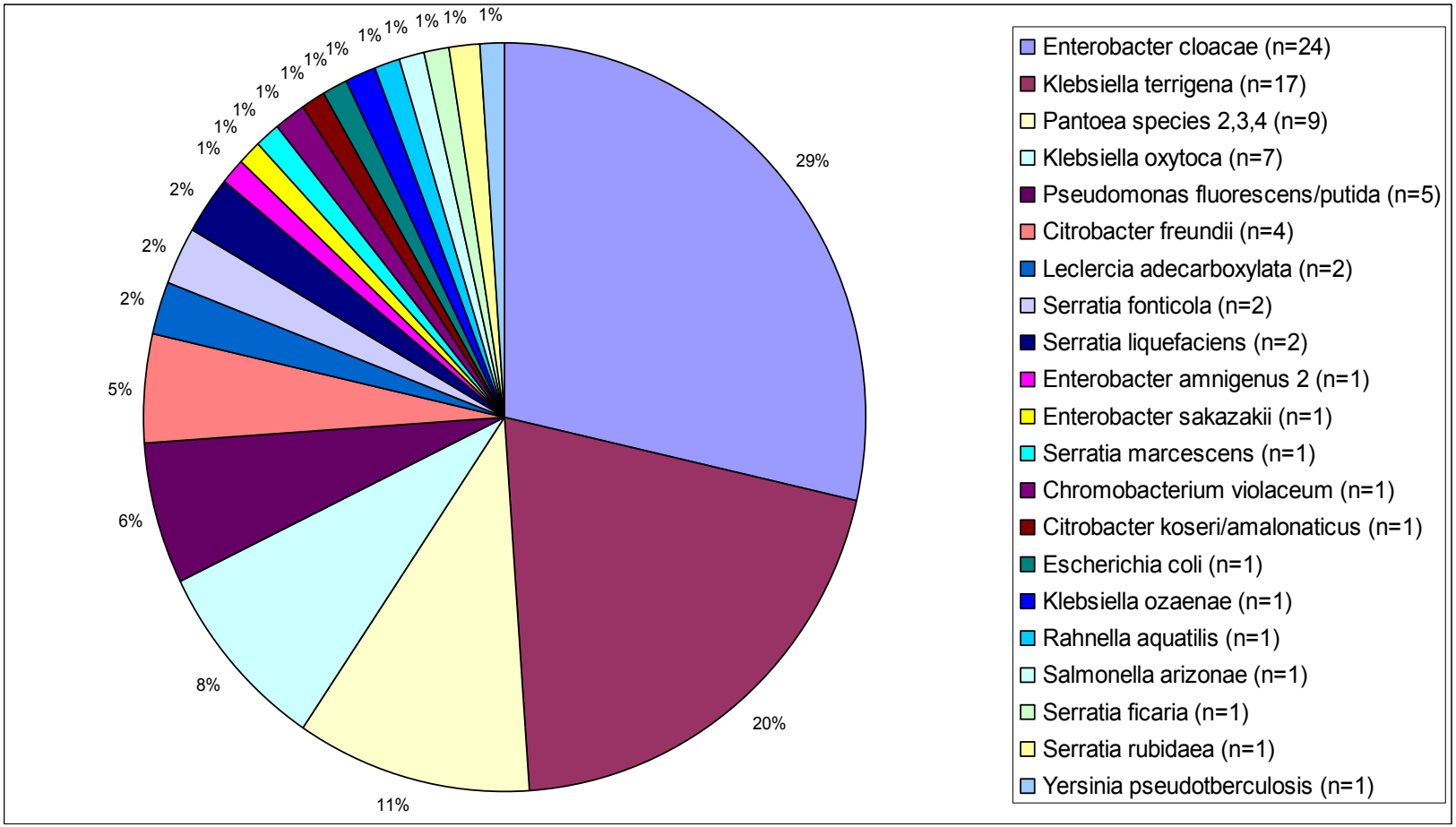

FIGURE 5.5 Visit 2 (V2) Bacterial species identified from the positive swab samples collected from foodservice surfaces in 22 Texas childcare centers. Multiple species of bacteria were isolated from seventeen of the samples.

Chapter 6: Conclusions and Recommendations

The objectives of this study were to: 1) assess the sanitation level of food contact surfaces and areas of potential cross-contamination by recovery and identification of selected enteric, gram-negative bacteria; 2) to evaluate food safety attitudes, knowledge, and behaviors of cooks in childcare centers; and 3) to evaluate the effect of a food safety training class on the microbial findings and the food safety behaviors of cooks.

A total of 36 childcare centers participated in visit 1 of this study. Between visits 1 (V1) and 2 (V2), four centers closed or changed ownership, reducing the final sample to 32 centers (89% retention). The results of this study show an overall lack of compliance with food safety standards in this sample of Texas childcare centers and a decline in sanitary conditions over a 12-month time period.

The results of this study expose the urgent need for changes in the current system of food safety training and certification of childcare center foodservice employees. Food safety standards for childcare centers must be standardized at a national level and easily accessible to those working in these centers. The food safety regulations established should be ones most likely to reduce the incidence of foodborne illnesses while requiring the least investment of resources as possible, such as frequent, proper handwashing; cooking foods to required temperatures; and proper holding temperatures. The regulations established must be regularly, consistently, and strictly enforced. Due to time and resource constraints, childcare staff may focus on completing tasks most often enforced by regulatory agencies, this is why childcare directors must also make it their mission to monitor and enforce strict food safety standards.

All persons in childcare centers handling food, whether regularly or occasionally should be required to have food safety training certification. The researchers suspect that participants may have learned the material to pass the certification exam but not apply the principles in their daily work activities. Researchers also suppose that more frequent, constant training is needed to reinforce best food safety practices.

Research shows that knowledge alone does not predict behavior. Employees must have the skills and confidence necessary to perform the behaviors. Foodservice employees must also understand the reasons for following food safety standards and the risks involved when preparing foods for a vulnerable population. The serious health risks to children from foodborne illnesses must be an essential part of the training. Education must be applicable to all types of food service establishments, since the needs of different establishment vary greatly. The regulations that are established by the state and local health authorities must be strictly regulated and enforced, yet be flexible enough to protect the population served by different types of establishments. Changes to the existing system are our only chance to protect children from the plague of evermore virulent foodborne illness-causing pathogens.

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